

STRUCTURAL SPECIFICATIONS INDEX

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03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Basic Specification: Perform work of this Section according to ACI 301-05, "Specifications for Structural Concrete," except as specifically modified herein. Numbers in parentheses (0.00) indicate a related paragraph of ACI 301.
- B. Section Includes: All cast-in-place concrete shown on the Drawings and required by these Specifications. Allow for the installation of cast-in-place items furnished under other Sections. Install anchor bolts for structural steel. Provide and install grout under steel column base plates and beam bearing areas.
- C. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.
- D. Provide concrete pads, piers, curbs, and bases required for equipment of all trades. Coordinate dimensions and details with requirements of equipment being supplied, prior to placing concrete.
- E. Coordinate the work of other trades who will provide and install items (sleeves, piping, conduit, inserts, etc.) to be cast in the concrete. Place no concrete until all such items are in place.
- F. Inspection and testing services required by this Section are to be performed by an agency retained by the Contractor. This includes not only the services required to establish mix designs, but also includes all field sampling and testing required by the Field Quality Control Article of this Section (1.6.2 through 1.6.4).
- G. Related Sections: Carefully examine all other Sections and all Drawings for related work, which includes but is not limited to:
 - 1. Section 05 12 00, "Structural Steel"
 - 2. Section 05 30 00, "Metal Decking"

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. ACI 117-06 Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI Detailing Manual, SP66(04).
 - 3. CRSI "Placing Reinforcing Bars," 2006, 8th edition.
 - 4. WRI "Manual of Standard Practice" July 2001, 6th edition.

1.03 SUBMITTALS

- A. Submit for approval the name of the agency proposed for the required inspection and testing services. All of the required field testing and sampling is to be performed by personnel employed by the proposed agency.
- B. Submit a mix design for each class of concrete required (1.6.3.2.e). Submittals to comply with appropriate methods listed in ACI 301-05 (4.2.3). Indicate whether mixes have been designed for pumping.
- C. Submit shop drawings for all reinforcing. Indicate strength, size, and details of all bar reinforcing, and style and specification of all welded wire fabric (3.1.1). Notwithstanding any other requirements specified elsewhere in these specifications, three (3) sets of prints and one (1) set of reproducible shop drawings shall be submitted for approval. The reproducible set will be returned to the Contractor, who will make and distribute as many copies as needed. Only prints with the approval stamp printed on them shall be permitted on the site.
- D. Submit, on request only, product literature for admixtures and curing compounds proposed for use.
- E. Submit reports of all required testing and inspection.
- F. Submit for approval proposed spacing and location of construction and/or control joints in concrete slabs on grade.

1.04 FIELD REFERENCE MANUALS

- A. Provide at least one (1) copy of the ACI Field Reference Manual, SP-15(05), and one (1) copy of CRSI's "Placing Reinforcing Bars," in the field office at all times (1.3.3).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cementitious Material (4.2.1.1):
 - 1. Portland Cement: ASTM C150-07, Type I, II, or III.
 - 2. Ground Granulated Blast-Furnace Slag (GGBF): ASTM C989-06, Grade 100 or higher. GGBF can be substituted for Portland cement up to a maximum of 30% by mass.
 - 3. Fly Ash or Pozzolans: ASTM C618-08, Class F. Maximum loss on ignition 3%.
- B. Water: Potable, conforming to C94/C94M-09 (4.2.1.3).
- C. Aggregates: ASTM C33-07. Use size No. 57 coarse aggregate, unless otherwise indicated (4.2.1.2).

- D. Admixtures (where required or permitted) (4.2.1.4):
1. Water-Reducing: ASTM C494/C494M-08a, Type A or D.
 2. Superplasticizer: ASTM C494/C494M-08a, Type F or G. Acceptable products include, but are not limited to:
 - a. Eucon 37 by Euclid Chemical Company.
 - b. Sikament 300 by Sika Corporation.
 - c. Rheobuild 1000 by Master Builders.
 - d. Daracem 19 by W.R. Grace.
 - e. ADVA Flow by W.R. Grace.
 - f. Catexol 1000 SP-MN by Axim.
 3. Superplasticizer (Polycarboxylates): ASTM C494/C494M-08a, Type A and F. Acceptable products include, but are not limited to:
 - a. Plastol 341 by Euclid Chemical Company.
 - b. ADVA 140M by W.R. Grace.
 - c. ViscoCrete 4100 by Sika.
 - d. Glenium 3030 NS by BASF.
 - e. Duraflux 33, 66 and 77 by Axim.
 4. Air-Entraining: ASTM C260-06.
 5. Accelerating: ASTM C494/C494M-08a, Type C or E, containing no more chlorides than are present in municipal drinking water. Acceptable products include, but are not limited to:
 - a. Accelguard 80 by Euclid.
 - b. Pozzutec 20 by BASF.
 - c. Plastocrete 161FL by Sika Corporation.
 - d. PolarSet by W.R. Grace.
 - e. Catexol 2000 R.H.E. by Axim.
 6. Calcium Chloride is NOT permitted (4.2.1.4).
 7. Synthetic Fiber Reinforcement: ASTM C1116/C1116M-08a. Acceptable products include, but are not limited to:
 - a. Nycon Nylon RC Fibers by Nycon
 - b. Nylo-Mono Nylon Fibers or Mighty-Mono Polypropylene Fibers by Forta
 - c. Fibermesh 150 Polypropylene Fibers by Propex
 - d. Polypropylene Fibers or Polypropylene Microfibers by Grace
 - e. Fiberstrand 150 or Fiberstrand 150 ML by Euclid
 - f. Fibrasol or Fibrasol IIP by Axim.
- E. Reinforcing Steel (3.2.1):
1. Deformed Bars: ASTM A615/A615M-08a, A996/A996M-06a, or A706/A706M-08a. Minimum yield strength to be 60 ksi.
 2. Welded Wire Fabric: ASTM A185-07. Provide in sheet form (not rolls) (3.2.1.6).
- F. Preformed Expansion Joint Filler: ASTM D1751-04(2008) (2.2.1.4).
- G. Curing Compound: Comply with ASTM C309-07, Type 1, Class B (clear). Compound shall comply with EPA's VOC requirements. Must be compatible with adhesive specified for floor finishes.

- H. Curing and Sealing Compound: Comply with ASTM C1315-08. Type I Class A (clear) compound shall comply with EPA's VOC requirements. Apply at the manufacturer's written recommended application rate. Must be compatible with adhesive specified for floor finishes.
- I. Grout for Masonry Core Fill: ASTM C476-08, coarse type or fine type, placed ACI 530.1-08, Table 5.
- J. Non-shrink Grout under Bearing Elements: Conform to Corps of Engineers Specification CRD-C621-83 and ASTM C1107/C1107M-08. Acceptable products include, but are not limited to:
1. Crystex by L & M Construction Chemicals, Inc.
 2. NS Grout and TammsgROUT Supreme by Euclid.
 3. SikagROUT 212 by Sika.
 4. Multipurpose Construction Grout by Dayton Superior.
 5. SureGrout by Kaufman Products.
 6. Kemset Grout by ChemMasters.
 7. Conspec 100 Non-Shrink Non-Metallic Grout by Dayton Superior.
- K. Dovetail Slots: Galvanized steel, 24 gauge, minimum.
- L. Bonding Agent: No thinner than 75 square feet per gallon. Acceptable products include, but are not limited to:
1. Euco #452 MV by Euclid.
 2. Sikadur 32 Hi-Mod by Sika.
 3. Sure-Poxy HM by Kaufman Products.
 4. Spec-Bond 100 by Dayton Superior
- M. Joint Sealant: Use 1-component polyurethane, conforming to ASTM C920-08, Type S, Grade NS, Class 25. Use with backer rod as required. Acceptable products include, but are not limited to:
1. Eucolastic I by Euclid.
 2. Sikaflex-1a by Sika.
 3. Dymonic by Tremco.
- N. Sealer: Clear membrane-forming compound which will not yellow. Must be formulated for the intended application, either interior or exterior and applied per the manufacturer's written recommendations. Must comply with EPA VOC requirements and be compatible with the curing compound used.
- O. Keyed Floor Slab Joints: Mill galvanized steel, 20 gauge minimum, with minimum key dimensions of 3/4 inch deep by 1 1/2 inches at its widest point. Acceptable products include, but are not limited to:
1. Tongue & Groove Joint 95 by Heckmann Building Products, Inc.
 2. G-33 Screed Key Joint by Dayton Superior
- P. Paper Curing Membranes conforming to ASTM C171-07:
1. Orange Label Sisel Kraft by Fortifiber, or
 2. Blue Shield 3560 by Holland.

- Q. Plate Dowels at Construction Joints: Smooth steel plate dowels, A36/A36M-08 steel. Acceptable products include, but are not limited to:
1. Greenstreak Speed Plate System by Greenstreak Group, Inc.
- R. Load Plate Baskets at Control Joints: Smooth steel plate bars, A36/A36M-08 steel. Acceptable products include, but are not limited to:
1. Greenstreak Speed Basket System by Greenstreak Group, Inc.

2.02 MIXES

- A. The following classes of concrete are required (4.2.2.8.b):
1. Class I – footings. Minimum $f'c=3000$ psi.
 2. Class II - interior slabs on grade, walls, and all interior concrete not otherwise identified. Minimum $f'c=4000$ psi; water-reducer required. Minimum cementitious content 517 lbs. per cubic yard. Maximum water-cementitious material ratio 0.45. All Class II concrete used for interior slabs on grade shall have synthetic fiber reinforcement unless shown otherwise on drawings.
 3. Class III - exterior slabs on grade, piers, walls and columns, and all exterior concrete not otherwise identified. Minimum $f'c=4000$ psi; air-entraining admixture and water-reducer required. Minimum cementitious content 564 lbs. per cubic yard. Maximum water-cementitious material ratio 0.45, air content $6 \pm 1, -1.5\%$ (4.2.2.4).
 4. Class IV - backfill below footings. Minimum $f'c=1500$ psi (lean mix).
- B. Pozzolans are permitted in all Classes.
- C. Class IV concrete may be site mixed; all other concrete is to be ready-mixed (4.3.1). All admixtures are to be added at the batch plant, except that superplasticizer, where used, is to be added at the site. Superplasticizer retarder can be added at the batch plant.
- D. Concrete used for floors (Class II) is to have a minimum three (3) day compressive strength of 1800 psi.
- E. Slump:
1. Design concrete mixes for a maximum slump of 4 inches, unless a superplasticizer is to be used.
 2. If a superplasticizer is to be used, design mixes for a slump of 2 inches - 4 inches before its addition; maximum slump permitted after its addition is 8 inches.
- F. Synthetic fiber reinforcement shall be used in strict accordance with the manufacturer's recommendations. Dosage rate shall be as recommended by the manufacturer, but not less than 1 lb. per cubic yard.
- G. No air entraining admixture is required unless an air content is specified (4.2.2.4).
- H. Concrete mixes shall not contain any deleterious or other reactive aggregates or materials that can initiate and promote alkali silica reaction (ASR).

PART 3 EXECUTION

3.01 ERECTION

- A. This structure is designed to be self-supporting and stable after the building is fully completed. It is solely the Contractor's responsibility to determine erection procedures and sequence, and to ensure the stability of the building and its component parts, and the adequacy of temporary or incomplete connections, during erection. This includes the addition of any shoring, sheeting, temporary guys, bracing or tie-downs that might be necessary. Such material is not shown on the Drawings. If applied, they shall be removed as conditions permit, and shall remain the Contractor's property.

3.02 SURFACE CONDITIONS

- A. Verify that excavations are free of water and ice, are of the required dimensions, and have been approved by the testing agency responsible for soils inspection, prior to placing concrete (5.3.1).
- B. Determine field conditions by actual measurement.
- C. Notify the Architect not less than 24 hours in advance of placing concrete. Place concrete only when the Architect is present, unless this requirement is specifically waived.
- D. Prior to application of sealer, remove any synthetic fiber reinforcement projecting above the top surface of slabs which remain exposed.

3.03 FORMWORK AND REINFORCING

- A. Footings may be cast against earth cuts when soil conditions permit (2.2.2.3).
- B. At the Contractor's option, welded wire fabric can be substituted for deformed bars if the welded wire fabric is engineered per ACI 318-05 and approved by the Engineer.
- C. Removal of Forms and Shoring:
 - 1. Remove no forms within first 24 hours after placement

3.04 EMBEDDED ITEMS

- A. Install embedded conduit, pipes, sleeves and anchor bolts subject to the following limitations:
 - 1. Do not embed aluminum without prior approval of coating material.
 - 2. Do not displace reinforcing steel.
 - 3. In slabs, limit outside dimension of conduits and pipes to 1/3 member thickness. Where conduits cross, maintain same minimum concrete cover as required for reinforcing bars
 - 4. Maintain a center-to-center spacing of at least 3 diameters of conduit, pipe or sleeve.
 - 5. Install anchor bolts for base plates of steel elements according to tolerances of AISC Code of Standard Practice for Steel Buildings and Bridges, March 18, 2005, Paragraph 7.5.

3.05 DELIVERY AND PLACEMENT

- A. Preparation Before Placement:
1. Remove all debris from forms.
 2. Do not use additives or salts to remove ice.
 3. In cold weather, maintain temperature of forms and reinforcing such that concrete temperature can be kept within the specified range.
- B. Delivery:
1. Conform to ASTM C94/C94M-09.
 2. ASTM C94 requires discharge within 1 1/2 hours or 300 revolutions, whichever occurs first, after the introduction of water to cement and aggregates, or the introduction of cement to the aggregates (4.3.2.2). The Architect may require an earlier discharge during hot weather or when high-early strength cement is being used.
 3. Place concrete at the maximum slump for which the mix was designed with a tolerance of up to 1 inch above the maximum for one (1) batch in any five (5) consecutive batches tested (4.3.2.1).
- C. Placement:
1. Place within 6 feet of final position. Spreading with vibrators is prohibited.
 2. In walls and columns, deposit concrete in uniform horizontal layers with a maximum depth of 5 feet.
 3. Maximum free fall without chutes or elephant trunks to be 5 feet.

3.06 JOINTING

- A. Interior Slabs on Grade:
1. Locate control and construction joints as shown on the Drawings. In the absence of information on Drawings, locate at openings, walls, columns, grid lines, inside corners and at 15 feet on center generally. Schedule slab placements and sawcutting operations such that sawing is completed prior to onset of shrinkage cracking (5.3.5). Complete saw cutting within 12 hours after placement.
 2. Provide isolation joints at columns (1/2 inch thick) and at walls (1/4 inch thick). Where isolation joint will be exposed to view, set top of joint filler below top of slab a distance equal to the filler thickness, to receive sealant. Where not exposed to view, set top of filler flush with top of slab.
 3. Where joints are exposed to view in the finished building, provide joint sealant.
 4. Construction joint plate dowels shall be installed to ensure vertical and horizontal alignment at mid-depth of slab.
 5. Control joint load plate baskets to be centered horizontally within plus or minus (+/-) 2" of the saw cut joint. Size 2" x 3/8" x 12" minimum placed at 24" on center unless noted otherwise on drawings.
- B. Exterior Slabs on Grade: Locate joints as shown on the Drawings. In the absence of information on the Drawings, provide the following:
1. Expansion Joints: Full depth, with 1/2 inch joint filler, where slabs abut vertical surfaces, at intersections of sidewalks, at abrupt changes in width, and at a spacing not exceeding 30 feet.
 2. Control Joints: Tooled, 7/8 inch deep, 4 feet to 6 feet on center between expansion joints.

3.07 FINISHES

- A. Schedule of finishes on flatwork is as follows:
1. Troweled finish: typical interior floor areas to receive adhesive-applied finish, or carpet, or to remain exposed (5.3.4.2.c).
 2. Floated finish: interior floor areas to receive finish in cementitious setting bed (5.3.4.2.b).
 3. Light broom finish. Truck bays.
 4. Broom finish: exterior slabs (5.3.4.2.d).
 5. Storage areas indicated on Drawings:
 - a. Hardener - per the manufacturer's instructions, under direction of the manufacturer's representative (5.3.4.2.e).

3.08 FINISHING TOLERANCES

- A. Conform to F-number requirements noted below and as described in ASTM E1155-96(2008) for all interior slabs (5.3.4.3.c):
1. Interior slabs on grade with fork lift traffic: F_F-50/F_L-30 minimum overall for composite of all measured values; F_F-30/F_L-20 minimum for any individual floor section.
 2. All other interior slabs on grade: F_F-25 minimum overall for composite of all measured values; F_F-18 minimum for any individual section.
- B. Take remedial measures if flatness and levelness testing indicates either of the following conditions exist:
1. The entire floor composite value, when installation is complete, measures less than either of the specified overall F-numbers.
 2. Any individual floor section measures less than either of the specified minimum section F-numbers.
- C. Individual floor sections for floor tolerance testing purposes shall be bound by the following that provide the smallest sections: construction joints, control joints, column lines and half-column lines.
- D. Obtain written approval of the Architect and Engineer for remedial measures proposed before implementing measures.
- E. All exterior slabs shall be finished to a 1/2 inch in 10 foot tolerance.

3.09 CURING AND PROTECTION

- A. Temperature:
1. When air temperature during placement is less than 40 degrees, or will be within 24 hours, temperature of concrete as placed is to be between 50 and 90 degrees F (55 and 90 degrees F for sections less than 12 inches thick). Maintain concrete temperature within these limits for the full curing period of seven days (or three (3) days for high-early-strength concrete) (4.2.2.7).
 2. The temperature of concrete as delivered shall not exceed 90 degrees F (4.2.2.7).

- B. Curing:
1. Interior slab areas which will receive finish in cementitious setting bed or to receive adhesive applied finishes are to be cured using paper curing membranes, without the use of a curing compound (5.3.6.4.a through 5.3.6.4.d).
 2. All other slab areas may be either moist-cured or receive an application of curing compound or cured using paper curing membranes (5.3.6.4.e).
 3. Whichever curing method is used, it is to commence immediately after disappearance of water sheen, and continue for at least seven (7) days. Cure high-early-strength concrete for a minimum of three (3) days (5.3.6.1). Do not allow curing to be delayed overnight.
 4. Prevent excessive moisture loss from formed surfaces (5.3.6.3). If forms are removed before seven (7) days have elapsed, cure the formed surfaces by moist-curing or application of curing compound for the remainder of the curing period.
 5. All exterior slabs are to receive an application of sealer prior to completion of construction.
 6. Interior slabs which remain exposed are to receive an application of sealer prior to the completion of construction.

3.10 GROUTING

- A. Grout below bearing plates, setting plates, and column base plates is to be installed only after the steel is plumbed. The use of leveling plates at column bases is prohibited.
- B. Install grout per the recommendations of the manufacturer.

3.11 FIELD QUALITY CONTROL

- A. Obtain concrete for required tests at point of placement (1.6.4.2).
- B. For each concrete class, perform one strength test for each 50 yards, or fraction thereof, placed in any one day (1.6.4.2.d and 1.6.4.2.e).
- C. Determine slump for each strength test (1.6.4.2.f).
- D. Determine air content for each strength test of air-entrained concrete (1.6.4.2.h).
- E. Determine concrete temperature for each strength test when air temperature is less than 40 degrees F or will be within 24 hours (1.6.4.2.g).
- F. Do not place concrete when slump, air content or temperature vary from allowable.
- G. Test interior floor slab finished surfaces for flatness and levelness in accordance with ASTM E1155-96(2008) (5.3.4.3.c).
- H. Individual floor sections for floor tolerance testing purposes shall be bound by the following that provide the smallest sections: construction joints, control joints, column lines and half-column lines.
- I. Each individual floor cast in a single day shall meet the composite flatness requirements.

- J. Floor tolerance tests shall typically be performed (and all defective areas identified) within 24 hours after slab placement and reported to all parties as soon as possible, but not later than 72 hours after installation. At areas cured with a paper curing membrane, floor tolerance tests shall be performed immediately following its removal. Shored elevated slabs shall be tested prior to removal of shoring.

- K. Visual inspections:
 - 1. Periodically inspect reinforcing steel for size, location and placement.
 - 2. Continuously inspect reinforcing to be welded.
 - 3. Continuously inspect anchor bolts cast into concrete.
 - 4. Periodically verify the use of the required design mix.
 - 5. Continuously inspect the placement of the concrete for proper techniques. Periodically inspect for maintenance of specified curing temperature and techniques.
 - 6. Periodically inspect concrete formwork for shape, location and dimensions of members.

- L. Maintain records of all tests, indicating exact location of the structure represented by each test.

END OF SECTION

05 12 00
STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: All labor and materials required to furnish and install the structural steel shown on the Drawings and required by these Specifications, including that shown on mechanical or electrical Drawings, or required in their Specification Sections.
- B. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.
- C. Related Sections: Carefully examine all other Sections and all Drawings for related work, which includes but is not limited to:
 - 1. Section 03 30 00, "Cast-in-Place Concrete"
 - 2. Section 05 30 00, "Metal Decking"
 - 3. Division 9 "Finish Painting"
- D. Work Furnished but Installed Under Other Sections: Anchor bolts, loose bearing and base plates, and loose lintels.
- E. Work Affected by Others: Framing, loads, openings, and structure in any way related to plumbing, HVAC, or electrical requirements is shown for bidding purposes only. Responsibility for coordinating the work of this Section with these requirements is solely that of the Contractor. Contractor's review of shop Drawings will be taken to indicate that this coordination has been accomplished.
- F. Inspection and testing required by this Section to be at the Contractor's expense.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. By the American Institute of Steel Construction (AISC):
 - a. Specification for Structural Steel Buildings (March 9, 2005).
 - b. Specification for Structural Joints using ASTM A325 or A490 bolts (June 30, 2004).
 - c. Code of Standard Practice for Steel Buildings and Bridges (March 18, 2005).
 - 2. By the American Welding Society (AWS):
 - a. Structural Welding Code – Steel AWS D1.1/D1.1M:2008, Paragraph 6.6.5 specifically excluded.
 - b. Symbols for Welding and Non-Destructive Testing AWS A2.4:2007.

- B. Fabricator's Qualifications:
 - 1. Minimum five (5) years' continuous experience in the fabrication of steel for projects of similar quality and scope.
 - 2. Certification Standard for Steel Building Structures (STD) in accordance with the American Institute of Steel Construction.
- C. Erector's Qualifications: Minimum five (5) years' continuous experience in similar steel erection.
- D. Welders' Qualifications: Personnel and procedures are to be qualified in accordance with AWS D1.1/D1.1M:2008.
- E. Inspection Agency's Qualifications: Minimum three (3) years' experience in similar steel inspection, and approval of the Architect.

1.03 SUBMITTALS

- A. Certification of Experience: Submit, on request only, written summary of personnel, projects, and equipment which document the experience and qualifications required of the fabricator, inspection agency, erector, and welders.
- B. Shop Drawings:
 - 1. Indicate all shop and erection details, including cuts, copes, connections, holes, threaded fasteners, and welds. Include layout plan of all items to be embedded into concrete.
 - 2. Indicate material specifications and finishes.
 - 3. Indicate shop and field welds with symbols per AWS A2.4:2007.
 - 4. Notwithstanding any other requirements specified elsewhere in these Specifications, three (3) sets of prints and one (1) set of reproducible shop Drawings shall be submitted for approval. The reproducible set will be returned to the Contractor, who will make and distribute as many copies as needed. Only prints with the approval stamp printed on them shall be permitted on the site.
- C. Proof of Compliance for Materials: Submit the following upon request only:
 - 1. Mill reports for properly identified material for:
 - a. Structural steel shapes.
 - b. High strength threaded fasteners.
- D. Inspection Reports: Submit reports for the inspection specified.

1.04 PRODUCT DELIVERY AND STORAGE

- A. Delivery:
 - 1. Comply with A6/A6M-08a. Non-compliance will be cause for rejection.
 - 2. Deliver anchor bolts and other items to be embedded in cast-in-place concrete or masonry prior to the start of that work. Provide setting drawings, templates, or instructions required for the installation of such items.
- B. Storage:
 - 1. Store steel at site above ground on platforms, skids or other supports.
 - 2. Protect steel from damage.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Steel Wide Flange Shapes:
 - 1. $F_y=50$ ksi Steel: ASTM A572/A572M-07 or ASTM A992/A992M-06a.
- B. Structural Steel Channels, Angles, Plates, Bars, Etc.:
 - 1. $F_y=36$ ksi Steel: ASTM A36/A36M-08.
- C. Structural Steel Tubing:
 - 1. $F_y=35$ ksi Round Tubing: ASTM A501-07, or ASTM A53/A53M-07, Grade B.
 - 2. $F_y=46$ ksi Square and Rectangular Tubing: ASTM A500/A500M-07, Grade B.
- D. Anchor Bolts, Standard Bolts and Nuts: ASTM A307-07b, or ASTM A36/A36M-08. Provide washers and heavy nuts for anchor bolts (both ends).
- E. High Strength Threaded Fasteners:
 - 1. Bolts: ASTM A325-07a, A325M-08, A490-08a or A490M-04ae1. All bolts are to be cold-forged with rolled threads.
 - 2. Nuts: ASTM A194/A194M-08b, Type 2 or 2H, or ASTM A563-07a or A563M-07, Type C, C3, D, DH, D3 or DH3. No other nuts are acceptable; nuts must show manufacturer's name and the 2H symbol.
 - 3. Washers: ASTM F436-07a or F436M-04.
- F. Welding Electrodes:
 - 1. For Carbon Steels: Conform to requirements of AWS D1.1/D1.1M:2008, using Series E70 electrodes, appropriate for the materials being welded.
- G. Shop Paint Primer:
 - 1. For bare steel, use modified alkyd or alkyd-oil primers, equal in quality to 10-99 Tnemec Primer, 10-99W Tnemec Primer, or 4-55 Versare Primer by Tnemec Company, Inc.
 - 2. For galvanized steel to be painted, use epoxy primer, equal in quality to Series 27 F.C. Typoxy by Tnemec Company, Inc.
 - 3. Primer to be compatible with finish paint.

2.02 FABRICATION

- A. Conform to applicable provisions of the reference standards listed in Part 1 of this Section, as modified herein.
- B. Connection Design:
 - 1. Select connections per AISC standards for the full uniform load capacity of the member.
 - 2. Connections of beams framing into a girder from one side only, such as at spandrel girders, shall be made with double angle connections. Unless indicated otherwise, all other connections may be double angle connections or single plate shear connections.
 - 3. Connection details on the Drawings are to illustrate location, type, and general arrangement only, and to establish minimum requirements.
 - 4. Shop connections may be welded or bolted, unless shown otherwise.

5. Field connections shall be bolted, unless shown otherwise.
 6. Standard bolts and nuts are permitted only for connections of secondary members, unless noted otherwise. High strength threaded fasteners are required for all other bolted connections.
- C. Sweep: Fabricate exterior spandrel beams with natural sweep toward the interior of the building.
- D. Finishing: Ends of members in direct contact bearing, such as columns at their bases and splices, are to be "finished," as defined in the Code of Standard Practice.
- E. Bearing and Base Plates: Column base plates are to be shop attached. Beam bearing plates may be attached or loose.
- F. Holes: Drill or punch holes in members as required for passage of conduit and piping, and attachment of joists, nailers, etc. Burning such holes is not permitted. If opening is not shown on structural Drawings, obtain prior approval.
- G. Shop Painting:
1. Shop-paint steel exposed to view in the finished structure, except that to be galvanized, with primer as follows:
 - a. Prepare surface by commercial blast cleaning (SSPC - SP6) and apply one (1) coat of primer.
 - b. Minimum dry film thickness shall be 2.0 mils. The primer shall be applied in a manner to assure no runs or sags in the coating and an overall uniform application.
 - c. Do not paint surfaces to be encased in concrete or to receive sprayed fireproofing, or contact surfaces in slip-critical connections, or surfaces to be field welded.
 2. Steel not exposed to view in the finished structure need not be painted, except columns and portions of beams other than lintels embedded in or built within exterior walls, which shall be painted with two (2) coats of primer per the requirements in #1 above, for a total dry film thickness of 4.0 mils.
 3. Paint all lintels in interior walls with one (1) coat of primer per the requirements in #1 above.
 4. See the Architectural Drawings and Section 09 90 00 for galvanized steel items to be painted. Prepare the galvanized surface of galvanized steel that is to be painted by solvent cleaning (SSPC-SP1) or by high-pressure detergent cleaning to remove soluble contaminants. Use SSPC-SP2 Hand Tool Cleaning or SSPC-SP3 Power Tool Cleaning to remove insoluble contaminants such as white rust, if present. Complete the cleaning process with SSPC-SP7 Brush Off Blast Cleaning, using the proper abrasive and care to prevent removal of the galvanizing. Prime paint with primer to be used for galvanized steel.
- H. Galvanizing:
1. Galvanizing is to conform to ASTM A123/A123M-08, Grade 100, or ASTM A153/A153M-05, Class C. Follow all recommendations of the American Galvanizers Association.
 2. Except for bolts, nuts, washers, and anchors, perform all galvanizing after fabrication.
 3. Prior to galvanizing, clean steel of foreign substances per ASTM A385-08.
 4. Do not treat galvanized finish with a stain-inhibiting chromate treatment.

5. After final erection, touch-up all abrasions with a cold galvanizing compound, Z.R.C. Cold Galvanizing Compound or Z.R.C Galuilite Galvanizing Repair by Z.R.C Worldwide, or equal.
6. Galvanize all shelf angles, lintels in exterior walls, all exterior steel exposed to the elements, and all items indicated on the Drawings as "galvanized."

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Prior to beginning work of this Section, verify that the installed work of other trades is complete and correct to the extent necessary for the proper execution of the work of this Section. This includes locations of anchor bolts, and lines and grades of bearing areas.
- B. In the event of discrepancies, immediately notify the Architect. Do not proceed with work affected by the discrepancies until they have been resolved.

3.02 ERECTION

- A. Conform to the applicable provisions of the reference standards listed in Part 1 of this Section, as modified herein.
- B. This structure is designed to be self-supporting and stable after the building is fully completed. It is solely the Contractor's responsibility to determine erection procedures and sequence, and to ensure the stability of the building and its component parts, and the adequacy of temporary or incomplete connections, during erection. This includes the addition of any shoring, sheeting, temporary guys, bracing or tie-downs that might be necessary. Such material is not shown on the Drawings. If applied, they shall be removed as conditions permit, and shall remain the Contractor's property.
- C. Safety: It is solely the Contractor's responsibility to follow all applicable safety codes and regulations governing this work.
- D. Clean bearing surfaces and other surfaces in permanent contact, prior to assembly.
- E. Field corrections of fabrication errors by gas cutting is not permitted in structural members without prior approval of the Architect.
- F. The use of leveling plates or leveling nuts at column bases is prohibited. Grout below column base plates is to be installed only after the steel is plumbed.
- G. Touch-up Painting: After erection, touch-up field connections and abrasions in the shop coat with same paint used for shop coat. Do not paint welds until they have been cleaned in accordance with AWS D1.1/D1.1M:2008.
- H. Remove galvanizing prior to welding. Touch-up with ZRC cold galvanizing compound by ZRC Products Company.

3.03 FIELD QUALITY CONTROL

- A. Inspection agency shall perform the following:
1. Review qualifications of welders, operators, and welding procedures submitted by the Contractor.
 2. Review materials' proofs of compliance. Identify markings of structural steel shapes to conform to ASTM standards specified. Review structural steel shapes certificates of compliance.
 3. Inspect bolted connections, per the requirements of the AISC Specification for Structural Joints. Periodically identify markings of bolts to conform to ASTM standards specified. Periodically inspect bearing type bolts. Continuously inspect slip-critical connections. Review bolt manufacturer's certificates of compliance.
 4. Inspect welded connections per the requirements of AWS D1.1/D1.1M:2008, Chapter 6. Identify markings of weld filler materials to conform to AWS specifications specified. Review weld filler materials certificates of compliance. Continuously inspect and test complete and partial penetration groove welds by other than visual methods. Continuously inspect and test multipass fillet welds using other than visual methods. Periodically inspect and test single pass fillet welds by visual methods.
 5. Inspect installation of stud welding, per the requirements of AWS D1.1/D1.1M:2008, Articles 7.7 and 7.8.
 6. Periodically inspect bracing and stiffening details of the steel frame for compliance with the construction documents.
 7. Periodically inspect member locations of the steel frame.
 8. Inspect the application of joint details at each connection for compliance with the construction documents.
- B. Inspection agency shall be directly responsible to the Architect.

3.04 ADDITIONAL TESTING

- A. The Owner reserves the right to perform non-destructive testing other than visual on any shop or field weld. The Owner shall be responsible for all associated costs including handling, surface preparation and non-destructive testing if welds are found to be acceptable, per AWS D1.1, Section 6, Part C. If the welds are not found to be acceptable the Contractor shall be responsible for the repair of discontinuities and all associated costs including those listed above.

END OF SECTION

05 30 00
METAL DECKING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: All labor and materials required to furnish and install metal decking and accessories including shear connectors, closures, hanger devices, edge filler plates, pour stops, sump pans, ridge and valley plates and end closure angles, where shown on the Drawings and/or required for a complete installation.
- B. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.
- C. Work Furnished but Installed Under Other Sections: Trench header duct, preset inserts, activation kits and other accessories required for electrified floor construction are to be furnished under this Section but installed as part of the work of Division 16.
- D. Related Sections: Carefully examine all other Sections and all Drawings for related work, which includes but is not limited to:
 - 1. Section 05 12 00, "Structural Steel"
- E. Inspection Agency shall be the same agency retained under Section 05 12 00, "Structural Steel."

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. North American Specification for the Design of Cold-Formed Steel Structural Members, 2007 Edition, by the American Iron and Steel Institute.
 - 2. Design Manual No. 31 for Composite Decks, Form Decks and Roof Decks, November 2007, by the Steel Deck Institute.
 - 3. Diaphragm Design Manual, Third Edition (DDM03) September 2004, by the Steel Deck Institute.
- B. Manufacturer's Qualifications: Regularly engaged in the manufacture of similar decking.
- C. Erector's Qualifications: Minimum five (5) years' experience in installation of similar decking.
- D. Welder's Qualifications: Personnel and procedures are to be qualified per the requirements of the American Welding Society, as given in AWS D1.3/D1.3M-2008.

1.03 SUBMITTALS

- A. Certification of Experience: Submit, on request only, written summary of personnel, projects, and equipment which document the experience and qualifications required of the manufacturer, erector, and welders.
- B. Shop Drawings:
 - 1. Indicate mark, number, type, finish, and location of all deck units.
 - 2. Indicate method of connection to supporting members. Provide literature from the fastener and/or deck manufacturers verifying compliance with the minimum required diaphragm shear strengths and stiffnesses.
 - 3. Indicate details and installation instructions for all accessories.
 - 4. Indicate sequence of installation, where critical.
 - 5. Notwithstanding any other requirements specified elsewhere in these Specifications, three (3) sets of prints and one (1) set of reproducible shop drawings shall be submitted for approval. The reproducible set will be returned to the Contractor, who will make and distribute as many copies as needed. Only prints with the approval stamp printed on them shall be permitted on the site.
- C. Manufacturer's Certification:
 - 1. Certify compliance with structural criteria. Published load tables and literature are usually acceptable. Provide design calculations on request only.
 - 2. Certify compliance with finish criteria, with test reports as required.
 - 3. Furnish evidence of listing by Underwriters' Laboratory for the specified fire resistance rating.
 - 4. Submit, on request only, mill test reports and certificates of compliance for shear connectors.
 - 5. Submit the manufacturer's certification of compliance with SDI Design Manual and AISI Specification.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Prevent damage to deck or finish during handling and storage.
- B. Store on blocking or platforms, off the ground, with one end elevated for drainage.
- C. Protect from rusting with waterproof covering, or storage under roof.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Typical Roof Deck:
 - 1. Type: 1 1/2 inches deep, 20 gauge minimum, wide rib.
 - 2. Finish: Galvanized.
 - 3. Acceptable products include, but are not limited to:
 - a. B30 or B36 by Epic Metals Corporation.
 - b. BW-36 by Wheeling Corrugating Company.
 - c. B-Dek by Consolidated Systems, Inc.
 - d. 1.5B by Vulcraft Division of Nucor Corp.
 - e. 1.5B by Cordeck Building Solutions.

2.02 MATERIALS AND FINISHES

- A. Materials: Steel sheet conforming to ASTM A653/A653M-08 or A1008/A1008M-08a.
- B. Finishes:
 - 1. Galvanized: Conform to ASTM A653/A653M-08, G60.
- C. Accessories: Same material and finish as deck units, except that interior closures may be of compressible material.
- D. Field Touch-Up Paint:
 - 1. For painted deck, use air-drying paint similar to shop coat.
 - 2. For galvanized deck, use zinc chromate paint.
- E. Welding Electrodes: Conform to requirements of AWS D1.3/D1.3M-2008 using Series E60 electrodes, appropriate for the materials being welded, with welding washers as required.
- F. Driven Fasteners: Manufactured from AISI 1061, 1062 or 1065 steel austempered to a minimum core hardness of 50-56 RC, and zinc-plated in accordance with ASTM B633-07 or ASTM B695-04 to a minimum thickness of 0.0002 inches. Acceptable manufacturers include, but are not limited to:
 - 1. Hilti Fastening Systems
 - 2. ITW Buildex
 - 3. Pneutek, Inc.
- G. Self-drilling Fasteners: Heat-treated and zinc-plated with fluted drill point. Acceptable products include, but are not limited to:
 - 1. Traxx screws by ITW Buildex.
 - 2. Kwik-Pro by Hilti Fastening Systems.

2.03 FABRICATION

- A. Units are to be continuous over at least three (3) spans, where possible. Where units are single or double span, use heavier gage if required for stress or deflection control. End laps (2 inches minimum) are to occur over supports.
- B. Units are to have nested side laps.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Prior to beginning work of this Section, verify that the installed work of other trades is complete and correct to the extent necessary for the proper execution of the work of this Section.
- B. In the event of discrepancies, immediately notify the Architect. Do not proceed with work affected by the discrepancies until they have been resolved.

3.02 ERECTION

- A. Install decking in accordance with approved placing Drawings.
- B. Tolerance: Align adjacent units within 1/4 inch in 40 feet.
- C. Connection to Supporting Members: Connect to supports from top side only. Powder- and pneumatically-driven fasteners are not permitted. Welds which burn holes in decking or supporting members will be rejected. Erector shall select the method of connecting the deck to the supports, including the connector type and spacing, and also the method of sidelap fastening, including the connector type and spacing, to provide the following minimum diaphragm shear strengths and stiffnesses, in accordance with the SDI Diaphragm Design Manual:

Deck Type	Shear Strength (plf)	Stiffness (k/in)
1 1/2 inch roof deck	300	21

Submit for approval the proposed method of connecting the deck and information verifying compliance with the above requirements. Additional minimum requirements for connections are as follows:

- 1. Roof Deck: Attach to resist a gross uplift of 30 lbs. per square. Connections shall occur at every other rib for 1 1/2 inch roof deck (12 inch spacing), except all side laps shall be connected to supports.
 - 2. Miscellaneous: Connection spacing shall be the same for all supports (both interior and end lap supports).
- D. Sidelap Fastening: Spacing shall not exceed 3 feet
 - E. Construction Loads: Do not use deck as storage or working platform until it has been permanently attached to supports. Assure that construction loads do not exceed the carrying capacity of the deck.
 - F. Repair and Touch-Up:
 - 1. Where deck will be exposed to view, remove and replace any units with damage or defects which cannot be concealed by painting.
 - 2. Where deck will not be exposed to view, repair any cuts and holes with plate of same gage as deck.
 - 3. Touch up all damaged areas of finish, on both top and bottom sides of deck.

3.03 FIELD QUALITY CONTROL

- A. Inspection shall include visual examination of deck and its attachment to the supporting structure, including quantity of connectors and/or fusion welds and the quality of the connections to the supporting structure.

END OF SECTION

MECHANICAL SPECIFICATIONS INDEX

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20 05 01
INTRODUCTORY STATEMENT

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. The requirements of Instructions to Bidders, General Conditions, and Division 1 apply to all work herein.
- B. In addition to conforming to the documents listed in Paragraph A above, the work performed by the Plumbing, Fire Protection, and Heating, Ventilating and Air Conditioning (HVAC) Contractors shall conform to all provisions of Sections 20 00 00 through 20 99 99 as included in this Specification. The Plumbing, Fire Protection, and Heating, Ventilating and Air Conditioning Contractors are each to consider the word "Contractor" when used in these Sections to mean themselves.
- C. All Plumbing, Fire Protection, and Heating, Ventilating and Air Conditioning Contractors must read the entire Specification and all divisions therein because they will be responsible for Work described in other Sections where reference is made to "Mechanical Contractor" or other commonly used terminology that implies the Plumbing Contractor, Fire Protection Contractor, or Heating, Ventilating and Air Conditioning Contractor.
- D. Plumbing Contractor shall provide temporary water, unless otherwise assigned in Division 1. Heating, Ventilating and Air Conditioning Contractor shall provide temporary heat, unless otherwise assigned in Division 1.
- E. All work included under this heading is subject to the Bidding Requirements, General Conditions, and Division 1 General Requirements written for this entire Specification, whether attached to this Part or not, and the Contractor is notified to refer thereto as an integral part of the work.

1.02 APPLICABLE SECTIONS

- A. Contractors shall perform work described in the preceding paragraphs, the General Conditions, Division 1 and in the following Sections (as included):
 - 1. Fire Protection: Sections 20 00 00 through 20 99 99
Sections 21 00 00 through 21 99 99
 - 2. Plumbing: Sections 20 00 00 through 20 99 99
Sections 22 00 00 through 22 99 99
 - 3. HVAC: Sections 20 00 00 through 20 99 99
Sections 23 00 00 through 23 99 99
- B. Contractors are required to coordinate their work with that described in other Sections, and therefore, must familiarize themselves with the entire set of Specifications.

1.03 RESPONSIBILITY

- A. The Engineer's efforts under this contract are aimed at designing a project that will be safe after full completion. The Engineer has no expertise in, and assumes no responsibility for, construction means and methods, nor job site safety during construction. These are exclusively the Contractor's responsibility. The Engineer may process or approve Contractor submitted means or methods that may contain information related to construction methods or safety issues. The Engineer may also participate in meetings where such issues might be discussed. Such processing or participation shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

END OF SECTION

20 05 05

PLUMBING, FIRE PROTECTION, AND HVAC GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish all materials, labor, tools, and equipment to complete and leave ready for operation all Fire Protection, Plumbing and Heating, Ventilating and Air Conditioning (HVAC) systems.
- B. By submitting a Bid, the Contractor certifies that:
 - 1. The Contractor has visited the site and is satisfied that he/she understands all site conditions that may affect his/her Bid price, with the sole exception of those items which he/she specifically is taking exception to in writing in his/her Bid.
 - 2. The Contractor fully understands the make-up, construction, and operation of all systems and equipment he/she is bidding on and has included in his/her price all materials, supplies, accessories, and services necessary to make these systems complete and operational, whether such materials, supplies, and services are explicitly shown on the Drawings or included in these Specifications or only implied by the clear intent of these Documents that the Contractor provide a complete and fully operational system as part of the scope of work undertaken by this Contractor.
- C. These General Requirements are in addition to the other requirements referenced elsewhere within these Specifications.

1.02 ENVIRONMENTAL GUIDELINES

- A. Comply with all Project Requirements in Division 01 for Construction Waste Management.
- B. Minimize the use of virgin materials and minimize waste during construction.
- C. Use low-VOC mastics and sealants.

1.03 STANDARDS OF QUALITY

- A. Provide quality work conforming to the best accepted practice and standards of the trade. Further definition of quality is given by reference to various laws, codes, standards, and regulations.
- B. All laws and codes having jurisdiction over this project are deemed to be included in their entirety as a part of these Specifications. Also, any other laws, codes, standards, or regulations referenced herein are deemed to be included in their entirety.
- C. If a conflict occurs between the Drawings, the Specifications, and the applicable codes, immediately call the conflict to the attention of the Architect before bids are submitted. The Architect will determine which interpretation shall take precedence. Conflicts not brought to the Architect's attention before bids are due shall be priced by the Contractor to include the most expensive, highest quality alternative.

- D. Material and equipment installed under this Contract shall be new, undeteriorated, and of a quality not less than the minimum specified. All equipment shall be certified, listed, and labeled by UL. If UL does not certify an associated piece of equipment, then certification by another nationally recognized testing laboratory such as CTL shall be permissible. If equipment is of a type that no testing lab lists nor labels, then a safety evaluation must be performed at the supplier's expense by the inspecting authority or another federal, state or municipal agency.
- E. The following codes apply to this work (as approved and amended by the Authority Having Jurisdiction including all applicable sections of interim agreements in effect at the time of permit issuance):
1. Local
 - a. Building Code
 - b. Fire Code
 2. State of Ohio
 - a. Ohio Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Boiler Code including ASME Boiler and Pressure Vessel Code Section I, "Power Boilers," and Section IV, "Heating Boilers"
 - f. Elevator Code
 - g. Pressure Piping Code
 - h. Fire Code
 3. National
 - a. National Fire Protection Association (NFPA) Codes as listed in subsequent Sections and Article 101
 - b. Power Piping ASME B31.1
 - c. Refrigeration Piping ASME B31.1
 - d. All applicable OSHA Requirements
 - e. All applicable EPA Requirements
- F. Work must be performed by licensed Contractors as required by Local and State Codes.
- G. Methods and materials must be certified where noted in the individual Specification Sections.
- H. All equipment and appliances must bear a tag or label of an Approved Testing Agency. Review Local Code requirements.
- I. Work must comply with City of Dayton, Ohio; Ohio Building, Mechanical, Plumbing, and Fire Codes. Unless otherwise noted, the latest enforced code edition shall apply to this work.
- J. All hardware, software, and firmware installed under this Contract, individually and in combination with each other, shall function free of any fault in processing dates and any information related to dates (including calculating, comparing and sequencing information or functions that depend on dates) through and beyond January 1, 2000. Such fault-free operation must not require any modification after the system is installed and shall be transparent to the user.

- K. If the hardware or software installed under this Contract interacts with any existing systems that do not already have this feature, this Contractor is to notify the Owner, in writing and in a timely manner, of the specific changes that the Owner must make to the existing systems to bring the combined system into compliance with this requirement.

1.04 CONTRACT DRAWINGS

- A. Drawings are schematic and show approximate locations and extent of work. Exact locations and extents must be coordinated with other Contractors and verified in the field. Coordination of the final fabrication drawings and final coordination of the installation in the field is the Contractor's responsibility. The Contractor is to take the design to the next level of detail, knowing exactly what equipment and materials he/she is going to provide, and build the project on the basis of that equipment and other approved Shop Drawings.
- B. The Drawings indicate required size and points of termination of pipes and ducts and suggests proper routes to conform to structure, avoid obstructions, and preserve clearances. However, it is not intended that Drawings indicate all necessary offsets, and the Contractor shall, without further instructions or additional cost to the Owner, make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear.
- C. When the work as indicated on the Contract Drawings exceeds the minimum required by any code, standard, requirement, rule or regulation, the Contract Drawings shall govern the design and installation of the work.
- D. Significant deviations from Drawings must be approved by the Architect.
- E. Up to the time of roughing in, the Architect reserves the right to make minor changes in location that do not require additional labor or material. No cost shall be added to the Contract for a minor change. The Architect shall determine what is a "significant" and what is a "minor" change.

1.05 ABBREVIATIONS AND SYMBOLS

- A. Listed below are titles and abbreviations used in the Specification. All may not necessarily apply to this work.
 - 1. AABC Associated Air Balance Council
 - 2. ADA Americans with Disabilities Act
 - 3. ADC Air Diffusion Council
 - 4. AGA American Gas Association
 - 5. AMCA Air Movement and Control Association
 - 6. ANSI American National Standards Institute
 - 7. ARI Air Conditioning and Refrigeration Institute
 - 8. ASA Acoustical Society of America
 - 9. ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers
 - 10. ASME American Society of Mechanical Engineers
 - 11. ASSE American Society of Sanitary Engineers
 - 12. ASTM American Society for Testing and Materials
 - 13. AWWA American Water Works Association
 - 14. BAS Building Automation System

15. CGA	Compressed Gas Association
16. CISPI	Cast Iron Soil Pipe Institute
17. EJMA	Expansion Joint Manufacturers Association, Inc.
18. EPA	Environmental Protection Agency
19. FM	Factory Mutual
20. HVAC	Heating, Ventilating, and Air Conditioning
21. MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
22. NEBB	National Environmental Balancing Bureau
23. NEC	National Electrical Code
24. NEMA	National Electrical Manufacturers Association
25. NFPA	National Fire Protection Association
26. NSF	National Sanitary Foundation
27. OAC	Ohio Administrative Code
28. OBC	Ohio Building Code
29. ODH	Ohio Department of Health
30. ODOE	Ohio Department of Energy
31. ODOT	Ohio Department of Transportation
32. OSHA	Occupational Safety and Health Administration
33. PDI	Plumbing and Drainage Institute
34. SMACNA	Sheet Metal and Air Conditioning Contractors National Association
35. TAB	Testing, Adjusting, and Balancing
36. UL	Underwriters' Laboratories

- B. The abbreviations are shown on Drawings. For further abbreviations, Contractor shall refer to the symbols list shown in the latest ASHRAE Fundamentals Handbook.

1.06 DEFINITIONS

- A. Applicable definitions as listed by Ohio Building Codes apply to this work.
- B. "The Authority Having Jurisdiction" shall refer to any duly authorized governmental body or public utility and/or their agents having jurisdiction over the work as provided under this Contract.
- C. "Concealed": Embedded in or installed behind walls, within partitions, above suspended ceilings, in trenches, in tunnels, below floor slabs, and within crawl spaces. Items within mechanical rooms are not considered "concealed."
- D. "Contractor": Means the Contractor whose scope of work is described within Divisions 20, 21, 22, or 23.
- E. "Ductwork": Duct and fittings, dampers, vanes, controls, hangers, bracing, insulation and other items required or necessary.
- F. "Exposed": Not installed underground or "concealed," as defined previously. In full view, all items within a mechanical room are considered "exposed."
- G. "Furnish": To purchase and deliver products to the project site and make ready for installation.

- H. "Install": To take furnished products, assemble, erect, secure, connect, and place into operation.
- I. "Piping": Pipe, fitting, flanges, valves, controls, specialties, hangers, concrete inserts, bracing, insulation, and other items required or necessary.
- J. "Products": Includes materials, systems, and equipment.
- K. "Provide": To furnish, erect, install, and connect to make completely ready for regular operation.
- L. "Work": The providing of products for entire Contract.

1.07 PERMITS, FEES, AND NOTICES

- A. Secure and pay for all permits and governmental fees, bonds, licenses, and inspections necessary for the proper execution and completion of the work. Refer also to specific permit requirements in other Sections of Divisions 20, 21, and 22 (as included) and in Division 1.
- B. Give notice and comply with all laws, ordinances, rules, regulations, and lawful orders of any public authority bearing on the performance of the work.
- C. The Plumbing, HVAC, and Fire Protection Contractors shall arrange for inspection of the work by the Code Authority having jurisdiction.
- D. If the Contractor performs any work knowing that work to be contrary to such Laws, Ordinances, Rules and Regulations, and without notice to the Architect, the Contractor shall assume full responsibility for and shall bear all costs associated with such work.

1.08 EXAMINATION OF SITE

- A. Certain existing conditions affect the manner or sequence of the work performance. Review existing services, structures, and operating schedules to facilitate installation of the Work. Coordinate scheduling of the work with existing operations.
- B. Visit the site of the proposed project and familiarize with all conditions which might affect the work. After the Contract is signed, no allowance will be made for lack of knowledge of project conditions.
- C. Prior to bidding the project, verify and reconcile work required by the Contract Documents with conditions at the Site.
- D. Should any discrepancies be noted during the Bidding Period, notify the Architect immediately, in writing, to permit the issuance of an addendum to prevent misunderstandings at a later date.

1.09 UTILITIES

- A. Prior to construction, locate any existing utilities within the project limits. Make minor relocations to permit installation of work. Advise the Architect immediately of major conflicts on a site plan layout to permit modifications of the Contract Documents, and submit to the Architect for review prior to any excavation. Where existing utilities conflict with new work, mark and identify proposed modifications on the site plan layout.
- B. Record locations of all concealed utilities on the Record Drawings.
- C. Coordinate any utility service shutdown or outages with the Architect and the Owner. Shutdowns shall conform to all utility company requirements. Avoid inconveniencing the Owner, and provide temporary service during the curtailment, as required by the Architect or Owner. Provide five (5) working days (minimum) advanced notice to the Owner for any required utility outages.
- D. At least two (2) working days prior to construction in an area in which underground utility facilities may be located, notify the Project Engineer, the registered utility protection service, and the Owner of each underground utility facility listed here:
 - 1. Utilities Protection Service
Phone: 1-800-362-2764
 - 2. Vectren Energy
Phone: 1-800-227-1376
 - 3. City of Dayton Water Department
Division of Water Engineering
Phone: 937-333-3725
 - 4. City of Dayton
Division of Sewer Maintenance
Phone: 937-333-4915

1.10 CONTRACTOR DESIGN/DETAILING

- A. The Contractor is required to include the design of component parts, subsystems, and installation details as required by the Specifications, as indicated on the Drawings, and as required for a complete and operating installation. This design work shall be done after all equipment manufacturers and material types have been selected from those allowed by the Specifications. If required by the Specifications, submit design calculations for review. Obtain the services of qualified personnel to perform this design and detailing. The Contractor's design and detailing does not relieve the Contractor from complying with the Contract Documents.

1.11 RECORD DRAWINGS

- A. Maintain at the job site one (1) copy of Drawings, which shall be used exclusively for recording the location of all installed work.
- B. Record deviations in locations of concealed piping, valves, all buried or concealed utility services (water, gas, fire, manholes, etc.), dimensioned from a fixed control point, including depth of bury at start of gas line, at each change of direction as required for further reference. Minor piping variations need not be recorded. Record Addendum and Change Order Items.

- C. Record deviations necessary to incorporate equipment different from the Design Base equipment.
- D. At completion of the project, deliver Record Drawings and Coordination Drawings to the Architect.
- E. Refer to Division 1, Section 01 74 01, "Execution Requirements," for additional requirements.

1.12 GUARANTEE

- A. Guarantee equipment, workmanship, and materials for one (1) year from date of Contract Completion. If defects develop within this guarantee period, and upon receiving written notice from the Architect or Owner, remedy the defects and reimburse the Owner for all damage to other work caused either by the defects or during the work of correcting the defects.
- B. Refer also to Division 1 and any individual Sections that define the starting date of the guarantee period or discuss either additional warranty requirements or extended warranties beyond the standard period.

1.13 COORDINATION

- A. Coordinate work carefully with the work of all other Contractors.
- B. Consult all contract documents that may affect the locations of any piping, and make minor adjustments in location to secure coordination.
- C. Before preceding, coordinate drilling, welding, etc., and method of attachment to columns, joists, beams, girders, etc., with Structural Engineer and General Trades Contractor.

1.14 TEMPORARY UTILITIES

- A. Refer to Division 1, General Requirements.

PART 2 PRODUCTS

2.01 DESIGN-BASE MANUFACTURERS

- A. The Drawings and Specifications are based on the requirements and layouts of the equipment of the Design-Base Manufacturers. Design of equipment has been coordinated with the building and other Trades for these specific models and manufacturers of equipment. Where several manufacturers are listed, the first named is the Design-Base Manufacturer, unless specifically noted otherwise. Submit for final approval products of the listed manufacturers that are of performance and quality comparable to the Design-Base Manufacturer's products.

- B. Where necessary, prepare new layouts to be used for other equipment listed. Adjust and coordinate the layouts with the equipment and service requirements and with Code-required working clearances that may have different dimensions or service requirements from the Design-Base Manufacturer's equipment. Verify that this equipment will fit and function in the indicated application and will coordinate with adjacent equipment for fit and clearances. Submit all new layouts as part of the shop drawing review.
- C. Whenever the Contractor furnishes equipment or material other than that of the Design-Base Manufacturer, he/she is responsible for the cost and coordination of all modifications required not only for his/her work, but also for the work of all other Trades affected. Where changes to other Trades' work are required, the Contractor furnishing the equipment or material must include the additional costs of all such changes in his/her Bid, arrange with these other Trades for the changes, and compensate them accordingly.

2.02 APPROVED EQUALS

- A. Equal (equivalent) components (articles, materials, forms of construction, equipment, fixtures, etc.) by manufacturers not listed but meeting the Specifications may be submitted to the Architect for approval and subsequent inclusion into the bidding documents. Submittal must be received no later than ten (10) working days before bid date. If approved, such manufacturers will be listed in an addendum.
- B. Submittals must include all of the following:
 - 1. Cover Letter: Company letterhead addressed to Architect. Indicate the following:
 - a. Project name, project building name, project number, and phase or bid package if applicable
 - b. Specification Section by number and title
 - c. Specified Product
 - d. Proposed Product
 - e. Deviations, if any, from Specified Product
 - f. List of attachments
 - 2. Product Data: Manufacturer's literature, fully describing proposed product with exact item highlighted or clearly indicated.
 - 3. Specifications: Manufacturer's Specifications with all modifications noted as required to show compliance with Bidding Documents.
 - 4. Test Data: Where performance requirements are specified, submit laboratory tests to indicate compliance.
 - 5. Samples: When required by Architect, submit appropriate samples of proposed product showing color, texture, construction and other attributes necessary for evaluation.
- C. If the Contractor fails to comply with all of the preceding requirements and fails to provide all of the requested information, the submittal will not be reviewed.

2.03 SUBSTITUTIONS

- A. Contractor may submit equipment and material substitutions of his/her choice, without prior approval, on the "Substitution Sheet" included in the Bid Schedule. Such substitutions will not form the basis of the award and may be considered only after selection of the lowest bidder furnishing "Standards" as specified.

2.04 MANUFACTURER'S DECLARATION

- A. Submit a list of the suppliers to be used on this project within thirty (30) days of award of contract. Type this list on company letterhead and include the project title. Include all equipment listed in Section 20 05 15, "Submittals." Adjacent to each Specification Section number and product description, list the manufacturer and catalog number/type.

2.05 QUANTITIES

- A. Equipment may be referred to either in these Specifications or on the Drawings, as singular or plural; Contractor is responsible for verifying the exact number of items required to complete his/her work.

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

- A. Unless otherwise required in the General Conditions and other Specification Sections, the Contractor shall include in his/her Bid the cost of all cutting and patching required for his/her work. Work must be accomplished in a neat and workmanlike manner that is acceptable to the Architect.
- B. If necessary to cut into the work of other Trades, the other Trades shall do the cutting in at this Contractor's expense. Patching shall be done in the same fashion.
- C. Cutting of structural support beams, joists, plates, precast, or other structural members is strictly prohibited without the specific written consent of the Architect and Structural Engineer. Use rotary drills where cutting holes through concrete, brick, plaster, or tile is necessary. Obtain approval of the Architect before proceeding with work.
- D. All cutting and patching shall be done promptly and all repairs shall be made as necessary to leave the entire work in good condition, including all cutting, fitting, and drilling of masonry, concrete, metal, wood, plaster, and other materials as specified or required for proper assembly, fabrication, installation, and completion of all work of the Contract.
- E. Patching shall match adjacent materials and shall be accomplished only by tradesmen skilled in the respective craft required. Materials and equipment used in the patching work shall comply with requirements of those Sections of the Specifications relating to material to be used in new construction. Contractor is not necessarily obliged to employ the General Trades Contractor to do patching. The HVAC, Plumbing, and Fire Protection Contractors shall incur all cost for cutting and patching necessary for their installation of their respective work.
- F. Patch to match adjacent surface construction. Exception: Portions of the existing floor slab shall be cut and removed by Contractor and replaced by the other Contractors is appropriate for the underfloor plumbing piping. Plumbing Contractor shall excavate and backfill for his/her own work.
- G. Refer to Division 1 and Division 2 for additional requirements.

3.02 PAINTING AND RELATED WORK

- A. Finish painting in areas of new construction and remodeled areas is the responsibility of the General Trades Contractor and is specified in Division 9.
- B. Any other painting required by Sections of Division 20, 21, 22, or 23 is the responsibility of the respective HVAC, Plumbing, or Fire Protection Contractors. Such painting shall be done by a qualified tradesman skilled in the craft and shall meet the requirements of Division 9. Each Contractor is responsible for repainting of finished areas disturbed by his/her own cutting and patching. Finishes shall match existing conditions.
- C. If factory-finished equipment has rusted or has been damaged, clean the equipment, spot prime it with zinc chromate, and finish it to the original quality and color.
- D. Clean HVAC, Plumbing, and Fire Protection support steel and bare ferrous metal, remove all rust, apply primer, and paint in accordance with Division 9 Specifications.
- E. Prime and finish all plywood mounting boards in accordance with Division 9 Specifications.

3.03 CLEANING

- A. Upon completion of work, thoroughly clean of dirt, stickers, grease, rust, oil and other foreign matter, all material, fixtures and equipment furnished in this Contract. Prepare for finish painting, where painting is specified.
- B. Clean galvanized piping and ductwork in exposed areas with diluted acetic acid.
- C. Clean copper piping in exposed areas with fine emery cloth and solvent.
- D. Clean all gauges, thermometers, traps, dirt legs, strainers and fittings.
- E. Clean all insulation coverings.
- F. Keep all areas as clean as possible during construction. Refer to Division 1 for additional requirements.

3.04 SCAFFOLDING, RIGGING, HOISTS, AND TRANSPORTATION

- A. The Contractor shall provide scaffolding, staging, cribbing, tackle, hoists, and rigging necessary for placing of his/her materials and equipment in their proper places in the Project.
- B. The Contractor shall pay costs for transportation of materials and equipment to the job site and shall include such costs in his/her proposal. The Contractor shall pay costs for storage of materials and equipment if space is not available at the site and shall include such costs in his/her proposal.
- C. Scaffolding and hoisting equipment shall comply with requirements of applicable Federal, State, and Local Laws and Codes.

3.05 TESTS

- A. The Contract Documents, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction may require portions of the work to be inspected, tested, or approved. These services shall be performed by approved agencies.
- B. The Architect must receive notification of all scheduled tests and adjustments at least 72 hours before they are scheduled so he/she may witness the tests and adjustments. If the Contractor performs any test or adjustment without the Architect present or without proper notification, the Contractor may be required to perform the test or adjustment a second time at the Contractor's expense. To minimize inconvenience, all test schedules shall be coordinated with the Owner.
- C. Secure required certifications of inspection, testing, or approval and include those in the Service Manuals. See Section 20 05 20, "Record and Information Booklets."
- D. Test and secure approval after the piping installation has been completed, but before the piping has been concealed and before the pipe covering has been applied. Each system shall be tested as required by other Sections of this Specification. The piping shall be free of leaks at the test pressure. If a leak appears, repair the line and any damage resulting from the leak at no additional cost to the Owner. The test shall be repeated until the system is proven to be free of leaks and properly anchored.
- E. Should any of the work be covered up or enclosed before all required inspections are completed and approvals obtained, uncover the work as required and, after the work has been completely inspected and approved, make all repairs and replacements, with such materials and workmanship as are necessary for the approval of the Architect. Do so at no additional cost to the Owner.

3.06 TESTING PROCEDURES

- A. Provide all tools, instruments, personnel, and equipment required to perform tests. Make all required temporary connections. Properly repair defects that develop under tests and repeat the tests. Do not caulk threaded joints, cracks, or holes. Repair leaks by tightening threaded joints or by replacing pipe, fittings, or equipment with new materials. Minor leaks in welded joints may be chipped out and rewelded.
- B. Perform hydrostatic and air tests before piping is concealed or covered. Completely drain all systems after hydrostatic tests are performed.
- C. Testing of service lines shall follow recommended practices. Remove all air from lines when testing with water pressure, to avoid false pressure readings.

3.07 INSPECTION

- A. Check each piece of equipment in the system for defects. Verify that all parts are properly furnished and installed, that all items function properly, and that all adjustments have been made.

3.08 PROTECTION

- A. Do not deliver equipment and material to the site until the work is ready to receive it, unless it can be protectively stored in a manner acceptable to the Architect.
- B. During construction, protect all equipment and materials during construction from damage by weather, water, dirt, paint droppings, welding and cutting spatters, and other construction activities.
- C. Elevate and protectively cover all materials or equipment stored outside.
- D. Store inside all materials and equipment sensitive to weather or construction conditions. Where necessary, store sensitive equipment in a heated area.
- E. During construction, cover all non-operating motors, bearings, and controls that are stored or installed in place.
- F. Refer also to individual Specification Sections for specialized protection.
- G. Immediately repair or replace damaged equipment or materials to the satisfaction of the Architect and at no additional cost to the Owner.
- H. Protect the building and other Contractor's material and equipment from damage caused by your work. Protect floors from cutting oil and chips.
- I. Use all means necessary to protect materials before, during, and after installation.

3.09 NOTIFICATION OF START-UP

- A. Notify the Architect of the start-up schedule for all equipment. The Architect shall then notify the Owner.

3.10 PROTECTION FOR PUBLIC AND EMPLOYEES

- A. Refer to Division 1, General Requirements.

3.11 TEMPORARY FIELD OFFICE AND MATERIALS STORAGE

- A. Refer to Division 1, General Requirements.

3.12 USE OF EXISTING FACILITIES

- A. Refer to Division 1, General Requirements.

3.13 DEMOLITION AND REMOVAL

- A. Refer to Division 1, General Requirements.

END OF SECTION

20 05 10
COORDINATION BETWEEN TRADES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Plumbing, Fire Protection, HVAC, and Electrical Contractors shall coordinate their rough-in, service, and control wiring requirements with each other. Electrical Contractor shall review all control Drawings to coordinate exact number of temperature control panels, as well as to provide proper starters (including necessary time delays, auxiliary contacts, etc.).
- B. Motors 1/2 horsepower or smaller shall be single phase; larger motors shall be 3 phase, unless otherwise noted.
- C. Equipment drawing 1,000 watts or more, before power factor correction, must have a power factor of 85% or greater at rated load conditions. Equipment with an operating power factor of less than 85% shall be corrected to at least 90% under rated load-operating conditions. The Contractor furnishing the equipment shall be responsible for power factor correction devices.
- D. The Electrical Contractor shall install all wiring required to power Plumbing, Fire Protection, or HVAC equipment, including 120 volt to control panels as shown. The Contractor furnishing the control device is responsible for all control and interlock wiring, regardless of voltage, except if the control device actuates or is actuated by the fire alarm control panel. The Electrical Contractor shall be responsible for this wiring from the fire alarm control panel to the control device. The Contractor providing a control panel shall extend control power for temperature control panels required, but not shown on the Drawings from the nearest available breaker to the control panel.
- E. Each Contractor furnishing motors is responsible for advising Electrical Contractor of the exact function of the systems to assure proper type of starter (including necessary time delays, etc.) with correct number of auxiliary contacts required for proper system operation. If motors that require larger starters, safety switches, circuit breakers, fuses, or branch circuit conductors than indicated are furnished, the Contractor furnishing the motors shall reimburse the Electrical Contractor for any cost differential.
- F. All electrical devices furnished as part of Plumbing, Fire Protection, and HVAC equipment, and the installation requirements for all electrical work included in the project, shall conform to all other applicable Sections of these Specifications.
- G. The Plumbing, Fire Protection, and HVAC Contractors shall be responsible for start-up, commissioning, and final operation of equipment provided under their respective contracts, and shall demonstrate the operation of all systems to the Owner. Provide the appropriate personnel for the checkout of the building life safety systems and for the life safety system demonstration to the Authorities having jurisdiction.

- H. Minimum acceptable motor efficiencies are tabulated here. Motors used in variable speed applications shall be rated in accordance with NEMA Revision 1, Part 31.40.4.2 with 1,600 volt insulation and meet the minimum tabulated efficiencies at full-rated RPM. See individual product specifications for performance of chiller drive motors and other assemblies that have an energy efficiency rating.

Typical Calculated Performance Data

Minimum Motor Efficiencies

Motor Horsepower	1200 RPM (Nom.)		1800 RPM (Nom.)		3600 RPM (Nom.)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
5	88.5	88.5	87.5	88.5	85.5	87.5
7.5	89.5	89.5	88.5	91.0	87.5	88.5
10	90.2	89.5	89.5	91.0	88.5	89.5
15	91.0	90.2	91.0	91.0	89.5	90.2
20	91.0	91.0	91.0	91.7	90.2	90.2
25	91.7	91.7	92.4	92.4	91.0	91.0

1.02 COORDINATION

- A. The Plumbing, Fire Protection, HVAC, and Electrical items are listed in the Coordination Schedule, with key letters and numbers to identify the responsibility of each Contractor. The following two (2) paragraphs describe the key numbers and letters.
- B. Combinations of Contractors doing the different parts of the work are identified as follows:
 1. To be furnished and installed by Plumbing, Fire Protection, or HVAC Contractor supplying the equipment.
 2. To be furnished and installed by Electrical Contractor.
 3. To be furnished by Plumbing, Fire Protection, or HVAC Contractor and installed by Electrical Contractor.
 4. To be furnished by Owner and installed by Plumbing, Fire Protection, or HVAC Contractor.
 5. To be furnished by Owner and installed by Electrical Contractor.
- C. The items to be furnished are identified by key letters as follows:
 - A - Disconnect
 - B - Line voltage starter
 - C - Reduced voltage starter
 - D - Combination disconnect starter
 - E - Factory pre-wired control panel with integral starter
 - F - Variable Frequency controller
 - G - Duplex outlet

1.03 COORDINATION SCHEDULE

ITEMS	A	B	C	D	E	F	G
Fire Protection:							
Jockey pump	2				1		
Fire pump					1		
Air compressor	2				1		
Plumbing:							
Water heater	2				1		
Recirculating pump	2	1					
Disposer	2				1		
Hot water dispenser	2						
Vacuum pump					1		
Oxygen manifold	2						
Electric water cooler	2						2
Water pressure booster pump					1		
Air compressor	2				1		
Sump pump/sewage ejector	2				1		
Water softener	2						
Automatic faucets	2						
Point-of-use electric water heaters	2						
Natural gas water heaters	2						
HVAC:							
Fan-powered terminal box	2	1					
Cabinet unit heater	1	1					
Exhaust fan	2	2					
Rooftop unit	2				1		
Rooftop exhaust fan	1	2					
	A	B	C	D	E	F	G

END OF SECTION

20 05 15
SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION

- A. For general requirements, refer to the GENERAL CONDITIONS and Division 1.
- B. Materials and equipment installed in this work shall meet all the requirements of the Contract Documents and no materials or equipment shall be ordered until submittals are reviewed and approved by the Contractor, Architect, and Engineer.
- C. Contractors assume all responsibility for changes required as a result of work performed, or equipment ordered, by the Contractor prior to submittal approval.
- D. Submit complete copies of the catalog data or Drawings for each manufactured item of equipment and each component to be used in the work as required in the table below. Catalog data shall include specific performance data, utility requirements, service area required, material description, rating, capacity, working pressure, dimensional data, material gauge or thickness, wiring diagrams, brand name, catalog number, and general type.
- E. Submittals reviewed by the Engineer shall not take precedence over the Contract Documents, and the Engineer's review shall not relieve the Contractor from the responsibility for complying with the Drawings or Specifications, nor from the responsibility for providing proper clearance and coordination with other Trades.
- F. When submitted for review, all shop Drawings shall bear the Contractor's certification that he/she has reviewed, checked, and approved the shop drawings, that they have been coordinated with the requirements of the project and the provisions of the Contract Documents, and that he/she has verified all field measurements and construction criteria, materials, catalog numbers, and similar data. Submittals without a Contractor's approval will not be reviewed and will be returned.
- G. Submittals shall include the complete package of equipment materials, piping, and insulation pertaining to that piece of equipment. A package of equipment requiring long lead times may be submitted earlier.
- H. The Engineer's review and approval does not extend to means, methods, manners, techniques, sequences, procedure of construction or to safety precautions or programs incident thereto. This is solely the Contractor's responsibility.
- I. Shop Drawings that are submitted, but are not required by the table below, will not be reviewed, and they will not be returned.
- J. Shop Drawings that are indicated to be provided for Record Purposes only will not be reviewed, and they will not be returned.

1.02 CONTRACTOR'S RESPONSIBILITIES

- A. Completely review and approve shop Drawings, product data, and samples prior to submittal.
- B. Determine and verify:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Catalog numbers and similar data
 - 4. Conformance with Specifications
 - 5. Quantities
- C. Coordinate each submittal with requirements of the work and the Contract Documents and other Trades.
- D. Notify the Architect in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents. The Contractor must boldly note all deviations on the submittal.
- E. Make submittals promptly in accordance with the approved schedule and in such sequence as to cause no delay in the work of the Contractor or any other Contractor.
- F. Correct or change and then resubmit rejected submittals as required until approved. The Contractor must clearly note all revisions on resubmitted submittals. Resubmittals without the revisions noted may be returned without review.
- G. Do not begin fabrication or work that requires submittals until approved submittals are returned.

1.03 CERTIFICATIONS

- A. Provide:
 - 1. Test Agency results verifying capacities, operating conditions and power requirements at design conditions. Test Agencies are to be hired by the Contractor at the Contractor's expense.
 - 2. Manufacturer's Statement of Compliance with Standards discussed in individual Specification Sections.
 - 3. Equipment labels indicating Certification requirements.
 - 4. Quality standard designations on each unit piece, for example, each pipe length, pressure vessel or valve.
 - 5. Typed verification that noted mixes, chemical compositions and testing procedures were complied with.
 - 6. Other Certifications listed in other Sections of the Specifications.

1.04 REQUIRED SUBMITTAL INFORMATION (ALSO REFER TO DIVISION 1)

- A. Submittal Transmittal
1. Provide the following information on the Transmittal Form for each submittal:
 - a. Project name
 - b. Specification number for each submittal item required in table below
 - c. Item description, as listed for each submittal item required in table below. Where equipment is identified by number or tag on the documents, use the same identification on the submittal.
 - d. Specification number and item description (b and c, preceding) for each submittal if more than one (1) submittal is sent under one (1) transmittal form.
 - e. Name, address, and telephone number of Contractor.
 - f. Bid package number.
 2. Submittal transmittal forms not properly identified with the preceding information will be returned (without review) to the Contractor.
- B. Shop Drawing Requirements
1. Shop Drawings – Provide catalog cuts, Drawings, warranties, motor efficiencies and power factor information (where applicable), wiring diagrams (where applicable), performance curves and characteristics. The total number of copies submitted will be as described in Division 1, but not less than seven (7) copies will be submitted. The submittals will be returned to the Contractor, who will make and distribute as many copies as needed. Only prints with the approved stamp printed on them shall be permitted on the site.
 2. Color Samples of the following items are to be provided:
 - a. Cabinet Unit Heaters
- C. Submit ductwork layout shop Drawings for record purposes only after coordination between all Contractors has occurred. Drawings shall be at 1/4 inch equals 1 foot scale and shall include duct, top and bottom elevations with enlarged sections and elevation plans as necessary. Coordinate size and location of ductwork with structure, piping, lighting, equipment, conduit, bus ducts, ceiling construction, and clear height above and other items that may present a potential conflict. These Drawings will not be reviewed or returned.
- D. Submit HVAC piping layout shop Drawings for record purposes only after coordination between all Contractors has occurred. Drawings to be a 1/4 inch equals 1 foot scale with enlarged sections and elevation plans as necessary. Identify all valve locations, as well as all piping and support elevations. Coordinate size and location of ductwork with structure, ductwork, lighting, equipment, conduit, bus ducts, ceiling construction, and Owner's desired clear headroom. These Drawings will not be reviewed or returned.
- E. Certain Fire Protection Shop Drawings listed in the table below are to be provided to the Engineer for record purposes only. The final approval for these systems is by the Authority Having Jurisdiction (AHJ). Provide these submittals to the AHJ for their approval prior to installing work. The Engineer will not review or return these Drawings.

F. Each Contractor shall submit information on the equipment items as listed in the following table. Identify each item with Specification numbers.

Section #	Item	Provide for Approval	Provide for Record Purposes Only
General Items for Plumbing, Fire Protection, and HVAC			
20 05 05	Suppliers and manufacturers list	X	
20 05 20	Record and information booklets	X	
20 05 35	Fire stops through floors and walls		X
20 05 40	Piping expansion, noise and vibration isolation	X	
20 05 45	Hangers, supports and inserts		X
20 05 61	Power factor correction		X
Fire Protection Contract Items			
20 05 99	Certificate for approval from state fire marshal		X
21 12 28	Fire valve cabinets	X	
21 13 13	Wet sprinkler piping system		X
Plumbing Contract Items			
22 11 23	Recirculating pumps	X	
22 33 13	Point-of-use electric water heaters	X	
22 33 38	Combination steam-fired electric water heaters	X	
22 34 36	Natural gas water heaters	X	
22 34 37	Gas-fired storage water heaters	X	
22 42 01	Plumbing fixtures	X	
22 61 19	Medical air compressors	X	
HVAC Contract Items			
23 05 93	HVAC systems balancing	X	
23 31 10	Low-velocity ductwork - Fabrication Drawings		X
23 31 11	High-velocity ductwork - Fabrication Drawings		X
23 34 17	Exhaust fans	X	
23 36 05	Terminal boxes	X	
23 37 13	Grilles, registers and diffusers	X	
23 37 23	Roof ventilators	X	
23 74 14	Rooftop air-conditioning units	X	
23 81 27	Ductless split system air conditioner	X	
23 82 20	DX fan coil units	X	
23 82 23	Unit ventilators	X	
23 82 29	Cabinet unit heaters	X	
23 83 34	Infrared heaters	X	

END OF SECTION

20 05 20
RECORD AND INFORMATION BOOKLETS

PART 1 GENERAL

1.01 DESCRIPTION

- A. See Division 1 for general requirements.
- B. Submit draft manual to the Architect for review and approval thirty (30) days before final inspection is due.
- C. After approval, submit two (2) copies of approved booklets to the Owner and obtain receipt. (See Section 20 05 99, "Requirements for Contract Completion.")

PART 2 PRODUCTS

2.01 MANUALS

- A. Manuals shall be loose leaf, three-ring, hardcover binders. Material shall be typewritten or printed (in English) and fully legible. Each section shall be divided by labeled tabs and organized by Specification number.
- B. The following items, together with any other necessary pertinent data, shall be included in each Record and Information Booklet:
 - 1. Each manual to be labeled on front cover with Project name, Contract, Contractor's name, Architect's name, Engineer's name, and date of Project Completion.
 - 2. Manufacturers' names, nearest factory representative (including postal and e-mail address, telephone and fax number), and model and serial numbers of components of systems.
 - 3. Name, postal and e-mail address, telephone and fax number of contact persons handling warranty work and issues.
 - 4. Operating instructions, including start-up and shut-down procedures.
 - 5. Maintenance and lubrication instructions, including routine and emergency service information and instructions.
 - 6. Parts list with numbers of replaceable items (such as couplings and packings). Include sources of supply, with postal and e-mail address, telephone and fax number.
 - 7. One (1) approved copy of each shop Drawing submitted.
 - 8. Temperature control diagrams.
 - 9. Valve charts.
 - 10. Written warranties.
 - 11. Belt sizes, types, and lengths.
 - 12. Wiring diagrams, as actually wired.
 - 13. Testing and balancing reports.
 - 14. Copy of Owner's statement concerning completion of instruction period (see Section 20 05 99, "Requirements for Contract Completion").
 - 15. Routine and 24-hour emergency service and repair information:
 - a. Name, post and e-mail address and telephone and fax number of servicing agencies - routine and emergency.
 - b. Names of personnel to be contacted for service arrangements - routine and emergency.

END OF SECTION

20 05 25

EXCAVATION, BACKFILL, AND PROTECTION OF UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide all protection, removal, and relocation of existing utilities and all excavation and backfilling (including concrete) associated with the work of this Division. Protect above grade and below grade utilities that are to remain.
- B. Locate all existing utilities and equipment, in all areas of work, and record the actual locations. Take extreme care during excavations to avoid interruption of utilities. Protect above grade and below grade utilities that are to remain.
- C. Disconnect all utilities designated for removal or relocation, in conformance with the requirements of the utility company and the Owner.
- D. Cooperate with other Contractors and the utility company to protect existing utilities and avoid disruption of service. Repair damaged utilities.
- E. Restore or repair to their existing condition all lawns, planting areas, curbs, paving, streets, and walks damaged by the work of this Division.
- F. Coordinate the timing of excavation and backfilling with the work of other Contractors.
- G. Protect plant life, lawns, and other features remaining as a portion of final landscaping. Coordinate with General Trades Contractor.
- H. Protect benchmarks, existing structures, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.
- I. In general, conform to the requirements of Division 2, except as specifically modified in this Section.

1.02 EXCAVATION

- A. Excavations are to be open cuts from the surface. Undercuts are prohibited.
- B. Maintain 5 feet clear between trench and parallel building footing. When parallel trenches are required to be deeper than the footing, maintain a clear distance at least 1 1/2 times the vertical distance below the bottom of the footing or 5 feet, whichever is greater.
- C. Where necessary, keep excavations free of standing water by drainage or pumping.
- D. Keep excavations free of frost by covering, heating, or both.
- E. If soil at planned elevation is found unsuitable for support of sewers, manholes, mechanical equipment, and materials, make provisions for proper support, and Contract price will be adjusted accordingly.

- F. To prevent surface water from draining into excavation, grade top perimeter of excavation.
- G. Hand trim excavation. Remove loose matter.
- H. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measure by volume.
- I. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- J. Correct areas over excavated by error.

1.03 EXCAVATION SAFETY

- A. The Contractor has the responsibility to comply with all governing Codes and Ordinances regarding safety of open excavations. This responsibility includes the use of all sheet piling, bracing, shoring, sheathing, warning lights, barricades, etc., that may be required. Such material will remain the Contractor's property upon completion of the work.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Granular Material: Material shall consist of natural or synthetic mineral aggregate such as broken or crushed rock, gravel, or sand; graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
2 1/2 inches	100
1 inch	70 to 100
No. 4	25 to 100
No. 40	5 to 50
No. 200	0 to 10

ODOT #310.

- B. Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ANSI/ASTM C136, to the following:
 - 1. Minimum Size: 1/4 inch.
 - 2. Maximum Size: 5/8 inch.

- C. Sand: Natural river or bank sand; washed: free of silt, clay, loam, friable or soluble materials, or organic matter graded in accordance with ANSI/ASTM C136, within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 14	10 to 100
No. 50	5 to 90
No. 100	4 to 30
No. 200	0

- D. Subsoil: Reused, select onsite or borrow soil materials conforming to the following:
 1. ASTM D2487 Soil Classification Groups GW, GC, GM, SW, SC, SM, CL, and ML.
 2. Less than 3% organic material by weight.
 3. Free of unstable or unsuitable material or construction debris.
- E. Coarse Material: Coarse aggregate, washed gravel, carbonate stone, graded within the following limits.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 inches	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

ODOT #57

- F. Concrete: Structural concrete conforming to Section 03 30 00 with a compressive strength of 1500 psi.
- G. Drainage Fill: #8 Stone – ODOT #703.
- H. Crushed Stone or Crushed Gravel: The aggregate shall be crushed carbonate stone or crushed gravel, graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Total Percent Passing</u>
2 inch (50 mm)	100
1 inch (25.0 mm)	70-100
3/4 inch (19.0 mm)	50-90
No. 4 (4.75 mm)	30-60
No. 30 (600 µm)	9-33
No. 200 (75 µm)	0-13

Prior to placing, aggregate shall have a reasonably uniform moisture content at or near optimum for compaction.

ODOT #304

2.02 BEDDING AND BACKFILL

- A. Bedding Materials:
 1. Coarse Material (ODOT #57) - round/not crushed
 2. Drainage Fill (ODOT #703) - round/not crushed
 3. Pea Gravel
 4. Sand

- B. Backfill Materials:
1. Below Floor Slabs: Coarse Material (ODOT #57), Drainage Fill (ODOT #73), Pea Gravel, Crushed Stone or Gravel (ODOT #304) and Granular Material (ODOT #310) compacted to 100% standard Proctor Density (ASTM D698-91).
 2. Below Asphalt, Concrete or Plazas: Crushed Stone or Gravel (ODOT #304) and Granular Material (ODOT #310) compacted to 98% standard Proctor density (ASTM D698-91).
 3. Lawn Areas: Suitable native material compacted to 95% standard Proctor density (ASTM D698-91).
- C. Prohibited Materials: Backfill may not contain large rocks (over 2 inches), building materials, masonry debris, cinders, rubbish, wood or other material subject to decay, or material prone to damage buried portions of the work. The use of grits for backfill is prohibited.

PART 3 EXECUTION

3.01 BACKFILL

- A. Where unstable or wet soil in trench bottom requires over excavation to firm soil, and in areas of accidental undercutting, backfill to planned bottom elevation with crushed stone, tamped firmly in place.
- B. Backfill only when exact locations of lines and equipment have been recorded and all tests and inspections have been completed.
- C. Do not use fill that is frozen or place fill on frozen ground.
- D. Allow and pay for compaction control testing by the Soils Engineer retained under Division 2.
- E. During backfilling operation, install a continuous 6 inch wide vinyl plastic tape with printing identifying buried service, 12 inches below finished grade.
- F. In trenches below footings or walls, provide concrete encasement for full width and height of trench, extending 1 foot beyond each edge of footing or walls.
- G. Where top of pipe is within 24 inches of driving or parking surface, provide concrete encasement in pipe trenches. Top of encasement to be minimum 12 inches above top of pipe.
- H. For all lines below slabs on grade within building, all sanitary and storm lines outside building, all lines accidentally or intentionally undercut, and in other locations as may be required by governing Codes (except where concrete encasement is required), provide pipe bedding of pea gravel or coarse sand, 4 inches below pipe and 12 inches above pipe.
- I. To impede natural flow of groundwater, provide clay bulkheads (of native materials), minimum 3 feet long, across full width of pipe trenches at 100 foot intervals. Extend bulkheads to 12 inches above top of pipe.

- J. Provide washed gravel backfill in trenches containing concrete encased underground ducts. Top of gravel 6 inches minimum above top of duct.
- K. Provide manufacturer recommended backfill around underground sumps, interceptors, meter pits, catch basins, and tanks.

END OF SECTION

20 05 30
CONCRETE BASES AND SUPPORTS

PART 1 GENERAL

1.01 CONCRETE WORK

- A. Provide all concrete bases required for equipment supplied under this Division. Coordinate all pertinent dimensions, details, and cast-in-place items with the equipment being supplied.
- B. All other concrete work incidental to the work of this Division is the responsibility of this Division's Contractor. Conform to the quality standards in Division 3. Such concrete includes but is not limited to:
 - 1. Backfill in trenches, where required to be concrete
 - 2. Pipe or duct encasement, thrust blocks, and similar concealed work
 - 3. Manholes, interceptors, catch basins, or other underground structures
- C. Do not mount equipment on concrete supports until concrete has had sufficient setting time (seven (7) days minimum).

1.02 SUPPORT STEEL

- A. In general, all hangers, concrete anchor bolts, brackets, and other steel supports incidental to the work of this Division are to be provided by this Division's Contractor. Conform to the quality standards in Division 5. Only major support framing shown on the structural Drawings is to be provided by the others. For the proper execution of this work, provide all pertinent dimensions, details, and weights to those others.

PART 2 PRODUCTS

2.01 PREFABRICATED ROOF CURBS

- A. Construction: Minimum 18 gauge galvanized steel, continuous welded seams, mitered corners, pressure treated wood nailer strip, 12 inches minimum height above finished roof elevation, and counterflashing with lag screws. Where curb is used for equipment support, provide integral base plates and internal reinforcing as required to support equipment load. Where curb is around a roof penetration, provide 1 1/2 inch thick, 3 lb. density rigid fiberglass insulation. Provide pitched roof curb as required to keep equipment level.
- B. Manufacturers: Pate Company, Louvers & Dampers, Inc., Vent Products Company, Swarthout, Inc., Shipman Industries, or Thy-Curb.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Other Contractors, as appropriate, shall provide roof openings and installation of roof curbs.

- B. The HVAC Contractor shall coordinate the size and location of all roof curbs.
- C. Provide weathertight curb caps if equipment cannot be set immediately.
- D. Install thrust blocks at least 72 hours before testing the water lines.

END OF SECTION

20 05 35
SLEEVES, SEALS AND FIRESTOPS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish sleeves for pipe and duct penetrations through precast concrete, masonry, and concrete construction or where piping or ductwork passes through walls, through smoke-rated or fire-rated separations, and equipment room walls and floors.
- B. Provide watertight and fire rated seals and firestops as specified herein.
- C. Use sleeving with absolutely watertight seal for piping passing through all foundation walls, floor slabs on grade, and other below grade penetrations into building.
- D. Provide dimensions and locations of openings for sleeves, piping, ducts, louvers, grilles, and similar items to the Contractor requiring the information.
- E. Carefully coordinate and check locations of sleeves immediately before and after each concrete pour and masonry installation.
- F. Provide approved firestop materials around all penetrations through fire-rated construction walls and floors per ASTM E814 and ASTM E119, including but not limited to pipes, ducts, drains, closet flanges, conduits, and raceways.
- G. At no additional cost to the Owner, correct unacceptable seals and firestops, and provide additional inspection as necessary to verify compliance with this Specification.

1.02 QUALITY ASSURANCE

- A. Firestop materials shall be classified by UL as "fill, void, or cavity materials" and "through penetration firestop systems."
- B. Firestop materials shall conform to both Flame (F) and Temperature (T) ratings as tested by nationally accepted test agencies per ASTM E814 or UL 1479 Fire Tests of Through-Penetration Firestops.
 - 1. The F rating shall be a minimum of one (1) hour but not less than the fire-resistance rating of the assembly being penetrated.
 - 2. Conduct the fire test with a minimum positive pressure differential of 0.01 inches of water column.
- C. Firestop materials and equipment used shall be in accordance with the manufacturer's written installation instructions. Installer shall be experienced, certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. Note that a manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

- D. Firestop materials shall be expanded to fill cavities or provide adhesion to substrates that will maintain seal under normal expected movements of substrates.
- E. For those firestop applications that exist for which no UL-tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment Drawings must follow requirements set forth by the International Firestop Council.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 20 05 15, "Submittals":
 - 1. Manufacturer's product data sheets indicating product characteristics, performance, and limiting criteria.
 - 2. Manufacturer's installation instruction for each type of seal or firestop required by the project.
 - 3. Written certification that firestop systems meet firestop requirements specified herein.
- B. To be included in Record and Information Booklets:
 - 1. One (1) copy of each approved submittal.

1.04 MANUFACTURERS

- A. Seals:
 - 1. "Link-Seal" by Thunderline Corporation
 - 2. CSD Sealing Systems
 - 3. Calpico
 - 4. Wayne
 - 5. Michigan
 - 6. Metraflex
- B. Firestop materials:
 - 1. Hilti
 - 2. 3M
 - 3. CSD Sealing Systems
 - 4. Johns-Manville
 - 5. Tremco
 - 6. Rectorseal
 - 7. Proset Systems
 - 8. Nelson
 - 9. Firestop "Flame Safe"
 - 10. STI

PART 2 PRODUCTS

2.01 SLEEVE MATERIAL

- A. For sleeves less than 8 inches in diameter, use machine cut, standard weight, black steel pipe. Fabricate sleeves 8 inches in diameter and larger from 12 gauge galvanized steel sheet.
- B. Use copper sleeves for bare copper piping.
- C. Sleeves to be large enough for insulation to be continuous or for seals to be installed, but clearance all around to be less than 1/4 inch for both insulated and uninsulated pipes that penetrate walls and slabs.
- D. Proset system prefabricated fire-rated sleeves may be installed as an option for poured-in-place concrete or through cored holes in floors or masonry walls.
- E. Provide with waterstop anchor flange at midpoint where penetrating below grade floor slab or exterior structure at or below grade. Sleeves shall have a full-length welded intermediate flange and be imbedded in masonry. The Contractor may provide steel wall sleeves by Link-Seal or Proset Systems Prefabricated Sleeve System.

2.02 SEALS

- A. Modular Mechanical Type:
 - 1. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between conduit and sleeve.
 - 2. Seal assembly shall have steel bolts and nuts and rubber sealing element for service and environment under which assembly will be used. Seal shall have a pressure resistance rating of 20 psig.
- B. Sealing Plug Type:
 - 1. Seals shall consist of two (2) identical piece plugs made of synthetic rubber with one edge flanged, serrated profile on the outside, and on the inside a series of ridges that compress and assure a tight seal. Seal shall have a pressure resistance of 15 psig at the plug base and 30 psig at the flange. Rubber grade shall be suitable for the service and environment under which sealing plug will be used.

2.03 WATERTIGHT SEALS

- A. Modular, mechanical-type watertight seals shall have zinc galvanized bolts and nuts with EPDM rubber sealing element. Seals shall be Link-Seal, Type C.
- B. Sealing-plug-type watertight seals shall be made of EPDM rubber. Seals shall be by CSD Sealing Systems. OPTION: Proset System Elastomeric Seals.

2.04 FIRE-RATED SEALS

- A. Sealing-plug-type fire-rated seals shall be made of fire resistance rated rubber for three (3) hour fire resistance rating. OPTION: Proset System Elastomeric Seals.

2.05 FIRESTOPPING MATERIALS

- A. Penetration sealants:
 - 1. 3M Brand "Fire Barrier" caulk, putty or penetrating sealing systems
 - 2. CSD Sealing Systems CSD-FW and CSD-F caulk and putty
 - 3. Johns-Manville "Cerafiber"
 - 4. Rectorseal "Metacaulk"
 - 5. Tremco
 - 6. Hilti
 - 7. Firestop "Flame Safe"
 - 8. Spec Seal
- B. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire resistance-rated systems. Contractor shall be responsible for using the correct method and type of fire sealant and fire-rated seals in each type of installation.
- C. All firestop installations shall be UL rated.

PART 3 EXECUTION

3.01 CUTTING

- A. Cut sleeves through walls flush with each surface. Unused sleeves shall extend beyond wall surface and be capped on each end.
- B. Cut sleeves 3/4 inch above finished floors or concrete curbs and 4 inches above floors in equipment rooms, rooms with floor drains, and shafts. Sleeves through waterproof floors shall project a minimum of 4 inches above the floor. Cut bottom of sleeve flush with bottom of floor.
- C. Core drill holes for sleeves in existing construction.
- D. Patching shall be by others at this Contractor's expense.

3.02 INSTALLATION OF SLEEVES

- A. Carefully coordinate and check locations of sleeves immediately before and after each concrete pour and masonry installation. Install cast-in-place sleeves subject to the following limitations:
 - 1. Do not embed aluminum without prior approval of coating material.
 - 2. Do not displace reinforcing steel.
 - 3. Maintain a center-to-center spacing of at least 3 diameters of sleeve.
 - 4. Do not install sleeves in any concrete beam, unless specifically shown on the structural Drawings.

- B. Give other Contractors as appropriate locations and sizes of all openings required for sleeve installation before construction of masonry or concrete walls and floors is started. If it is necessary to cut into the new work of other Trades due to the failure of this Contractor to provide proper notification, the other Trades shall do the cutting in at this Contractor's expense. Patching shall be done in the same fashion.
- C. Core drill hole for sleeves in existing construction after locations have been approved by the Structural Engineer and General Contractor.
- D. Size sleeves with 1/4 inch minimum and 1 inch maximum clearance all around pipe or pipe insulation.
- E. Piping is not to bear on sleeves. Install sleeves plumb with respect to wall.
- F. Minimize gaps between sleeve and ducts and pipes passing through walls and floors. Seal space up to a 1/2 inch gap with sealant or caulking. Close off space greater than 1/2 inch gap with sheet metal and seal airtight. To maintain fire rating of structure, pack all fire-rated separation sleeves with fire retardant or other noncombustible material. To fill space around all sleeves leading into exposed areas, use material compatible with adjacent construction and finish.
- G. Plug, pack, and finish unused sleeves to match adjacent surface and be compatible with their ratings.
- H. Use sleeves where round or oval duct openings are required through exposed walls, smoke or fire partitions, or equipment room walls. Close off all spaces around rectangular ducts through these walls.
- I. Provide chrome plated wall or floor escutcheons, sized to cover opening and seal, for all exposed installations.

3.03 INSTALLATION OF SEALS AND FIRESTOPS

- A. Clean surfaces and substrates of dirt, oil, loose materials and other foreign materials that may affect the proper bond or installation of seals and firestopping.
- B. Do not apply seals and firestopping to surfaces previously painted or treated with a sealer curing compound or similar product. Remove coatings as required in compliance with manufacturer's instructions. Provide primers, as required, that conform to manufacturer's recommendations for various substrates and conditions.
- C. Follow manufacturer's written instructions for installation of seals and firestopping.
- D. To ensure an effective smoke seal and to maintain the assembly's fire-resistance rating, install firestops with sufficient pressure to fill seal holes, voids, and openings.
- E. Tool or trowel exposed surfaces. Remove excess firestop material promptly as work progresses and upon completion.

- F. Fill and surround unused sleeves with firestop material. Sleeve ends. Contractor may use blind sealing plugs.
- G. Install watertight seals for all below grade penetrations of piping into the building.
- H. To maintain the fire-rating of the structure, pack all openings in fire-rated walls and floors and between sleeves and pipes with noncombustible material. Pipe insulation shall not be continued through a rated partition, unless sealant assembly is listed for use with continuous insulation. Maintain vapor barriers at all penetrations.

3.04 INSPECTION

- A. Examine seals and firestops to ensure proper installation and full compliance with this Specification. Work shall be accessible until inspection and approval by the applicable Code authorities.
- B. At no additional cost to the Owner, correct unacceptable seals and firestops, and provide additional inspection to verify compliance with this Specification.
- C. Maintain a current, legible copy of the manufacturer's written instructions for installation of seals and firestopping at the project site, for all products being used on the Project. Make installation instructions available on request for all Inspecting Authorities, the Architect, and the Engineer.

END OF SECTION

20 05 40
PIPING EXPANSION, NOISE AND VIBRATION ISOLATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide thermal expansion control for all piping.
- B. Isolate all piping for both noise and vibration transmission.
- C. To prevent damage to building, equipment, joists, hangers, and piping, provide expansion loops, expansion joints, guides, anchors, and offsets in piping systems as necessary to accurately control pipe movement resulting from equipment operation or thermal gradients.
- D. Provide flexible connectors on all piping to equipment 5 hp and larger and where shown on equipment of lower horsepower.

1.02 MANUFACTURERS

- A. Metraflex Company, Flexible Metal Hose, Wheatley, Proco, Mason Industries, or General Rubber.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Line Expansion:
 - 1. U Bends: In all piping subject to expansion and contraction, install U Bends or loops in piping, in accordance with ASHRAE Equipment Handbook.
- B. Branch Connections:
 - 1. Make branch connections to mains with a minimum of two (2) 90 degree elbows, and incorporate at least one (1) change of direction in the horizontal plane and one (1) change of direction in the vertical plane before connecting to equipment or fixtures, or dropping into or rising in a wall.
 - 2. Bullhead connections in any piping services are expressly prohibited.
- C. Guides: To preserve alignment and pitch, supplement all loops and expansion joints with adequate guides as close to loops and joints as possible and additionally at recommended intervals from joints. Rigidly secure guides to the structure and ensure that only axial movement is permitted. Provide auxiliary support metal as required to secure guides to structure. Follow the recommendations and guidelines of the Expansion Joint Manufacturer's Association, Inc.
- D. Anchors: Install pipe anchors where required to secure the pipe and totally eliminate movement. Attach the anchors securely to the structure.

END OF SECTION

20 05 45
HANGERS, SUPPORTS AND INSERTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide hangers, supports, concrete inserts, threaded rods, framing steel, and hardware required for piping, ductwork, and equipment installed under this Division.
- B. Install all necessary inserts, expansion shields, beam clamps, floor supports, and auxiliary steel.
- C. For new concrete installations, furnish and install concrete inserts (when used or required) for the work. Coordinate with other Contractors as appropriate.
- D. So as not to delay construction, the Plumbing, Fire Protection, and HVAC Contractors are responsible for correct locations, size, type, and installation of the concrete inserts for their work. Coordinate work with other Contractors as appropriate.
- E. Install wall brackets where required. Provide pipe guides and anchors as required to properly control pipe movement. Method to suit job conditions. Refer to Section 20 05 40, "Piping Expansion, Noise and Vibration Isolation."

1.02 QUALITY ASSURANCE

- A. All piping supports and parts shall conform to the latest requirements of the Code for Power Piping (ANSI B31.1) and MSS Standard Practice SP-58 and SP-69, except as supplemented or modified by the requirements of this Specification.
- B. Components shall be selected and matched to the load imposed on them.
- C. For ductwork supports, refer to SMACNA's "HVAC Duct Construction Standards Metal and Flexible" (latest edition).
- D. Items specified in this Section that are used for fire suppression systems shall be UL or FM listed and NFPA approved for the usage.

1.03 MANUFACTURERS

- A. Pipe Hangers: PHD, PHP, Michigan Hanger (Erico), Hilti, Kinetics, B-Line, Anvil, or Modern.

PART 2 PRODUCTS

2.01 HANGERS

- A. Uninsulated Piping:
1. Steel or Plastic:
 - a. 1/2 Inch to 6 Inches: PHD Fig. 151, adjustable swivel ring, steel band, adjusting nut or Fig. 450 adjustable clevis, carbon steel yoke, U-strap, bolt and hex nuts.
 - b. 8 Inches to 16 Inches: PHD Fig. 470, adjustable clevis roller hanger, cast iron roll, carbon steel yoke, rod, and hex nuts.
 - c. 18 Inches to 24 Inches: PHD Fig. 470, adjustable clevis roller hanger, cast iron roll, carbon steel yoke, rod, and hex nuts. Structural reinforcement of building structure is required at attachment point.
 - d. 30 Inches to 36 Inches: Fig. 450 adjustable clevis, carbon steel yoke, U-strap, bolt and hex nuts. Structural reinforcement of building structure is required at attachment point.
 2. Copper:
 - a. Use copper-plated hangers as specified previously for sizes up to 6 inches.
- B. Insulated Piping:
1. Cast Iron (Storm), Steel, Plastic or Copper:
 - a. All piping except steam and hot water piping, all sizes: PHD Fig. 450, adjustable clevis, carbon steel yoke, U-strap, bolt, and hex nuts. Provide thermal protector.
 - b. Hot Water Piping:
 1. 1/2 Inch to 1 1/2 Inches: PHD Fig. 450, adjustable clevis, carbon steel yoke, U-strap, bolt, and hex nuts. Provide thermal protector.
 2. 2 Inches to 16 Inches: PHD Fig. 475, adjustable roller, carbon steel yoke, cast iron roll, rod and hex nuts.
 3. 18 Inches to 24 Inches: PHD Fig. 475, adjustable roller, carbon steel yoke, cast iron roll, rod and hex nuts. Structural reinforcement of building structure is required at attachment point.
 4. 30 Inches to 36 Inches: Fig. 450 adjustable clevis, carbon steel yoke, U-strap, bolt, and hex nuts. Provide thermal protector. Structural reinforcement of building structure is required at attachment point.
 - c. Hanger size must be sufficient to accommodate pipe and insulation without compressing insulation.
 2. Thermal Protector:
 - a. 6 inch long segments of 20 pcf molded fiberglass blocks Hamfab "H-block" or hardwood (oak) blocks supported by PHD Fig. 170, galvanized steel protection shield. Outdoor installations to be hardwood inserts, paraffin-coated. No softwood (pine) wood blocks or wooden dowels will be permitted. Provide a vapor barrier cover over inserts so that the insulation vapor barrier will not be broken.
 - b. Insulated saddle system consisting of a factory-assembled glass-reinforced polypropylene saddle and steel pipe spacer. Assembly shall be rated for at least 40 degrees F to 200 degrees F service. Anvil Figure 260.

- C. Sanitary and Vent Piping:
 - 1. Cast Iron: PHD Fig. 450, adjustable clevis, carbon steel yoke, U-strap, bolt and hex nuts.
 - 2. Plastic: PHD Fig. 440, lightweight, adjustable clevis, carbon steel yoke, U-strap and bolt.

- D. Vertical Piping:
 - 1. Cast Iron, Plastic or Steel Piping:
 - a. 1/2 Inch to 10 Inches: Friction clamp with two point bearing, PHD Fig. 550 series at each floor level.
 - b. 12 Inches to 14 Inches: Friction clamp with two point bearing, PHD Fig. 550 series at each floor level and Fig. 855 wall bracket at mid span of the floor height.
 - c. 16 inches and above are to be support at base of riser by pipe stanchions from the floor below the riser or stack. Structural reinforcement of building structure is required at stanchion attachment point.
 - 2. Copper Piping: Copper-plated friction clamp with two point bearing for sizes up to 6 inches, PHD Fig. 552.

2.02 TRAPEZE HANGERS

- A. Pre-engineered strut or angle iron of sufficient length to support pipes and insulation on individual hangers, roller supports, or saddles with insulation protectors as specified for hangers above; trapeze hanger rod diameter and quantity as required to support total piping load. Loading on any attachment point to the structure shall not exceed 1,000 lbs. Trapeze hangers are to be spaced to not exceed this maximum structural load.

2.03 SUPPORTS

- A. Hanger for Individual Pipes:

Pipe Size	Max Pipe Support Spacing Copper Tube or Plastic Pipe	Max Pipe Support Spacing Steel Pipe	Structural Attachment Based on PHD Manufacturer	PHD Hanger Figure	Rod Size based on Hanger (Larger rods may be used)
Inches	Feet	Feet			Inch
3/4 or smaller	5 - copper 3 - plastic	7	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/ Fig 259	151 or 450	3/8
1	6 - copper 3 - plastic	7	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/ Fig 259	151 or 450	3/8
1 1/4	6 - copper 4 - plastic	9	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/ Fig 259	151 or 450	3/8
1 1/2	8 - copper 4 - plastic	9	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/ Fig 259	151 or 450	3/8
2	8 - copper 4 - plastic	10	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/ Fig 259	151 or 450 or 470 or 475	3/8

Pipe Size	Max Pipe Support Spacing Copper Tube or Plastic Pipe	Max Pipe Support Spacing Steel Pipe	Structural Attachment Based on PHD Manufacturer	PHD Hanger Figure	Rod Size based on Hanger (Larger rods may be used)
Inches	Feet	Feet			Inch
2 1/2	9 - copper 4 - plastic	11	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/Fig 259	151 or 450 or 470 or 475	1/2
3	10 - copper 4 - plastic	12	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/Fig 259	151 or 450 or 470 or 475	1/2
3 1/2	10 - copper 4 - plastic	12	Concrete insert Fig 951 or 950 Beam Clamp Fig 270 w/Fig 259	151 or 450 or 470 or 475 or 505	1/2
4	10 - copper 4 - plastic	12	Concrete attachment plate Fig 903 Beam clamp fig 350 w/Fig 359 or Fig 360 w/Fig 359	151 or 450 or 470 or 475 or 505	5/8

For fire sprinkler systems, conform to latest NFPA standards required by OBC.

B. Beam Clamps:

1. "C" Clamps: PHD Figs. 270 w/259, 350 w/359, 360 w/359, malleable iron body, steel pointed set screw with lock nut and a minimum of 11 gauge steel retainer strap. Beam clamps by themselves (C-clamps) are expressly prohibited. Provide retainer straps with all beam (C-Clamps). Consult with MSS SP-58 and SP-69 for C-Clamp identification.
2. PHD Fig. 930 steel washer plate, double nutted with threaded rod.

C. Wall Brackets: PHD Fig. 850 (lightweight 750 lbs. load) or Fig. 855 (medium weight 1,500 lb. load), carbon steel, back plates and bolts. Wall brackets for horizontal piping runs are limited to 10 inch pipe size and smaller.

D. Welded Beam Attachment: PHD, Fig. 900 concrete rod attachment plate.

2.04 FINISH

- A. Unless otherwise noted, all hangers and supports to be standard black, except that hangers and supports for exposed exterior applications and in the warehouse and service bays shall be hot-dipped galvanized.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Install necessary pipe hangers and supports to properly support all piping and to maintain piping uniformly level or vertical (3/4 inch maximum deflection). Hangers to be double-nutted.

- B. Maximum spacing of piping supports shall be per Hanger Table included in this Specification. Provide additional hangers as follows:
 - 1. On both sides of steel or brass, or cast metal valves for pipe sizes 6 inches and larger.
 - 2. Horizontal DWV Plastic Piping: At branch connections and at each change of direction.
 - 3. Vertical DWV Piping: At branch connections, at each change of direction, at each floor, and mid-story, for no more than a 10 foot vertical spacing. Provide additional supports as necessary to maintain piping alignment at the base.
 - 4. Cast Iron Piping: Horizontal at intervals not in excess of the standard lengths of pipe used; vertical 15 foot maximum intervals, at base, and at each floor.
 - 5. Fire Protection Piping: Locate and space per NFPA requirements.

3.02 DUCTWORK HANGER INSTALLATION

- A. Install necessary hanger rods and angle iron support brackets to properly support ductwork, insulation, reinforcing, and external loads. Friction clamps are excluded as upper attachment devices.
- B. Maximum spacing of supports to be as follows:

Rectangular Ducts

1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Less than 72	3/8	10
72 to 120	3/8	8
120 to 192	1/2	5

Round Ducts

Duct Diameter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Through 24	1/4	12
25 through 36	3/8	12
37 through 50	1/2	12

- 1. Use a pair of rods, one (1) on each side of ductwork. Rods to be uncoated, hot-rolled steel.
- 2. OPTION: 1 inch wide sheet metal straps may be used on sizes up to 22 inches wide (or 22 inches in diameter), one (1) sheet metal gauge (minimum) thicker than ductwork being supported.

3.03 GENERAL INSTALLATION

- A. Ceiling grid system shall not be used to support ductwork, electrical conduit, heating or plumbing lines, or any other utility lines. Each utility and the ceiling grid system shall be a separate installation and each shall be independently supported from the building structure. To support ductwork or piping where interferences occur, the Contractor must install trapeze type hangers or supports that shall be located where they do not interfere with access to fire dampers, valves, and other mechanical equipment items.

- B. Where necessary, the Contractor shall furnish and install proper angles or channels for hanger supports between joists. Weld to steel structural members.
- C. Do not support hangers from roof deck.
- D. Use inserts to avoid cutting concrete or masonry. To avoid burning metal deck, use top flange beam clips.
- E. Vertical storm and waste stacks to rest firmly on masonry footings and be firmly supported at each floor.
- F. The following hanger methods are not permitted:
 - 1. Wood, lead, or plastic plugs
 - 2. Perforated band iron
 - 3. Hook chain supports
 - 4. Baling wire, etc.
 - 5. Power-actuated anchors
- G. Whenever possible, use supports, clamps, hangers, etc., designed especially for the equipment to be installed.
- H. Where necessary, furnish and install proper angles or channels or support steel to reinforce the building structure or to spread out the load on the building structure. Weld to steel structural members or attach to concrete structures using inserts or concrete fasteners.

3.04 COORDINATION

- A. Coordinate drilling, welding, etc., and method of attachment to columns, joists, beams, girts, etc., with Structural Engineer and other Contractors as appropriate before proceeding.

END OF SECTION

20 05 50
GENERAL PIPING REQUIREMENTS

PART 1 GENERAL

1.01 PIPING SYSTEMS - GENERAL

- A. The following instructions apply to all piping systems, except where otherwise noted:
1. Provide unions or flanges at each final connection and at each piece of equipment. Arrange piping and locate unions and flanges to permit easy removal of parts and equipment for inspection and cleaning. Welded connections to equipment are prohibited.
 2. Make connections to equipment as detailed on the Drawings and according to the manufacturer's installation instructions.
 3. Where connection size is smaller than piping make reduction at final connection only (do not reduce size of pipe drop).
 4. Provide valves and specialties as required to complete installation of each piece of equipment for proper operation.
 5. Install all piping parallel to building lines, level and plumb unless required to slope.
- B. Cleanout and flush water piping systems.
- C. If other means of draining are not provided, install drain valves at all low points to permit complete draining of each of the following:
1. All water systems
 2. Fire sprinkler systems (according to NFPA)
- D. Contractor to provide information on chases, sleeves, and openings required for his/her work to other Contractors. This Contractor to assume cost and responsibility for all cutting and patching resulting from improper coordination of the work.
- E. Certified Pipe Welding Bureau. Welds to be stamped at each joint or fitting.
- F. Install dielectric unions at all connections of dissimilar metals.

PART 2 PRODUCTS

2.01 UNIONS

- A. Unions in Copper Pipe: Bronze 150 lb. ground joint, cast body, solder end (do not use wrought copper unions). Mueller, Chase, Crane, or Northern Indiana Brass Company.
- B. Unions in Steel Pipe: Black malleable iron, bronze ground ball joint. Mueller, Chase, Crane, or Northern Indiana Brass Company.
- C. Dielectric unions when connecting steel to copper pipe: 250 lb. W.P., insulating gasket, and dielectric insulators. Epcoc, Dart, Capital, or Watts.
- D. Dielectric fittings on flanges when connecting flanges on piping of dissimilar metals: 175 psig W.P., insulating gaskets, dielectric insulators including bolt isolators.

2.02 JOINTS

- A. Flanges:
 - 1. Through 2 1/2 Inches: Cast iron screwed, 125 lb. or higher as required.
 - 2. 3 Inches and Larger: Steel welding neck, 150 lb. or higher as required.
- B. Gaskets: Asbestos-free, suitable for the intended service. Use dielectric gaskets where joining dissimilar piping material.
- C. Bolts for steel, cast iron, brass, and bronze, for 250 lb. SWP and 450 degrees F or below to be carbon steel, with American Standard, regular, square heads and American Standard, heavy, hexagon grade or better semifinished nuts.
- D. ASTM A307, Grade B, Tee head, high-tensile steel bolts and nuts may be used in mechanical joint pipelines. (Mechanical joints are not to be used with tubing of copper or aluminum alloys.)
- E. Screwed Piping: Use NPT tapered threads.

2.03 GROOVED PIPING

- A. Where grooved piping systems are allowed by reference in other Sections within this Specification, the installing Contractor must have installed at least five (5) grooved mechanical piping systems.
- B. Install grooved couplings on 2 inch – 24 inch roll-grooved, standard weight Schedule 40 pipe in accordance with the coupling manufacturer's installation instructions. Cut-grooved piping systems will be unacceptable.
- C. Install flexible couplings with the bolt pads metal to metal; rigid (slant bolt pad) couplings shall be installed within the bolt pads metal to metal with equal offset. Installing Contractor shall verify that bolt pad gaps do not exist.
- D. The grooved mechanical coupling manufacturer shall perform on-site installation demonstrations for the Installing Contractor before grooved coupling installation begins.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each union or flange to permit removal of parts, valves, and equipment and in a position permitting the device or equipment to be removed without disconnecting piping. Use flanged equipment connections exclusively on all steam and condensate systems.
- B. Make reductions in piping lines with reducing coupling or weld fitting reducer. No bushings will be permitted.

- C. Install piping to provide clearance for personnel passage, headroom, operation of doors or windows, equipment, lighting outlets, and for the Owner's apparatus and equipment. Coordinate pipe runs and elevations with other Contractors before installation. Where interferences develop in the field, pipes may need to be offset or rerouted, at no additional cost to the Owner, as required to resolve interferences.
- D. In pipe spaces to be entered for servicing, offset piping so that all lateral runs are located either near the floor or at least 6 feet above the floor, and all vertical piping is held close to the wall through that height. Keep all piping to the side of the chase wherever possible. Offset vents immediately above the connection to the waste line.
- E. Piping shall not be installed over electrical equipment, motor control centers, or transformers and shall not be installed within elevator shafts or elevator equipment rooms.
- F. Install pipes, valves, fittings, etc. with a minimum of 1/2 inch clearance between the finished covering and other work and between the finished covering of parallel, adjacent pipes.
- G. Use fittings to make changes in pipeline direction. Do not bend or spring piping.
- H. Offset lines around columns, beams, and other obstructions as required. Where special conditions are encountered in the field, arrangement and alignment of piping shall be decided by the Architect and Engineer.
- I. At time of assembly, clean piping components of loose material. After assembly and before putting in service, blow or flush lines free of loose materials. Clean strainer screens and sediment pockets prior to putting the lines in service.
- J. Install valves at service connections to equipment and branch lines from main lines. Install all valves and unions so that they are accessible through ceiling or wall access panel.
- K. Use dielectric unions, shims, gaskets, or coatings to insulate direct contact between pipe, fittings, and hangers of dissimilar metal.
- L. Install thermometers and gauges to permit them to be read from floor level.
- M. Securely support all piping from structure with approved hangers, rods, brackets, and accessories.
- N. Where piping is installed in new masonry block walls, coordinate other Contractors as appropriate so that piping extends out through a masonry joint where possible.
- O. Bullhead connections are not allowed.
- P. Where exposed pipes pass through walls, floors, or ceilings of finished rooms, provide chrome-plated escutcheons. Prime-coated black iron escutcheons may be used in unfinished rooms. Protect escutcheons from tool marks.
- Q. Keep pipe level except where a slope is required. Use eccentric reducers to keep bottom of pipe level.

- R. Avoid trapping of piping.
- S. Install ball valves at pressure gauges and air vents at high points of piping.
- T. Provide a union or bolted flange fitting downstream and within approximately 12 inches of each valve and adjacent to both inlet and outlet of pumps and other equipment.
- U. When copper lines are supplied, install dielectric unions or flanges on water line connections to water heaters and equipment with steel pipe connections.
- V. Provide unions or flanged connections where required for construction or assembling purposes.

3.02 WELDED CONNECTIONS

- A. Welded joints to be fabricated and stamped by welders qualified and certified for the positions, materials, methods, and equipment being used and as required by enforcing bodies.
- B. Buttweld joints shall have substantially full penetration and recommended bead reinforcement.
- C. Slip-on, socket, and fillet welds to have geometry indicated in the "Code for Power Piping" (ANSI B31.1).
- D. Remove weld scale from joints as work proceeds and at completion.

3.03 SOLDERED AND BRAZED CONNECTIONS

- A. Joints to have pipe or tubing end reamed to full I.D. after cutting.
- B. Exterior of joint shall be smooth.
- C. Clean with steel wool.
- D. Apply flux to prevent oxidation.
- E. Apply solder or brazing filler material and thoroughly heat to completely melt material and cause it to migrate completely over the mating surfaces.
- F. Solder and brazing work shall comply with ANSI Standard B31.1.

3.04 THREADED CONNECTIONS

- A. Ream pipe ends of threads to full cross sectional area after cutting. Threads shall conform to ANSI Standard B2.1.
- B. Joints shall be made with TFE tape, applied to male threads only. Option: Use Permatex pipe dope.

3.05 FLANGED CONNECTIONS

- A. Face flanged joints square and true. Install gaskets suitable for the operating temperature and pressure of the fluid or gaseous medium being piped.

3.06 PIPE CLEANING

- A. Before systems are placed in operation, flush out all water piping systems to remove dirt and grease from pipes and equipment. Clean strainers after each flushing until they remain clean.
- B. Fire protection mains to be flushed at flows required by NFPA-13 and NFPA-24.

3.07 PIPING PROHIBITIONS

- A. Do not run piping over electrical equipment, across windows, door openings, access panels or lighting fixtures or within 36 inches in front of electrical panels that operate at a voltage of 150 volts or less, or within 42 inches of electrical panels that operate at a voltage of 151 to 600 volts. Obtain instructions from the Architect if a conflict occurs. Coordinate with the Electrical Contractor.
- B. On any given system, the Contractor will not be permitted to mix and join different types of pipe material. For example, if a storm or sanitary system uses plastic, copper, and cast iron, the Contractor may change from one to the other only once. The line may not be changed back to the first material further downstream.
- C. Storm, vent and sanitary lines shall be continuously sloped; trapping is expressly prohibited.

3.08 EMBEDDED PIPING LIMITATIONS

- A. Install embedded pipes and sleeves subject to the following limitations:
 - 1. Do not embed aluminum without prior approval of coating material.
 - 2. Do not displace reinforcing steel.
 - 3. In slabs and walls, limit outside dimension of pipes to 1/3 member thickness. Minimize crossing embedded piping, and where crossing cannot be avoided, maintain same minimum concrete cover as required for reinforcing bars. For slabs over metal decks, slab thickness is measured from the top of the metal deck.
 - 4. In columns, limit total area of pipes to 4% of column area.
 - 5. Maintain a center-to-center spacing of at least three diameters of pipe or sleeve.
 - 6. Do not install sleeves or piping in any concrete beam, unless specifically shown on the structural Drawings.

END OF SECTION

20 05 55
VALVE TAGGING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide valve tags on all HVAC, Plumbing, and Fire Protection valves including control valves. Stamp tags with service designation and number tags consecutively for each system. Coordinate numbering with any existing valve tag schedules and with the Owner.
- B. Prepare a typewritten valve tag directory with charts showing locations, designations, and sizes of valves. Laminate under plastic and mount as directed by the Architect. Include additional copies of valve charts in the Service Manuals.

1.02 COORDINATION

- A. Coordinate with all other Contractors to ensure that the valve tagging used by all Trades is uniform in type, style, and appearance.

1.03 MANUFACTURERS

- A. Brady, Seton, Kolbi, EMED, MSI, or Brimar.
- B. All valve tags used on the project shall be same type, shape, and lettering and be made by the same manufacturer. Coordinate with all other Contractors.

PART 2 PRODUCTS

2.01 TAGS

- A. 2 inch diameter, 16 gauge, brass tag with brass chain. 1/4 inch high stamped letters over 1/2 inch high stamped numbers, both black-filled.
- B. Furnish and install color-coded tags to indicate concealed valve locations. Attach color-coded tags to the ceiling T-bars. Match tag colors to the color of the pipe band specified.

2.02 IDENTIFICATION SCHEDULE

- A. Identify as follows:

	Type of Service	Valve Tag Designation
PLUMBING	Domestic cold water	DCW
	Domestic hot water	DHW
	Domestic hot water return	DHWR
	Natural gas	GAS
FIRE PROTECTION	Fire and water service	FW
	Wet pipe sprinkler system	SPR
	Combination sprinkler system	SPR

PART 3 EXECUTION

3.01 INSTALLATION

- A. Tags:
1. Attach to valve handwheels.
 2. Locate to be easily readable from standing position when valve is in normal position.

END OF SECTION

EQUIPMENT, PIPING AND DUCTWORK IDENTIFICATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Identify by labels and tags the following items:
 1. Equipment such as water heaters, expansion tanks, pumps, and similar items.
 2. Piping exposed in equipment rooms and accessible service areas.
 3. Piping running above accessible ceiling construction and near access panels in nonaccessible ceiling construction.
 4. Ductwork in equipment rooms.
- B. Install laminated plastic nameplates for equipment, and install color banding, flow arrows, and contents identification for piping.

1.02 COORDINATION

- A. Coordinate with other Contractors to ensure that the identification used by all Trades is uniform in type, style, and appearance.
- B. Coordinate all identification systems with any already existing.

1.03 MANUFACTURERS

- A. Brady, Seton, Kolbi, Graphic Products, CALPICO, EMED, MSI, or Brimar.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

- A. Engraved laminated plastic, white over black, sized for 3/4 inch high letters or numbers, Gothic style.

2.02 PIPING AND DUCTWORK IDENTIFICATION

- A. Provide vinyl adhesive pipe labels or vinyl wrap-around markers. Match label background color to 2 inch color band.
- B. Size to be as follows:

Outside Diameter of Pipe or Covering	Minimum Letter Height
3/4" to 1-1/4"	1/2"
1-3/8" to 2"	3/4"
2-1/8" to 7-7/8"	1-1/4"
8" to 10"	2-1/2"
Over 10"	3-1/2"

2.03 COLOR BANDS

- A. Provide 2 inch wide (minimum) painted gloss enamel or vinyl tape color band on each pipe, completely wrapping the pipe circumference. See "Identification Schedule" for band color.

2.04 FLOW ARROWS

- A. Provide color-coded adhesive vinyl flow arrow on each pipe, secure flow arrows to pipe at each end of flow arrow with a color band, completely wrapping the pipe circumference. Match flow arrow color with color band.

- B. Size to be as follows:

Outside Diameter of Pipe or Covering	Minimum Flow Arrow Size
3/4" to 1-1/4"	1-1/8" by 4"
1-3/8" to 2"	1-1/2" by 4"
2-1/8" to 7-7/8"	2-1/4" by 6"
8" and over	4" by 7"

- C. In lieu of separate flow arrows, flow arrows may be incorporated into color bands. See "Identification Schedule" for band color, and match flow arrow color lettering color.

2.05 IDENTIFICATION SCHEDULE

- A. Identify as follows:

Type of Service	2 Inch Color Band and Label Color	Lettering Color	Designation
FIRE PROTECTION			
Sprinkler	Red	White	SPR
Drain	Red	White	D
Dry pipe	Red	White	DP
PLUMBING			
Domestic cold water	Green	White	DCW
Domestic hot water	Yellow	Black	DHW
Domestic hot water return	Yellow	Black	DHWR
Natural gas	Yellow	Black	GAS
Storm	Green	White	STM
Sanitary	Yellow	Black	SAN
Vent	Yellow	Black	V

Type of Service	2 Inch Color Band and Label Color	Lettering Color	Designation
HVAC DUCTWORK			
Supply air	---	---	Supply
Return air	---	---	Return
Exhaust air	---	---	Exhaust
Relief air	---	---	Relief
Outside air	---	---	Outside Air

PART 3 EXECUTION

3.01 INSTALLATION

- A. Attach equipment tags with screws. Exception where screws might damage equipment or ductwork, use compatible adhesive instead of screws.
- B. Apply piping identification only after finish painting is completed.
- C. Provide service designations, flow arrow, and color banding at intervals of 15 feet (maximum).
- D. Also identify piping at connections to equipment, at entrances to spaces, at valves, near access doors to pipe spaces, at branches from main, at each riser, and at both sides of the wall or barrier through which the piping passes.
- E. Clean piping, duct, or insulation in area of labeling just before labeling of pipe, duct, or insulation.
- F. Ensure that labels are readable from a normal standing position.

END OF SECTION

20 05 70
DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Carefully inspect the entire project and verify with the Architect all items designated to be removed or to remain. Refer also to Division 1 for additional requirements.
- B. Perform demolition work of all Plumbing, Fire Protection, and HVAC items as shown or described on the Drawings. Remove from the site all items designated as scrap.
- C. Locate all existing utilities requiring removal and determine all requirements for disconnecting and capping.
- D. Locate all existing active utilities designated to remain and determine the requirements for their protection.
- E. Take care not to damage adjacent construction designated to remain.
- F. Unless otherwise noted, carefully remove existing ceiling tiles and supporting structure as required to install or remove existing material and replace after work is completed. Any damaged ceiling tiles and supporting tiles shall be replaced by each Contractor at no additional cost to the Owner.
- G. All demolished Plumbing, Fire Protection, and HVAC items in good condition are to remain the property of the Owner. Verify with the Owner's representative which demolished items are considered scrap and are to be removed from site.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.00 PREPARATION

- A. Notify the Architect at least two (2) full working days prior to commencing work in a particular area.
- B. Coordinate and schedule all work in a careful manner with all necessary consideration for the Owner, neighbors, and the public. Avoid interference with the use of, and passage to and from, adjacent areas and facilities designated to remain in use during demolition. Coordinate work with the other Contractors and Owner.
- C. Before starting site operations, disconnect or arrange for the disconnection of all utilities or equipment designated to be removed. Perform all such work in accordance with the requirements of the utility company and the Owner.
- D. Maintain in operating condition all active utilities designated to remain.

3.01 DEMOLITION

- A. Demolish and remove equipment foundations and supports, piping, ductwork, abandoned utility lines, and all other existing items designated for removal as indicated on the Drawings and in these Specifications.
- B. Do not use equipment or methods that will cause damage to adjacent construction designated to remain.
- C. Plug or cap piping that Drawings or Specifications indicate will remain.
- D. Plug or cap wall and floor sleeves not being reused. Refer to Section 20 05 35, "Sleeves, Seals, and Firestops."
- E. Cap removed branch ducts close to mains with 24 gauge galvanized sheet metal.

3.02 RELOCATION

- A. Remove and store until the construction is ready for their installation, all items designated to be relocated.
- B. Clean all Plumbing, Fire Protection, and HVAC fixtures and equipment designated to be relocated after relocation is complete.

3.03 SALVAGE AND SCRAP

- A. Maintain salvaged materials in good condition. Salvaged materials shall remain the property of the Owner. Salvaged materials not acceptable to the Owner shall be considered scrap and removed by the Contractor from the job site.
- B. Tag and identify salvaged materials.
- C. Coordinate with Owner's representative all Plumbing, Fire Protection, and HVAC items to be salvaged and stored on site as directed. Storage of salvaged items will be permitted only at specified areas. Provide weather covering of stockpiled salvage materials. The Owner shall remove salvaged and stored items from the site.
- D. Remove all scrap items from the building and arrange for disposal in accordance with State and local regulations.

3.04 EXISTING EQUIPMENT TO REMAIN

- A. Clean all Plumbing, Fire Protection, and HVAC fixtures and equipment designated to remain in the areas of construction.

3.05 HAZARDOUS MATERIALS

- A. Contractors are cautioned to check premises for existence of hazardous materials such as paint with lead and asbestos in the form of pipe insulation or plaster. If materials that may present a health hazard to workers, occupants, or the public are encountered during the work, the Contractor shall do the following:
1. Take immediate action to limit the exposure or hazardous condition.
 2. Cease work in the area until suspected hazardous material can be identified. Laboratory testings, if required, will be paid for by the Owner.
 3. Follow procedures and requirements of the governing authority (including, but not limited to, EPA and OSHA) regarding monitoring, removal and disposal of the hazardous material. Provide special equipment as required.
 4. Costs relating to special work or procedures used or required for performance of the work required to monitor, remove and dispose of hazardous materials will be borne by the Owner.

END OF SECTION

20 05 71

DEMOLITION OF SYSTEMS CONTAINING REFRIGERANTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Perform demolition work of all refrigerant systems, including the three existing furnaces and split-system air conditioners.
- B. Demolition of HVAC equipment containing any refrigerant shall be in compliance with Section 608 Refrigerant Recycling Rule of the Clean Air Act of 1990.
- C. All demolished HVAC items are considered scrap and are to be removed from site.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.00 DISPOSAL OF AIR-CONDITIONING AND REFRIGERATION EQUIPMENT

- A. Contractor shall maximize recovery and recycling of ozone-depleting substances both chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) during the disposal of air-conditioning and refrigeration equipment.
- B. Contractor shall require technicians disposing air-conditioning and refrigeration equipment to certify to EPA that they have acquired refrigerant recovery equipment and are complying with the requirements of the Section 608 Refrigerant Recycling rule.
- C. Refrigerants shall be reclaimed by an EPA certified refrigerant reclaimer.
- D. Refrigeration and air-conditioning equipment that is dismantled on-site before disposal shall have the refrigerant recovered in accordance with EPA's requirements for servicing prior to their disposal.

END OF SECTION

20 05 75
ACCESS PANELS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish access panels necessary for access to mechanical equipment, valves, or other devices requiring service, adjustment, or maintenance as follows:
 - 1. Ceiling
 - 2. Wall
 - 3. Ductwork
- B. All access panels shall be 24 inches by 24 inches unless otherwise noted.

1.02 WORK NOT INCLUDED

- A. Access panels are to be turned over to other Contractors as appropriate for installation.

1.03 COORDINATION

- A. This Contractor is responsible for providing the dimension and locations of all ceiling, wall, and floor openings for the access panels to other Contractors requiring that information.
- B. Coordinate with other Contractors with respect to panel locations and group valves, traps, etc., so that they are accessible from a single panel.

1.04 MANUFACTURERS

- A. Milcor, Bilco, Zurn, Larsen's, Acudor, JL, Inland Ryerson, MIFAB, Nystrom, Mitco, or Karp.

PART 2 PRODUCTS

2.01 CEILING ACCESS PANELS

- A. Drywall Ceilings: Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double-acting concealed spring hinges, flush, screwdriver-operated, prime-painted for finish painting with ceiling.

2.02 WALL ACCESS PANELS

- A. Drywall: Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double-acting concealed spring hinge, flush, screwdriver-operated, prime painted for finish painting.
- B. Masonry and Tile: Milcor Style M Stainless, 14 gauge steel frame and door panel, concealed spring hinges, flush, screwdriver-operated, Style M stainless steel finish.

PART 3 EXECUTION

3.01 COORDINATION OF INSTALLATION

- A. Coordinate size, location, and installation of panels required to permit convenient access to valves, dampers, bearings, motors, filters, controls, and other equipment requiring adjustment, service, or maintenance. Mark locations of access panels on Record Drawings.

END OF SECTION

20 05 80
VIBRATION ISOLATORS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide a complete vibration isolation system to isolate motorized equipment, piping, ductwork, and appurtenances from the building structure and ceiling construction.

1.02 QUALITY ASSURANCE

- A. Expected noise levels in various parts of the building shall conform to noise criteria recommendations as set forth in the current edition of ASHRAE Guide and Fundamentals. The midpoint of the range of noise criteria curves shall apply and become part of these Specifications.
- B. Sound and vibration control design criteria for mechanical systems for this building shall conform to the chapter in Sound and Vibration Control in the current edition of ASHRAE Guide, HVAC Systems and Applications.
- C. Vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier.

1.03 MANUFACTURERS

- A. Kinetics, Korfund Dynamics Corporation, Vibration Eliminator Company, Inc., Vibration Mountings and Controls, Inc., or Mason Industries, Inc.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Type 2 - Hanger Mounts: Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding 0.40 inch shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds, and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30 degree arc without metal-to-metal contact or other short circuit.
 - 1. Kinetics Model RH

- B. Type 3a - Spring Hanger Mounts: Vibration isolators shall be hangers consisting of a freestanding, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity.
 - 1. Kinetics Noise Control Type SH

- C. Type 3b - Spring Hanger Mounts: Vibration isolators where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a pre-compressed molded fiberglass insert, complete with load transfer plates and assembled in a stamped or welded steel bracket. Vibration isolators shall be pre-compressed molded fiberglass pads individually coated with a flexible, moisture impervious elastomeric membrane. Vibration isolation pads shall be molded from glass fibers with fiber diameters not exceeding 0.00027 inches and with a modulus of elasticity of 10.5 million PSI. Natural frequency of fiberglass vibration isolators shall be essentially constant for the operating load range of the supported equipment. Vibration isolators shall be color coded or otherwise identified to indicate the load capacity. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity.
 - 1. Kinetics Noise Control Type SFH

- D. Type D - Roof Curb Isolation Rails: Prefabricated extruded aluminum rail system incorporating 1 inch deflection freestanding stable springs for vibration isolation and a continuous foam neoprene air and water seal. The aluminum rail shall include an integral slot anchoring springs to the bottom section, but allowing horizontal adjustment.
 - 1. Kinetics Model ASR

2.02 ISOLATOR SCHEDULE

- A. Furnish isolator types as follows:

Equipment Item	Base Type	Isolator Type	Deflection (Inches)
Packaged rooftop units	D	integral	0.75
Fan-powered terminals	---	3a	0.50
Piping	---	3b	0.50
Ductwork	---	3a	0.50

PART 3 EXECUTION

3.01 PREPARATION

- A. Use steel components that are phosphated and painted. Use only nuts, bolts, and washers that are zinc-electroplated.
- B. Thoroughly clean structural steel bases of welding slag and prime them with zinc-chromate or metal etching primer.
- C. All isolators exposed to the weather, located outdoors, or within manholes or tunnels shall have all steel parts either PVC-coated or hot-dip galvanized.
- D. Use aluminum components that are etched and painted.

3.02 INSTALLATION

- A. Equipment: All motorized heating and air-conditioning equipment, including pumps, fans and other equipment, shall be mounted on, or suspended with, vibration isolators.
- B. Piping and Ductwork:
 - 1. All piping over 1 inch outside diameter located in mechanical equipment rooms shall be isolated from the building structure by means of noise and vibration isolation hangers. The only exclusions are roof and floor drain piping, and all sprinkler piping.
 - 2. All piping located less than 50 feet (or 100 pipe diameters - whichever is greater) from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers. All piping in the building, which is connected to vibration-isolated equipment, shall be isolated at these connections to the building structure.
 - 3. All ductwork located in mechanical equipment rooms, and for a minimum of 50 feet from any connection to vibration-isolated air moving equipment shall be isolated from the building structure by means of noise and vibration isolation guides and supports.
 - 4. Isolate all ductwork vertical risers from the building structure by means of noise and vibration isolation guides and supports.
 - 5. Use vibration and noise isolating expansion hangers to isolate vertical pipe risers from the structure. The hangers shall have a minimum rated deflection of four times the anticipated pipe expansion and shall be enclosed in a housing for fail-safe operation.
 - 6. All piping and ductwork to be isolated according to this Section of the Specifications shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain a minimum of 3/4 inch and maximum of 1 1/4 inches clearance around the outside surfaces. This clearance space shall be tightly packed with 1.58 PCF glass fiber and shall be caulked airtight after installation of the piping or ductwork, to form an acoustic seal.
- C. The installed vibration isolation system for each floor or for ceiling supported equipment shall have a maximum lateral motion under equipment start-up or shutdown conditions of 1/4 inch. Motions in excess shall be restrained by approved spring-type thrust restraints as specified or approved by submittal Drawing.

END OF SECTION

20 05 99
REQUIREMENTS FOR CONTRACT COMPLETION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Following is a partial list of items that must be submitted as required before Contract Completion.
1. All Plumbing, Fire Protection, and HVAC Contractors:
 - a. Receipt for Operating Instructions and Service Manual
 - b. Certificate of Equipment Demonstration
 - c. Valve tags and charts
 - d. Receipt for keys
 - e. Warranties
 - f. All required test reports as specified in other Sections
 - g. All As-Built Drawings per Specifications
 2. Plumbing Contractor only:
 - a. Certificate of Plumbing Inspection
 - b. Certificate of Sterilization
 - c. Certification that the solder or brazing used for entire new domestic water piping system is lead-free.
 3. Fire Protection Contractor only:
 - a. Fire Marshal's certification of inspection and acceptance
 - b. Certification from local fire department that pipe threads are suitable for their equipment.
 4. HVAC Contractor only:
 - a. Certificate of Inspection
 - b. Air and water balance reports
 - c. Contractor's Certificate of Operation of fire and smoke dampers
- B. In addition to the written submittals, the following material shall also be submitted prior to Contract Completion. Submit a signed copy of the Certificate of Materials Receipt. (ATTACHED TO THE END OF THIS SECTION)
1. Loose or spare parts as specified in other Sections.
 2. Spare parts as specified in this Section.
- C. Refer to Division 1 for additional requirements.

PART 2 PRODUCTS

2.01 SPARE PARTS

- A. Furnish one complete set of the following spare parts:
1. Gaskets for each pump
 2. Pump packing/mechanical seal for each pump
 3. Gaskets for manholes and handholes
 4. Glass for each water gauge
 5. All air filters (does not include air filters used during construction)
 6. Special keys, wrenches, and similar required or special tools

PART 3 EXECUTION

3.01 OPERATIONAL TEST

- A. At completion, operate the systems at least five (5) days, not necessarily consecutive, to demonstrate fulfillment of the requirements of the Contract. During this time, make adjustments so that equipment will perform as the manufacturer intended and systems will function as designed. Complete balancing before operating test is started.
- B. Operate each system in every mode of operation and check the position of valves, dampers, and other devices for proper closure and switching.
- C. Following completion of the testing described previously, sign and submit the Certificate of System Completion. (ATTACHED TO THE END OF THIS SECTION)

3.02 PERSONNEL INSTRUCTION

- A. After all system operational tests have been completed, schedule an instruction period with the Owner. Instruct the Owner-designated personnel in the operation and maintenance of all systems and equipment. Use manuals to familiarize the Owner-designated personnel with equipment and procedures. Allow time as necessary for this instruction. Schedule time convenient for the Owner and the Architect.
- B. The instruction is to include the following:
 - 1. Location of items of equipment and explanation of their use
 - 2. Reference to service manual for record and clarity
 - 3. Coordination of written and verbal instructions so that each is understood by personnel
 - 4. Explanation of control system
 - 5. Complete review of items in the manuals
 - 6. Maintenance procedures to be followed by the Owner
- C. At the completion of instruction, have all attendees sign the Certificate of System Completion. (ATTACHED TO THE END OF THIS SECTION)

END OF SECTION

CERTIFICATE OF MATERIAL RECEIPT

Project Name: _____

Date: _____

Contractor: _____

Contractor's Representative: _____

On the date listed previously, the following pieces of equipment, as required by the Project Specifications, were delivered to the Owner's representative:

Equipment	Quantity
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

(Attach a separate page for additional items)

Owner's Representative: _____ (PRINT)

_____ (SIGN)

CERTIFICATE OF SYSTEM COMPLETION

Project Name: _____

Contractor: _____

System: _____

Specification Section Number: _____

A. Manufacturer's Inspection and Approval (if required by specification section)

The previously identified system has been inspected and approved as meeting the manufacturer's written instructions for installation and operation.

Manufacturer's Representative: _____ Date: _____

B. Testing

The previously identified system has passed all testing required by the Project Specifications and has met the terms of the contract. Written test results are attached.

Contractor's Representative: _____ Date: _____

C. Equipment Demonstration

The previously identified system has been demonstrated to the following Owner's representatives:

Name	Title	Date	Signature
------	-------	------	-----------

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.

(ATTACH A SEPARATE PAGE FOR ADDITIONAL NAMES)

21 05 01
FIRE PROTECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish material, labor, tools, accessories and equipment, final fabrication Drawings and detailed system design to complete and leave ready for operation all Fire Protection systems of this Project, as described in these Contract Documents, shown on the Drawings, and as otherwise required for a complete installation which complies with all codes having jurisdiction.
- B. Refer to Sections 20 00 00 through 20 99 99 (as included) for items of a general nature which apply to this portion of the work. Sections 21 00 00 through 21 99 99 (as included) also describe Fire Protection Work.
- C. It is the intent that the Fire Protection Work be complete in every respect.
- D. Portions of the existing areas are required to be modified to conform with the revised architectural layout, refer to Drawings.
- E. Use sufficient journeymen and competent supervisors in execution of this portion of the work to ensure proper and adequate installation throughout. In the acceptance or rejection of installed Fire Protection work, no allowance will be made for lack of skill on the part of workmen.
- F. Coordinate location of all work with other Contractors and equipment.
- G. Work includes, but is not limited to, the following:
 - 1. Wet Sprinkler System
 - 2. Demolition
 - 3. Obtain current flow test for hydraulic design
- H. Sprinkler system shall be hydraulically calculated and sized.
- I. This Contractor is responsible for all revisions necessary to the existing sprinkler heads and piping presently serving areas to be a remodeled, under this contract.
- J. Locate sprinkler heads so they are symmetrical.
- K. Connect to existing sprinkler riser as indicated on the Contract Drawings.

1.02 SITE WORK

- A. No site work is associated with this portion of the project.

1.03 QUALITY ASSURANCE

- A. Standards: American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), Underwriters' Laboratories, Inc. (UL) and Factory Mutual (FM), American Water Works Association (AWWA), American Standards for Testing Materials (ASTM), and Ohio Building Code (OBC).
- B. All Fire Protection work shall comply with applicable NFPA, Local Code requirements and the Contract Documents.

1.04 DRAWINGS

- A. Drawings are schematic showing the type, scope and general layout of the systems including suggested location of alarm valves, sprinkler heads, main piping fire hose cabinets as necessary.
- B. Drawings indicate the basis of design and general arrangement of the fire protection systems for use by the Contractor in developing the detailed design of the systems.
 - 1. The detailed system design is the responsibility of the Contractor.
 - 2. Not all system details, heads, and other materials are shown on the Contract Documents; no additional payment will be made for such details or materials required to comply with codes or to secure a building permit.
 - 3. Contractor's design-build responsibilities include providing everything required for a complete system which complies with the conditions of the Contract Documents and the codes having jurisdiction.
- C. The number and location of sprinkler mains, branch piping and heads shall be coordinated with other architectural, structural, mechanical and electrical equipment items such as ceiling panel patterns, beams, diffusers, speakers and light fixtures.
 - 1. The Fire Protection Contractor shall coordinate any and all changes in this layout with the other Contractors; notify the Architect immediately of any changes in location or other conflicts that may affect either the fire protection coverage or the work of other Contractors.
- D. The work shall be installed in accordance with the Contract Documents, applicable codes and governing agencies.
 - 1. Furnish all necessary valves, fittings, devices and accessories required, including hangers, inserts, and other accessories.
 - 2. Locate sprinkler heads in a pattern so spaced as to meet the minimum requirements of the Governing Authorities, conforming with the architectural interior design and coordinated so as not to interfere with the work of any other Trade.
- E. The Contractor is responsible for the hydraulic calculations, design, installation and obtaining all approvals for the Fire Protection Systems.
 - 1. Prepare complete working reproducible (sepias or mylars) shop Drawings of the entire Fire Protection System including the renovated areas.
 - 2. Submit to the local Authority Having Jurisdiction (AHJ) for approval.
 - 3. Shop Drawings shall bear the stamp of a registered Professional Engineer or State Certified Sprinkler Designer.

- 4. Submit hydraulic calculations and shop Drawings that have been approved by the AHJ to the Architect/Engineer for record purposes; comments will be made only if the documents do not conform to the Contract Documents, see Section 20 05 15, "Submittals" for additional submittal requirements.

- F. No additional money will be allowed for additional heads and piping required after code review.

1.05 LICENSES

- A. The installation of this Fire Protection work shall be made only by a Contractor using craft persons licensed and certified by the City, County, and State to work on fire protection systems.
- B. Include copies of the Certificate of Approval in the Record and Information Booklets turned over to the Owner.

1.06 FEES

- A. This Contractor shall pay for all permits, inspection fees and other charges related to the installation of the Fire Protection work.

1.07 COMPLETION OF FIRE PROTECTION SYSTEM

- A. The Fire Protection system shall not be considered complete and acceptable unless and until all Code and Governing Agency requirements are satisfied.
- B. All control valves, alarm devices, supervisory devices, drain valves and gauges shall be checked for proper operation with a written record of these checks submitted to the Architect.
- C. Final completion of the work shall require successful completion of all required testing and approval, and submittal of the Contractor's Material and Test Certificate.

END OF SECTION

21 05 02
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide UL/FM listed fire protection specialties or accessories as required by the Contract Documents, equipment manufacturer or Local Code Authority.
- B. The Fire Protection Contractor provides and installs supervisory valve and flow switches; Electrical Contractor provides wiring.

1.02 MANUFACTURERS

- A. Reliable, Viking, Autocall, Star, Guardian, Gem, Globe, Central Sprinkler, Potter-Roemer, Potter, Notifier, Elkhart Brass, Simplex, Croker, Victaulic, W.D. Allen or Automatic Sprinkler.

1.03 QUALITY ASSURANCE

- A. Standards: Currently listed as approved in the "Fire Protection Equipment List" as published by Underwriters' Laboratories, Inc. (UL), or the Factory Mutual System Approval guide (FM), bearing the proper labels as identified therein.

PART 2 PRODUCTS

2.01 FLOW SWITCH

- A. Vane-type switch, weather-resistant adjustable pneumatic time delay 90 seconds or less, two (2) sets of single-pole double-throw micro-switches, tamper-proof cover (extra set of contacts), steel U-bolt clamp, saddle type mounting directly to piping.
 - 1. Potter-Roemer Fig. 6200 series.

2.02 SUPERVISORY (TAMPER) SWITCH

- A. Weather-resistant, single-pole, double-throw switch, roller type switch actuator, spring-loaded plunger, tamper-proof cover (extra set of contacts).
 - 1. Potter-Roemer Fig. 6220.

2.03 PRESSURE GAUGE

- A. Dial spring, brass case, 3 1/2 inches diameter, 1/4 inch NPT male connection, range: 0-300 psig.
 - 1. Reliable Model UA.

2.04 ELECTRIC SPRINKLER ALARM SWITCH

- A. Two (2) single-pole, double-throw snap-acting electric switches, spring loaded plunger, self-setting, 4-20 psi adjustable range, 180 degrees F, NEMA 1 enclosure, with tamper switch.
 - 1. Potter Model PS10-2A.

2.05 INSPECTOR'S TEST CONNECTIONS

- A. Sight Test Connection:
 - 1. Steel, clear tube, smooth bore, non-corrosive orifice with flow equivalent to one (1) sprinkler head, 1 inch NPT connection.
 - 2. Reliable Model B or equivalent test module Victaulic 718 or "Test-an-Drain."
- B. Blind Test Connection:
 - 1. Bronze, non-corrosive, smooth bore orifice with flow equivalent to one (1) sprinkler head, 1 inch NPT connection.
 - 2. Reliable Model A or equivalent test module Victaulic 718 or "Test-an-Drain."

2.06 IDENTIFICATION SIGNS

- A. All control, drain, and test valves shall have marked identification signs indicating the portion of the system controlled by each valve. Reliable Model A.
- B. 18 gauge steel, porcelain enameled, white lettering on red background.
 - 1. General Purpose Valve Control - Reliable Style A
 - 2. Specific Identification - Reliable Style B
 - 3. Fire Alarm - Reliable Style D
 - 4. Hydraulic Calculated System - Reliable Style E
- C. 20 gauge steel, porcelain enameled, white lettering on red background.
 - 1. Cold Weather - Reliable Style C
- D. Locate signs per NFPA 13 requirements.
- E. When item being identified is above suspended ceiling, sign is to be placed on nearest ceiling pad below shut-off valve or other item being identified.
- F. Signs shall be secured with noncorrosive wire, chain(s) or other approved means.

2.07 DRAINS

- A. Furnish drains using Schedule 40 black steel pipe (ASTM A120). Exterior piping shall be galvanized steel (with no raw steel exposed) or non-ferrous to prevent staining exterior walls.

2.08 HANGERS

- A. Refer to Section 20 05 45, "Hanger, Supports and Inserts" which is part of this contract work.

- B. All component parts of hanger assemblies shall be listed by UL/FM and NFPA.
- C. All hangers shall support the total load of the water-filled pipe in addition to a minimum of 250 lb. load applied at the hanger.
- D. All hangers installed shall be appropriate for type of building structure indicated.
- E. C-clamps without retaining straps are expressly prohibited.

2.09 SPRINKLER GUARDS

- A. Welded wire steel, baked synthetic red enamel finish, for use with 1/2 inch or 3/4 inch NPT male pipe threads, 2 3/4 inches by 3 inch square base, 2 7/8 inches high.
 - 1. Reliable Model B.

2.10 BAFFLES

- A. 18 inches by 18 inches galvanized steel.
 - 1. Potter-Roemer, Inc. Fig. 5021-D.

2.11 ELECTRIC ALARM BELL

- A. Furnished and installed by the Electrical Contractor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install supervisory switches on all operable valves except fire department valves, refer to Drawings.
- B. Install flow switches at locations indicated on the Drawings and as required.
- C. Do not install a flow switch within 12 inches of a "tee" or "elbow" or within 18 inches of a gate valve.
- D. Install pressure gauges on the sprinkler riser, at each test connection and where shown on the Drawings.
- E. Pressure gauges shall be located where water will not freeze, provided with a shutoff valve and with provision for draining.
- F. All drain and Inspectors Test piping passing through an exterior wall shall be galvanized or non-ferrous, no raw steel surface shall be exposed.
- G. Install a blind test connection in test pipes connected to an open drain and a sight test connection in test pipes that connect to closed drains.
- H. Install all necessary pipe hangers of approved spacing, type and size per NFPA 13.

- I. Provide splash blocks for all drain and inspectors test outlets occurring in sodded areas.
- J. Install baffles on sprinkler heads less than 6 feet apart.

3.02 COORDINATION OF WIRING

- A. Required wiring from fire protection specialties to the fire alarm panel is provided by the Electrical Contractor.

END OF SECTION

21 05 23
FIRE PROTECTION VALVES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide UL/FM listed and labeled valves for the fire protection water piping system shown on the Drawings.
- B. Tag all valves, provide valve chart per Project Specifications.

1.02 QUALITY ASSURANCE

- A. Standards: Underwriters' Laboratories (UL), Factory Mutual (FM) and National Fire Protection Association (NFPA).
- B. All valves of the same type used on the project shall be by the same manufacturer, except as noted.

PART 2 PRODUCTS

2.01 SWING CHECK VALVE

- A. UL/FM listed, 175 lb. (WWP) cast iron body; brass moving parts including clapper valve seat and pivot shaft, Buna-N "O" ring, flanged connections.
- B. Viking Model G-1 or approved equal by Gem, Reliable, Central, Mueller, Automatic Sprinkler, Nibco, Watts, Star or Victaulic.
- C. The use of interior springs to assist closing of disc(s) shall not be accepted.

2.02 BRONZE GATE VALVES (UP TO 2 INCHES)

- A. UL/FM listed, 175 lb. (WWP) bronze body, threaded ends, OS & Y rising stem, bronze yoke, solid wedge, repackable when wide open.
 - 1. Fire Suppression System Manufacturer, Nibco, Watts, Mueller, Stockham Fig. B-133, Kennedy, Crane or Victaulic.

2.03 IRON BODY GATE VALVES (2 1/2 INCHES AND LARGER)

- A. UL/FM listed, 175 lb. (WWP) high strength reinforced alloy iron body and bonnets, 125 lb. ANSI flanges, OS & Y rising stem, renewable bronze yoke bushing, bronze seat rings, solid taper wedge, repackable when wide open, blind bosses for drain tapping.
 - 1. Fire Suppression System Manufacturer, Nibco, Watts, Mueller, Stockham Fig. G-634, Kennedy, Crane, or Victaulic.

2.04 BRONZE GLOBE VALVES (UP TO 2 INCHES)

- A. UL/FM listed, 300 lb. (WWP) bronze body, threaded ends, integral seats, Nitrile rubber disc, bronze stem and lock nut.
 - 1. Fire Suppression System Manufacturer, Nibco, Watts, Mueller, Stockham, Kennedy, or Crane.

2.05 BUTTERFLY VALVES (IN LIEU OF GATE VALVES 2 1/2 INCHES AND LARGER)

- A. UL/FM listed, 175 lb. (WWP) ductile iron body, aluminum-bronze disc, stainless steel stem, Buna-N seat, phenolic ring, lever lock handle (up to 6 inches) or gear operator for 8 inches and larger.
 - 1. Fire Suppression System Manufacturer, Nibco, Watts, Gem, Victaulic 708 or Sprink JPL Watchman.

2.06 MISCELLANEOUS VALVES

- A. All valves to be UL/FM listed.
- B. Angle Valves: 175 lb. (WWP) bronze, rubber disc, wheel handle.
 - 1. NIBCO T-301-W or equal.
- C. Hose End Gate Valves: 175 lb. (WWP), bronze, solid wedge, screw-in bonnet non-rising stem, iron handwheel with cap and chain.
 - 1. NIBCO T-103-HC or equal.
- D. Hose End Angle Valves: 175 lb. (WWP), bronze, renewable composition disc, iron handwheel w/cap and chain.
 - 1. NIBCO T-331-HC or equal.
- E. Test Valve: 300 lb. (WWP) bronze, three-way, needle seat, integral tapered disc, wheel handle.
 - 1. NIBCO T-291-W3 or equal.

2.07 WET PIPE ALARM VALVE AND TRIM

- A. UL/FM listed, 175 lb. (WWP), cast iron body, tapped bases for alarm accessories, pressure gauges, drain, bronze moving parts, including clapper and bushings, rubber gasket, flanged connections.
- B. Trim: Include retard chamber, pressure switch, strainers, gauges, fittings, piping and drain, control, and test valves.
- C. Reliable Model E or approved equal by Victaulic, Gem, Globe, Viking, Central, Automatic Sprinkler, or Star.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves and accessories as indicated on the Drawings and as required by NFPA 13 in locations that are accessible to qualified personnel.
- B. Tag all valves as required.

3.02 COORDINATION

- A. Coordinate location of valves with Architect.
- B. Coordinate location of access panels as required with Architect and Contractors.

END OF SECTION

21 13 13
WET SPRINKLER PIPING SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Connect to fire water service line inside building above floor slab where shown on Drawings, extend to building sprinkler system, refer to Drawings.
- B. Provide sprinklers and piping to provide coverage of new area of the Building and revise the existing system unless otherwise noted on Drawings.
- C. Install recessed sprinklers with white escutcheon plate in finished areas (lay-in or plaster ceilings), and brass upright sprinkler heads in areas without ceilings.
- D. Sprinkler system shall be sized based on hydraulic calculations.
 - 1. The water flow velocity anywhere within the piping system shall not exceed 25 feet per second.
- E. Contractor shall locate sprinklers in ceilings so they are symmetrical and in coordination with the architectural plans.
- F. Test complete system.

1.02 QUALITY ASSURANCE

- A. Standards: National Fire Protection Association (NFPA 13 and 25), Underwriters' Laboratories Inc. (UL), and Factory Mutual (FM), American Standards for Testing Materials (ASTM), American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Water Works Association (AWWA), and Ohio Building Code (OBC).

1.03 BUILDING FIRE HAZARD CLASSIFICATION

- A. Light Hazard and Ordinary Hazard, refer to the drawings.

1.04 CEILING TEMPERATURE COORDINATION

- A. It shall be the responsibility of this Contractor to install sprinklers having the proper temperature ratings.
 - 1. Contractor shall check ceiling temperatures as needed to determine proper sprinkler head temperature ratings.

1.05 MANUFACTURERS

- A. Reliable, Gem, Globe, Automatic Sprinkler, Viking, Victaulic, Star or Central.

PART 2 PRODUCTS

2.01 PIPING

- A. Interior Piping:
 - 1. Electric-resistance welded steel (ASTM A135).
 - 2. Wrought steel (ANSI/ASME B36.10M).
 - 3. Welded and seamless steel (ANSI/ASTM A53).
 - 4. Galvanized, welded and seamless steel (ASTM A795).
 - 5. Type "L" seamless copper tubing (ASTM B88).
- B. Piping shall be UL listed and FM approved. All steel piping wall thickness shall be at least Schedule 40, regardless of the joining method.

2.02 FITTINGS

- A. Cast iron screwed or flanged fittings, 125 lb. or 250 lb. SWP as required, (ASME B16.4 and B16.1).
- B. Malleable iron screwed fittings, 150 lb. or 300 lb. SWP as required (ASME B16.3).
- C. Factory-made wrought steel, butt-weld fittings (ASME B16.9).
- D. Butt welding ends for pipe, valves, flanges and fittings (ASME B16.25).
- E. Steel pipe flanges and flanged fittings (ASME B16.5).
- F. Forged steel fittings, socket welded and threaded (ASME B16.11).
- G. Wrought copper and bronze solder-joint pressure fittings (ASME B16.22).
- H. UL listed and FM Approved Copper Pipe Extracted Fitting (T-Drill): An extracted mechanical tee joint may be made in copper tube. The joint shall be made using tooling specifically designed for this type of joint, and the tooling shall extrude a collar with a minimum height of three times the thickness of the tube wall. The branch tube shall be beveled to match the contour of the main run of the piping and dimpled to control the depth of insertion. The fitting penetration shall not impede the free flow within the piping system. The joint shall be completed using a certified method of brazing in accordance with ASME brazing requirements. The brazing filler material shall be of the copper phosphorous classification. This joining method shall be in strict accordance with the written installation instructions as published by T-Drill Industries, Inc.
- I. Fittings shall be UL listed and FM approved.

2.03 SOLDER AND BRAZING ALLOYS

- A. Brazing filler metal (Classification BCUP-3 or BCUP-4) (AWS A5.8).
- B. Solder metal, 95/5 Tin-Antimony-Grade 95 (ASTM B32).

2.04 SPRINKLERS

- A. General: All sprinklers shall be UL listed and FM listed and bear an approved stamp or label.
- B. Construction: Automatic spray, quick response, glass bulb type, bronze tensioned frame, directional deflectors, and threaded connection. Orifice and connection size to be determined by density requirements and hydraulic calculations.
- C. Furnish following sprinkler head types:
 - 1. Upright: Reliable Model F1FR, brass finish (unfinished areas without ceilings).
 - 2. Pendent or upright sprinkler heads with guards for storage and service areas.
 - 3. Concealed: Reliable Model G4A with adjustable coverplate.
- D. Temperature Ratings:
 - 1. Unless otherwise noted, furnish Ordinary Class, 135 to 170 degree F sprinklers, except in the following areas:
 - a. Mechanical Rooms: Intermediate Class, 177 to 225 degrees F.
 - b. Mechanical Rooms with High Pressure Steam Equipment: High Class, 250 to 300 degrees F.
 - c. Electrical Rooms and Telephone Equipment Rooms: Intermediate Class, 175 to 225 degrees F.
 - d. Near Heating Equipment: Intermediate Class, 175 to 225 degrees F.
- E. Finish:
 - 1. Standard factory brass finish for upright sprinkler heads in areas without ceilings.
 - 2. Pendant, sidewall, concealed, and semi-recessed sprinkler heads shall be white.
- F. Escutcheon Plates:
 - 1. Escutcheon plates shall be installed tight to the ceiling.
- G. Spare Heads:
 - 1. This Contractor shall provide a sprinkler head wrench and a stock of spare heads in a cabinet for future use for each type and temperature rating of head installed. Furnish quantity of each type and temperature rating per the following schedule:

<u>NUMBER OF HEADS</u>	<u>EXTRA HEADS</u>
Up to 300	6
301 - 1000	12
Over 1000	24

- 2. Mount sprinklers and wrench in cabinet and install cabinet on wall next to alarm valve or on alarm valve piping.

PART 3 EXECUTION

3.01 INSPECTION

- A. Schedule all inspections required by Code and Governing Agencies.

3.02 INSTALLATION

A. Piping:

1. All piping shall be arranged in accordance with the best standards of the trade, with risers plumb and horizontal mains and branches run parallel or perpendicular to the building walls.
2. Securely fasten pipe and support with hangers that meet NFPA requirements, spaced not less than 12 inches or more than 18 inches from a sprinkler head; one hanger on each length of pipe and cross mains between each branch line.
3. Install all piping and valves as required in connection with this installation.
4. Install all necessary standard hangers and special hangers of approved type and size; refer to other sections within these Specifications regarding hangers, supports and inserts.
5. All piping in interior areas having ceilings shall be concealed, unless noted otherwise.
6. No wet piping to be installed in areas where space temperature may drop below 40 degrees F.
7. All piping systems shall be installed with adequate provisions made for expansion and to prevent stresses on valves and equipment; provide adequate pipe anchors and guides and support from building structure.
8. Pitch piping to drain toward alarm valve and make provisions to drain all piping; provide auxiliary drains where necessary.
9. Ceiling grid systems shall not be supported from, or used to support from, or used to support, electrical conduit, sprinkler lines, or any other utility lines. Each utility and the ceiling grid system shall be independently supported from the building structure, concrete, steel or masonry. Where interferences occur, in order to support piping, conduit, ceiling grid systems, trapeze-type hangers or supports will have to be employed and shall not be located where they interfere with access panels, valves and other mechanical equipment items.
10. Drain/test pipes shall be installed at base of sprinkler riser.
11. All drain and test piping passing through an exterior wall shall be galvanized or non-ferrous, no raw steel surface shall be exposed.
12. Install flow and supervisory switches where shown on Drawings, wiring provided by the Electrical Contractor.
13. Tag and identify all piping and valves installed under this work.
14. All drains/test pipe locations shall be approved by Local Fire Department and Architect.
15. Provide all necessary adaptors, fittings and piping required to make connections to the water service piping.

B. Joints:

1. Threaded Pipe and Fittings:
 - a. Ream pipe ends to full cross sectional area after cutting.
 - b. Threads shall conform to ANSI Standard B2.1.
 - c. Joints shall be made using an appropriate thread compound or tape.
2. Welded Pipe:
 - a. All welding and brazing shall be done by an AWS-Certified welder in accordance with the American National Standards Institute "Code for Power Piping, Pressure Piping," (ANSI B31).

- b. All welders or brazers shall be certified by this Contractor as being qualified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."
 - c. Torch cutting of pipe is prohibited.
 - d. Butt-welded joints shall have substantially full penetration and recommended bead reinforcement.
 - e. Slip on, socket and fillet welds shall have geometry indicated in the "Code for Pressure Piping" (ANSI B31).
 - f. All slag and other welding residue shall be removed as work proceeds and at completion.
- C. Install sprinkler heads in center of ceiling tile in lay-in ceiling system to within 1 inch of exact center of ceiling grid, refer to details on Drawing.

3.03 TESTS

- A. After all tests have been completed; the Contractor's Material and Test Certificate required by NFPA 13 shall be completed and forwarded to the Authorities Having Jurisdiction along with placing a copy in the Record and Information Manual.
- B. The sprinkler system shall be tested hydrostatically at 200 psig for two (2) hours. The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested. There shall be no visible leakage during the hydrostatic testing.
- C. Comply with NFPA 25, "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems."
- D. Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.
- E. Brine or other corrosive chemicals shall not be used for testing systems.
- F. Tests shall be observed by Approving Authorities and Architect's Representative.

3.04 WIRING

- A. Alarm wiring from the wet pipe alarm valve to the fire alarm panel by the Electrical Contractor.

END OF SECTION

22 05 01
PLUMBING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish material, labor, tools, accessories and equipment to complete and leave ready for operation all plumbing systems of this project as described in these Specifications and shown on the Drawings.
- B. Refer to Sections 20 00 00 through 20 99 99 (as included) for items of a general nature which apply to this portion of the work. Sections 22 00 00 through 22 99 99 (as included) also describe Plumbing work.
- C. It is the intent that the Plumbing Work be complete in every respect.
- D. Use sufficient journeymen plumbers and competent supervisors in execution of this portion of the work to ensure proper and adequate installation throughout. In the acceptance or rejection of installed plumbing, no allowance will be made for lack of skill on the part of workmen.
- E. Coordinate location of all work with other Contractors and equipment.
- F. Work includes, but is not limited to, the following:
 - 1. Site Work:
 - a. Gas Service
 - b. Sanitary Sewer System
 - c. Garage interceptor system
 - 2. Plumbing Insulation
 - 3. Interior Domestic Water Piping System
 - 4. Interior Natural Gas Piping System
 - 5. Interior Sanitary, Waste and Vent Piping System
 - 6. Plumbing Specialties
 - 7. Water and Drain Valves
 - 8. Plumbing Equipment:
 - a. Natural Gas Storage Water Heater
 - b. Circulating Pump
 - c. Garage interceptor
 - 9. Plumbing Fixtures
- G. Plumbing Rough-in and Final Connections
 - 1. Provide service rough-ins and make final connections to equipment furnished by the Equipment Contractor or the Owner.
 - 2. Install plumbing equipment furnished by the Owner, unless otherwise noted.
 - 3. Provide piping, valves and specialties as required and as specified under other Sections of these Specifications.

- H. Equipment Connections
 - 1. Make final connections to equipment, coordinate rough-in locations with other Contractors and Owner.
 - 2. Refer to approved equipment Drawings for exact rough-in sizes and locations.
 - 3. Provide stops on supplies to equipment not otherwise furnished with integral stops.

1.02 LICENSES

- A. The installation of this plumbing work shall be made by a Contractor and craftsperson's licensed by the City, County, or State.
- B. Obtain from the AHJ, a Certificate of inspection and approval a copy of which shall be inserted into the record and information booklets turned over to the Owner.
- C. Pay for all permits, tapping fees, inspection fees, meter cost, and other charges related to Plumbing work listed.

END OF SECTION

22 05 02
PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide plumbing piping specialties or accessories as listed herein, specified or indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Standards: Plumbing and Drainage Institute (PDI), American Society of Plumbing Engineers, American Society of Sanitary Engineering (ASSE), American National Standards Institute (ANSI).
- B. All cast brass or bronze products shall be certified to be lead-free; meeting EPA Standards when installed in waterways used for potable water.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. 4 1/2 inch diameter dial, glass face with standard stainless steel bourdon tube spring, black die cast aluminum case, 0 to 160 psig range, 1/2% accuracy, provided with ball valve.
 - 1. Weiss Model 4PGA-1, Terice, Ashcroft, Miljoco, Marsh, or Marshalltown.

2.02 THERMOMETERS

- A. Industrial thermometer, heavy-duty casing, 9 inch scale, mercury-free, non-toxic, organic spirit-filled, front double strength window, adjustable angle, 30 to 240 degree F range with required insertion length to sense fluid temperature (1.5 inches minimum), brass or stainless steel separable sockets of required length with insulation extension and heat transfer paste, recalibration feature.
 - 1. Weiss Model, Miljoco, Terice, Ashcroft, Marsh, or Marshalltown.

2.03 BACKFLOW PREVENTERS

- A. 175 lb. SWP reduced pressure (ASSE 1013), bronze or cast iron body, with vents, inlet/outlet valves, test cocks, neoprene discs, Buna-N or plastic disc-stainless spring, interior check and differential pressure relief valves, air gap drain funnel, 32 degrees F to 145 degrees F temperature range meeting the requirements of the local water department and EPA. Backflow preventer shall be serviceable without removal from pipe, install strainer on inlet.
 - 1. 1/2 Inch to 3 Inches: Watts Model 009 with air gap drain funnel.
 - 2. 4 Inches to 10 Inches: Watts Model 909 Series with air gap drain funnel.
 - 3. Acceptable Manufacturers: Watts, Ames, Cla-Val Company, Conbraco, Hersey or Wilkins.
 - 4. Pipe backflow preventer drain through air gap fittings and down to 2 inches above nearest floor drain. Secure and support drain line.

- B. Coffee, ice and vending machines backflow preventer: Watts Model 7C continuous pressure type, chrome brass body, stainless steel springs, and parts, double-check valve assembly, FDA approved.
- C. Manufacturers and their models shall be approved by the EPA.

2.04 VACUUM BREAKERS

- A. 125 lb. SWP (ANSI 112.1.1, ASSE 1001) bronze body construction, chrome plated, full line size with body trim, disc float, full size orifice. (For use without continuous backpressure.)
 - 1. Watts No. 288C, Conbraco, Lawler, Wilkins, or Clayton.
- B. 150 lb. SWP (ASSE-1056) bronze construction, 3/8 inch and 1/2 inch size, body trim, disc float, anti-siphon, spill-proof. (For use with continuous back pressure.)
 - 1. Watts No. 008QT, Conbraco, Wilkins, Hersey or Clayton.

2.05 SHOCK ABSORBERS

- A. Shock absorbers shall conform to ASSE Standard 1010, PDI WH-201 and ANSI A112.26.1M-1984, stainless steel housing.
 - 1. Jay R. Smith, Zurn, Wade, Josam, or Watts.

2.06 WATER HEATER EXPANSION TANKS

- A. Welded ASME 125 psig steel tank with air charge valve, hot water connection, flexible heavy duty butyl diaphragm, rigid polypropylene liner and air precharge, FDA approved or certified for use in potable water service.
 - 1. Amtrol "Ex-Trol" tank, State, Taco, Bell & Gossett, Wilkins or Wessels Expansion Tanks.

2.07 STRAINERS

- A. 1/2 Inch to 4 Inches: Watts No. 777S, "Y" strainer, 125 SWP, bronze body with 20 mesh stainless steel screen, threaded ends. Provide drain valve on strainer with 3/4 inch garden hose threaded outlet and capped.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all plumbing specialties per manufacturer's instructions.
- B. Locate shock absorbers according to PDI Standard WH-201, where shown on the Drawings; tagging with size designations for field inspection.
- C. Install thermometers on the inlet and outlet piping to the water heaters and on domestic hot water circulating pumps or where shown on the Drawings.

- D. Install pressure gauges on the inlet and outlet piping of all pumps.
- E. After installation of mixing valve assembly, flush water supply line to remove debris. Clean out shower mixing valve assembly and inlet strainers after flushing; install strainers on upstream lines to inlets on mixing valve.
- F. Install continuous back pressure vacuum breaker on all lines to hose bibs if not furnished with integral vacuum breaker.

3.02 COORDINATION

- A. Coordinate installation height and location of hose bibbs, faucets and interior/exterior wall hydrants with the Architect.
- B. Coordinate locations of garage interceptor with other Contractors and equipment.

END OF SECTION

22 05 23
WATER AND DRAIN VALVES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide valves to facilitate maintenance and isolation of piping systems.
- B. All valves shall be line size.
- C. Provide valve chart, refer to Section 20 05 20, "Record and Information Booklets."
- D. Shut-off valves shall be provided on all branches of main water lines and ahead of dielectric unions.

1.02 QUALITY ASSURANCE

- A. Standards: American National Standards Institute (ANSI), American Society of Plumbing Engineers (ASPE), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM) and the Manufacturers' Standardization Society of the Valve and Fittings Industry (MSS).
- B. All cast brass or bronze valves shall be certified to be lead-free; meeting EPA Standards when installed in potable waterways.

1.03 MANUFACTURERS

- A. Gate Valves: Milwaukee Valve, Hammond, Stockham, or Powell, Watts, Nibco or Victaulic.
- B. Balance Valves: Milwaukee Valve, Apollo (Conbraco Industries), Hammond, Taco or Armstrong.
- C. Ball Valves: Milwaukee Valve, Apollo (Conbraco Industries), Hammond, Stockham, Watts, or Nibco.
- D. Butterfly Valves: Milwaukee Valve, Apollo, Hammond, Nibco, Keystone, Crane, Mueller, Watts, Stockham or Victaulic.
- E. Water Pressure Reducing Valves: Watts, Conbraco, Clayton (CLA-VAL), Cash, Acme, Ames, Baukmann or Wilkins.
- F. Check (Swing) Valves: Milwaukee Valve, Hammond, Stockham, Watts, Nibco or Victaulic.
- G. Globe Valves: Milwaukee Valve, Hammond, Watts or Nibco.
- H. All valves of the same type used on the project shall be by the same manufacturer, except as noted.

PART 2 PRODUCTS

2.01 BALL VALVES

- A. 2 Inches and Smaller: 2-piece ball valves, 600 lb. WOG, 150 SWP, cast bronze body conforming to ASTM B584, reinforced Teflon seats, hexagonal threaded packing gland, TFE packing, full port, blow-out proof stem, adjustable packing gland, extension shaft for insulation clearance, stainless steel or chrome plated solid bronze ball, screwed or soldered ends.
1. Milwaukee Valve #BA-400 N61 (threaded ends) or BA-450 N61 (soldered ends).

2.02 CHECK VALVES

- A. 2 Inches and Smaller: Class 125, 200 lb. WOG, cast bronze body and cap conforming to ASTM B-62, swing check design, with solder joint tubing or screwed ends, with replaceable composition disc and integral seat.
1. Milwaukee Valve #509T(TE) (threaded ends) or #1509T(SE) (soldered ends).
- B. 2 1/2 Inches and Larger: Class 125, 200 lb. WOG, cast iron body, bronze trim and bolted cap conforming to ASTM A-126, Class B. Flanged ends, swing type disc.
1. Milwaukee Valve #F2974.
- C. The use of interior springs to assist closing of disc(s) shall not be accepted.

2.03 BUTTERFLY VALVES

- A. 2 Inches and Smaller: 175 lb. SWP, B62 bronze body, screwed or solder joint ends, stainless steel shaft and disc, Viton seal, extension shaft for insulation clearance, lever handle.
1. Milwaukee "Butterball" Model BB2-100 (threaded ends) or BB2-350 (soldered ends).
- B. 2 1/2 Inches and Larger: Lug type body, extended neck, 200 psig conforming to ASTM A-126, Class B cast iron, EPDM cartridge liner, with aluminum bronze disc, Type 416 stainless steel stem, sizes up 6 inches - lever operated, 8 inches and larger - gear operated. Provide lever with lever operated valve.
1. Milwaukee Valve CL 1223E Series - sizes up to 6 inches, Model CL 323E series - 8 inches up to 12 inches.

2.04 BALANCING VALVES

- A. 2 Inches and Smaller: 175 lb. SWP, ASTM B-62 bronze body (less than 3% lead content), screwed or solder joint ends, stainless steel shaft and disc, Viton seal, memory stop tab, extension shaft for insulation clearance, lever handle. The valve shall be equipped with integral meter connections or such connections provided on each side of the valve. Should they be located on both sides of the valve, spacing shall be such as to provide an accurate flow reading.
- B. Valves shall be suitable for use on domestic hot water systems.

2.05 DRAIN VALVES

- A. Rough ASTM B-62 bronze body, angle pattern, screwed, boiler drain valves with packing nuts, garden hose thread outlet with bronze cap and chain as manufactured by any of the above listed Manufacturers.
- B. Ball Drain Valve: Bronze body, chrome plated ball, 600 WOG, 150 SWP, teflon seats, blow-out proof stem, adjustable packing gland, garden hose thread outlet with bronze gasketed cap and chain. Hammond No. 8501H.
- C. 3/4 inch ball valve with capped hose end connector may be used at Contractor's option.

2.06 GLOBE VALVES

- A. 2 Inches and Smaller: Class 150, 200 lb. WOG, cast bronze body and cap conforming to ASTM B-62, union bonnet, with solder joint tubing or screwed ends, gland packed, composition teflon disc, malleable iron handwheel.
 - 1. Milwaukee Valve #590 T (threaded ends) or #1590 T (soldered ends).
- B. 2 1/2 Inches and Larger: Class 125, 200 lb. WOG, bronze trim with cast iron body and bonnet conforming to ASTM A-126, Class B cast iron, flanged ends, N.A. packing, malleable iron handwheel.
 - 1. Milwaukee Valve #F2981.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves and specialties where indicated on the Drawings or where required for maintenance and service.
 - 1. Install valves with stems horizontal wherever possible, or within 15 degrees of vertical.
 - 2. Install valves with stems in the vertical in piping near the floor.
- B. Install 3/4 inch drain valves with hose end and capped in piping at low points to provide complete drainage of all systems.
- C. Install valves on hot and cold water branches serving more than one fixture, in supply lines to any equipment not provided with stops and in lines to wall hydrants.
- D. Install all valves in accessible locations; coordinate with ceilings, structure, mechanical and electrical equipment.
- E. Provide space to allow adjustment of balancing valve.
- F. Install union between each valve and piece of equipment.
- G. Install valves on branches to isolate areas of the building.
- H. Extend drain from water pressure relief valve to 2 inches above floor drain.

3.02 PROHIBITIONS

- A. Do not install any valves where the fluid operating pressure exceeds 80% of its pressure rating.
- B. Do not install solder joint valves on systems where the fluid temperature may soften the solder.

3.03 TESTS

- A. Test all valves for tightness.
- B. Test operate all valves at least once from closed-to-open-to-closed positions while valve is under pressure, replace or repair leaking valve.

END OF SECTION

22 07 01
PLUMBING INSULATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Insulate all domestic cold, hot, tempered and return water supply lines, regardless of length or location, as well as insulate the following:
 - 1. Electric water cooler waste traps and piping to wall.
 - 2. All above-floor slab trap primer drain lines to trap inlet.
 - 3. All above-floor slab main water supply lines from building entrance to domestic water connection.
- B. Insulation damaged while in storage or during installation shall be replaced at no additional cost to the Owner.

1.02 FACTORY-INSULATED EQUIPMENT

- A. Water heaters and hot water storage tanks shall be factory-insulated to comply with the State Energy Code and shall comply with Federal Standards HHI-530A.

1.03 QUALITY ASSURANCE

- A. Reference standards: National Fire Protection Association (NFPA) and Underwriters' Laboratories (UL).
- B. Insulation shall be in accordance with the State Energy Code and provide a maximum allowable heat loss as follows:
 - 1. Piping: 25 BTUH psf of pipe surface area.
- C. Insulation to be installed according to "Commercial and Industrial Insulation Standards," as published by the Midwest Insulation Contractor's Association, latest edition.

1.04 FIRE AND SMOKE HAZARD RATINGS

- A. Indoor pipe insulation shall have a flame-spread rating not exceeding 25, a smoke-developed rating not exceeding 50, and a fuel-contributed rating not exceeding 50. All insulation accessories shall have similar ratings. Rates are as tested by procedures ASTM E-84, NFPA 255, and UL 723.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protection: Leave insulation boxed and stored until time for use. Elevate and cover material to avoid moisture condensation and physical abuse and to protect from weather.

1.06 MANUFACTURERS

- A. Pipe and Roof Sump Insulation
 - 1. Fiberglass: Owens-Corning, Manson, Knauf, or Johns-Manville.
 - 2. Closed Cell Insulation: Nomaco, Tundra, "Armaflex," Rubatex, or IMCOA.
 - 3. PVC Insulation Covers: Speed Line, CertainTeed, IMCOA, Knauf, CEEL-CO CEEL-TITE 300 Series, Foster Sealfas, or Zeston.

PART 2 PRODUCTS

2.01 ADHESIVES, FINISHES AND MASTICS

- A. Use the following items or equivalent items:
 - 1. Vapor barrier lap adhesive - Foster Drion Contact Bond Cement 85-75
 - 2. Lagging adhesive - Foster 81-42W
 - 3. Metal bonding adhesive - Foster 85-15
 - 4. Indoor vapor barrier finish - Foster 30-80
 - 5. Indoor breather finish - Foster Lagtone 46-50
 - 6. Outdoor vapor barrier mastic - Foster 46-50
 - 7. "Fuse-Seal" sticks and applicator (for polyolefin insulation)
- B. The use of the preceding adhesives, finishes, and mastics shall be approved by the insulation manufacturer. Once dried, these materials shall have a flame-spread rating not exceeding twenty-five (25) and a smoke-developed rating not exceeding fifty (50).

2.02 THERMAL RESISTANCE OF PIPING INSULATION

- A. Insulate all piping installed to serve buildings and within buildings in accordance with the minimum pipe insulation as listed in the following table:

Minimum Pipe Insulation based on a conductivity of 0.24 to 0.28 (Btu)(in)/((hr)(cu.ft.)(°F))
100 degree F Mean Rating Temperature

Insulation Thickness for Pipe Sizes (Inches)

Piping System	Fluid Temperature Ranges (°F)	1 and Less	1 1/4 to 2	2 1/2 to 4	5 and Larger
DOM hot water, tempered water and hot water return	any	1.0	1.0	1.5	2.0
DOM cold water	40-55	0.5	0.5	1.0	1.0
EWC and DF waste	40-55	--	1.0	--	--

- B. The pipe sizes given in the preceding table are nominal dimensions.

2.03 INDOOR PIPING

- A. Fiberglass heavy-density insulation with all service vapor membrane jacket and pressure sealing lap adhesive on longitudinal and butt strips, K=0.23 at 75 degrees F, Owens-Corning 25 ASJ/SSL II. Staple and seal with pressure sealing lap adhesive on longitudinal and butt strips. Jacket vapor membrane shall have an installed vapor permeance of not more than 0.09 perms.
- B. Polyolefin foam insulation (for service temperature up to 210 degrees F), K=0.24 at 75 degrees F, IMCO "IMCOLOCK" or "IMCOSHIELD." No vapor barrier is necessary with 0.0 perm/inch permeability.
- C. A flexible, closed-cell elastomeric insulation with pressure sealing longitudinal joints or applied adhesive meeting ASTM E84's ratings of 25 flame-spread and 50 smoke-developed. Adhesive shall be approved by Insulation Manufacturer.

2.04 EXPOSED INDOOR PIPING DROPS UP TO 10 FEET ABOVE NEAREST WALKING SURFACE

- A. Insulation same as for indoor piping and cover with ultraviolet-resistant PVC jacket, self-extinguishing and zero fuel contribution.
 - 1. PVC jacket shall have a flame-spread rating not exceeding twenty-five (25) and a smoke developed rating not exceeding fifty (50).
 - 2. All piping visible inside and outside mechanical rooms is considered exposed.

2.05 FITTINGS AND VALVES

- A. Premolded PVC covers over molded insulation. Insulation same thickness as on adjoining pipe. Insulation shall have a flame-spread rating not exceeding twenty-five (25) and a smoke-developed rating not exceeding fifty (50).
 - 1. Polyolefin insulation, use insulation of same type and thickness as on adjoining pipe.

2.06 PIPE INSULATING SUPPORT

- A. Refer to Section 20 05 45, "Hangers, Supports and Inserts." The use of thermal protectors as pipe insulation supports are noted elsewhere in this specification. Where inserts are used, maintain insulation vapor barrier integrity.

2.07 DOMESTIC HOT WATER STORAGE TANKS

- A. Minimum thickness of 2 inches of fiberglass, 6 pcf, compressive strength 300 psi at 10% deformation, thermal conductivity 0.32 btu/(hour) (square foot) (°F/inch) at 175 degrees F mean temperature. Foam insulation may be used as long as the thermal conductivity is equal to or less than just listed and is approved for use intended by domestic hot water storage tank manufacturer.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION NOTES

- A. Installation shall be in accordance with the manufacturer's recommendations.
- B. Use no damaged or water-soaked insulation.
- C. Insulate all water piping as described above, including piping concealed in walls.
- D. Insulation to be continuous through sleeves and hangers.
- E. When piping is installed through fire-rated walls and floors, the insulation shall be continuous and fire-rated calking shall be installed between pipe insulation and wall sleeve without any interruption to the vapor barrier.
- F. Leave no "raw" ends on fiberglass insulation. Bevel fiberglass insulation terminations seal with insulating cement and cover ends with glass cloth or similar to pipe insulation covering.
- G. Ensure that exposed insulation has a neat and finished appearance, provide sizing for insulation if required to leave ready for painting.
- H. Overlap jacket joints and seal with a suitable adhesive.
- I. Install all insulation with a continuous, unbroken, and unpunctured factory-applied vapor membrane.

END OF SECTION

22 11 16
INTERIOR DOMESTIC WATER PIPING SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Connect into the existing domestic water piping system where shown on the Drawings.
- B. Provide a complete system of hot, tempered, hot or tempered return, and cold water to fixtures and equipment.
- C. Provide a domestic hot water circulating system throughout the building as shown on the Drawings, and include the following:
 - 1. Provide manual air vents at all high points within the circulating portions of the system.
 - 2. Provide balancing, check, and service shut-off valves at each branch of the circulating system.
 - 3. Provide "Pete's plugs" before and after the balancing assemblies unless they are incorporated into the balance valve assembly, refer to details on the Drawings.
- D. Provide a trap primer discharge line from outlet of each trap primer to each associated floor drain inlet.
- E. Test and sanitize the complete domestic water system.

1.02 QUALITY ASSURANCE

- A. Standards: American Society of Plumbing Engineers (ASPE), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), National Sanitation Foundation (NSF) and Plumbing and Drainage Institute (PDI), Columbus, Ohio Division of Water.
- B. Provide only fittings, piping, valves, and solder certified to be lead-free in accordance with EPA and NSF requirements.

PART 2 PRODUCTS

2.01 PIPING

- A. 4 Inches and Smaller: Type "L" hard drawn copper tubing (ASTM B88).
- B. Piping Below Grade, 2 Inches and Smaller: Type "K" soft temper copper tubing (ASTM B88).

2.02 JOINTS

- A. Copper: Wrought copper socket solder (ANSI B16.22) or brazed (ANSI B31.1) joints.

- B. Pipe Extracted Fitting (T-Drill): An extracted mechanical tee joint may be made in copper tube. The joint shall be made using tooling specifically designed for this type of joint, and the tooling shall extrude a collar with a minimum height of three times the thickness of the tube wall. The branch tube shall be beveled to match the contour of the main run of the piping and dimpled to control the depth of insertion. The fitting penetration shall not impede the free flow within the piping system. The joint shall be completed using a certified method of brazing in accordance with ASME brazing requirements. The brazing filler material shall be of the copper phosphorous classification.
 - 1. This joining method shall be in strict accordance with the written installation instructions as published by T-Drill Industries, Inc.
- C. Underground Copper: Wrought copper fittings with brazed joints.

2.03 SOLDER AND BRAZING ALLOYS

- A. Solder: 95/5 tin-antimony (ASTM B32), lead-free (above grade use only).
 - 1. "Silvabrite 100" as manufactured by Englehard or equal.
 - 2. "Bridgit" as manufactured by J.W. Harris Company or equal.
 - 3. "Sterling" as manufactured by Tarament or equal.
- B. Copper Brazing Alloys: AWS A5.8 Class BCUP-5 alloys having a melting point greater than 1350 degrees F. (ANSI B31.1), lead-free.
 - 1. Sil-Fos filler as manufactured by Handy and Harmon or equal.
 - 2. Aircosil 15 filler as manufactured by Airco Welding Products or equal.
 - 3. "Stay-Silv "15" as manufactured by J.W. Harris.
- C. No alloys containing lead shall be used for joints within any portion of the potable water system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all valves in accessible locations and coordinated with access panel locations.
- B. Make all joints in strict accordance with the manufacturer's written installation instructions and best practices of the profession.
- C. Install water lines located in exterior walls closest to the "heated" side of the wall.
 - 1. Cover the piping with continuous insulation.
 - 2. Pack the space between the insulated pipe and the "unheated" side of the wall with a continuous layer of building insulation.
- D. Install shock absorbers as sized and indicated on the documents.
- E. Provide an approved dielectric brake between piping of dissimilar metals; fittings, flanges, transition materials, etc.
- F. Install unions or flanges between valves and final connections to all equipment.

- G. Use only nipples of the same or similar material as the pipe being connected.
- H. Install valves on all branch line, fixture group areas, wall hydrant drops at the wall and at all equipment connection, whether specifically shown on the Drawings or not.
- I. Securely anchor all supply piping to fixtures, faucets, hydrants and flush valves to prevent movement.
- J. Provide all low points within the potable water systems with drain valves to facilitate drainage.
 - 1. Install system to permit complete drainage of the system.
- K. Where piping is installed above ceilings, below ceiling insulation, the Plumbing Contractor shall confirm that ceiling insulation has no insulation voids above piping.

3.02 COORDINATION

- A. Coordinate piping with beams, joints, wall, HVAC piping, ductwork, equipment and electrical equipment and conduit.
- B. Coordinate installation height and location of faucets, hose bibbs, and wall hydrants with the Architect.
- C. Install exterior wall hydrants flush and plumb with exterior wall.
- D. Coordinate any shutdown time for water line connection(s) with the Owner and General Trades Contractor.
- E. Coordinate location of rough-ins, outlets, and final equipment connections with all other Contractors and Owner's equipment.

3.03 TESTS

- A. Perform tests as required by the Local Code Authority and as specified below:
 - 1. Take precautions to remove all air before performing hydrostatic tests.
 - 2. Test piping at 1 1/2 times actual working pressure or 125 psig, whichever is greater, for six hours with no pressure drop. All tests shall be made before piping is concealed. Tests shall be witnessed by the Architect's Representative.
 - 3. If a leak occurs, defective piece or joint shall be replaced. Caulking is prohibited. Repeat tests until no leaks are detected.
 - 4. Perform all testing after completion of roughing-in, before setting of fixtures.
- B. Submit test reports to the Architect.

3.04 STERILIZATION OF WATER LINES

- A. After the water system is complete and fixtures have been installed, flush piping clean and sterilize all new hot and cold-water piping, including water service line and water heaters. Sterilize lines under the immediate on-the-job supervision of a Water Testing Laboratory regularly engaged in the service.

- B. This Contractor shall pay all fees for testing and use of testing equipment.
- C. With all outlets closed, fill system to working pressure and close valve on supply main.
- D. Open all fixtures slightly and pump a sterilization solution into test tap to achieve a minimum of 50 maximum parts per million chlorine solution made from a sanitation grade of hyperchlorite, 70% available chlorine; hyperchlorites may be Pittchlor, H.T.H. or Perclorn.
- E. Test every outlet, hot or cold, during fill to prove the presence of chlorine at that outlet. Chlorine shall be present at all outlets.
- F. Water piping system shall remain filled for a period of 24 hours. As an alternative, the system may be filled with a 200 part per million solution of chlorine, and allowed to stand for three hours.
- G. After sterilizing, all outlets shall be opened wide and the main supply valves opened, flushing system free of chlorine with clean water. Outlets shall be again checked and flushed until free of chlorine. Flush entire system. Coordinate this action with Owner if building is occupied.
- H. After final flushing, all electric water cooler strainers, faucet aerators and mixing valve strainers shall be removed, cleaned and reinstalled.
- I. Chlorination of the system may be performed at same time the pressure test is conducted.
- J. After sterilization of system is complete, obtain from the Water Testing Laboratory a test report concerning the complete biological examination of the system.

3.05 BALANCING OF DOMESTIC HOT WATER CIRCULATION SYSTEM

- A. After final flushing and sterilization, balance the domestic hot water circulation system.
- B. Unless noted otherwise on Drawings, balance each leg of the domestic hot water circulation system for equal flows.
- C. Record all flow measurements and balance valve settings and submit report as part of close-out documentation.

END OF SECTION

22 11 23
RECIRCULATING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide domestic hot water circulating pump for the hot water return system.
- B. Provide an immersion aquastat with timer for domestic hot water return pump control.
- C. All portions of pump that come in contact with domestic hot water shall be lead-free.

1.02 PUMP RATINGS AND CAPACITIES

- A. Pump Operating Point Requirements: The operating point of each pump at the conditions shown shall be within five percentage points of the maximum efficiency on its impeller curve. The impeller furnished is not to exceed 90% of the cutwater diameter available for the pump casing furnished. The impeller curve shall be continuously rising throughout the range contained within its efficiency curves. The peak of the impeller curve shall be a minimum of 10% above the total head shown on the Drawings. The pump must not overload the motor at any point on the impeller curve.

1.03 RATINGS AND CAPACITIES

- A. Refer to equipment schedule on the Drawings for GPM, Ft.Hd., HP., and electrical requirements.

PART 2 PRODUCTS

2.01 INLINE PUMP

- A. Inline circulating pump to be stainless steel or lead-free all bronze, horizontal, oil-lubricated with steel shaft, thrust collar, two horizontal sleeve bearings, non-ferrous impeller, non-ferrous waterway, mechanical seals.
- B. Motor to be open drip-resistant, with vibration isolation.
- C. Provide shielding around the packing areas.
- D. Manufacturers: Bell & Gossett, Grundfos, Amtrol Inc., Ayan, Taco, or Federal Pumps, Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide ball valve and unions on inlet and outlet side of pump.
- B. Do not support pump motor by itself; refer to manufacturer's recommendations for support.
- C. Provide timer or a temperature sensor (aquastat) for start/stop control of the pump.
 - 1. Temperature sensor may be integral with the pump, or installed in the piping.

3.02 WIRING

- A. Power wiring to aquastat and to circulating pump is by the Electrical Contractor.
- B. Provide all control wiring required for external timer, including power wiring for timer.

END OF SECTION

22 13 01
SANITARY SEWER SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Revise the sanitary sewer system as shown on the Contract Documents.
- B. Connect to existing sanitary sewer lateral, installing a manhole over existing sanitary lateral where shown on Drawings.
- C. Provide and install new piping, concrete manhole(s) and cleanouts at location(s) indicated on Drawing.
- D. Provide garage interceptor where shown on Drawings.
- E. Test complete new system.

1.02 QUALITY ASSURANCE

- A. National Agencies: American Society of Testing and Materials (ASTM), National Clay Pipe Institute (NCPI), American Concrete Pipe Association (ACPA), Cast Iron Soil Pipe Institute (CISPI) and American Water Works Association (AWWA).
- B. The following local agencies:
 - 1. State Environmental Protection Agency.
 - 2. Occupational Safety and Health Administration.
 - 3. City Sewer Department
- C. Installation shall meet State and Local requirements.

1.03 CONCRETE WORK

- A. Unless otherwise noted, all cast-in-place concrete for the plumbing work shall be by the Plumbing Contractor.
- B. Unless otherwise noted, all concrete material and installation shall be as required in Division 3 of the Specifications.

1.04 MANUFACTURERS

- A. Vitreous Clay Sewer Pipe: Logan Clay Products Company or approved equal.
- B. Cast Iron Pipe: Griffin, Clow, American Cast Iron, Richmond Foundry, U.S. Pipe, Tyler Pipe, or Charlotte Pipe.
- C. PVC Plastic Pipe: Manville, Certain-Teed, JMR-T, Capco, Yardly or Charlotte.

- D. Plastic Pressure Pipe: Manville "Blue Brute," North Star "Aqua-Lite," Certain-Teed or Robin Tech.
- E. Cleanouts: J.R. Smith, Zurn, Wade, Josam or Watts.
- F. Precast Concrete Manholes: E.C. Babbert, North Star, Price Brothers, Mack Industries, Reliance Universal or approved equal.

1.05 COMPLETION

- A. Upon their completion, sewers, manholes, cleanouts, and garage interceptors are to be left clean and free from rubbish until the acceptance of the work.
 - 1. Repairs or alterations made to the manholes and the grease interceptor after performing the leakage test may be justification for a retest of the section of sewer involved.

PART 2 PRODUCTS

2.01 SEWER PIPE

- A. Under roadways, driveways and parking areas or where final cover over sewer is less than 3 feet or more than 12 feet use the following:
 - 1. Service weight cast iron soil pipe and fittings for sizes through 15 inches: Bell and spigot type conforming to ASTM A74 with compression gasket joints.
 - 2. Extra strength vitrified clay sewer pipe (ASTM C700), with (ASTM C425) rubber or plastic ring gaskets, and poured 8 inch thick concrete all around.
 - 3. Reinforced concrete sewer pipe for sizes 12 inches and larger Class IV, conforming to ASTM C76 or equivalent. Design and construction of pipes shall meet minimum Class 3 strength requirements or equivalent sufficient to obtain 0.01 inch crack and ultimate D load of 2,000 lbs., ASTM C443 rubber gaskets.
- B. Under sodded areas or non-traffic areas, use the following:
 - 1. Extra strength vitrified clay sewer pipe bell and spigot ASTM C700 with rubber or plastic ring gasket joints conforming to ASTM C425.
 - 2. Hubless cast iron pipe (CISPI-301) with "No-Hub" couplings.
 - 3. Service weight cast iron bell and spigot type pipe ASTM A74 with ASTM C564 compression seal gasket joints.
 - 4. PVC plastic sewer pipe (ASTM/ANSI D3034), Type PSM, SDR 35 with (ASTM D3212) flexible elastomeric seals.
 - a. Contractor shall install pipe per ANSI/ASTM 2321 - "Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe," and ANSI/ASTM D3221.
- C. Cast iron pipe and fittings shall have factory-applied coating with enamel (ASTM A-74), OEPA acceptable.

2.02 FITTINGS

- A. All fittings shall be of the same type and class of material as the pipe or of materials having equal or superior physical and chemical properties.

- B. Fittings shall be molded or formed to suit pipe size and end design, in required tees, bends, elbows, cleanouts, reducers, and other configurations required.

2.03 JOINTS

- A. Joints for Cast Iron Soil Pipe:
 - 1. Rubber gasket compression type joint conforming to ASTM C564 shall be "dual-tight" or "Ty Seal" with lubricant equal to "Lubrifax."
 - 2. "No-Hub" couplings (CISPI-310-90) with neoprene sleeve and heavy duty Type 304 stainless steel collars and a minimum of four (4) stainless steel clamps. ANCO "Husky," "Clamp-All," Mission or Mage. Option: Cast iron coupling equal to ALFA, MG or Gustin-Bacon couplings.
- B. Joints for Vitrified Clay Pipe:
 - 1. Compression type, rubber ring gasket conforming to ANSI/ASTM C425.
- C. Joints for Plastic Pipe:
 - 1. ASTM D3212, bell and spigot style, flexible elastomeric seals.

2.04 MANHOLES

- A. Provide manhole (if no local standards exist) of either prefabricated masonry units ASTM C-478 or with ASTM C-443 joints constructed of brick with every six (6) course a stretcher course. Solid concrete radial blocks or cast-in-place concrete with #4 bar reinforcing 12 inch centers vertically and horizontally with 6 inch thick walls may be used. The base is to be a minimum of 6 inch thick precast or cast-in-place concrete. The base channels shall be built with concrete and lined with split pipe or brick, except the curve portion may be formed with concrete. The ladder rungs shall be 16 inches wide, 3/4 inches thick mild steel bars cast in the walls at 12 inches on center.
- B. Precast Manhole Construction:
 - 1. All precast manholes exceeding 6 feet in depth shall be of an eccentric design.
 - 2. The walls shall be corbelled in at the top to receive heavy duty frame and cover conforming to Local Code Standards.
 - 3. Rungs of plastic coated 3/4 inch mild steel bars shall be built into walls 12 inches to 16 inches maximum spacing on centers to form a ladder.
 - 4. Interior bottom shall be left clean and free of all debris.
 - 5. Precast concrete manholes shall be constructed to meet all requirements of Governing Agency and approved by Local Code Authorities, but must have eccentric top with straight walls to bottom of steps.
 - 6. Precast concrete manholes and eccentric cone top sections shall be in accordance with ASTM C478 with ASTM C443 joints.
- C. Manhole Covers:
 - 1. Best quality soft gray iron castings (ASTM A48), sound and true to pattern, with removable solid or grated cover, "roadway" weight, coated with two (2) coats of varnish at factory. "Sanitary" cast mark on lid shall identify service. Refer to Drawings for size and type manhole covers.
 - 2. Conform to Local Code Requirements.
 - 3. Neenah, McKinley, Vulcan or East Jordan.

PART 3 EXECUTION

3.01 SITE INSPECTION

- A. Contractor must examine the areas and the conditions under which sanitary sewer system work is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected and existing sewer location, size and depth has been established.
- C. The location of existing sewer line and manhole shown on the Drawings was determined from available construction records and should be considered approximate.
- D. The Contractor is responsible for determining the exact location of existing sewer line or existing manhole to which making connections, may disturb during earth moving operations, or which may be affected by the work in any way.
- E. Existing lines may not be taken out of service unless approved by the Architect or Owner.
- F. Notify the Architect and Owner for approval, at least 48 hours in advance of the desired time for taking any line out of service.
- G. Verify that trench cut is ready to receive work, and excavations, dimensions, and elevations are as indicated on Drawings.
- H. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION OF SEWER LINE

- A. General:
 - 1. Install pipe, fittings and accessories, in accordance with manufacturer's requirements and requirements of the Local Code Authority, except where more stringent requirements are required by these Specifications.
 - 2. Inspect piping before installation to detect any apparent defects; mark defective materials with white paint and promptly remove from the site.
 - 3. Lay piping beginning at the low point of a system, true to the elevation and alignment indicated, with unbroken continuity of invert.
 - 4. Place groove or bell end of pipe facing upstream.
 - 5. Install gaskets in accordance with the manufacturer's recommendations for use of lubricants, cements and other special installation requirements. Seal joints watertight.
 - 6. Where minimum cover of sewer pipe during construction or proposed cover over the top of the pipe is 30 inches or less, for sizes 6 inches to 27 inches in diameter inclusive, pipe shall be encased in 8 inches of concrete all around.
 - 7. Concrete Pipe: Install in accordance with applicable provisions of the American Concrete Pipe Association "Concrete Pipe Field Manual," unless otherwise noted.
 - 8. Vitrified Clay Pipe: Install in accordance with applicable provisions of ASTM C12, "Recommended Practice for Installing Clay Sewer Pipe," unless otherwise indicated.
 - 9. Cast Iron Soil Pipe: Install in accordance with applicable provisions of "Cast Iron Soil Pipe and Fittings Handbook" published by Cast Iron Soil Pipe Institute.

10. Plastic Pipe: Install in accordance with applicable provisions of ANSI/ASTM 2321, "Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe," ANSI/ASTM D3221, and Manufacturer's Recommendations at the elevation, depth and slope indicated on Drawings.
11. All plastic sewer pipe stored outside shall be covered until installed per Manufacturer's recommendations.
12. Contractor shall provide and install construction stakes, lines and grades or any other items necessary for the installation of the sewer line.
13. Provide all necessary adapters, fittings and pipe required to make connections to existing sewer lines and manholes.
14. Hand trim excavation to required elevations. Correct over excavation with fill material of fine aggregate.
15. Remove large stones or other hand matter which could damage pipe or impede consistent backfilling or compaction.
16. Bed and backfill pipe as specified and per Code.
17. Lay pipe to slope gradient noted on Drawings.
18. Increase compaction of each successive lift. Do not displace or damage pipe when compacting.
19. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. Prior to the placing of a length of pipe, the end joint of the previously laid length shall be carefully and thoroughly wiped smooth and cleaned to obtain an even and close fitting joint.
20. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.
21. Where existing pipe is to be extended, the same type of pipe shall be used unless otherwise specified or directed.
22. Only full lengths of pipe are to be used in the installation, except that partial lengths of pipe may be used at the entrance to structures where necessary to obtain a proper connection to the structure.
23. All pipe entering structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe and surface of the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges, or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation.
24. The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over the adjacent to any pipe shall be done at the Contractor's risk.
25. At all times when pipe laying is not in progress, all open ends of all pipes shall be closed by approved temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been pumped dry and all danger of water entering the pipe has passed.
26. Protect pipe and aggregate cover from damage or displacement until backfilling operation in progress.
27. When crossing above water lines, install pressurized sewer line a minimum of 10 feet on each side of water line.
28. Existing lines may not be taken out of service unless approved by the Architect and Owner.
29. Notify the Architect and Owner for approval, at least 48 hours in advance of the desired time for taking any line out of service.

- B. Cleaning:
 - 1. Clear the interior of all pipe of dirt and other superfluous material. 2. Place plugs in the ends of uncompleted pipe at the end of the day or whenever work stops.
 - 2. Flush new and existing lines if required to remove collected debris.
 - 3. Sewer pipe, manholes, cleanouts and garage interceptor upon their completion, are to be left clean and free from rubbish until acceptance.
- C. Inspection:
 - 1. Inspect pipe to determine whether line displacement or other damage has occurred.
 - 2. Make inspections after lines between manhole locations have been installed and approximately 2 feet of backfill is in place and at completion of the project.
 - 3. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, take whatever steps are necessary to correct these deficiencies; coordinate with Architect.
- D. Backfill Requirements:
 - 1. Under pavements and sidewalks; backfill with excavated material in 8 inch lifts compacted to 95% ASTM D698.
 - 2. Lawn areas; backfill with excavated material in 12 inch lifts compacted to 90% ASTM D698.

3.03 PRECAST MANHOLE CONSTRUCTION

- A. Unless otherwise noted in State or Municipal Standards, precast manholes shall be installed as follows:
 - 1. Place precast concrete sections as required. Where manholes occur in pavements, set tops of frames and covers flush with finish surface, unless otherwise indicated. Top 12 inches of manhole structure may be constructed of brick.
 - 2. Use epoxy bonding compound where manhole steps are mortared into manhole walls.
 - 3. Install rubber joint gaskets complying with ASTM C443.
 - 4. Manhole steps vertical spacing to be 12 inches with a horizontal projection of 7 inches.
 - 5. Form bottom of excavation clean and smooth to correct elevation.
 - 6. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
 - 7. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.
 - 8. Mount lid and frame level in grout, secured to top cone section to elevation indicated on Drawings.
- B. The walls shall be corbelled in at the top to receive heavy duty frame and cover, and conforming to local standards. Ladder side of manhole walls shall have a straight wall to bottom of steps and steps meet "OSHA" requirements.
- C. Where it is necessary to provide drop manholes, drop shall be made adjacent to and outside of the manhole and pipe encased in concrete, or supported in an approved manner.
- D. The base channels shall be built with concrete and lined with split pipe or brick, except the curve portion may be formed with concrete.

3.04 COORDINATION

- A. Coordinate locations and installation of manholes and cleanouts with the General Trades Contractor.

3.05 TESTING

- A. For a minimum test (if no Local Code exists) air test all piping per the National Clay Pipe Institute's tables for vitrified clay pipe or ASTM C-924 for concrete pipe. Plug all manhole connecting pipes and fill the manhole with water to 2 feet above the highest entering pipe. Allow water to stand for 24 hours; no loss of water is permitted in a four hour period.
- B. All tests shall be performed before any piping is covered or concealed.
- C. A written record of tests shall be submitted to the Architect.
- D. Isolate existing system as much as possible during test.
- E. Leakage Tests: Leakage through the joints of all sanitary sewer pipes shall not exceed the following allowable limits: 200 gallons per inch of tributary pipe diameter per 24 hours per mile of length or the computed equivalent for shorter lengths and shorter periods of time. Test all sanitary sewers.
- F. Infiltration Test: This test is to be conducted when the height of ground water table is 2 feet or more above the elevation of the inside crown of pipe at the upstream limit of the section being tested. The infiltration test shall be made by installing a weir or other measuring device approved by the Engineer in the lower end of the sewer section to be tested. The quantity of ground water infiltration into the sewer shall be measured and shall not exceed the allowable leakage.
- G. Exfiltration Test: This test is to be conducted when the height of the ground water table is less than 2 feet above the elevation of the inside crown of pipe at the upstream limit of the section being tested.
 - 1. The exfiltration will be determined by measuring the volume of water that is required to be added to return the surface of the water in the upstream grease interceptor to the test elevation mark. The test period shall be a minimum of one hour duration from the start of the test.
 - 2. The Engineer, because of adjacent trench material consideration, may order that after the completion of the exfiltration test, the test section of line shall be drained and the infiltration, under existing ground conditions, shall be measured within three (3) hours by means of a weir located in the downstream manhole.
 - 3. The allowable leakage is based on maximum difference in elevation of 8 feet between the level of water in the upper grease interceptor and the invert of the bulkheaded pipe at the downstream manhole. If the difference in elevation exceeds eight feet, the allowable leakage shall be increased 5% for each 1 foot in excess of 8 feet.

- H. Air Test: In lieu of exfiltration tests required for pipe sizes 8 inches through 24 inches and subject to approval of the Engineer, the Contractor may request an air test of checking tightness of sanitary sewer pipe construction.
1. Selected sections or sections of pipe between manholes shall be tested. The selection of sections to be tested are subject to approval of the Engineer. Manholes shall be tested by plugging connecting pipe and filling with water to 2 feet from the crown of the highest entering pipe. After the filled manhole has been allowed to stand for 24 hours, no loss of water will be permitted in a four hour period.
 2. Air testing of pipes will be accomplished only by use of equipment that has been approved by the Engineer and in accordance with the following steps:
 - a. Plug all pipe outlets with suitable test plugs. Brace each plug securely.
 - b. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
 - c. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
 - d. When pressure decreases to 3.5 psig, start stop-watch. Determine the time in seconds that is required for the internal air pressure to reach 2 psig. Minimum permissible pressure holding time for runs of single pipe diameter and for systems of 4 inch, 6 inch, or 8 inch laterals in combination with trunk lines shall be as published in tables by the National Clay Pipe Institute.
 3. In the event the allowable leakage limits are not met, the Contractor shall determine the location where excess water is entering or leaving the sewer. The sewer and/or manholes shall be repaired in a manner satisfactory to the Engineer and retested until the leakage is within the allowable limits.
 4. The Contractor shall include, in the bid price the cost of all bulkheads, plugs, pipe stopper, pumps, compressors, water, weirs, labor, delay, and any other items of cost necessary for the performance and completion of the required leakage test and for the cost of any repairs or adjustments which may be necessary to make the project conform to the required allowable leakage limits.
 5. All leakage tests shall be conducted under the supervision of the Architect/Engineer's representative.

END OF SECTION

22 13 16
INTERIOR SANITARY WASTE AND VENT PIPING SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide a complete system of soil, waste, and vent piping to fixtures and equipment, including traps, floor drains and cleanouts, extending to points outside building wall and connect to site sanitary sewer system as shown on the Drawings.
- B. Site sanitary sewer system revised by this Contractor.
- C. Refer to Drawings for size of connections to fixtures.
- D. Test complete new system.

1.02 QUALITY ASSURANCE

- A. Standards: American Society for Testing and Materials (ASTM) and the Cast Iron Soil Pipe Institute (CISPI), American Water Works Association (AWWA), American Society of Mechanical Engineers (ASME), and American National Standard Institute (ANSI).
- B. All pipe and fittings shall conform to the requirements of Commercial Standard CS188.

1.03 MANUFACTURERS

- A. Piping:
 - 1. Cast Iron: Tyler Pipe or Charlotte Pipe & Foundry.
 - 2. Copper: American Brass Company, Revere, Chase Brass Company or Nibco.
 - 3. PVC Plastic: Charlotte, Nibco, Manville, Yardley, Freedom or Crestline.
- B. Drains and Cleanouts: Jay R. Smith, Zurn, Wade, MIFAB, Watts or Josam.
- C. Trench Drains: ABT, Inc. – PolyDrain, Josam, Zurn, Polycast, or Jay R. Smith

PART 2 PRODUCTS

2.01 PIPING

- A. Piping and fittings in earth under slab:
 - 1. Hubless cast iron (CISPI-301), factory enamel coated.
 - 2. Service weight cast iron soil pipe and fittings (ASTM A74), factory enamel coated.
 - 3. Copper/DWV (ASTM B306) pipe.
 - 4. Schedule 40 PVC (ASTM D2665) plastic pipe.

- B. Interior Piping and Fittings Above Slab:
 - 1. Hubless cast iron (CISPI-301), factory enamel coated.
 - 2. Service weight cast iron (ASTM A74), factory enamel coated.
 - 3. Copper/DWV (ASTM B306).
 - 4. Schedule 40 PVC (ASTM D2665).
- C. Vent Piping and Fittings:
 - 1. Hubless cast iron (CISPI-301).
 - 2. Service weight cast iron (ASTM A74).
 - 3. Copper/DWV (ASTM B306).
 - 4. Schedule 40 PVC (ASTM D2665).
- D. Note: Ceiling area(s) are used as a return air plenum; plastic piping is prohibited.
- E. All cast iron piping and fittings shall have factory-applied coatings, E.P.A. acceptable.
- F. All fittings shall be drainage type and be same manufacturer as piping and be compatible with piping for size, material, and joint type.

2.02 JOINTS

- A. Cast Iron Piping:
 - 1. Compression type plastic or rubber gaskets (ASTM C564) by Dual-Tight or Ty Seal with lubricant equal to "Lubrifast."
 - 2. No-Hub couplings shall be Factory Mutual approved to FM-1680, Class 1 and so marked on each coupling, ASTM C-564 neoprene sealing sleeve, minimum of 28 gauge (0.016 inch) thick heavy duty slotted or corrugated Type 304 stainless steel shield with a minimum of two (2) stainless steel bands on pipe sizes 1 1/2 inch to 4 inches - Clamp-All Model #80, minimum of four (4) stainless steel bands on pipe sizes 5 inches to 10 inches - Clamp-All Model #125, 15 psig rating. Anco "Husky," Mission, Tyler and Charlotte Heavy Duty are approved as long as they meet all of the specified requirements.
 - a. The no-hub manufacturer shall provide the following guarantee: The no-hub coupling manufacturer shall make a full replacement for the number of couplings acknowledged by mutually agreeable independent third party analysis to have failed. No-hub coupling manufacturer will help subrogate the portion of any direct or consequential damage, deemed by mutually agreeable independent third party analysis, to have been caused by coupling failure for the life of the piping system.
- B. Copper DWV Piping:
 - 1. Cast brass solder type (ASTM B-584). No soldering or brazing alloys containing lead shall be used.
- C. PVC Plastic Piping:
 - 1. Solvent and cements as recommended by the pipe and fittings manufacturer and with a VOC content of 510 g/L less water.

2.03 FLOOR DRAINS

- A. General Construction: Drains to be adjustable, coated cast iron double drainage pattern, bottom outlet, inside caulk with flashing clamp, strainers, sediment buckets and trap primer inlets where required and other accessories and features indicated on the Schedule on the Drawings.
- B. Each floor drain, other than a light duty rating, shall have an ANSI load rating and be so indicated on the Shop Drawings. If rating is not indicated on Shop Drawings, they will be rejected.
- C. Provide membrane clamps on all floor drains in floors having waterproof membrane.
- D. Slot in grates shall be free of flashing (clean cut), and tops shall not have sharp edges which may be injurious to bare feet when used in shower or swimming pool areas.
- E. Refer to Schedule on the Drawings for specific types and accessories.

2.04 CLEANOUTS

- A. General Construction: Floor cleanouts shall be adjustable, inside caulk with flashing clamp and other accessories and features indicated on the Schedule on the Drawings.
- B. General: All cleanouts to be line size up to and including 4 inches and installed in accessible locations.
- C. Each floor cleanout other than a light duty rating, shall have an ANSI load rating and be so indicated on the Shop Drawings. If rating is not indicated on Shop Drawings, they will be rejected.
- D. Provide membrane clamps on all cleanouts in floors having waterproofing membranes.
- E. Refer to Schedule on the Drawings for specific types and accessories.

2.05 TRAPS

- A. Same material as piping.
- B. Refer to Section 22 42 01, "Plumbing Fixtures" for fixture traps, exception, floor mounted fixtures.

2.06 SOLDER AND BRAZING ALLOYS

- A. Solder: 95/5 tin-antimony (ASTM B32).
- B. Copper Brazing Alloys: Silver/phosphorous or silver/zinc alloys having a melting point greater than 1,000 degrees F.
 - 1. Sil-Fos filler as manufactured by Handy Harmon.

2.07 TRENCH DRAINS

- A. Large Trucks or Buses:
 - 1. Pre-slope fiberglass or polymer concrete trench drain system, 6 inch or 12 inch wide, interlocking joints with screwed connections. Heavy-duty frame assembly with bracket support or anchor bars for concrete installation. Section will have end caps, no-hub end outlets, no-hub bottom outlet or 12 x 24 or 24 x 24 inch catch basins with dome strainer for bottom outlet or 18 gauge stainless steel sediment baskets for catch basins. Grate will be slotted cast iron or ductile iron and secured to the trench with screws to the frame or locking device and meeting "AASHTO" HS-20 loading standards.
 - 2. Refer to the drawings for length, sizes, (widths) connections, etc.
 - 3. Manufacturers: ABT, Inc. (Polydrain), Zurn, Neenah, Quazite (Polycast), or approved equal.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Pitch soil and waste piping no less than 1/8 inch per foot, for pipes 2 inches and smaller, pitch at 1/4 inch per foot. Pitch kitchen piping at 1/4 inch per foot from the grease interceptor to sanitary inlet piping.
- B. Minimum size is 2 inches for underground waste and vent piping.
- C. Install P-trap below floor for floor drains, floor sinks, janitor receptors, showers, standpipes, bathtubs, and hub drains.
- D. All changes of directions shall be made with TY or Y fittings and 1/8 bends as required.
- E. All pipe joints shall be compatible with piping for size, material and joint types.
- F. Provide all necessary adapters, fittings, and pipe required to make connections to site utility piping and to new and existing building sewer and drains.
- G. All sanitary waste and vent piping in return air plenums required to be insulated, shall be insulated with pipe insulation meeting the requirements for return air plenums.
- H. Plastic piping shall not be allowed in return air plenums and other areas prohibited by Code.
- I. All piping shall be concealed, unless indicated on Drawings.
- J. The threading of cast iron pipe is prohibited.

3.02 VENTS

- A. Install vents through roof as follows:
 - 1. 3 inches minimum size.
 - 2. Locate at least 8 feet away from outside wall of building and 15 feet away from outside air intakes or operable windows.
 - 3. Offset vent piping below roof to allow for thermal expansion and contraction, minimum 4 foot offset.
 - 4. Vents to extend 12 inches above roof, except where specifically required to be higher or lower by code.
 - 5. Plumbing Contractor cuts hole(s) in roof. Install vent through roof vent boot or sleeve in membrane or metal roof. Roof vent boots furnished and installed by General Trades Contractor shall make the penetration watertight.
 - 6. Coordinate vent locations through roofs with General Trades Contractor, HVAC Contractor and Architect.
- B. Connect to existing vents where shown on Drawings.
- C. Pitch vents for proper drainage.

3.03 FLOOR DRAINS AND CLEANOUTS

- A. This Contractor is responsible for installing top of floor drains and cleanouts flush and level with wall or finished floor. If not shown on Architectural Drawings, confirm elevation and proper floor pitch to floor drains and floor cleanouts with Architect before roughing in. All items not installed flush and level will be removed and replaced by this Contractor at no cost to the Owner.
- B. Use an appropriate thread compound on the cleanout plug.
- C. Protect covers from scratching and collection of dirt and debris during construction.
- D. Install wall cleanouts in finished areas, at the base of all stacks at 18 inches above finished floor where indicated on Drawings.
- E. Provide exposed cleanout plugs without coverplate in unfinished areas or in above ceiling installations.
- F. All floor drain interiors shall be clean just prior to final inspection.
- G. Install floor drains and cleanouts in accessible locations.
- H. Install square cleanouts and floor drains in quarry tile floors and carefully align edges parallel to room walls.

3.04 COORDINATION

- A. Coordinate piping with beams, joists, foundation piers and walls and footings, HVAC piping and ductwork, equipment, electrical equipment, wiring, and installation with conduit, crane and crane rails.

- B. Coordinate vents through roof, floor and hub drain and cleanout locations and elevations and installation with walls, equipment and housekeeping pads with the General Trades Contractor and other Contractors.
- C. Coordinate location and elevation of site sanitary sewer.

3.05 TESTS

- A. Test entire new sanitary system as required by the Local Code Authority.
- B. For a minimum test, plug piping and fill with water to highest vent on roof to provide a minimum of 10 foot of head of water on all parts of the system. Maintain for one hour with no leakage. Repair any deficiencies. Final test to be conducted with smoke or peppermint at 1 inch W.C. for fifteen (15) minutes. Install gaskets or reset fixtures with new gaskets as required.
- C. All tests to be performed before any piping is covered or concealed and a written record of the test shall be submitted to the Architect's Representative as a part of the Owner's Record and Information Booklets.
- D. Should leaks occur, the defective section(s) of pipe and/or defective fitting(s) shall be removed and replaced with new materials at no cost to Owner.
- E. Tests shall be repeated until no leaks occur.
- F. Isolate existing system as much as possible during test.

END OF SECTION

22 34 36
NATURAL GAS WATER HEATERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide a gas-fired storage type water heater complete with gas piping, valves, and controls.

1.02 QUALITY ASSURANCE

- A. Standards: American Society of Mechanical Engineers (ASME), National Board of Boiler and Unfired Pressure Vessel Inspectors (NB), Underwriters' Laboratories (UL), National Sanitation Foundation (NSF) and American Gas Association (AGA).

1.03 RATINGS AND CAPACITIES

- A. Refer to the Drawings for dimensions, recovery, storage capacity input and output operating parameters.

1.04 ENERGY CODE

- A. Heater shall comply with the Latest Edition of the State Energy Code and ASHRAE 90.1.

1.05 GUARANTEE

- A. Heater shall have a commercial use three (3) year limited warranty against leaks and one (1) year parts.

1.06 MANUFACTURERS

- A. Lochinvar, A.O. Smith, Ruud, Reco, Precision, Ace, Raypack or PVI.

PART 2 PRODUCTS

2.01 GAS-FIRED WATER HEATER

- A. Tank: 160 lb. W.P., glass lined tank, ASME T&P relief valve, completely encased in high density insulation, anode rod, pilot and high temperature safety gas cutoffs, heavy gauge steel jacket assembly, primed and pre-painted on both side with a baked enamel finish, brass full port ball drain valve.
- B. Burner: Stainless steel sealed combustion chamber with condensate drain, natural gas capable of full modulation firing down to 20% of rated input with turn down ration of 5:1, pre-mix design, stainless steel woven metal fabric,.

- C. Controls: Gas valve capable of operating between 4 inches and 14 inches of water column, 24-volt control circuit, electronic display of set-up, status and diagnostics, inlet and outlet water temperature sensors, flue temperature sensor, runtime and alarm contacts, pump delay and exercise control, direct spark ignition.
- D. Safeties: Manual reset high temperature limit, ASME temperature and pressure relief valve, low water flow and built-in freeze protection, low water cutoff and condensate neutralization kit.
- E. Pump: All bronze tank circulation to minimize tank stratification.
- F. Efficiency: Third party testing by AHRI to a minimum 96% thermal efficiency.
- G. Operation: Lo-NOx operation

PART 3 EXECUTION

3.01 HEATER INSTALLATION

- A. Install heater and connect gas, flue/combustion air and water piping.
- B. Extend T&P relief and condensate drain lines full-size to 6 inches above floor to adjacent floor drain.
- C. Install condensate neutralization kit
- D. Power wiring for water heater by the Electrical Contractor, single point connection.

3.02 FLUE INSTALLATION

- A. Flue/combustion air piping and roof termination is the responsibility of this Contractor.

END OF SECTION

22 42 01
PLUMBING FIXTURES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide new plumbing fixtures installed in place, complete with carrier supports, supply and waste trim as indicated on the Drawings.
- B. Provide trim, fittings, carriers, stops, chrome water supply piping and all accessories required for a complete installation.
- C. Fixture connection sizes are shown on Drawings.

1.02 QUALITY ASSURANCE

- A. Standards: American National Standards Institute (ANSI A112.19 and Z124), American Society of Plumbing Engineers (ASPE), American Society of Sanitary Engineering (ASSE), National Sanitation Foundation (NSF), Plumbing and Drainage Institute (PDI), city and state plumbing and energy codes.
- B. Unless otherwise noted, all fixtures of the same type shall be by the same manufacturer.
- C. Fixtures and trim shall be free of defects.
- D. Electric water cooler components that come in contact with the potable water shall be lead-free per the Safe Drinking Water Act of 1986 as amended, and contain no CFC refrigerants.
- E. All faucets shall meet or exceed NSF 61, Section 9 drinking water standard as amended.

1.03 SUBMITTALS

- A. Submit manufacturer's product data for all products specified in this section and shown on Drawings.
- B. Shop Drawings: Each submittal shall be clearly marked with fixture designation number, model number, and indicate all required fittings, construction, color and rough-in requirements; include a color charts when required.
- C. The approved fixture's shop drawings shall be a part of the Owner's Manual.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protection: Fixtures and trim shall remain crated and stored until installation to prevent moisture and dirt contamination and physical damage; adequately protect installed fixtures from damage.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES AND ACCESSORIES

- A. Refer to the Specifications and Drawings for specific catalog numbers and required fittings.
 - 1. Provide white vitreous china or enamel fixtures, unless otherwise noted.

- B. Fixture Manufacturers:
 - 1. Vitreous China Fixtures: American Standard, Eljer, Crane or Kohler.
 - 2. Stainless Steel Sinks: Just, Elkay, Moen, Republic, Metcraft, or American Standard.
 - 3. Fiberglass Reinforced or Acrylic Plastic Showers: Clarion, American Standard, Dura Glass, Eljer, Aquarius, Aqua Glass, Fiat, Lasco or Kohler.
 - 4. Electric Water Coolers and Drinking Fountains: Oasis, Haws, Elkay, Sunroc or Halsey-Taylor.
 - 5. Janitor's Receptor: Mustee, Zurn, Fiat, Stern-Williams, or Creative.
 - 6. Safety Shower/Eyewash: Bradley, Chicago Faucet, Econ, Haws, Guardian, Speakman, Western or Water Saver.
 - 7. Kitchenette Disposer: In-Sink-Erator, KitchenAid, Waste King or Whirlaway.
 - 8. Stainless Steel Showers: Bradley, Acorn or Metcraft.
 - 9. Hot Water Dispenser: In-Sink-Erator, KitchenAid or Elkay.
 - 10. Kitchen (Commercial) Stainless Steel Sinks: Amteko, Elkay, Just, Duke, Eagle, Advance Tabco, Marlo or Metcraft.
 - 11. Kitchen (Commercial) Disposer: In-Sink-Erator, KitchenAid, Hobart, Waste King, Master or Salvajor.
 - 12. Wash Fountains: Bradley, Acorn, Metcraft, Intersan, Willoughby or Sanispray.
 - 13. Penal Fixtures: Acorn, Bradley, Metcraft, Intersan or Willoughby.

- C. Fittings Manufacturers:
 - 1. Flush Valves: Moen, Geberit/Chicago, Zurn, Sloan, Delany, or ToTo, all with vandal-resistant stop cap cover.
 - 2. Water Closet Seats: Olsonite, Bemis, Beneke or Church.
 - 3. Faucets: Powers, Geberit/Chicago, Zurn, T&S Brass, Watersaver, American Standard, Symmons, Eljer, Speakman, Moen, or Kohler.
 - 4. Automatic Flush Valves: Moen, Geberit/Chicago, Zurn, Sloan, Josam-Stern, Delany, or ToTo with vandal-resistant stop cap cover.
 - 5. Automatic Faucets: Bradley, Geberit/Chicago, Zurn, Sloan, Speakman, T&S, ToTo, or American Standard.
 - 6. Supplies and Stops: McGuire Mfg. Co., Central Brass, EBC, Dearborn, Bridgeport, Speedflex, T & S Brass, Chicago Faucet, Consolidated, Frost, Waterway, Sanitary Dash, Speedway or Brass Craft.
 - 7. Fixture Traps: McGuire Mfg. Co., EBC or Central Brass.
 - 8. Shower Controls: Powers, Chicago Faucet, Leonard, Speakman, Lawler, Zurn, Haws, American Standard, Eljer, Symmons, Acorn, Bradley or Metcraft.
 - 9. Shower Heads: Powers, Zurn, Sloan, Leonard, American Standard, Chicago Faucet, Haws, Eljer, Symmons, Acorn, Bradley or Metcraft.

- D. All trim and exposed piping to be chrome-plated unless noted otherwise.

- E. Faucets to have renewable seats.

- F. Shower controls to have integral check and screwdriver stops.
- G. Wall faucets to include vacuum breaker, pail spout and wall brace.
- H. All plumbing fixtures and accessories of the same generic type shall be the products of the same manufacturer.
- I. Supplies to lavatory and sink fittings shall be flexible tube risers with keyed stops (unless otherwise noted), all chrome plated.

2.02 CARRIERS

- A. Provide heavy duty, rectangular vertical support, floor supported, commercial type fixture carrier for all new wall mounted plumbing fixtures, unless noted otherwise. Provide carrier-bearing plates for electric water coolers and urinals as part of the fixture carrier. Provide flush valve supply support as part of the urinal fixture carrier.
- B. Water Closets: Floor supported, with buttress foot and foot anchor, rear foot support, flush valve supply support, finishing frame, cast iron, commercial type, neoprene gaskets. The studs and nipple on the carrier shall be adjustable without cutting or defacing the wall and still maintain a tight joint. Coordinate location of carrier closely with Architect.
- C. All carriers shall be specifically chosen to accommodate the particular brand and style of fixture actually installed, the particular type of floor and wall actually present at each fixture location and the piping arrangement at each fixture. Furnish plastic or metal positioning frames to isolate carrier bolts from wall construction. Anchor carriers firmly to the floor with maximum sized bolts that feet will accommodate.
- D. Provide neoprene carrier gaskets.
- E. Jay R. Smith, Zurn, Wade, MIFAB, Josam or Watts.

PART 3 EXECUTION

3.01 COORDINATION

- A. See Architectural Drawings for the exact location of plumbing fixtures.
- B. Review approved millwork shop drawings from the General Trades Contractor, coordinate location and size of countertop fixtures, casework and openings before ordering or proceeding with rough-in work.
- C. Countertop lavatory and sink openings and cabinet base backs for drains and water supply stop valves shall be cut by the General Trades Contractor; furnish templates.
- D. Coordinate location and rough-in requirements with equipment requiring plumbing with General Trades Contractor, other Contractors, and Owner.

3.02 INSTALLATION

- A. Install fixtures according to the manufacturer's written installation instruction.
- B. Refer to Architectural Drawings for fixture mounting heights.
- C. Fixtures to be mounted at the following heights or according to the manufacturer's recommendations, unless noted or directed otherwise.
 - 1. Regular Mounting Heights:

Wall Hung Water Closet (not including seat)	15 inches to top
Wall Hung Lavatory	31 inches to rim
Wall Hung Urinal	24 inches to lip
Electric Water Cooler	40 inches to spout outlet
Drinking Fountain	40 inches to spout outlet
Shower Head	76 inches to centerline of shower head arm
Janitor's Sink (Receptor) Faucet	36 inches to centerline of faucet
 - 2. Handicapped (Disabled) Mounting Heights:

Wall Hung Water Closet (including seat)	17 to 19 inches to top of seat
Wall Hung Lavatory	29 inches to bottom of apron, maximum height to rim 34 inches
Wall Hung Urinal	17 inches to top of lip
Electric Water Cooler	36 inches to spout outlet, 27 inches clearance from floor
Drinking Fountain	36 inches to spout outlet, 27 inches clearance from floor
Shower Heads	7 inches from floor to centerline of shower head room
Shower Controls	48 inches maximum to centerline
- D. At floor and wall, caulk between fixture with silicone caulking compatible with the wall paint, refer to Division 7 of Specifications for specific requirements.
 - 1. Exception: Electric water coolers - caulk top and side of basin only.
- E. Install fixture carriers and drainage fittings on wall hung fixtures such as water closets, lavatories, urinals, sink, electric water coolers, etc.; securely anchor all carriers to the floor.
- F. Install chrome plated brass escutcheons on waste and supply piping at walls, including piping in cabinets.
- G. Install stops on all cold and hot water supplies to fixtures.
- H. Thoroughly clean all fixtures of paper and dirt before final acceptance.

- I. Plug-in unit and adjust electric water coolers flow for correct operation and temperature of 55 degrees F outlet.
- J. Provide all required seals, gaskets, nuts, bolts and washers.
- K. Fixtures shall be carefully assembled and connected to the required plumbing inlets and outlets, and tested so fixtures will be functioning correctly when the Work is completed.
- L. After the installation of the plumbing fixtures is completed, all connecting water pipes shall be flushed out through the fixtures to eliminate scale; clean faucet and electric water cooler strainers and aerators.
- M. Adjust self-sustaining water closet seats self-sustain in any position.
- N. Adjust shower mixing valves for correct leaving water temperature of 105 degrees F.
- O. Provide anchors and supports behind walls and chases for flush valve supply piping.
- P. Install check valves on shower mixing valves inlets unless shower mixing valve already has a combination check stops
- Q. Do not permit the use of installed plumbing fixtures by construction personnel without prior written consent by the Owner.
 - 1. Any of the installed fixtures or trim found damaged prior to final acceptance shall be removed and replaced by the Contractor at no additional cost to the Owner.
- R. Adjust faucets with temperature limit stops for a maximum leaving temperature of 110 degrees F.
- S. Adjust all flush valves and/or flush tanks for proper operation.
- T. Adjust all sensor type automatic water coolers, faucets and flush valves for proper operation, per manufacturer's written installation instructions.
- U. Install strainers on shower mixing valve inlets.
- V. Provide a bed of grout for shower basins and bathtubs.

3.03 SPECIAL INSTALLATION INSTRUCTIONS

- A. Install handicapped water closet flush valves so the control lever is on the wide side of water closet and no more than 44 inches A.F.F.
- B. Install handicapped urinal flush valve control levers at no more than 44 inches A.F.F. Coordinate locations with any grab bars.
- C. Insulate all water and drain piping that could come in contact with wheelchair occupants. Refer to Section 22 07 01, "Plumbing Insulation" and Drawings.
- D. Coordinate exact location of shower and bathtub controls used by the handicapped with the Architect.

END OF SECTION

22 71 01
GAS SERVICE

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide a new medium pressure (2 psig) natural gas service line from the Utility provided meter/regulator assembly near the fence line to the building, as shown on the Drawings.
- B. Provide approved flexible gas risers and supports at both end of the service line.
- C. All underground piping and regulator(s) shall be installed in accordance with Utility Company Standards.
- D. Provide cathodic protection on all steel risers/lines regardless of coating.
- E. Test complete new system.

1.02 QUALITY ASSURANCE

- A. Standards: American National Standards Institute (ANSI), American Society of Plumbing Engineers (ASPE), American Society for Testing and Materials (ASTM), American Gas Association (AGA), and National Fire Protection Association (NFPA).

PART 2 PRODUCTS

2.01 UNDERGROUND GAS PIPING

- A. Non-flammable, HDPE thermoplastic gas pressure pipe and fittings (ASTM D2513 and ASTM 2683) with two (2) No. 12 TW single strand, single conductor, copper tracer and lead wires.
 - 1. Pipe and fittings must be approved by Utility Company and AHJ.
- B. Black carbon steel pipe, conforming to ASTM A120 or ASTM A53, butt welded joints with backing rings were required, electric resistance welded, or seamless, Schedule 40, factory coated.
- C. Black carbon steel pipe shall be polyethylene sheathed, conforming to Federal Specification L-C-530 with heat shrunk sleeves for butt joints and manufacturer's standard tape wrapping for fittings.
- D. Polyethylene sheathing shall be as manufactured by Scotchcoat 202, Sheath, Republic "X-TRU-COAT" or equal.
- E. Repair damaged coatings by wrapping with the manufacturer's approved tape.
 - 1. Acceptable Manufacturers: Tapecoat Company "Tapecoat CT," Kendall Company "Polyken 930," Rolyston Labs "Greenline" or Republic Steel "X-Tru-Tape #35." Install with 1/2 inch minimum overlap.

- F. Install pipe coating on underground steel piping according to manufacturer's recommendations.

2.02 FITTINGS

- A. Black carbon steel butt-weld fittings, conforming to ASTM A234 and ANSI B16.9, wall thickness to match pipe wall. Install coating after installation.
- B. Forged steel, slip-on or weld neck flanges, conforming to ASTM A181, Grade 1 or 2, ANSI B16.1. Install coating after installation.
- C. Steel-to-polyethylene transition, ASTM D-2513 category 1, ANSI B1.20, ANSI B 31.8, US DOT Part 192, NFPA-58 and CSA B137.4
 - 1. Steel riser fabricated by welding or by shop bending the pipe to 90 degrees through a radius of not less than 1 foot shall be used; coated with protective tape and protected with an anode.
 - 2. Perfection Corporation, Continental Industries, Dresser Manufacturing Division, Pottstown Pipe Products, Inc., Robroy Industries, Tec-Line Products or Upsco, Inc.
- D. Top-connection, non-corrosive steel encased plastic gas riser using a permanent leak-free coupling connection with sunlight-resistant PVC-coated steel flex, a plastic centering sleeve and factory installed moisture seal/sleeve protector; ASTM D-2513 category 1, ANSI B1.20, ANSI B 31.8, US DOT Part 192, NFPA-58, and CSA B137.4.
 - 1. Perfection Corporation, Continental Industries, Dresser Manufacturing Division, Pottstown Pipe Products, Inc., Robroy Industries, Tec-Line Products or Upsco, Inc.

2.03 LUBRICATED PLUG VALVES

- A. 2 Inches and Smaller: 175 lb. WOG, semi-steel body, insulating type, lock wing head or equivalent, tamperproof core, drilled and tapped 1/8 inch port on the inlet side of valve body with Allen head plug, screwed ends with TFE stem seal and seat, square stem, wrench-operated.
 - 1. Nordstrom (Rockwell) #142, Homestead or Powell.

2.04 GAS REGULATOR

- A. 3/4 Inch to 2 1/2 Inches: Cast iron body with screwed connection, aluminum die cast diaphragm case that is spring loaded with 10 degree valve, internal relief (3/4 inch orifice), outlet pressures from 1 1/2 inches W.C. to 10 psi and maximum inlet pressure of 60 psi (ANSI Z21.18), refer to the Drawing for the outlet pressure required.
 - 1. Sensus Gas Regulator Company or approved equal.
- B. Size and capacity as required by equipment.
- C. Acceptable manufacturers must be approved by the Gas Company.

PART 3 EXECUTION

3.01 SITE INSPECTION

- A. Contractor must examine the areas and conditions under which gas service system work is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. The location of existing pipeline shown on the Drawings was determined from available construction records and should be considered approximate.
- D. The Contractor is responsible for determining the exact location of any existing pipe to which connection(s) are to be made, or disturbed during earth moving operations, or affected by the work.
- E. Existing lines may not be taken out of service unless approved by the Architect and Owner.
- F. Notify the Architect and Owner for approval, at least 48 hours in advance of the desired time for taking any line out of service.

3.02 INSTALLATION

- A. Provide all necessary adapters, fittings, tapping machines and pipe required to make connections to the system.
- B. The gas line shall run horizontal or pitch upward in the direction of flow, provide 2 feet minimum cover over buried pipe.
- C. A minimum of 6 inches of clearance shall be provided between the gas line and any other underground utility line crossing or paralleling it, except for electric lines, in which case the minimum clearance shall be 12 inches.
- D. Provide all welded assembly with welding work in accordance with ANSI B31.1 Code for Pressure Piping, performed by welding operators certified by the National Weld Test Bureau, or other approved bureau or agency.
- E. Remove all damaged polyethylene shielding and replace with heating shrinkable sleeves placed on freshly adhesive-primer-coated surface.
- F. Install pipe tape coating on underground steel piping according to manufacturer's recommendations, repair damaged pipe tape coating.
- G. Wrap tape onto fittings or joints with 50% overlap, in accordance with manufacturer's most stringent requirements or recommendations.
- H. Contractor shall install an isolating union, flange or coupling, and shutoff valve on the building riser, above to electrically isolate the service line from the house lines.

- I. All plastic gas line stored outside shall be covered until installed per manufacturer's recommendations.

3.03 TESTING

- A. Purge all gas piping completely after testing according to recommendations of and under supervision of Gas Company.
- B. Gas service line shall be tested to a pressure of not less than 90 psig for 1-hour with no leakage.
 1. Additional test requirements may be required by the Utility Company representative or AHJ.
- C. All tests shall be performed before any piping is covered or concealed.
- D. Tests shall be witnessed by the Utility Company, AHJ and/or Architect's Representative.
- E. Obtain Utility Company and Inspector approval.
- F. A written record of tests shall be submitted to the Architect's Representative and inserted in the Owner's service manuals.
- G. Contractor shall soap suds test all exposed fittings at operating pressure.
- H. Should leaks occur, the defective section(s) of new pipe and/or fitting(s) shall be removed and replaced with new materials without any cost to Owner.
 1. Test(s) shall be repeated until no defects occur.
- I. Air or inert gas such as nitrogen, air or carbon dioxide shall be used to pressurize the new gas piping; in no case shall natural gas, oxygen, acetylene, Freon or other gases be used.
- J. The date(s) and result(s) of test shall be recorded, witnessed and submitted to the Architect.
- K. Isolate existing gas system as much as possible during test.

3.04 CATHODIC PROTECTION

- A. Provide cathodic protection on all new underground steel gas lines.
- B. Provide cathodic protection per Utility Company Standards and specifications for magnesium anodes, anode size and spacing and attachment method.
 1. Loop lead wire around steel pipe.
- C. Magnesium or zinc anodes shall be high purity magnesium alloy and shall comply with Gas Company composition specification and shall be installed according to Gas Company requirements.
 1. Dow Chemical, Federated Metals, Kaiser Magnesium.

3.05 COORDINATION

- A. Coordinate actual gas regulator inlet pressure with Utility Company and verify gas pressure.
- B. Coordinate gas line location, meter, riser and regulator location with Utility Company before installation.
- C. Determine exact gas pressure at outlet of meter installation, coordinate with Drawings.
- D. Coordinate size of gas meter, regulator requirements, and other requirements with Utility Company and Architect.
- E. Coordinate location of new gas line through the building wall.
- F. Contractor shall contact the Utility Company for installation advisory assistance regarding the installation of piping and meter set assembly.

END OF SECTION

22 71 02
INTERIOR NATURAL GAS PIPING SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide natural gas piping, regulator(s) and valves for equipment and provide final connection where shown on Drawings.
- B. Connect to new gas line at point indicated on the Drawing and extend inside the building.
- C. Extend and connect to existing building and new low pressure (7" w.c.) gas piping system and medium pressure (2 psig.) line to emergency generator where shown on Drawings.
- D. Connect to gas fired equipment with a dirt leg, union, shut-off valve where shown on Drawings.
- E. Gas distribution pressure shall be 2 psig from the house service to the new and existing regulated low pressure (7" w.c.) system as well as the new emergency generator line.
- F. Provide all regulators, vent piping and miscellaneous appurtenances required to complete all supply piping systems.
- G. Test complete new system.

1.02 QUALITY ASSURANCE

- A. Standards: National Fire Protection Association (NFPA 54), American Society of Plumbing Engineers (ASPE), American Society for Testing & Material (ASTM) and American Gas Association (AGA), Local Utility Company requirements.

PART 2 PRODUCTS

2.01 GAS PIPING

- A. Aboveground Piping: Standard weight, Schedule 40, Type F, Grade B, welded, screwed, or welded ends (refer to fittings below), black carbon steel pipe (ANSI/ASTM A53).
- B. Underground Piping: See gas service 22 71 01 for the underground line serving the emergency generator.
- C. All new piping larger than 1½" shall be welded.

2.02 FITTINGS

- A. 1 1/2 Inches and Smaller: 150 lb. screwed banded malleable black iron fittings (ANSI B16.3).

- B. 2 Inches to 2 1/2 Inches: Welded (ANSI B31.1 steel).
- C. 1 1/2 Inches and Larger: Forged steel butt welded flanged, 150 SWP, (ASTM A234). Provide gaskets suitable for natural gas.

2.03 BALL VALVES (2" AND SMALLER)

- A. AGA and UL listed for gas service, 175 lb. (UL), bronze body, full port, viton seat, screwed ends, stainless steel disc and stem, lever handle.
 - 1. Milwaukee "Butterball," Model BB2-100, Conbraco GB Series or approved equals.
 - 2. Each type of valve shall be by the same manufacturer.

2.04 LUBRICATED PLUG VALVES

- A. 2 Inches and Smaller: AGA and UL approvals, 175 lb. WOG, semi-steel or brass body, screwed ends with TFE stem seal and seat, square stem, wrench-operated.
 - 1. Nordstrom Fig. 142, Powell Fig. 2200 or Homestead Fig. 611, Hays Series 7455 or Walworth Fig. 1796.
 - 2. Provide wrench.
- B. Each type of valve shall be by the same manufacturer.

2.05 PRESSURE REGULATORS

- A. 3/4 Inch to 2 1/2 Inches: (ANSI Z21.18) cast iron body with screwed connection, aluminum die cast diaphragm case that is spring loaded with 10 degree valve, internal relief (3/4 inch orifice) outlet pressures from 1 1/2 inches W.C. to 10 psig and maximum inlet pressure of 60 psig.
 - 1. Size, capacity and pressure requirements as required by equipment.
 - 2. Sensus- or equal.

2.06 GAS METER AND REGULATOR ASSEMBLY

- A. Gas meter and regulator(s) provided and installed by Utility Company.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install a dielectric union at point of gas line entrance through building wall; enter through a pipe sleeve above grade, caulk around pipe between sleeve.
- B. Gas piping shall run horizontal or pitch upward in the direction of flow at a rate of not less than 1/4 inch in 15 feet.
- C. Provide shut-off valve, dirt leg and union at each final connection to equipment.
- D. All concealed or encased piping and casing shall be welded.

- E. Gas piping system within building shall be electrically continuous and bonded to any grounding electrode.
 - 1. Bonding shall be by the Electrical Contractor.
- F. Provide drip legs at any point in line where condensate may collect; located where the condensate may not freeze.
- G. Purge existing abandoned lines to outside.
- H. All new and revised gas piping shall comply with the requirements of NFPA 54 and American Gas Association.
- I. Provide 36 inch minimum cover over buried pipe. A minimum of 6 inches of clearance shall be provided between the gas line and any other underground utility line crossing or paralleling it, except for electric lines, in which case the minimum clearance shall be 12 inches.
- J. Ground joint unions shall be used only at final equipment connection; otherwise use flanged unions.

3.02 COORDINATION

- A. Coordinate the actual location and size of meter and regulator location with Utility before installation.
- B. Verify actual gas regulator inlet and outlet pressure with Gas Company.
- C. Contractor shall contact the Gas Company for installation advisory assistance regarding the installation of piping from meter set assembly.
- D. Coordinate gas pressure requirements of all new gas-fired fixtures and equipment to determine gas pressure regulator requirements.
- E. Coordinate fixture and equipment location and connection requirements.
- F. Coordinate any service shut-down with Owner.
- G. Coordinate all pipe runs with other work.

3.03 TESTS

- A. Perform tests and inspection before concealing any work.
 - 1. Tests shall be witnessed by the Architect Representative, and/or AHJ.
 - 2. Tests shall be per NFPA 54.
- B. Air or inert gas such as nitrogen, air or carbon-dioxide shall be used to pressurize the new gas piping; natural gas, oxygen, acetylene, Freon or other gases shall not be used.
- C. New gas piping system (including valves, excluding equipment) shall be given a pressure test of not less 50 psig for not be less than 1/2 hour.

- D. Contractor shall soap suds test all exposed valves and fittings at operating pressure.
- E. Should leaks occur, the defective section(s) of pipe and/or fitting(s) shall be removed and replaced with new materials without any cost of Owner.
- F. Test(s) shall be repeated until no defects occur.
- G. The date(s) and result(s) of tests shall be recorded, witnessed and submitted to the Architect. A written record of tests shall be provided as a part of the Owner's record and information booklets.
- H. Obtain inspector approval.
- I. Purge new system completely after testing.

END OF SECTION

23 05 01
HEATING, VENTILATING AND AIR CONDITIONING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish material, labor, tools, accessories and equipment to complete test, adjust, start up, balance and successfully run all HVAC systems of this Project as described in these Specifications and as shown on the Drawings.
- B. Refer to Sections 20 00 00 through 20 99 99 (as included) for items of a general nature which apply to this portion of the Work. Sections 23 00 00 through 23 99 99 (as included) describe the HVAC work.
- C. Work includes, but is not limited to, the following:
 - 1. Vibration Isolators
 - 2. HVAC Insulation
 - 3. Refrigerant Piping System
 - 4. Cabinet Unit Heaters
 - 5. Infrared Heaters
 - 6. Filters
 - 7. Exhaust Fans
 - 8. Low Velocity Ductwork
 - 9. High Velocity Ductwork
 - 10. Terminal Boxes
 - 11. Grilles, Registers and Diffusers
 - 12. Dampers
 - 13. Roof Ventilators
 - 14. Rooftop Air Conditioning Units
 - 15. Wall Air Conditioner
 - 16. Ductless Split System Air Conditioner
 - 17. HVAC Systems Balancing

1.02 LICENSES

- A. The installation of this HVAC work shall be made by a Contractor and craftsmen licensed by the Governing Authorities.
- B. Obtain all permits and licenses required by Local Code Authorities having jurisdiction.

1.03 FEES

- A. Unless otherwise noted, this Contractor shall pay for all permits, inspection fees, and other charges related to the installation and inspection of the HVAC work.

1.04 CODES, REGULATIONS AND STANDARDS

- A. Unless otherwise noted, the latest enforced Edition shall apply to this work.

1.05 HVAC ROUGH-INS

- A. Provide service rough-ins and make final connections to equipment furnished by the Equipment Contractor or the Owner.
- B. Provide piping, valves, ductwork and specialties as required, and as specified under other Sections of these Specifications.

1.06 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment. Coordinate rough-in locations with other Contractors.
- B. Refer to approved equipment drawings for exact rough-in sizes and locations.

END OF SECTION

23 05 93
HVAC SYSTEMS BALANCING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide all labor, materials, and tools for completely testing, balancing and adjusting the air systems.

1.02 QUALITY ASSURANCE

- A. Standards: AABC National Standards for Field Measurement and Instrumentation.
- B. Instruments used for testing and balancing of air and hydronic systems must have been calibrated within a period of six months and checked for accuracy prior to start of work on this project.
- C. Any discrepancies over plus or minus 5% or items not in accordance with contract documents, which may affect the total system or systems balance shall be reported to the HVAC Contractor for corrections. Air balance must be repeated following corrections to confirm that corrections were made.

1.03 BALANCING CONTRACTOR QUALIFICATIONS

- A. The HVAC Contractor shall retain the services of an Independent Testing, Adjusting, and Balancing (TAB) Agency that specializes in, and whose business is limited to, the testing and balancing of HVAC systems. The Agency selected shall be fully certified by the Associated Air Balance Council, and shall have at least one member certified by the National Examining Board-United States and Canada. Certification by NEBB will also be acceptable.

1.04 BALANCING REPORT

- A. Submit a completed balancing report indicating the performance of fans, rooftop units, dampers, and air distribution devices.
- B. Flows shall be within 5% of design CFM.

1.05 AIR SYSTEMS

- A. Air Velocities shall be measured with an anemometer, velometer or pitot tube and manometer. Static pressures and total pressures shall be measured with a velometer or pitot tube and manometer. Fan RPM shall be measured with a tachometer or revolution counter. Motor amperage shall be measured with an "Amprobe" or similar device. Voltages shall be measured with a voltmeter.
- B. In measuring velocities in ducts or at outlets, traverse the duct or outlet so that one reading is taken for each 80 square inches maximum of flow area, but a minimum of six readings shall be taken for each duct or outlet regardless of size.

1.06 QUALITY CONTROL

- A. Testing and balancing shall be performed in complete accordance with AABC National Standards for Field Measurement and Instrumentation, Form Number 81266, Volume One, Sections as applicable.
- B. Air flows shall be balanced within 5% of design conditions.

END OF SECTION

23 09 33
TEMPERATURE CONTROL

PART 1 GENERAL

- 1.01 Furnish and install as hereinafter specified, a system of electric or electronic control.
- A. All automatic control dampers shall be furnished and installed by the HVAC Contractor.
 - B. Electric Wiring: Provide all temperature control wiring and interlocks for a complete and workable temperature control system as herein specified and shown on the Drawings. The temperature control wiring shall conform to all the requirements of Division 26. Provide complete wiring diagrams with submittal drawings.
 - C. Interlock Wiring: All cable required shall be installed in a protective enclosure and shall conform to Section 725, Class 2 wiring of the National Electrical Code.
 - D. Owner's Instructions: Upon completion of the work and acceptance by the Owner, provide instruction to the Owner's operating personnel who have responsibility for the mechanical system.
 - E. Documentation: The following information shall be provided upon project completion. Provide one set for each operating manual.
 - 1. Shop drawing of control system showing all devices, all interconnections between devices, and all connections to items provided by others. Provide a sequence of operation.
 - 2. Specification data sheets on each device.
 - 3. A reference table listing the settings.
 - F. System Acceptance: The Contractor shall issue a report upon project completion stating that the system is complete, has been adjusted, and is operating in accordance with the Specifications. Any deviations from specified settings or operations necessitated during system adjustment shall be specifically noted. A demonstration of complete system operation shall be made to the Owner's Representative.
 - G. Guarantee: The control system designated on the Drawings and Plans and herein specified shall be guaranteed to be free from original defects in both material and workmanship for a period of one year of normal use and service, excepting damage from other causes. This guarantee shall become effective with the date of Project Completion.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Electric Room Thermostats: Heavy duty snap action type with key operators rated at 6 FLA at 120 VAC contacts suitable for the intended service. Provide manual selector switches, as required, in the sequence of operation.

- B. Temperature Sensors: Each temperature sensor shall match the requirements of the associated VAV box temperature controller. Sensors of the nickel wound, thermistor, or platinum type shall be provided. Each sensor shall be designed for the appropriate application (i.e. duct, immersion, etc.) and be provided with all necessary installation accessories. Ranges shall be selected to the middle of the control range.
- C. Dampers (Multiple Blade Dampers): Automatic dampers shall be single or multiple blade as applicable. Dampers are to be furnished and installed by the HVAC Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the HVAC Contractor. All damper frames are to be constructed of No. 13 gauge galvanized sheet metal and shall have flanges for duct mounting. Damper blades shall not exceed 8 inches width. All blades are to be of corrugated or roll formed type construction. Blades are to be suitable for high velocity performance. All damper bearings are to be made of nylon. Bushings that turn in the bearings are to be oil impregnated sintered metal. All damper linkages shall be housed in the damper side channel. Replaceable butyl rubber seals are to be provided with the damper. Butyl rubber seals are to be installed along the top and bottom of the frame and along each blade edge. Independent, self-compensating, stainless steel end seals shall be installed to insure minimum leakage between blade ends and damper frame. Seals shall provide a tight closing low leakage damper. Damper sections shall not exceed 16 sq. ft. and shall have minimum of one operator per damper section. All outside air and return air dampers shall be parallel blade, low leakage dampers.

END OF SECTION

23 09 93
SEQUENCES OF OPERATION

PART 1 GENERAL

1.01 CONTROL DIAGRAMS AND SCHEDULE

- A. Refer to Drawings for information which indicates the components and intended control functions and devices.
- B. The HVAC Contractor shall be responsible for all control wiring connections, auxiliary devices and control wiring diagrams to complete the control system and attain the described sequence of operation.
- C. All setpoints of thermostats, controllers and the like, that are not factory preset, shall be preset by the HVAC Contractor before system startup.

1.02 SEQUENCES OF OPERATION

- A. Single Zone VAV Rooftop Unit Controls (RTU1)
 - 1. Rooftop unit controls are provided as a factory installed package within the RTU, capable of executing the following sequence of operation. Unit shall be packaged direct expansion cooling rooftop unit with powered exhaust as shown on the Drawings and as specified.
 - 2. The unit manufacturer shall provide the controls components.
 - 3. Occupied Mode: The main supply shall operate continuously and provide required air flow to the variable volume terminals.
 - 4. The RTU microprocessor controller shall maintain cooling supply air temperature by sequencing the compressors and/or compressor unloading valves of the RTU in the mechanical cooling mode. The microprocessor shall also control the economizer dampers and power exhaust fan in economizer mode. The supply air setpoint shall be 52 degrees F to 55 degrees F (adjustable) during this mode.
 - 5. The RTU microprocessor controller via a static pressure sensor located approximately two-thirds down the length of the supply air duct run with the greatest static pressure shall maintain the minimum duct static pressure by modulating the fan speed via a variable frequency drive. The power exhaust fan shall operate with the economizer.
 - 6. Unoccupied Mode: A 7-day time clock program shall initiate the unoccupied mode during which the RTU shall be shutdown. Override timers shall be provided to enable RTU (cooling) operation if required during the unoccupied mode. Sensors shall also be provided to override the system if the unoccupied temperature exceeds a preset limit (80 degrees F to 85 degrees F). RTU shall have an override timer and sensor located in the area being served. Field verify the location of the timer and sensor.
 - 7. Minimum outside air damper position adjustment capability shall be provided with the RTU microprocessor control system. Set minimum position initially at the CFM shown on the schedule, adjustable. Provide active, real time measurement of the outside air quantity, at an accuracy of plus or minus 10% of full economizer airflow.
 - 8. Smoke detectors located in the return air ducts shall stop the fan if smoke is detected in the air stream. Detectors are furnished and installed by the Electrical Contractor.

- B. Variable Air Volume Box with Reheat:
1. The electronic controller in each VAV box shall modulate its volume damper and its electronic reheat coil to maintain the setpoint (74 degrees F, adjustable) of its respective zone sensor.
- C. Fan Powered VAV Boxes:
1. The electronic controller in each Fan Powered VAV box shall modulate its volume damper (open/closed) in response to deviation from setpoint (74 degrees F, adjustable) of its respective zone sensor. The electronic controller will also measure airflow and maintain the zone air volume within maximum and minimum flow settings (adjustable). This volume regulation will compensate for variations in duct supply static pressure (Pressure Independent Control). If the space is below setpoint, the electronic controller will provide the following heating sequence:

Stage 1: Close volume damper or valve to minimum position.
Stage 2: Start VAV fan and draw available heat from return plenum.
Stage 3: Energize 1st stage of electric heat.
Stage 4: Energize 2nd stage of electric heat.
Stage 5: Energize 3rd stage of electric heat (if applicable).
- D. Exhaust Fans:
1. EF2 through EF6: Interlock fan to run whenever RTU1 is operating.
 2. EF7 through EF9: Interlock fan to run whenever the associated infrared heater is cycled on. When the fan and heater are cycled on, the associated roof ventilator shall open. See below for specific assignments.
 3. EF10: Interlock fan to cycle on when the wall mounted air conditioning unit AC1 is operating. The duct mounted motorized damper for RV4 shall be open when EF10 is cycled on.
- E. Baseboard Heater
1. A unit-mounted thermostat shall engage the heater contactor to maintain space temperature requirements.
- F. Service Bay Infrared Heaters
1. Space thermostats shall cycle the associated infrared heater(s) to maintain the space temperature setpoint of 55 degrees F (adjustable).
 2. When an infrared heater is cycled on, the associated exhaust fan shall energize and outside air intake damper shall open, until the space thermostat is satisfied.
 3. The following exhaust fans, intakes, and infrared heaters shall be interlocked together to operate according to this sequence of operation:
 - a. EF7a, IRH2a, RV1a
 - b. EF7b, IRH2b, RV1b
 - c. EF7c, IRH2c, RV1c
 - d. EF7d, IRH2d, RV1d
 - e. EF9, IRH2e, RV3
 - f. EF8, IRH2f, RV2
- G. Air Conditioner AC1 and ACCU1
1. The unit will be maintaining space temperature by its own control package. Provide a temperature sensor to monitor the space and to report to the DDC system.
 2. When AC1 is operating, EF10 shall cycle on and RV4 shall be open.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

23 31 10
LOW PRESSURE DUCTWORK

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies the construction of ductwork for the listed systems when the duct static pressure is 2 inches W.C. or less (positive or negative). Each duct system shall have a single pressure classification, which shall exceed to fan's external static rating listed in the equipment schedules. In cases where an external fan static is not given in the equipment schedules, the pressure classification of the duct system shall exceed the fan's total static rating.
- B. Provide ductwork and/or plenums for the following low pressure air systems:
 - 1. Supply air downstream of terminal boxes
 - 2. Relief air and transfer air
 - 3. Exhaust air other than fume hood exhausts
 - 4. Return air
- C. Include all turning vanes, extractors, volume dampers, duct access doors, walls and ceiling access panels, flexible connections, flexible duct, duct sealing systems, hangers and supports necessary to complete the indicated and specified system and achieve the desired system operation.
- D. The following rectangular ductwork shall be lined:
 - 1. All supply air ductwork downstream of terminal boxes
 - 2. All return air ductwork
 - 3. All relief air and transfer air ductwork

1.02 QUALITY ASSURANCE

- A. The listed standards are referenced for the contractor to follow for the construction of ductwork items not specifically addressed in this specification section. This specification takes precedence over the referenced standards.
- B. Standards:
 - 1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Sheet Metal and Air Conditioning Contractors National Association (SMACNA), National Fire Protection Association (NFPA), and Underwriters' Laboratories (UL).
 - 2. SMACNA "HVAC Duct Construction Standards Metal and Flexible" 1985 edition. Construct ductwork to meet all functional criteria defined in the 1985 SMACNA standards except where noted otherwise. Note: Duct constructions compliant with other editions of the SMACNA standards that do not meet or exceed the 1985 SMACNA standard are unacceptable.
 - 3. SMACNA "HVAC Air Duct Leakage Test Manual" latest edition.

- C. All ductwork and fittings must have a computer generated label affixed to each section detailing all applicable information including the duct dimensions, gage, reinforcement type/class, and connector type of systems manufacturer. In addition, galvanizing thickness and country of origin must be clearly stenciled on each duct section.
- D. The Engineer reserves the right to randomly check sheet metal gauges and reinforcing to verify all duct construction is in compliance. Non-conforming material will be replaced by the Contractor at no cost to the Owner.

1.03 SUBMITTALS

- A. Submit ductwork fabrication and layout shop drawings in accordance with Section 20 05 15, "Submittals." Coordinate the detailed fabrication drawings with all trades. Coordinate size and location of ductwork with structure, piping, lighting, equipment, conduit, bus ducts, ceiling construction and clear height above ceilings and other items which may present a potential conflict.
- B. Layout Drawings shall be at 1/4 inch = 1 foot scale on reproducible media with enlarged sections, elevations, plan drawings, and mechanical room drawings as necessary to ensure a coordinated installation.
- C. Written program outlining protection of ductwork from contamination with dirt and procedures for cleaning contaminated ductwork.
- D. Submit documentation that the minimum two weeks building 100% outside air flush-out was completed, including dates when the flush-out was begun and completed and what steps were taken to guarantee 100% outside air usage.
- E. Submit documentation for the filtration media used during the flush-out period, including filtration media manufacturer's name, model number, and MERV value.
- F. Submit documentation that all filtration was replaced immediately, prior to occupancy including filtration media manufacturer's name, model number, and MERV value.
- G. Low Emitting Materials Documentation:
 - 1. Provide a cut sheet and a Material Safety Data Sheet for each adhesive used in the building highlighting compliance with Specification requirements.
 - 2. Provide a cut sheet and a Material Safety Data Sheet for each sealant used in the building highlighting compliance with Specification requirements.

1.04 DUCT DIMENSIONS

- A. The dimensions indicated on the drawings are the net inside clear dimensions available for airflow.
- B. Contractor shall allow for shop-lined or exterior insulation thickness as required and indicate this on the ductwork layout shop drawings.

PART 2 PRODUCTS

2.01 STEEL DUCTWORK

A. MATERIAL

1. Unless noted otherwise, all ducts shall be constructed with G-90 or better galvanized steel conforming to ASTM A653/A653M and A924/A924M Standards, Lock-Forming Quality (LFQ). Chem treat to all galvanized steel to be used for ductwork that will not be painted. Provide a factory-applied surface protection such as oil or a paint-compatible chem treat on all galvanized steel to be used for ductwork that will be painted.
2. Pre-engineered low pressure duct systems with factory fabricated fittings utilizing gasketed joints are acceptable. "Spiro-safe" by Lindab, "Uni-gasket" by McGill Airflow Corporation, or "Greenseam I" by Ductmate Industries.

2.02 RECTANGULAR DUCT

- A. The following table indicates the minimum duct gauge based on largest dimension of the duct.

DUCT DIMENSION	DUCT GAUGE WITHOUT REINFORCEMENT	DUCT GAUGE REINFORCED 4 FT ON CENTER	DUCT GAUGE REINFORCED 5 FT ON CENTER
12" or less	24	--	--
13" to 14"	22	24	24
15" to 18"	20	24	24
19" to 20"	18	24	24
21" to 24"	16	24	24
25" to 42"	--	24	22
43" to 48"	--	22	20
49" to 60"	--	20	18
61" to 84"	--	18	--

1. Ducts with one (1) dimension 85 inches to 120 inches shall be 18 gauge with reinforcement 2 feet on center. Reinforce all ducts having one (1) dimension over 120 inches per SMACNA standards.
2. Duct reinforcement must be provided and spaced as indicated above on all ducts with a dimension greater than 24 inches. All reinforcements shall meet SMACNA standards with regards to reinforcement style and rigidity. Reinforced ductwork gauges shall not be reduced from the minimums indicated in this specification. All reinforcement shall be galvanized steel.
3. All ductwork with a side 16 inches or greater and 20 gauge or less thickness with more than 10 square feet of panel area shall be cross-broken or beaded.
4. Bead, crossbreak and reinforce flat surfaces of all fittings the same as straight duct sections.
5. Transverse joints shall not be considered as duct reinforcement unless specifically stated and listed in the SMACNA standard.
6. Rectangular elbows shall be radius, 1.5 times duct width, or square throat with vanes. Drawings indicate style of elbow to be provided.

7. All rectangular duct fittings shall conform to the gauge and reinforcement requirements indicated for the largest connected straight duct section.
8. Provide opposed multiblade volume dampers in rectangular ducts.
9. Turning vanes shall be double wall with every sixth vane welded to the runner.
 - a. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct.
 - b. 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.
 - c. Rails for mounting turning vanes shall have self locking, friction fit tabs designed to facilitate proper alignment of vanes.

2.03 ROUND DUCT

- A. The following table indicates the minimum gauge for round ductwork for fans with positive external static pressures of up to 2 inches W.C.:

DUCT DIAMETER	SPIRAL SEAM GAUGE	LONGITUDINAL SEAM GAUGE	FITTING GAUGE
3" thru 8"	28	24	24
9" thru 14"	26	24	24
15" thru 26"	24	22	22
27" thru 36"	22	20	20
37" thru 50"	20	18	18
51" thru 60"	18	16	16
61" thru 84"	16	14	14

- B. The following table indicates the minimum gauge for round ductwork for fans with negative external static pressures of up to minus 2 inches W.C.:

DUCT DIAMETER	SPIRAL SEAM GAUGE	LONGITUDINAL SEAM GAUGE	FITTING GAUGE
3" thru 8"	28	26	26
9" thru 14"	26	24	24
15" thru 20"	24	22	22
21" thru 26"	22	20	20
27" thru 34"	20	18	18
36" thru 42"	20	16	16
43" thru 48"	20	N/A	18*
49" thru 60"	18	N/A	18*
61" thru 72"	16	N/A	16*

* Provide reinforcement rings

1. Seam construction shall be spiral seam, lap and rivet or tack weld on 6 inch interval, spot weld on 2 inch interval, continuous butt weld, or lapped and seam welded.

- 2. Round elbows shall be radius type, with a centerline radius of 1.5 times the duct diameter, of stamped, pleated, or three-piece segmented construction.
- 3. Provide round volume dampers with wing nuts, hand quadrants, bearings and stiffened blades.

2.04 FLAT OVAL DUCT

- A. The following table indicates the minimum gauge for oval ductwork for fans with positive external pressures of up to plus 2 inches W.C.:

MAJOR DIMENSIONS	SPIRAL SEAM GAUGE	LONGITUDINAL SEAM GAUGE	FITTING GAUGE
to 24"	24	20	20
25" to 36"	22	20	20
37" to 48"	22	18	18
49" to 60"	20	18	18
61" to 70"	20	16	16
71" to 84"	18	16	16

- 1. Provide duct reinforcement and tie rods spaced 4 feet on center for flat sides of ducts 24 inches wide or greater of the same size and spacing interval as specified for rectangular ductwork above. Reinforced ductwork gauges shall not be reduced from the minimums indicated in this specification and shall meet or exceed SMACNA standards with regards to reinforcement style and rigidity. All reinforcement shall be galvanized steel.

2.05 EXPOSED DUCTWORK

- A. All ductwork exposed in conditioned spaces shall be provided with a paint-grip galvanized finish or similar mill surface etch treatment for painting. Prime with Glidden #5229.
- B. On round ducts, provide pleated elbows.
- C. Provide tapered wedge (ramp) joint or gasketed fittings on round ducts.
- D. Minimize the use of duct sealants.

2.06 SPLITTER DAMPERS

- A. 20 gauge galvanized steel blades welded to square cold-rolled steel operating rod, air tight end bearings with rubber gasket, adjustable locking mechanism.

2.07 DUCT SEALS

- A. Seal all duct transverse joints and longitudinal seams to meet SMACNA Seal Class A for 2 inches of static pressure (positive or negative) as a minimum, and so that leakage rates do not exceed those stated in other sections of this specification.

- B. Duct Sealant: Liquid seal for joints and seams. Surfaces are to be clean and free from oil, dust, dirt, rust, moisture, or any substance which would interfere with bonding of sealant. Where metal clearances exceed 1/16 inch, several applications are required.
 1. McGill AirSeal Corporation, "United Duct Sealer – Water Based"
 2. Hardcast "Duct-Seal 321"
 3. Ductmate "Proseal"
 4. Products with documented VOC-emission rates meeting LEED guidelines by Dow Corning, Miracle Adhesives, Ductmate Industries, or Surebond, Inc.

2.08 INSULATED FLEXIBLE DUCTWORK

- A. Five feet is the maximum allowable length for final connection to supply diffusers in suspended ceilings. Flexible ductwork shall not be used to connect return or exhaust air devices unless specifically indicated on Drawings.
- B. All flexible ducts shall be UL-listed for use as flexible air ducts, and rated for 10 inches W.C. positive pressure and 5 inches negative pressure for sizes through 16 inches diameter, from -20 degrees F to +250 degrees F. Provide gray or black, non-reflective CPE or multi-polyester inner liner, mechanically bonded to a corrosion-resistant steel helix. Average attenuation across octave bands one through seven, based on 650 FPM velocity through 9 feet of 8 inch duct, shall be 23 dB.
- B. Each flexible duct section shall be supported by a minimum of two duct supports and shall not sag more 1/2 inch per linear ft of duct.
- C. Manufacturers: Flexmaster USA Type 8B or 8M, or approved equal by Hart & Cooley, or Thermaflex.

2.09 FLEXIBLE CONNECTIONS

- A. Flexible duct connector shall be used where ductwork connects to fans of apparatus, or apparatus casing to fans to isolate vibration transfer. Connectors shall be attached in such a manner as to provide an airtight and waterproof seal. Connectors will comply with NFPA 90A, "Installation of Air Conditioning & Ventilation Systems" and NFPA 90B, "Installation of Warm Air Heating & Air Conditioning Systems."
- B. Indoor installations shall be of a UL 214 listed, fire retardant Vinyl coated woven nylon or Neoprene coated woven fiberglass fabric. Minimum density of Vinyl is 20 ounces per square yard and rated to 200 degree F. Minimum density of Neoprene is 30 ounces per square yard and rated to 200 degrees F.

2.10 DUCT LINER

- A. Semi-rigid fiberglass duct liner with flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 and K=0.23 at 75 degrees F, 1 inch thick.
- B. All edges of liner facing in the direction of airflow shall be coated with adhesive or shall have a metal nosing.

- C. Mechanical fasteners shall be used to install the liner in addition to the adhesive. Fasteners shall be welded pin and washer or clinching type impact fasteners - galvanized.
- D. Remove and replace all liner that is exposed to water during construction.

2.11 DUCT LINER ADHESIVE

- A. Adhesive shall conform to Adhesive and Sealant Council Standards for Adhesives for duct liner: ASC-A-7001C-1972.
 - 1. Foster Model 85 water-based adhesive
 - 2. McGill AirSeal water-based "Uni-Tack" or water-based "Uni-Grab"
 - 3. Ductmate water-based "PROtack"

2.12 BLANK-OFF PANELS

- A. Provide 16 gauge, steel or aluminum, double skinned, insulating blank-off panels behind louvers as indicated on the drawings. Sheet metal material shall match louver material. Panel finish and color to match louver. Seal panel joints airtight. Provide panels with a minimum R-value of 6.

2.13 SPIN-IN FITTINGS

- A. Heavy gauge fitting with volume damper. Provide insulation guard when used with internally lined ductwork.
 - 1. K and J, Philman, S and J, Flexmaster or Genflex.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All duct installations and duct construction shall comply with all requirements of this specification and meet or exceed SMACNA standards and recommendations for construction and installation.
- B. Provide turning vanes or sweep elbows at all changes of direction in supply, exhaust, and return ductwork.
- C. Seal all seams and joints.
- D. Provide a minimum 6 inch flexible connection where ductwork connects to motor-driven equipment. Do not bulge or install on a bind.
- E. Provide duct access doors at all fire and fire/smoke dampers. Provide ceiling access panel in dry wall or other inaccessible ceiling systems such that fire dampers are serviceable.
- F. Keep ductwork tight to underside of structure. Maintain at least 7 inches clear between duct and suspended ceiling construction.
- G. Install all dampers and provide blank-off plates to seal frames airtight.

- H. Provide volume dampers at each branch to balance system to air flows indicated on the drawings.
- I. All duct liners shall be secured in place with mechanical fasteners and adhesive spread over the entire contact surface. Pin spacing shall meet or exceed SMACNA requirements.
- J. Install flexible ducting only for termination in 5 feet maximum lengths and with only one 90 degree bend at a radius of two duct diameters.
- K. Metallic flexible duct shall be attached with at least three (3) #8 sheet metal screws equally spaced around duct circumference, and five (5) #8 screws for ducts over 12 inches in diameter. Locate screws at least 1/2 inch from duct end.
- L. Non-Metallic flexible ducts shall be secured with a draw band. On ducts over 12 inches in diameter, position draw band behind a bead in the metal collar.
- M. Secure all insulation and vapor barriers on factory-fabricated flexible ducts with a separate draw band, independent of any used for the connection of the flexible duct to the duct collar.
- N. Provide duct access doors at all duct smoke detector locations. Coordinate locations with the Electrical Contractor.
- O. Galvanizing Repairs – Repair galvanizing damaged by welding, scratches, etc., using cold galvanizing compound.

3.02 DUCT CLEAN OUT

- A. Clean and blow out complete duct system before any connections to equipment are made. Inspect ductwork for debris before starting any fans.
- B. Interior surfaces shall be free of dust and debris prior to initial start up. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- C. When internally cleaning duct work prior to installation or shipment to the jobsite, cover all duct ends and openings with a dual polyethylene protective film. Securely affix the film to protect against dirt and debris. Film must be translucent to facilitate inspection of interior surfaces without removing film. Film must have a minimum elongation of 600%, contain no VOC and leave no residue on duct after removal. Ductmate Industries "ProGuard" or approved equal.
- D. Clean external surfaces of foreign substances that might cause corrosion, deterioration of the metal, or where ductwork is to be painted.

END OF SECTION

23 31 11
HIGH PRESSURE DUCTWORK

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies the construction of ductwork for the listed systems when the duct static pressure is greater than 2 inches W.C. Each duct system shall have a single pressure classification, which shall exceed to fan's external static rating listed in the equipment schedules. In cases where an external fan static is not given in the equipment schedules, the pressure classification of the duct system shall exceed the fan's total static rating.
- B. Provide ductwork and/or plenums for the following high pressure air systems:
 - 1. Supply air upstream of terminal boxes
- C. Include all turning vanes, volume dampers, duct access panels, wall and ceiling access panels, flexible connections, flexible duct, duct sealing systems, hangers and supports necessary to complete the indicated and specified system and achieve the desired system operation.

1.02 QUALITY ASSURANCE

- A. The listed standards are referenced for the contractor to follow for the construction of ductwork items not specifically addressed in this specification section. This specification takes precedence over the referenced standards.
- B. Standards:
 - 1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Sheet Metal and Air Conditioning Contractors National Association (SMACNA), National Fire Protection Association (NFPA), and Underwriters' Laboratories (UL).
 - 2. SMACNA "HVAC Duct Construction Standards Metal and Flexible" 1985 edition. Construct ductwork to meet all functional criteria defined in the 1985 SMACNA standards except where noted otherwise. Note: Duct constructions compliant with other editions of the SMACNA standards that do not meet or exceed the 1985 SMACNA standard are unacceptable.
 - 3. SMACNA "Round and Rectangular Industrial duct Construction Standards." This is to be used for return duct subject to negative pressures greater than 4 inches W.C. Construct ductwork to meet all functional criteria defined in the 1985 SMACNA standards except where noted otherwise. Note: Duct constructions compliant with other editions of the SMACNA standards that do not meet or exceed the 1985 SMACNA standard are unacceptable.
 - 4. SMACNA "HVAC Air Duct Leakage Test Manual" latest edition.
- C. All ductwork and fittings must have a computer generated label affixed to each section detailing all applicable information including the duct dimensions, gage, reinforcement type/class, and connector type of systems manufacturer. In addition, galvanizing thickness and country of origin must be clearly stenciled on each duct section.

- D. The Engineer reserves the right to randomly check sheet metal gauges and reinforcing to verify all duct construction is in compliance. Non-conforming material will be replaced by the Contractor at no cost to the Owner.

1.03 SUBMITTALS

- A. Submit ductwork fabrication and layout shop drawings in accordance with Section 20 05 15, "Submittals." Coordinate the detailed fabrication drawings with all trades. Coordinate size and location of ductwork with structure, piping, lighting, equipment, conduit, bus ducts, ceiling construction and clear height above ceilings and other items which may present a potential conflict.
- B. Layout drawings shall be at 1/4 inch = 1 foot scale on reproducible media with enlarged sections, elevations, plan drawings, and mechanical room drawings as necessary to ensure a coordinated installation.
- C. Written program outlining protection of ductwork from contamination with dirt and procedures for cleaning contaminated ductwork.
- D. Submit documentation that the minimum two weeks building 100% outside air flush-out was completed, including dates when the flush-out was begun and completed and what steps were taken to guarantee 100% outside air usage.
- E. Submit documentation for the filtration media used during the flush-out period, including filtration media manufacturer's name, model number, and MERV value.
- F. Submit documentation that all filtration was replaced immediately, prior to occupancy including filtration media manufacturer's name, model number, and MERV value.
- G. Low Emitting Materials Documentation:
 - 1. Provide a cut sheet and a Material Safety Data Sheet for each adhesive used in the building highlighting compliance with Specification requirements.
 - 2. Provide a cut sheet and a Material Safety Data Sheet for each sealant used in the building highlighting compliance with Specification requirements.

1.04 DUCT DIMENSIONS

- A. The dimensions indicated on the contract drawings are the net inside clear dimensions available for airflow.
- B. Contractor shall allow for exterior insulation thickness as required and indicate this on the ductwork layout shop drawings.

PART 2 PRODUCTS

2.01 STEEL DUCTWORK

- A. Unless noted otherwise, all ducts shall be constructed with G-90 or better galvanized steel conforming to ASTM A653/A653M and A924/A924M Standards, Lock-Forming Quality (LFQ). Chem treat to all galvanized steel to be used for ductwork that will not be painted. Provide a factory-applied surface protection such as oil or a paint-compatible chem treat on all galvanized steel to be used for ductwork that will be painted.
- B. Stainless steel ductwork shall be [Type 304] [Type 316] stainless steel with a No. 2D finish in concealed locations, and a No. 4 finish for exposed locations, conforming to ASTM A-167 and A-480.

2.02 RECTANGULAR DUCT

- A. The following table indicates the minimum duct gauge based on largest dimension of the duct for fans with external static pressure over 2 inches W.G. up to 3 inches W.G. (Positive or Negative)

DUCT DIMENSION	DUCT GAUGE WITHOUT REINFORCEMENT	DUCT GAUGE REINFORCED 4 FT ON CENTER	DUCT GAUGE REINFORCED 5 FT ON CENTER
12" or less	22	--	--
13" to 14"	20	24	24
15" to 18"	18	24	24
19" to 24"	16	24	24
25" to 26"	--	24	24
27" to 30"	--	24	22
31" to 36"	--	24	20
37" to 42"	--	22	20
43" to 48"	--	20	18
49" to 54"	--	18	18
55" to 60"	--	18	16
61" to 72"	--	16	--

- 1. Ducts with one dimension 73 inches to 120 inches shall be 18 gauge with reinforcement 2 feet on center. Reinforce all ducts having one dimension over 120 inches per SMACNA standards.
- 2. Duct reinforcement must be provided and spaced as indicated on all ducts with a dimension greater than 24 inches. All reinforcement shall meet SMACNA standards with regards to reinforcement style and rigidity. Reinforced ductwork gauges shall not be reduced from the minimums indicated in this specification. All reinforcement shall be galvanized steel.

- B. The following table indicates the minimum duct gauge based on largest dimension of the duct for fans with external static pressure over 3 inches W.G. up to 4 inches W.G. (Positive or Negative)

DUCT DIMENSION	DUCT GAUGE WITHOUT REINFORCEMENT	DUCT GAUGE REINFORCED 4 FT ON CENTER	DUCT GAUGE REINFORCED 5 FT ON CENTER
10" or less	22	--	--
11" to 12"	20	24	24
13" to 16"	18	24	24
17" to 18"	16	24	24
19" to 22"	--	24	24
23" to 30"	--	24	22
31" to 36"	--	22	20
37" to 42"	--	20	18
43" to 48"	--	18	18
49" to 54"	--	18	16
55" to 60"	--	16	16

1. Ducts with one dimension 61 inches to 120 inches shall be 18 gauge with reinforcement 2 ft on center. Reinforce all ducts having one dimension over 120 inches per SMACNA standards.
2. Duct reinforcement must be provided and spaced as indicated on all ducts with a dimension greater than 18 inches. All reinforcement shall meet SMACNA standards with regards to reinforcement style and rigidity. Reinforced ductwork gauges shall not be reduced from the minimums indicated in this specification. All reinforcement shall be galvanized steel.

- C. Additional rectangular duct construction requirements include:

1. Transverse joints shall not be considered as duct reinforcement unless specifically stated and listed in the SMACNA standard.
2. Rectangular elbows shall be sweep elbows with a centerline radius of 1.5 times the duct width, or square throat with vanes. Drawings indicate style of elbow to be provided.
3. All rectangular duct fittings shall conform to the gauge and reinforcement requirements indicated for the largest connected straight duct section.
4. Provide opposed multiblade volume dampers in rectangular ducts.
5. Turning vanes shall be double wall with every sixth vane welded to the runner.
 - a. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct.
 - b. 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.
 - c. Rails for mounting turning vanes shall have self locking, friction fit tabs designed to facilitate proper alignment of vanes.

2.03 ROUND DUCT

- A. The following table indicates the minimum gauge for round supply ductwork for fans with external static pressure of up to 10 inches W.C.:

DUCT DIAMETER	SPIRAL SEAM GAUGE	LONGITUDINAL SEAM GAUGE	FITTING GAUGE
3" thru 14"	26	24	24
15" thru 26"	24	22	22
27" thru 36"	22	20	20
37" thru 50"	20	18	18
51" thru 60"	18	16	16
61" thru 84"	16	14	14

- B. Additional round duct construction requirements:
1. Seam construction shall be spiral seam up to 60 inches in diameter and continuous butt weld above 60 inches in diameter.
 2. All fittings are to be continuously welded construction.
 3. Round elbows shall be radius type with a centerline radius of 1.5 times the duct diameter.
 4. Provide round opposed multiblade volume dampers in round ducts.

2.04 FLAT OVAL DUCT

- A. The following table indicates the minimum gauge for flat oval supply ductwork:

MAJOR DIMENSION	SPIRAL SEAM GAUGE	LONGITUDINAL SEAM GAUGE	FITTING GAUGE
3" to 24"	24	20	20
25" to 36"	22	20	20
37" to 48"	22	18	18
49" to 60"	20	18	18
61" to 70"	20	16	16
71" to 84"	18	16	16

1. Provide duct reinforcement and tie rods for flat sides of ducts as per SMACNA standards without reduction of duct gauge according to the following:

FAN EXTERNAL STATIC	MAJOR DIMENSION ABOVE WHICH REINFORCEMENT IS REQUIRED
Over 2" up to 3"	24"
Over 3" up to 4"	18"

2. All fittings are to be continuously welded construction, or spot welded and bonded.

2.05 DUCT SEALS

- A. Seal all duct transverse joints and longitudinal seams to meet SMACNA Seal Class A for 10 inches of static pressure as a minimum.
- B. Duct Sealant: Liquid seal for joints and seams. Surfaces are to be clean and free from oil, dust, dirt, rust, moisture, or any substance which would interfere with bonding of sealant. Where metal clearances exceed 1/16 inch, several applications are required.
 - 1. McGill AirSeal Corporation "United Duct Sealer – Water Based"
 - 2. Hardcast "Duct-Seal 321"
 - 3. Ductmate "Proseal"
 - 4. Products with documented VOC-emission rates meeting LEED guidelines by Dow Corning, Miracle Adhesives, Ductmate Industries, or Surebond, Inc.
- C. Soft elastomer butyl gasket with adhesive backing shall be used to seal flanged joints.

2.06 FLEXIBLE DUCTWORK

- A. 5 feet is the maximum allowable length for connection to supply terminal boxes and laboratory air control supply terminals. Flexible ductwork shall not be used to connect return or exhaust air devices unless specifically indicated on Drawings.
- B. All flexible duct shall be UL-listed for use as flexible air ducts. Each flexible duct section shall be supported by a minimum of two (2) duct supports and shall not sag more 1/2 inch per linear foot of duct.
- C. In concealed and unconditioned spaces provide insulated flexible duct section with a double-ply polyester core or a heavy coated fiberglass cloth fabric core encapsulating a steel wire helix, and preventing all contact between the airstream and the insulating material. Minimum 12 inch W.C. working pressure from -20 degrees F to +250 degrees F, solid gray color. Flexmaster Type 3 or approved equal by other listed manufacturer.
- D. In exposed spaces provide uninsulated flexible duct section with a heavy coated fiberglass cloth fabric mechanically locked to encapsulate a steel wire helix. Minimum 12 inch W.C. working pressure from -20 degrees F to +250 degrees F, solid gray color. Flexmaster Type NI-45 or approved equal by other listed manufacturer.
- E. Manufacturers: Flexmaster, Hart & Cooley, or Thermaflex.

2.07 EXPOSED DUCTWORK

- A. All ductwork exposed in conditioned spaces shall be provided with a paint-grip galvanized finish or similar mill surface etch treatment for painting. Prime with Glidden #5229.
- B. On round ducts, provide pleated elbows.
- C. Take special care in applying duct sealants. Apply sealants at joints only in a neat and workman-like manner.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All duct installations and duct construction shall comply with all requirements of this specification and meet or exceed SMACNA standards and recommendations for construction and installation.
- B. Provide turning vanes at all changes of direction supply and return ductwork.
- C. Seal all duct seams, joints, connections, and penetrations.
- D. Provide a minimum 6 inch flexible connection where ductwork connects to motor drive equipment. Do not bulge or install on a bind.
- E. Provide duct access doors at all fire dampers, smoke dampers, combination fire/smoke dampers, and motor-operated control dampers. Provide ceiling access panel in drywall or other inaccessible ceiling systems such that all such dampers are serviceable.
- F. Keep ductwork tight to underside of structure. Maintain at least 7 inches clear between duct and ceiling construction.
- G. Install all dampers and provide blank-off plate to seal frames airtight.
- H. Provide volume dampers as needed to balance system to airflow indicated on the drawings.
- I. Metallic flexible duct shall be attached with at least three (3) #8 sheet metal screws equally spaced around duct circumference, and five (5) #8 screws for ducts over 12 inches in diameter. Locate screws at least 1/2 inch from duct end.
- J. Non-Metallic flexible ducts shall be secured with a draw band. On ducts over 12 inches in diameter, position draw band behind a bead in the metal collar.
- K. Secure all insulation and vapor barriers on factory-fabricated flexible ducts with a separate draw band, independent of any used for the connection of the flexible duct to the duct collar.
- L. Provide duct access doors at all duct smoke detector locations. Coordinate locations with the Electrical Contractor.
- M. Galvanizing Repairs – Repair galvanizing damaged by welding, scratches, etc., using cold galvanizing compound.

3.02 TESTING

- A. Test Requirements:
1. Installed ductwork shall be tested prior to installation of access doors, take-offs, etc.
 2. The Contractor shall give the Architect, Engineer, and Owner 72 hours notice prior to testing in order to provide an opportunity to witness the testing.
 3. Any testing conducted without prior notification providing an opportunity to witness the test shall be considered invalid and will be redone at the contractor's expense.
 4. Leak-test all ductwork. Air leakage in any tested section of ductwork shall not exceed that of SMACNA Leakage Class 6.
- B. Recommended Test Procedure: Perform testing in accordance with SMACNA HVAC Air Duct Leakage Test Manual and as follows below. Note that this reference establishes procedures only; and the allowable leakage rates are found in these Specifications.
1. Use a certified orifice tube and its corresponding logarithmic chart for measuring the leakage. Supply fan must have a CFM capacity greater than the allowable leakage in CFM for the section being tested.
 2. Define section of system to be tested and blank off.
 3. Determine the percentage of the system being tested, on a square foot of surface area basis.
 4. Using the percentage determined in Step "3" and the maximum allowable leakage of 2% of the total system volume, determine the allowable leakage (cfm) for the section being tested.
 5. Pressurize to 100% of the duct pressure class design pressure and repair any significant or audible leaks.
 6. Pressurize again and measure leakage.
 7. Repeat Steps "5" and "6" until the leakage measured is less than the allowable defined in Step "4."
- C. Document all duct testing and submit testing results as part of "As-Built" documents. Furnish copies of all completed duct testing documentation upon request of the Architect, Engineer, or Owner.

3.03 DUCT CLEAN OUT

- A. Clean and blow out complete duct system before any connections to equipment are made. Inspect ductwork for debris before starting any fans.
- B. Interior surfaces shall be free of dust and debris prior to initial start up. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- C. When internally cleaning duct work prior to installation or shipment to the jobsite, cover all duct ends and openings with a dual polyethylene protective film. Securely affix the film to protect against dirt and debris. Film must be translucent to facilitate inspection of interior surfaces without removing film. Film must have a minimum elongation of 600%, contain no VOC and leave no residue on duct after removal. Ductmate Industries "ProGuard" or approved equal.
- D. Clean external surfaces of foreign substances that might cause corrosion, deterioration of the metal, or where ductwork is to be painted.

END OF SECTION

23 33 13
DAMPERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide all dampers for adjusting and modulating airflow. See floor plans, schedules and details for required equipment for all specific situations.
- B. Scope of work includes the installation of all motor-operated control dampers, including those that may be furnished by the Temperature Control Contractor.

1.02 QUALITY ASSURANCE

- A. Standards: AMCA Standard 500 Certified Performance.

1.03 MANUFACTURERS

- A. Ruskin, Louvers and Dampers, Arrow/United, Vent Products, Air Balance, or American Warming and Ventilating.

PART 2 PRODUCTS

2.01 CONTROL DAMPERS

- A. Rectangular Balancing Dampers:
 - 1. Galvanized steel blades, 6 inches wide, 6 inches O.C., 16 gauge, 1/2 inch hex. steel axles, extended 1/2 inch O.D. control shaft. Opposed blade operation, concealed linkage, TFE-filled bearings.
- B. Round Balancing Dampers:
 - 1. Galvanized steel blades, 18 inches and less - 12 gauge; above 18 inches - 10 gauge, with neoprene blade seal. Plated steel axle, extended control shaft.
- C. Manual balancing dampers for rectangular ducts 12 inches and smaller:
 - 1. Galvanized steel blades, 5 inches wide, 16 gauge. 3/8 inch square control shaft, opposed blade damper operation, concealed linkage, TFE-filled bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all dampers in ductwork and provide access to adjustments as required.
- B. Coordinate the selection and installation of all motor-operated control dampers, including those that may be furnished by the Temperature Control Contractor.

3.02 CONTROLS

- A. See Section 23 09 23, "Temperature Control" for control requirements.
- B. Provide motor-operated dampers as required to execute the provisions described in Section, 23 09 93, "Sequences of Operation."

END OF SECTION

23 34 17
EXHAUST FANS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide packaged, factory-wired exhaust fans of the following types:
 - 1. Ceiling
 - 2. Power and Upblast Roof Exhauster
- B. Provide curbs, dampers, caps and other accessories as called for in the individual product sections.

1.02 QUALITY ASSURANCE

- A. Standards:
 - 1. AMCA 210: Fan performance rating.
 - 2. AMCA 300: Sound rating.
 - 3. U.L. Listed: Fan assembly.

1.03 RATINGS AND CAPACITIES

- A. Refer to the Drawings for CFM, static pressure, RPM, drive, sones, accessories, HP, and other electrical requirements.

1.04 SUBMITTALS

- A. Provide brake horsepowers to include drive losses. Data shall be provided with equipment submittal drawings.

PART 2 PRODUCTS

2.01 CEILING EXHAUST FANS

- A. General Construction: Galvanized steel housing with adjustable mounting brackets, complete with 1/2 inch acoustical lining, field adjustable (horizontal/vertical) discharge duct connection with backdraft damper, forward curved centrifugal fan wheel, statically and dynamically balanced, access panel, motor mounted on resilient isolators, control/junction box, and architectural inlet grille (where noted on the Drawings).
- B. Loren Cook, Greenheck, Acme, Jenn-Air, Twin City or Penn Ventilator.

2.02 POWER AND UPBLAST ROOF EXHAUSTERS

- A. General Construction: Aluminum materials for components in the airstream, and exposed to the weather, including base, shroud, birdscreen, motor cover and motor base pan, constructed and assembled in a manner providing a rigid unit for fan wheel and power assembly attachment; backward inclined centrifugal fan wheel, statically and dynamically balanced, venturi shaped inlet cone, steel shaft, permanently lubricated motor with sealed pillow block ball bearings, drive assembly mounted on vibration isolators, motor and drive located out of the airstream, removable drive assembly and wheel through motor cover, adjustable motor slide base, belts, factory installed and wired disconnect switch and roof curb.
- B. Upblast fans shall be of the vertical discharge type with drain trough at the base of the wind band and features as described above.
- C. Loren Cook, Greenheck, Jenn-Air, Twin City or Penn Ventilator.

2.03 UTILITY SET

- A. General Construction: Housing shall be heavy gauge, airtight and adequately braced to insure rigidity through range of Schedule CFM static pressure class, complete with housing supports and drive frame, quick opening gasketed access door, bottom drain and belt guard. Rotation and discharge designations shall be as scheduled.
- B. Loren Cook, Greenheck, Twin City or Hartzell.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Secure units to building structure in accordance with the Drawings and the manufacturer's recommendations.
- B. Furnish roof curbs for membrane type roof to General Trades Contractor for installation. Provide weathertight curb caps if units cannot be set immediately.
- C. Provide selection of fixed sheaves and belts, as required for belt-drive units, to Balancing Contractor for proper final balancing.

END OF SECTION

23 36 05
TERMINAL BOXES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide high velocity terminal boxes and fan powered terminal boxes, complete with direct digitally controlled velocity controller, electric actuator, velocity pressure pickup device, and attenuator section. Provide reheat coils and fans as scheduled on Drawings and specified herein.
- B. Terminal boxes and fan power boxes shall be pressure independent, and suitable for either constant volume or variable volume service as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Standards: American Refrigeration Institute (ARI), National Fire Protection Association (NFPA), and Underwriters' Laboratories (UL).
- B. ARI-880: Performance rating.

1.03 RATINGS AND CAPACITIES

- A. Refer to the Drawings for CFM, noise criteria and other design requirements.

1.04 MANUFACTURERS

- A. Titus, Anemostat, Trane, Price, Krueger, Tuttle and Bailey.

PART 2 PRODUCTS

2.01 TERMINAL BOXES

- A. General Construction:
 - 1. Galvanized steel, 22 gauge minimum, plenum box with 3/8 inch thick, 1.5 lb. density, fiber-free acoustical thermal lining in accordance with UL 181 and NFPA 90A. Fiberglass lining is not acceptable. Casing leakage shall be less than 9 CFM at 1 inch W.G.
 - 2. All components including inlet valves, reheat coils, velocity pickups, velocity controllers and operators shall be furnished and factory-mounted by the terminal box manufacturer. Coordinate thermostat requirements with factory-furnished and installed components.
- B. Inlet Dampers: Self-seating against a closed cell foam gasket, pivoted on self-lubricating Delrin bearings, mounted directly to the inlet port, and positively connected to a electric operator. Damper leakage not to exceed 8 CFM at 6 inches W.G. in fully closed position.

- C. Controls:
1. Each VAV terminal shall include application specific controls with integral microelectronic flow sensors mounted within a NEMA 1 enclosure. The controllers shall have been connected by suitable tubing to an inlet velocity sensor mounted in the inlet to the terminal.
 2. An individual transformer shall be furnished on each VAV terminal to provide power for the controller and the contactors for any required fan and electric heaters at 24 Vac at 50/60 Hz.
 3. Each controller shall control zone temperature by varying the airflow into the space using a PI control loop with programmable proportional and integral coefficients. Applications requiring supplemental heat shall utilize a separate PI algorithm, with programmable proportional and integral coefficients to maintain heating temperature setpoint.
 4. The controllers shall modulate the damper motors to maintain CFM from each terminal in accordance with the cooling/heating requirements calculated by comparing the sensed space temperature with the setpoint and time of day schedule. Zone temperature shall be controlled to +1 degree F. Airflow shall be controlled down to 250 fpm, and shall be read in 25 fpm increments at velocities greater than 500 fpm.
 5. Each controller shall have an internal software clock to implement setpoint changes and changes of control state, in accordance with the resident occupancy. The clocks will be synchronized hourly and automatically following power failures, by a battery backed real-time clock located in the system interface.
- D. Damper Operator: Supply suitable bi-directional 24 volt synchronous electric damper actuators. The motors shall have heavy duty gears and shall contain a magnetic clutch which releases when the damper is driven to either extreme. Stall type actuators or DC actuators without current limiting are not acceptable. The operator shall be sized to accurately and smoothly operate the damper through the expected CFM range of the terminal, against a duct static pressure ranging up to the largest external static pressure scheduled on the Drawings.
- E. Sound Attenuator Section: 22 gauge, galvanized steel with insulation lining to match the terminal box lining, 3 foot length minimum (unless noted otherwise on Drawings).
- F. Velocity Pickup: Ring or cross-shaped, multi-point center averaging type velocity pressure pickup shall be provided by Box Manufacturer. Velocity pickup shall amplify the duct velocity pressure, and maintain control accuracy with inlet ducts in any configuration. Single point or a single inline multiple point velocity pickups will not be accepted.
- G. Electric Heat:
1. Provide multi-step electric coils, supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices.
 2. Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, electronic airflow sensor for proof of flow, and line terminal block.

3. The electronic airflow sensor shall be totally independent of the duct static pressures. The heaters shall deliver maximum heating when needed with normal minimum airflow, and stop heating with no airflow. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized.
4. Heaters shall be equipped with a multi-step controller to stage the heater load according to the temperature control signal. The electronic controller shall be compatible with variable voltage signal (0-10 VDC), or pulse width modulation (AC or DC).

2.02 FAN POWERED TERMINAL BOXES

- A. General Construction: See "Terminal Boxes" above.
- B. Damper and Controls: See "Terminal Boxes" above.
- C. Damper Operators: See "Terminal Boxes" above.
- D. Sound Attenuator Section: See "Terminal Boxes" above.
- E. Velocity Pickup: See "Terminal Boxes" above.
- F. Fan Section:
 1. The fan shall be constructed of steel and have a forward curved, dynamically balanced wheel with direct drive motor. The motor shall be suitable for 60 cycle, single-phase power. The motor shall be of energy efficient design, permanent split capacitor type, with integral thermal overload protection and permanently lubricated bearings, and be specifically designed for use with an SCR for fan speed adjustment. Fan assembly shall include an anti-backward rotation device, torsion-flex tuned spring steel suspension, and isolation between motor and fan housing. Provide parallel or series arrangement as scheduled on Drawings.
 2. The terminals shall utilize a manual SCR, which allows continuously adjustable fan speed from maximum to minimum, as a means of setting fan airflow. The speed control shall incorporate a minimum voltage stop to ensure that the motor cannot operate in a stall mode.
 3. The parallel fan terminals shall include a gasketed backdraft damper at the fan section discharge to prevent primary air from flowing back through the fan section into the return air plenum.
 4. Provide filter frame with 1 inch thick disposable filter cartridge.
- G. Heating Coil: See "Terminal Boxes" above for construction requirements of electric heating coils. Factory-install heating coils at induced air inlet on parallel arrangement terminals, and at the discharge outlet of series arrangement terminals.
- H. Provide an induced air inlet attenuator constructed of 22 gauge sheet metal, lined with 1 inch thick glass fiber with high density facing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Support boxes independent of ceiling system. Coordinate with General Trades Contractor.
- B. Provide access as required for maintenance and repair. All boxes located above the ceiling shall be end discharge unless otherwise noted. All boxes shall deliver the air quantities shown on the Drawings at acceptable sound levels.
- C. Make flexible duct and flexible connections at box duct connections. Provide a transition from the full size of each terminal outlet to the discharge ductwork shown on Drawings. Transition shall be tapered with a 60 degree maximum included angle.
- D. Coordinate installation of controls.

END OF SECTION

GRILLES, REGISTERS AND DIFFUSERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide grilles, registers and diffusers as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Standards: Air Diffusion Council (ADC).

1.03 RATINGS AND CAPACITIES

- A. Refer to Drawings for air device construction, CFM, Noise Criteria, throw, pattern, finish and accessories.

1.04 MANUFACTURERS

- A. Titus, Anemostat, Tuttle & Bailey, Krueger and Price.

1.05 SUBMITTALS

- A. Provide noise criteria to meet that shown on the Drawing Schedules.

PART 2 PRODUCTS

2.01 GRILLES, REGISTERS AND DIFFUSERS

- A. General Construction:
 1. Steel or aluminum, factory-fabricated to evenly distribute design CFM throughout the space without causing noticeable drafts.
 2. Provide all diffusers and registers with a volume controller device complete with an accessible operator unless otherwise indicated.
 3. Diffusers shall be round, linear or square with adjustable air discharge pattern unless otherwise indicated.
 4. Square ceiling diffusers (for variable volume systems) shall have internal Coanda pockets with a 360 degree isovel pattern enabling them to maintain a nonsmudging horizontal pattern at various air volumes with or without a ceiling.
 5. Grilles shall be same construction as registers without volume-control damper.
 6. All diffusers, registers, grilles, and mounting frames shall be furnished with factory finish as scheduled.
 7. Provide concealed fastener mounting on all surface mount registers.
 8. Unless noted otherwise, provide a mounting frame for all air devices mounted in a drywall or plaster ceiling, Mounting frame shall be factory-fabricated by the same manufacturer as the air device being mounted, and shall match air device in material of construction, color, and finish. Permanently secure mounting frame in ceiling construction, and install "lay-in" type air device within mounting frame with flexible ductwork to permit future access above ceiling assembly.

2.02 EQUALIZING DEFLECTORS

- A. Steel bladed assembly, flat black finish.

2.03 COMBINATION VOLUME CONTROLLER/EQUALIZING DEFLECTOR

- A. Steel butterfly damper and steel bladed equalizing deflector assembly, flat black finish.

2.04 VOLUME CONTROLLER

- A. Steel radial blades with flat black finish for round neck square diffusers.
- B. Steel opposed blades with flat black finish for registers and square neck diffusers.

2.05 INTEGRAL EXTRACTORS AND BALANCING DAMPERS

- A. Steel frame and parallel diverting blades, angle bracket, pivot bearing assembly, worm gear operator and control shaft.
 - 1. Anemostat, Tuttle and Bailey or Titus.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Square diffusers supplied by flexible ducts shall be installed with volume damper and equalizing grid in the diffuser neck.
- B. Surface mounted registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.
- C. Wall supply registers shall be installed at least 6 inches below the ceiling, unless otherwise indicated.
- D. Provide additional support hangers for diffusers, grilles or registers mounted in lay-in ceiling tiles.
- E. Insure airtight seal at all connections.
- F. Paint inside portions of all ductwork or plenums that are visible behind registers or grilles, with non-specular flat black enamel.

END OF SECTION

23 37 23
ROOF VENTILATORS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide packaged, factory-wired roof ventilators of the following types:
 - 1. Gravity Intake
- B. Provide curbs, cants, dampers, caps and other accessories as required to complete the installation.

1.02 RATINGS AND CAPACITIES

- A. Refer to the Drawings for CFM, static pressure, RPM, drive, accessories, HP and other electrical requirements.

PART 2 PRODUCTS

2.01 GRAVITY INTAKE VENTILATOR

- A. General Construction: All aluminum, complete with anti-condensation coating, birdscreen and backdraft damper. Ratio of hood area to throat area shall be minimum of 1 1/2:1.
- B. Damper: Parallel aluminum blade with edge seals, balanced design, and low friction bearings and linkage assembly with drive arm on motorized units.
- C. Accessories: 18 gauge galvanized steel curb with 2 inch glass fiber insulation, integral cant, wood nailer strip and damper flange. Curb height shall be sufficient to hold hood intake a minimum of 24 inches above finished roof surface. Damper operators and other accessories as scheduled.
- D. Loren Cook, ACME, Greenheck, Jenn-Air, Twin City or Penn Ventilator.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Secure units to building structure in accordance with the Drawings and the manufacturer's recommendations.
- B. Furnish curbs to General Trades Contractor for installation. Provide weathertight curb caps, if units cannot be set immediately.

END OF SECTION

23 41 05
FILTERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide the following filters:
 - 1. Disposable Rigid MERV 8 (30-35% dust spot efficiency)

1.02 QUALITY ASSURANCE

- A. Standards:
 - 1. ASHRAE 52.2-99
 - 2. MIL-STD-282
 - 3. UL 900

1.03 DIMENSIONS AND RATINGS

- A. Refer to the Drawings for size, CFM, pressure drop and other design requirements.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Camfil-Farr
- B. American Air Filter

2.02 DISPOSABLE RIGID FILTERS

- A. Filter shall be high-efficiency, high lofted supported glass fiber media in enclosing frame. Filter media shall have reinforced backing, welded wire support grid for tapered radial pleats. Media shall be bonded to frame to prevent air bypass.
- B. MERV 8: Filter shall be 4 inches deep, UL Class 2 and have MERV 8 and a 30-35% average dust spot efficiency when tested to ASHRAE Standards. Initial resistance shall be rated at 0.20 inches W.C at 500 FPM face velocity.
 - 1. Camfil Farr Aeropleat IV.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Install filters and holding frame at locations indicated on the Drawings.
- B. Level filter assembly and provide service access.

- C. Tighten filters and achieve a 50% gasket crush to prevent air bypass.
- D. When operating fans during construction, filters are to be in place and replaced when pressure drop reaches 1 inch W.C. more than the initial resistance. Do not operate fans without filters.
- E. At the time of occupancy, install new media throughout for each piece of equipment requiring filters. Provide one (1) complete replacement set of filters for each piece of equipment upon completion of the project.

END OF SECTION

23 51 16
VENT PIPING, BREECHING AND STACK

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide venting system for products of combustion for the following low-heat appliances:
 - 1. Forced-Draft Gas-Fired Power Washer

1.02 QUALITY ASSURANCE

- A. Standards: Venting system shall be UL-listed.

1.03 SUBMITTALS

- A. Submit vent and flue fabrication and layout shop drawings in accordance with Section 20 05 15, "Submittals." Coordinate size and location of flue with structure, piping, lighting, equipment, conduit, bus ducts, ceiling construction and clear height, and other items which may present a potential conflict.
- B. Layout drawings shall be 1/4 inch equals 1 foot scale, minimum, with enlarged sections and elevations as necessary.

PART 2 PRODUCTS

2.01 TYPE B GAS VENT PIPING AND STACK

- A. Double-wall construction with 1/2 inch insulating air space. Provide factory assembled component pieces made of galvanized steel outer jacket and aluminum inner jacket, that create interlocking segments using integral couplings.
- B. Draft hood connectors, elbows, tees, top caps, increasers and reducers, and any other required fittings or accessory shall be made for and compatible with the vent pipe construction and coupling system.
- C. Metalbestos Model DF or approved equal by Duravent or Amerivent.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with the manufacturer's recommendations, including the installation instructions supplied with the product, which are a part of the UL listing.
- B. Complete chimney system shall be installed in accordance with the building code, fire code and NFPA 54 and 211.

- C. Seal positive pressure vents and B-vents with inner pipe joints with GE RTV-108 or Dow Corning RTV-732, RTV Silicone sealant. For stack temperature in excess of 600 degrees F, use Sauereisen No. 33 ceramic joint cement.
- D. Coordinate all roof openings with General Trades Contractor, who will cut roof and weatherproof the finished installation.
- E. Turn storm collar and flashing over to the General Trades Contractor for installation.
- F. Extend chimney top cap to a point at least 3 feet above the roof and at least 2 feet above any part of a building within 10 feet.
- G. Provide ventilated roof thimble.

END OF SECTION

ROOFTOP AIR CONDITIONING UNITS-VARIABLE VOLUME

PART 1 GENERAL

1.01 DESCRIPTION (RTU1)

- A. Provide packaged, DX cooling only rooftop unit with capability for final filters and prewired controls for use with a variable volume system.

1.02 QUALITY ASSURANCE

- A. Standards: American Refrigeration Institute (ARI) and Underwriters' Laboratories (UL).
- B. Unit shall be UL approved and factory run tested.

1.03 RATINGS AND CAPACITIES

- A. Refer to the Drawings for dimensions, CFM, cooling MBH, HP, voltage and other electrical requirements.

1.04 MANUFACTURERS

- A. Carrier, Trane, Aeon or York.

1.05 WARRANTY

- A. Provide one year warranty (parts and labor) on entire unit.
- B. Compressors to have five year parts warranty.
- C. Warranties shall commence at Project Completion, not shipping date or startup date.

1.06 MANUFACTURER'S RESPONSIBILITY

- A. Unit manufacturer to provide a factory-trained representative to supervise start-up of the unit and instruct the Owner's personnel in the proper operation and maintenance of the unit or approve the start-up services (described above) provided by the Contractor.
- B. The unit manufacturer shall furnish complete wiring diagrams for all power and control wiring, including interlocking and wiring of auxiliary equipment.

PART 2 PRODUCTS

2.01 ROOFTOP UNIT

- A. General Construction: Exterior wall panels shall be 16 gauge steel, phosphatized and painted cabinet with fiberglass internal insulation. 18 gauge steel, hinged access panels for access to filters, return/exhaust air, heating, supply fan sections and control components. Provide removable panels for access to refrigeration components. All access doors and panels shall have neoprene gaskets.
- B. Compressor: Scroll type compressors shall be direct drive, with 3600 RPM, suction gas-cooled motors. Compressors shall include oil pump, oil level, sight glass and oil charging valves. Control of compressors shall allow lead/lag of multiple compressors/circuits for even run time to increase life of compressors. Safety controls shall include high and low pressure cutouts, low oil pressure cutouts, and individually resettable lock out controls. Provide R410a refrigerant.
- C. Evaporator: Internally enhanced seamless copper tubing, 1/2 inch outside diameter, mechanically bonded to aluminum fins. All coils shall be equipped with thermal expansion valves and be factory pressure and leak tested to 300 psi.
- D. Condenser Coil: Aluminum fins mechanically bonded to 3/8" outside diameter seamless copper tubes. Provide subcooling circuits. All coils shall be factory tested at 450 psig and vacuum dehydrated. Provide hail guards.
- E. Condenser Fans: All condenser fans shall be vertical discharge, direct drive fans, statically and dynamically balanced, with steel blades and zinc-plated steel hubs. Motors shall be 3 phase with permanently lubricated ball bearings, built-in current and thermal overload protection, and weathertight slingers over motor bearings.
- F. Supply Fans: Fan assemblies shall have double inlet FC fan, motor, and fixed pitch sheaves. All fans shall be statically and dynamically balanced. Fans shall be factory tested, and unit shall reach rated RPM before fan shaft passes through first critical speed. Mount fan motor and fan assembly on common base completely isolated from unit and fan board by two inch deflection spring isolators. The supply fan shall be provided with a variable frequency drive with integral active harmonic control.
- G. Filters: Provide filters per Section 23 41 05 "Filters".
- H. Controls (Factory Installed): DDC microprocessor controls shall be provided to control all unit functions. The control system shall be suitable to control VAV (for terminal boxes) applications. The controls shall be factory installed and mounted in the control cabinet.

- I. Accessories furnished with unit.
 - 1. Variable frequency drive control of supply fan motor (factory mounted) for variable air volume units.
 - 2. Suction service valves and filter driers.
 - 3. Pitched evaporator drain pan.
 - 4. Unit exhaust fan which will operate when the unit is in economizer mode and the OA dampers open to the fan on position.
 - 5. 0-100 percent modulating fresh air economizer.
 - 6. High efficiency motors.
 - 7. Through the door non-fused disconnect with external handle.
 - 8. Single point power connection.
 - 9. Control transformer powered from unit single power connection.
 - 10. R410a refrigerant change.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install unit on roof curb. Install ductwork with flexible connections.
- B. Provide a Kinetics Model KSR 2-inch spring isolation rail between the unit and roof curb.
- C. Coordinate mounting and flashing with the General Trades Contractor.
- D. Install trapped drain line from drain pan to roof.
- E. Check and tighten bearings after 48 hours operation.
- F. Electrical Contractor shall provide all power wiring.
- G. Provide all interlock wiring between roof top units and building control devices as required.
- H. At final completion, replace all filters with clean, new filters, and turn one complete set of replacement filters over to the Owner.

END OF SECTION

DUCTLESS SPLIT SYSTEM AIR CONDITIONER

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide packaged ductless split system air conditioner complete with fan, filters, electronic controls, and DX coil.
- B. Provide matching air-cooled condensing unit complete with fan, coil, and compressor.

1.02 QUALITY ASSURANCE

- A. Standards: American Refrigeration Institute (ARI) and Underwriters' Laboratories (UL).
- B. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- C. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

1.03 RATINGS AND CAPACITIES

- A. See Drawings for capacity requirements.

1.04 MANUFACTURERS

- A. Friedrich, Mitsubishi, or Sanyo.

1.05 WARRANTY

- A. Provide a one year parts and labor warranty on the entire unit commencing at Project Completion. Provide a five-year warranty parts and labor warranty for compressors, commencing at Project Completion. Warranties commencing from the date of shipment or start-up are not sufficient.

PART 2 PRODUCTS

2.01 GENERAL DESCRIPTION

- A. The air conditioning evaporator shall be a self-contained factory assembled unit. The system shall be designed for draw through air arrangement to insure even air distribution to the entire face area of the coil.

2.02 STANDARD FEATURES

- A. Evaporator Fan Section: The evaporator unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Evaporator unit and refrigerant pipes will be charged with dry air before shipment from the factory. The evaporator fan shall be an assembly with a turbo fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The evaporator coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phosphor copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The condensate pump shall be able to raise drain water 33 inches above the condensate pan.
- B. Condensing Unit: The compressor shall be a high efficiency scroll design and shall operate with R410a. A crankcase heater shall be factory mounted on the outside of the compressor. The condensing unit shall have an accumulator. The compressor will be equipped with an internal thermal overload. The condensing unit shall have high pressure and low pressure safety switches. The condensing unit must have the ability to operate with a maximum height difference of 50 feet and have refrigerant tubing length of 75 feet between evaporator and condensing units without the need for line size changes, traps, or additional oil. The compressor shall be mounted to avoid the transmission of vibration. The condensing unit shall be capable of operating at 0°F outdoor ambient temperature.
- C. Control: This unit shall have a wired controller to perform input functions necessary to operate the system. The control system shall consist of two microprocessors interconnected by a single non-polar two wire cable. Wiring shall run direct from the indoor unit to the controller with no splices. Manufacturer shall provide 2 conductor 18 ga. stranded wire for connection to remote controller. The microprocessor located in the evaporator unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install unit and piping as per manufacturer's written recommendations.
- B. Make wiring connections between remote control panel and unit mounted control devices and panel. Also make any other field wiring connection required for remote or duct mounted sensors.
- C. Make all refrigerant-piping connections, fully charge unit and complete installation in accordance with the manufacturer's written installation instructions.

END OF SECTION

23 82 26
ELECTRIC BASEBOARD HEATERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide electric baseboard heaters, complete with internal thermostat controls, pedestal legs and all accessories required for end to end finishing.

1.02 QUALITY ASSURANCE

- A. Standards: Underwriters' Laboratories (UL) label.

1.03 RATINGS AND CAPACITIES

- A. Refer to the Drawings for arrangements, voltage, wattage and other design requirements.

1.04 MANUFACTURERS

- A. Raywall, Emerson Chromalox, Trane or Electromode.

PART 2 PRODUCTS

2.01 ELECTRIC BASEBOARD HEATERS

- A. General Construction: 16 gauge steel, or 14 gauge enclosure, individually adjustable legs, aluminum top discharge grille, all required controls and thermostats.
- B. Heating Element:
 - 1. Electric Heating: Heating elements shall be aluminum long-life metal sheath with low sheath temperature and corrosion-resistant finish. Provide integral circuit breaker.
- C. Controls: Power lead disconnect switch and thermal overheat protector.
 - 1. Unit-mounted thermostat.
- D. Finish: Submit available standard color charts for final color selection by Architect.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount unit on floor, level in the horizontal and vertical planes no closer than 3 inches and no further than 4 inches from floor, and 2 inches from glass or wall.

3.02 WIRING

- A. Power wiring is the responsibility of the Electrical Contractor.

END OF SECTION

23 83 34
INFRARED HEATERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide high-intensity, natural gas-fired infrared heaters including supports and controls.

1.02 QUALITY ASSURANCE

- A. Standards: High intensity infra-red heaters shall be Designed Certified by CSA, approved by Underwriter's Laboratories, Inc. (UL), comply with current Occupational Safety and Health Act (OSHA) requirements, and be accepted by Factory Insurance Association (FIA) and Mutual Fire Insurance Companies (FM).
- B. Warranty: The manufacturer shall provide a published warranty covering the heater's ceramic burner for a period of five years and all components utilized in the heater control assembly for a period of one year.

1.03 MANUFACTURERS

- A. Detroit Radiant (Re-Verber-Ray), Modine, or Reznor.

PART 2 PRODUCTS

2.01 INFRARED HEATERS

- A. The heater reflector housing shall be constructed of one-side bright polished aluminum. The emitter shall be composed of a perforated ceramic tile on which combustion takes place on the surface. The burner plenum shall be constructed of aluminized steel of one-piece drawn construction. The heater shall be of a modular design employing multiple burners to achieve the specified input. The venturi is constructed of stainless or aluminized steel. The secondary re-radiating rods shall be constructed of high temperature stainless steel alloy placed in close proximity of the ceramic burner face. Provide parabolic reflectors for focusing of the infra-red heating pattern.
- B. High intensity infra-red heaters shall be designed to operate when burning natural gas having a heat value of 1,030 BTU per cubic foot with a specific gravity of 0.60. The ceramic burner face shall operate at a temperature range of 1,660 degrees F to 1,810 degrees F and shall incorporate a secondary re-radiating surface of stainless steel rods to obtain optimum operating temperature and radiant output.
- C. Heaters shall be equipped with direct spark ignition of the main burner through a solid state ignition module operating a spark electrode. Loss of power causes 100% safety shut-off of main burner(s). System operates on 120 or 24 volts (NFS-2 or PFS-2).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount burners and hang units from structure with beam clamps and chain. Connect gas piping with shut-off valve.
- B. Mount thermostat on each unit from conduit. Locate so thermostats are not directly receiving radiant heat from heaters. HVAC Contractor is responsible for wiring between the thermostat and the infrared unit.

3.02 TESTING

- A. Test all piping with air at 50 psig for twenty-four (24) hours with no pressure drop.

END OF SECTION

ELECTRICAL SPECIFICATIONS INDEX

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<u>Facility Services Subgroup</u>	
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26 00 00

DIVISION 26 - ELECTRICAL INTRODUCTORY STATEMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. The requirements of Instructions to Bidders, General Conditions, and Division 1 apply to all work herein.
- B. In addition to conforming to the documents listed in Paragraph 1.01 A. above, the Work performed by the Division 26 Contractor shall conform to all provisions of Sections 26 00 00 through 26 99 99 as included in this Specification. The Division 26 Contractor is to consider the word "Contractor" when used in these Sections to mean himself/herself.
- C. The Division 26 Contractor must read the Specifications of all divisions therein because they will be responsible for Work described in other Sections where reference is made to "Electrical Contractor."
- D. All work included under this heading is subject to the Bidding Requirements, General Conditions and Division 1 General Requirements written for this entire Specification, whether attached to this Part or not, and the Contractor is notified to refer thereto as an integral part of the Work.

1.02 APPLICABLE SECTIONS

- A. Contractor shall perform Work described in the preceding paragraphs, the General Conditions, Division 1 and in the following Sections (as included):

Electrical: Sections 26 00 00 through 26 99 99
- B. Contractor is required to coordinate his/her work with that described in other Sections, and therefore, must familiarize themselves with the entire set of Specifications.

1.03 RESPONSIBILITY

- A. The Engineer's efforts under this Contract are aimed at designing a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed must not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

END OF SECTION

26 00 05

DIVISION 26 GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish all materials, labor, tools and equipment to complete and leave ready for operation all electrical systems as called for in these Specifications or shown on the Drawings and any and all details essential to complete the work.
- B. By submitting a bid, the Contractor certifies that:
 - 1. He/she has visited the site and is satisfied that he/she understands all site conditions that may have an effect on his/her bid price.
 - 2. He/she fully understands the makeup, construction, and operation of all systems and equipment he/she is bidding on, and that he/she has included in his/her price all materials, supplies, accessories, and services necessary to make these systems complete and operational.

1.02 REFERENCE

- A. These General Requirements are in addition to the other requirements referenced in Section 26 00 00, "Introductory Division 26 Statement." They are not meant to replace them. In case of conflict, ask the Architect for interpretation.
- B. The Contractor is responsible for becoming thoroughly familiar with all Drawings and Specifications prior to bidding so that all conditions of work are clear with regard to electrical requirements of equipment, mounting conditions, etc. Contractor shall study reflected ceiling plans, elevations, and details, etc.
- C. The Division 26 Contractor is responsible for all electrical work noted as by his/her division, on all Drawings and Specifications in the entire construction documents package. In case of conflict, Contractor shall include greatest quantity of equipment, extent of work, and expense in his/her bid.

1.03 STANDARDS OF QUALITY

- A. Provide quality work conforming to the best accepted practices and standards of the trade. Further definition of quality is given by reference to various laws, codes, standards, and regulations. Refer also to the publications of NECA (National Electrical Contractors Association).
- B. All laws and codes having jurisdiction over this project are deemed to be included in their entirety as a part of these Specifications. Also, any other laws, codes, standards, or regulations referenced herein are deemed to be included in their entirety.
- C. If a conflict occurs between the Drawings and the Specifications, immediately call the conflict to the attention of the Architect at least ten (10) days before bids are submitted, so an addendum clarification may be issued. Conflicts not brought to the Architect's attention before bids are due, shall be priced by the Contractor to include the most expensive, highest quality and quantity of the conflicting items in question.

- D. Material and equipment installed under this Contract shall be new, undeteriorated, and of a quality not less than the minimum specified. All equipment and conductors shall be certified, listed and labeled by UL. If UL does not certify an associated piece of equipment, then certification by another nationally recognized testing laboratory such as ETL shall be permissible. If equipment or conductors are of a type that no testing lab lists or labels, then a safety evaluation must be performed at the supplier's expense by the inspecting authority or another Federal, State or municipal agency.
- E. The latest adopted editions of the following also apply to this work:
 - 1. National Electrical Code, NEC
 - 2. National Fire Protection Association Publications, NFPA
 - 3. State Building Code

1.04 CONTRACT DRAWINGS

- A. Drawings are schematic and show approximate locations and the extent of work. Exact locations and extent must be coordinated with other Contractors and verified in the field. Coordination of the final fabrication drawings and final coordination of the installation in the field is the Contractor's responsibility. Contractor is to take the design to the next level of detail knowing exactly what equipment and materials he/she is going to provide and build the project based on that equipment and other approved shop drawings.
- B. Significant deviations from Drawings must be approved by the Architect.
- C. The Architect reserves the right to make minor changes in location which do not require additional labor or material up to the time of roughing-in without additional cost. No cost shall be added to the Contract for a minor change. The Architect shall determine what is "SIGNIFICANT" and what is a "MINOR" change.

1.05 DEFINITIONS

- A. "Provide": To furnish and install.
- B. "Concealed": Embedded in or installed behind walls, within partitions, above suspended ceilings, below grade, in trenches, in tunnels and in crawl spaces.
- C. "Exposed": Not installed underground or "concealed" as defined above.
- D. "Contractor": Means the Division 26 Contractor.
- E. "Furnish": To purchase and deliver products to the project site and make ready for installation.
- F. "Install": To take furnished products, assemble, erect, secure, connect, and place into operation.
- G. "Products": Includes materials, systems and equipment.
- H. "Work": The providing of products for entire Contract.

1.06 PERMITS, FEES AND NOTICES

- A. Unless otherwise excluded in the Contract Documents, secure and pay for all permits and governmental fees, licenses, and inspections necessary for the proper execution and completion of work.
- B. Give notice and comply with all laws, ordinances, rules, regulations and lawful orders of any public authority having jurisdiction on the performance of the work.

1.07 EXAMINATION OF SITE

- A. Certain existing conditions may affect the manner or sequence of the performance of work. Review existing services and structures prior to bidding the work. Review operating schedules for existing systems and services. Coordinate the scheduling of the work with existing operations.
- B. The Contractor is required to visit the site of the proposed project. After the Contract is signed, no allowance will be made for lack of knowledge of the project conditions.
- C. Verify and reconcile work required by the Contract Documents with conditions at the site.

1.08 UTILITIES

- A. Locate any existing utilities prior to construction. Advise the Architect immediately of major conflicts to permit modification of the Contract Documents.
- B. Contractor shall record exact locations of all existing overhead and underground site utilities within the project limits on a site layout plan and submit to Architect for review prior to any excavation. Where existing utilities conflict with new work, proposed modifications shall also be marked and identified on the site layout plan.
- C. Record locations of all concealed utilities on the Record Drawings.
- D. Coordinate any utility service shutdowns or outages with the Architect and the Owner. Shutdowns shall conform to all utility company requirements. Avoid inconveniencing the Owner and provide temporary service during the curtailment, as required by the Architect or the Owner. Provide ten working days advance notice for any required utility outages.
- E. At least ten (10) working days prior to construction in an area which may involve underground utility facilities, the Contractor shall notify the Project Engineer, the registered utility protection service and each underground utility company:
 - 1. Utilities Protection Service
Phone 1-800-362-2764

1.09 ABBREVIATIONS

- A. Abbreviations used in these specifications:
 - ADA - Americans with Disabilities Act
 - ANSI - American National Standards Institute
 - CBM - Certified Ballast Manufacturers

EIA	-	Electronic Industries Association
ETL	-	Electrical Testing Laboratories
FCC	-	Federal Communications Commission
ICEA	-	Insulated Cable Engineers Association
IEC	-	International Electro Technical Commission
IES	-	Illuminating Engineering Society
ITL	-	Independent Testing Laboratories
NEC	-	National Electrical Code
NECA	-	National Electrical Contractors Association
NEMA	-	National Electrical Manufacturers Association
NESC	-	National Electrical Safety Code
UL	-	Underwriters Laboratories

PART 2 PRODUCTS

2.01 DESIGN BASE MANUFACTURERS ("STANDARDS")

- A. The Contract Documents are based on the requirements and layout of the equipment of the Design Base Manufacturer. Coordination of equipment with the building and with other trades has been made for these specific models and manufacturers of equipment. Where several manufacturers are listed, the first named is the Design Base Manufacturer, unless specifically noted otherwise. Products of the other listed manufacturers which are of comparable performance and quality to the Design Base Manufacturers may be submitted for review and approval per Section 26 00 15, "Submittals." Refer to 26 00 05, "Division 26 General Requirements," Paragraph 2.02, "Approved Equals" for products of manufacturers not listed.
- B. Prepare new layouts for all non-Design Base Manufacturers equipment and adjust and coordinate these layouts with equipment dimensions or service requirements which may be different from those of the Design Base Manufacturer. Verify that this equipment will fit and function in the indicated application. Submit these layouts as part of the submittal review.
- C. Whenever the Contractor furnishes equipment or material other than the Design Base Manufacturer specified, the Contractor is responsible for the cost and coordination of all modifications required not only for his/her work, but also for the work of all other Trades affected. Where changes to other Trades' work are required, this Contractor must include the additional costs of all such work in his/her bid and ultimately make arrangements with these other Trades for such changes and compensate them accordingly. Where changes to design are required, the Contractor shall submit such changes to the Architect for approval. The Contractor shall investigate potential conflicts such as the following:
1. Physical dimensions and weights
 2. Code required working clearances
 3. Connecting pipe sizes
 4. Additional control and interlock wiring
 5. Lug size and quantity
 6. Increased wire size, fuse size, and motor control equipment size
 7. Increased ventilation requirements
 8. Battery capacity
 9. Sound levels of audible devices

10. Increased withstand and interrupting ratings of downstream equipment due to differences in overcurrent protective device characteristics

2.02 APPROVED EQUALS

- A. Equal (equivalent) components (articles, devices, materials, forms of construction, fixtures, etc.) by manufacturers not listed but meeting the specifications may be submitted to the Architect for approval and subsequent inclusion into the bidding documents. Submission must be received no later than ten (10) working days before bid date. If approved, such manufacturers will be listed in an addendum.
- B. Submittals must include all of the following:
 1. Cover Letter: Company letterhead; addressed to Architect. Indicate the following:
 - a. Project name, project number, and phase or bid package if applicable
 - b. Specification Section by number and title
 - c. Specified Product
 - d. Proposed Product
 - e. Deviations, if any, from Specified Product
 - f. List of attachments
 2. Product Data: Manufacturer's literature, fully describing proposed product with exact item clearly indicated.
 3. Specifications: Manufacturer's specifications with all modifications noted as required to show compliance with Bidding Documents.
 4. Test Data: Where performance requirements are specified, submit laboratory tests to indicate compliance.
 5. Samples: Submit appropriate samples of proposed product when required by Architect, showing color, texture, construction and other attributes necessary for evaluation.
- C. Failure to comply with and provide all of the above requirements will result in the submission not being reviewed.

2.03 QUANTITIES

- A. Equipment may be referred to either in these Specifications or on the Drawings, as singular or plural; Contractor is responsible for verifying the exact number of items required to complete his/her work.

2.04 OWNER FURNISHED (CONTRACTOR INSTALLED) EQUIPMENT

- A. Certain items of equipment may be furnished by the Owner to the Contractor. The Contractor shall take delivery of such items and unload them from the truck at the job site.
- B. The Contractor shall protect and store such items as part of this Contract.
- C. The Contractor shall install these items in conformance with the requirements of the Specifications and Drawings and the supplier's recommended installation instructions.

2.05 ACCESS DOORS

- A. Install junction boxes, remote ballasts, etc. in locations where they will be accessible. Where not possible, Division 26 Contractor shall pay General Contractor to install access doors for electrical equipment. Coordinate all access door types and locations with the Architect.

2.06 RECORD (AS-BUILT) DRAWINGS

- A. Contractor shall maintain at the job site, one (1) copy of Drawings which shall be used exclusively for recording the location of all installed work not extraneous information such as field notes. Neatly record all information with red pen.
- B. Record deviations in locations of concealed conduit, equipment, lighting, outlets, manholes, etc., dimensioned from a fixed control point, including depth of bury, at each change of direction, at each change of slope and as required for further reference. Minor variations need not be recorded. Addendums, Change Orders, Field Work Orders, Supplemental Instructions and other pertinent changes of record shall be recorded. These changes shall be reviewed monthly for conformance.
- C. Record deviations made necessary to incorporate equipment different from the Design Base equipment.
- D. Record deviations as noted above.
- E. At completion of the project, Contractor shall deliver "As-Built" Drawings and Coordination Drawings to the Architect for review and approval with regard to completeness. This submission shall consist of the job site "As-Built" Drawings in electronic format and as pdfs. Following approval, provide a full plotted set as well as the electronic version and original.
- F. Refer to Division 1 for additional requirements.

PART 3 EXECUTION

3.01 PAINTING AND RELATED WORK

- A. Finish painting in areas of new construction is the responsibility of the General Trades Contractor and is specified in Division 9.
- B. Any other painting, required by Sections in Division 26, is the responsibility of the respective Division 26 Contractor. It shall be done by a qualified tradesman skilled in the craft, and shall meet the requirements of Division 9. Each Contractor is responsible for repainting of finished areas disturbed by his/her own cutting and patching.
- C. Factory-finished equipment which has rusted or has been damaged shall be cleaned, spot primed with zinc chromate, and finished to the original quality and color by the Contractor.
- D. Support steel shall be cleaned, rust removed, primed, and painted.

3.02 CUTTING AND PATCHING

- A. Unless otherwise required in General or Special Conditions, Contractor shall perform all cutting and patching required for his/her own work. Work must be accomplished in a neat and workmanlike manner, acceptable to the Architect.
- B. If necessary to cut into work of other Trades, it shall be done by other Trades at this Contractor's expense. Patching shall be similarly executed.
- C. Cutting of structural support beams, joists, plates, or other structural members is strictly prohibited without the specific written consent of the Architect. Use rotary drills where cutting holes through concrete, brick, plaster, or tile is necessary. Obtain approval of the Architect before proceeding with work.
- D. All cutting and patching shall be done promptly and all repairs shall be made as necessary to leave the entire work in good condition, including all cutting, fitting, and drilling of masonry, concrete, metal, wood, plaster, and other materials as specified or required for proper assembly, fabrication, installation, and completion of all work of the Contract.
- E. Patching shall match adjacent materials and shall be accomplished only by tradesmen skilled in the respective craft required. Materials and equipment used in the patching work shall comply with requirements of those Sections of the Specifications relating to material to be used in new construction.

3.03 SCAFFOLDING, RIGGING, HOISTS AND TRANSPORTATION

- A. The Contractor shall provide scaffolding, staging, cribbing, tackle, hoists, and rigging necessary for placing of his/her materials and equipment in their proper places in the project.
- B. The Contractor shall pay costs for transportation of materials and equipment to the jobsite and shall include such costs in his/her proposal.
- C. Scaffolding and hoisting equipment shall comply with requirements of applicable Federal, State, and Local Laws and Codes.

3.04 CLEANING

- A. Upon completion of work, all material and equipment furnished in this Contract shall be thoroughly cleaned of labels, dirt, grease, rust, oil and other foreign matter. Prepare for finish painting, where painting is specified.

3.05 TESTS

- A. The Contract Documents, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction may require portions of the work to be inspected, tested, or approved. These services shall be performed by approved agencies.

- B. The Architect (and Owner's representative) must be notified of all scheduled tests and adjustments at least 72 hours before they are scheduled so that he/she may witness same. Obtain confirmation of attendance or absence for each test. If the Contractor performs any test or adjustment without the Architect present, or without proper notification, the Contractor may be required to perform the test or adjustment a second time. All test schedules are to be coordinated with the Owner to minimize inconvenience.
- C. The Contractor shall bear all costs of such inspections, tests, or approvals.
- D. Required certifications of inspection, testing, or approval shall be secured by the Contractor and included in the Record and Information Manuals. See Section 26 00 20, "Record and Information Manuals."

3.06 WARRANTY OF WORK

- A. The Contractor shall warrant all work for a period of one (1) year from date of Contract Completion against defects in materials, equipment, and workmanship. All manufacturer warranties shall begin on date of Contract Completion also.
- B. The Contractor will be required to make all repairs or changes which, in the opinion of the Owner, are necessary as the result of defective materials, equipment, or workmanship.
- C. The Contractor shall, promptly upon receipt of notice from the Owner, and without expense to the Owner, replace all defective work with suitable materials and equipment.
- D. Failure by the Contractor to promptly respond to warranty service calls can be sufficient reason for the Owner to have the defects corrected at the expense of the Contractor.
- E. Refer to Division 1 for additional guarantee requirements.
- F. Refer to other Specification Sections for extended warranty requirements.

3.07 TEMPORARY POWER

- A. Provide temporary electrical power to be used for construction purposes by all Contractors in accordance with Division 1. Provide all fixtures, wiring, and equipment, and make all connections required for temporary electrical service during the construction period; coordinate all power and lighting requirements with the various trades. Provide power to contractor job trailers, and power and lighting on the construction site. Contractor to pay for energy consumption, and any utility company charges to establish service.
 - 1. Temporary Service Panels: Provide a minimum of one (1) 100 Ampere rated service panel in a location or locations within 200 feet of all building work areas; include as many such panels as required to meet 200 foot maximum distance. Provide all wiring and raceways required for service connection and branch circuit wiring connecting each panel to the serving utility and to the following electrical loads; obtain all permits required.
 - 2. Lighting: Provide minimum of 5 footcandles of illumination in all building work areas where construction work is being accomplished; increase illumination to 50 footcandles for painting, plastering and other interior fine finish work.

3. Outlets: Provide duplex receptacle outlets on 100 foot centers maximum; arrange and locate so that no work area of the building is more than 100 feet from a 120 volt outlet; allow no more than five (5) outlets on any 20 Ampere circuit.
4. Power Circuit Breaker: Provide one 100 Ampere, 208 volt, 3 phase or 240 volt, 1 phase circuit breaker in each panel for power equipment.

END OF SECTION

26 00 10
COORDINATION BETWEEN TRADES

PART 1 GENERAL

1.01 DESCRIPTION

- A. The Division 21, 22, 23, 26, 27 and 28 Contractors shall coordinate their rough-in, service, and control requirements with each other. Division 26 Contractor shall review all control Drawings to coordinate exact number and locations of temperature control panels as well as to provide proper starters (including necessary time delays, auxiliary contacts, etc.).
- B. Division 26 Contractor shall coordinate all of his/her work with the General Trades Contractor for location of all devices, luminaires and equipment prior to rough-in.
- C. All wiring required to power Division 21, 22, 23, 27 and 28 equipment shall be installed by the Division 26 Contractor, including 120 volt to temperature control panels. All control and interlock wiring, regardless of voltage, is by the Contractor furnishing the control device. The Division 28 Contractor shall be responsible for all wiring from the fire alarm control panel.
- D. If motors and/or equipment are furnished by Division 21, 22 or 23, which require larger or smaller starters, safety switches, circuit breakers, fuses, and/or branch circuit conductors than indicated, due to a larger size than specified, the Contractor furnishing the motors shall reimburse the Division 26 Contractor for any cost differential.
- E. All electrical devices furnished as a part of Division 21, 22, 23, 27 and 28 equipment, and installation requirements of all electrical work done by Division 21, 22, 23, 27 and 28 Contractors shall conform to the applicable sections of Division 26.
- F. Division 26 Contractor shall coordinate with other Contractors prior to installation of panelboards to insure requirements of NEC Article 110 and 408 are met. The Contractor violating this requirement shall be responsible for the cost of all modifications required to comply to the satisfaction of the inspection agency for failure to meet the above code requirements.
- G. Final operation of equipment provided under Division 21, 22, and 23 shall be the responsibility of the respective Division 21, 22 or 23 Contractor.
- H. Division 26 Contractor shall coordinate with Divisions 8, 11, 13, and 14 Contractors for specific requirements for door hardware.

END OF SECTION

26 00 11
COORDINATION WITH UTILITY COMPANIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. The Division 26 Contractor shall coordinate division of responsibility with the utility companies serving the building.
- B. The Division 26 Contractor shall provide, furnish or install materials and labor not provided, furnished or installed by the utility companies.
- C. Electrical Utility Company Allowance: The Division 26 Contractor shall include in his/her Bid an allowance of payment to the electric utility company for electrical service and aid to Construction charges. The Division 26 Contractor shall provide actual invoice of charges and shall provide credit to Owner if charges are less than \$2,500. If actual invoice is greater, the Division 26 Contractor shall submit a change order for the additional charge over \$2,500.

1.02 DIVISION OF WORK - ELECTRIC POWER UTILITY COMPANY

- A. The electric power utility company is responsible for the following:
 - 1. Furnishing meter socket box and metering transformers
 - 2. Furnishing and installing service transformer
 - 3. Furnishing and installing primary voltage cables and lugs
 - 4. Furnishing and installing meter and metering wires
- B. The Division 26 Contractor is responsible for all other work, including the following:
 - 1. Providing trenching and backfill for primary and secondary service laterals
 - 2. Furnishing and installing conduits for primary and secondary laterals
 - 3. Furnishing and installing secondary voltage cables and lugs
 - 4. Furnishing and installing service transformer pad
 - 5. Furnishing and installing 2 inch rigid conduit for metering and transformer cabinets
 - 6. Installing metering transformers, meter socket box and supports
 - 7. Furnishing and installing ground rods and conductors to meters and transformers

1.03 DIVISION OF WORK – TELEPHONE/DATA UTILITY COMPANY

- A. The telephone/data utility company is responsible for the following:
 - 1. Furnishing and installing main service telephone/data cables
- B. The Division 26 Contractor is responsible for all other work, including the following:
 - 1. Providing trenching and backfill for telephone/data service lateral
 - 2. Furnishing and installing telephone/data service lateral conduits

PART 2 PRODUCTS

2.01 CONDUIT AND CABLE

- A. Refer to Section 26 05 43, "Underground Raceways."
- B. Refer to Section 26 05 10, "Wire and Cable."

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to applicable Division 26 Sections.

END OF SECTION

26 00 15
SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Refer to the GENERAL CONDITIONS and Division 1 for general requirements.
- B. Materials and equipment installed in this work shall meet all the requirements of the Contract Documents and no materials or equipment shall be ordered until submittals are reviewed and approved by the Architect and Engineer.
- C. Submit complete copies of the catalog data or shop drawings for each manufactured item of equipment and all components to be used in the work, including specific performance data, material description, rating, capacity, working pressure, dimensional data, material gauge or thickness, wiring diagrams, brand name, catalog number, and general type.
- D. Catalog data for equipment reviewed by the Engineer shall not take precedence over the requirements of the Contract Documents. The review of the Engineer shall not relieve the Contractor from the responsibility for deviations from Drawings or Specifications, nor from the responsibility for providing proper clearance and coordination with other Trades.
- E. When submitted for review, all shop drawings shall bear the Contractor's signed certification that he/she has reviewed, checked, and approved the shop drawings, that they have been coordinated with the requirements of the project and with the provisions of the Contract Documents, and that he/she has verified all field measurements and construction criteria, materials, catalog numbers, and similar data.
- F. Each copy of a required Specification Section submittal shall be bound in a cardboard folder with all pertinent project information on the cover or on a title sheet. Multiple Specification Section submittals may be bound in the same folder when by the same Manufacturer (i.e.: safety switches, panelboards, etc.). All luminaire submittals shall be included in one folder organized alphabetically and numerically.

1.02 CONTRACTOR'S RESPONSIBILITIES

- A. Complete review of shop drawings, product data, and samples prior to submission.
- B. Determine and verify:
 - 1. Field Measurements
 - 2. Field Construction Criteria
 - 3. Catalog Numbers and Similar Data
 - 4. Conformance with Specifications
- C. Coordinate each submittal with requirements of the work and the Contract Documents.
- D. Include a letter in the front of the submittal of any deviations in the submittals from the requirements of the Contract Documents.

- E. Make submittals and resubmittals, if necessary, promptly in accordance with the approved schedule and in such sequence as to cause no delay in the work or in the work of any other Contractor, or the project as a whole.
- F. Make any corrections or changes in rejected submittals as required by the Architect and resubmit until approved.
- G. Begin no fabrication or work which requires submittals until approved submittals are returned.
- H. The Contractor shall make and distribute, as many photocopies or blueline prints of approved stamped submittals as needed for manufacturers, subcontractor, record and information manuals, etc.

1.03 INCORPORATION OF SUBMITTALS INTO RECORD AND INFORMATION MANUALS

- A. Refer to Section 26 00 20, "Record and Information Manuals."

1.04 CERTIFICATIONS

- A. Provide:
 - 1. Test Agency results verifying capacities, operating conditions and power requirements at design conditions
 - 2. Manufacturer's Statement of Compliance with Standards discussed in individual Specification Sections
 - 3. Equipment labels indicating Certification requirements
 - 4. Quality standard designations on each unit piece
 - 5. Typed verification that noted mixes, chemical compositions, and testing procedures were complied with
 - 6. Other Certifications listed in other Sections of the Specifications

1.05 REQUIRED SUBMITTAL INFORMATION

- A. Submittal Transmittal
 - 1. Provide the following information on the Transmittal Form for each submittal:
 - a. Project name and address.
 - b. Specification number, as listed for each submittal item required in Paragraph 1.05C below.
 - c. Item description, as listed for each submittal item required in Paragraph 1.05C below. Where equipment is identified by number or tag on the documents, same shall be indicated on the submittal.
 - d. Specification number and item description (b and c, above) for each submittal if more than one submittal is sent under one transmittal form.
 - e. Name, address and telephone number of Contractor.
 - f. Bid package number (if applicable).
 - 2. Submittal Transmittal Forms not properly identified with the above information will be returned (without review) to the Contractor.

B. Refer to the following letter key:

KEY FOR REQUIRED SUBMITTALS:

- A. Shop Drawings and/or layout drawings - copies shall be submitted on those drawings which are in 8 1/2" x 11" or 14" format. Where they are submitted on C, D or E size sheets; two (2) sets of prints and one (1) set of reproducible shop drawings shall be provided. The reproducible set will be returned to the Contractor, who will make and distribute as many copies as needed, only prints with the approved stamp printed on them shall be permitted on the site.
- B. Product Data Sheets
- C. Color Samples
- D. Product Samples
- E. Typed Statement
- F. Typed Verification of Compliance with Certification Requirements
- G. Motor Efficiencies and Power Factor
- H. Wiring Diagrams
- I. Installation, Operation, and Maintenance Instructions
- J. Reports or Test results

C. Submit information on equipment items as listed below.

SECTION #	CONTRACT ITEM	SUBMITTALS REQUIRED
26 00 20	RECORD AND INFORMATION MANUALS	A, B, E, F, H, I
26 00 75	ACCESS PANELS	B
26 05 15	CABLE TV DISTRIBUTION SYSTEM	A, B, H, I
26 08 40	ELECTRICAL TESTS, ADJUSTMENTS, INSPECTIONS	J
26 24 20	PANELBOARDS-LIGHTING AND APPLIANCE	B, I
26 24 22	DISTRIBUTION PANELBOARDS-CIRCUIT BREAKER TYPE	B
26 27 19	PREWIRED MULTI-OUTLET SURFACE RACEWAY ASSEMBLY	A, B, H
26 27 26	WIRING DEVICES AND PLATES	B
26 28 13	FUSES	B
26 28 16	SAFETY SWITCHES	B, I
26 28 19	CIRCUIT BREAKERS	B, I
26 29 13	MOTOR CONTROLLERS	B, H, I
26 32 10	EMERGENCY GENERATOR	A, B, H, I
26 36 23	AUTOMATIC TRANSFER SWITCHES	A, B, H, I
26 43 13	TRANSIENT VOLTAGE SURGE SUPPRESSION	B, I
26 51 13	LUMINAIRES, LAMPS AND BALLASTS	B
26 81 10	FIRE ALARM SYSTEM	A, B, H, I

D. After approval, one (1) copy shall be returned to the Contractor. Contractor shall make prints of the approved transparencies and reproductions of all other shop drawing information as necessary for his/her use and for inclusion in the Record and Information Manuals.

END OF SECTION

26 00 20
RECORD AND INFORMATION MANUALS

PART 1 GENERAL

1.01 REFERENCE

- A. Refer to Division 1 for general requirements and for specific information regarding Record (As-Built) Drawings and quantity required.

1.02 SUBMITTALS

- A. Submit one (1) copy of draft manual to the Architect for review and approval thirty (30) days before final inspection is due.
- B. After approval, submit three (3) approved manuals to the Owner and obtain receipt. (See Section 26 00 99, "Requirements for Contract Completion.")

PART 2 PRODUCTS

2.01 MANUALS

- A. Manuals shall be loose leaf, three-ring, hard-cover binders. Material shall be typewritten or printed and be fully legible. Each section shall be divided by labeled tabs.
- B. The following items, together with any other necessary pertinent data, shall be included in each Manual:
 - 1. Each manual shall be labeled on front cover with project name, Contract, Contractor's name, Architect, Engineer, and date of project completion.
 - 2. Manufacturers' names, nearest Factory Representative, and model and serial numbers of components of systems
 - 3. Operating instructions, start-up and shutdown procedures
 - 4. Maintenance instructions
 - 5a. Routine and 24 hour emergency service/repair information:
 - a. Name, address and telephone number of servicing agency
 - b. Names of personnel to be contacted for service arrangements
 - 5. Parts list with numbers of replaceable items, including sources of supply
 - 6. Manufacturers' literature describing each piece of equipment
 - 7. One (1) approved copy of each submittal
 - 8. Written warranties
 - 9. Certificate of Material Receipt and Certificate of System Completion
 - 10. One (1) typewritten directory for each panelboard as installed
 - 11. Record (As-Built) Drawings
 - 12. Certificate of Final Inspection signed by Building Authority having jurisdiction
 - 13. Test results
 - 14. Video recordings of all equipment demonstrations and training sessions

END OF SECTION

EXCAVATION, BACKFILL AND PROTECTION OF UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide all protection, removal, and relocation of existing utilities and all excavation and backfilling (including concrete), associated with the work of this Division.
- B. Locate all existing utilities and equipment, in all areas of work, and record the actual locations. Take extreme care during excavations to avoid interruption of utilities. Relocate new work, as directed by the Architect or Engineer, if required to coordinate new work with existing conditions. If incorrectly charted or uncharted utilities are encountered, notify the Architect immediately.
- C. Disconnect all utilities designated for removal or relocation.
- D. Cooperate with other Contractors and Utility Companies to protect existing utilities and avoid disruption of service. Repair damaged utilities to the satisfaction of the Architect and the Utility Companies.
- E. Restore or repair to its existing condition all lawns, planting areas, curbs, paving, streets, and walks damaged by the work of this Division.
- F. Coordinate the timing of excavation and backfilling with the work of other Contractors and the requirements of the Architect.
- G. In general, conform to the requirements of Division 2, except as specifically modified in this Section.
- H. Refer to boring tests and other subsurface records for rock strata that will be encountered in excavation and include sufficient costs in bid for their removal.

1.02 EXCAVATION SAFETY

- A. It is solely the Contractor's responsibility to comply with all governing codes and ordinances regarding safety of open excavations. This includes the use of all sheet piling, bracing, shoring, sheathing, warning lights, barricades, etc. that may be required. Such material will remain the Contractor's property upon completion of the work.

1.03 SUBMITTALS

- A. For Review:
 - 1. Site layout plan sheet with recorded location of all existing utilities and equipment. Submit for review prior to starting any excavation work.

PART 2 PRODUCTS

2.01 BACKFILL

- A. Type A Materials:
 - 1. Crushed Stone: 3/8 inch size
 - 2. Pea Gravel: 1/4 inch minimum, 5/8 inch maximum
 - 3. Sand: Clean, dry, coarse or medium size
 - 4. Washed Gravel: 3/4 inch normal size
- B. Type B Materials: (Backfill may not contain large rocks (over 2 inches), building materials, masonry debris, cinders, rubbish, wood, or other material subject to decay or prone to damaged buried portions of the work.)
 - 1. Excavated Material (or other clean soil): As permitted in Division 2.

2.02 UNDERGROUND WARNING TAPE

- A. Tape shall be a 6 inch wide polyethylene material which resists acid, alkalis and other soil substances. Black printing shall identify buried service. Background color shall be as recommended by the American Public Works Association (APWA). Brady or equal.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Excavate as shown on the Drawings removing all material encountered.
- B. Excavations are to be open cuts from the surface. Undercuts are prohibited, except where specifically permitted by the Architect. Hold trench width to a minimum, with banks as nearly vertical as possible.
- C. Maintain 5 feet clear between trench and parallel building footing, unless specifically approved by the Architect. When parallel trenches are required to be deeper than footing, maintain a clear distance at least 1 1/2 times the vertical distance below the bottom of the footing, or 5 feet, whichever is greater.
- D. Where bedding or concrete encasement is required by Section 26 05 43, "Underground Raceways," extend mechanical excavation as required to accommodate bed.
- E. Where bedding or concrete encasement is not required, extend mechanical excavation only to within 4 inches of bottom of trench depth, and excavate remainder by hand, so that final support is by undisturbed soil. Shoring from bottom of excavated trench is prohibited.
- F. Keep excavation free of standing water by drainage or by pumping where necessary.
- G. Keep excavations free of frost by covering or heating or both.

3.02 BACKFILL

- A. Backfill shall be as follows:
 - 1. For excavations through lawn areas: Type B.
 - 2. For excavations through roadways, parking areas, sidewalks, plazas, etc.: Type A.
- B. Where unstable or wet soil in trench bottom requires over excavation to firm soil, and in areas of accidental undercutting, backfill to planned bottom elevation with crushed stone, tamped firmly in place.
- C. Backfill only when exact locations of lines and equipment have been recorded and all tests and inspections have been completed.
- D. Do not use fill in a frozen condition or place fill on frozen ground.
- E. Install a continuous warning tape with printing identifying buried service, 12 inches below finished grade, during backfilling operation.
- F. Refer to Section 26 05 43, "Underground Raceways" for concrete encasement requirements. Do not backfill above concrete until concrete has had sufficient setting time (one day minimum).
- G. Remainder of backfill shall be per the requirements of Division 2.
- H. Install backfill in 8 inch lifts and compact to 98%.
- I. Fill any settled areas at completion of project.

3.03 SPOILS

- A. Stockpile excavated material onsite in accordance with Owner's direction.
- B. Remove unused material prior to completion of project.

END OF SECTION

26 00 30
CONCRETE FOUNDATIONS, SUPPORTS AND ENVELOPES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide all concrete work needed for this Division as shown on the Drawings and herein specified. All concrete work incidental to the work of Division 26 is the responsibility of the Division 26 Contractor. Conform to the quality standards in Division 3. Such concrete includes, but is not limited to:
 - 1. Encasement of underground raceways, as specified in Section 26 05 43, "Underground Raceways."
 - 2. Lighting fixture foundations.
 - 3. Service transformer pad.
 - 4. Emergency generator concrete pad.
 - 5. Housekeeping pad.

1.02 QUALITY ASSURANCE

- A. Refer to Section 03 30 00, "Cast-in-Place Concrete."

1.03 SUBMITTALS

- A. For Review:
 - 1. Concrete compression testing reports
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

PART 2 PRODUCTS

2.01 CONCRETE

- A. Refer to Section 03 30 00, "Cast-in-Place Concrete."

PART 3 EXECUTION

3.01 APPLICATION

- A. Provide concrete pads of sufficient size and thickness in accordance with manufacturer of equipment. Details shown on the Drawings shall be considered a minimum requirement.
- B. Coordinate concrete pad requirements with provider of equipment.

3.02 INSTALLATION

- A. Refer to Section 03 30 00, "Cast-in-Place Concrete."

- B. Provide concrete compression testing for luminaire pole foundations and exterior equipment pads.
- C. Do not mount equipment on concrete supports until concrete has had sufficient setting time (seven days minimum).

END OF SECTION

26 00 55
SLEEVES, SEALS, AND FIRESTOPS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install sleeves for conduit penetrations through masonry and concrete construction or where conduit passes through walls exposed and through smoke or fire rated separations.
- B. Provide watertight, corrosive service, oil resistant service and fire rated seals and firestopping as specified herein.

1.02 QUALITY ASSURANCE

- A. Firestopping materials shall be classified by UL as "fill, void or cavity materials" and "through penetration firestop systems."
- B. Firestopping materials shall conform to both Flame (F) and Temperature (T) ratings as tested by nationally accepted test agencies per ASTM E-814 or UL 1479 Fire Tests of Through-Penetration Firestops.
 - 1. The F rating shall be a minimum of one (1) hour, but not less than the fire resistance rating of the assembly being penetrated.
 - 2. Conduct the fire test with a minimum positive pressure differential of 0.01 inches of water column.
- C. Firestopping equipment used shall be in accordance with the Manufacturer's written installation instructions.
- D. Firestopping materials shall be expanded to fill cavities or provide adhesion to substrates that will maintain seal under normal expected movements of substrates.

1.03 SUBMITTALS

- A. For Review:
 - 1. Manufacturer's product data sheets indicating product characteristics, performance and limiting criteria
 - 2. Manufacturer's installation instruction for each type of seal or firestop required by the project
 - 3. Written certification that firestopping systems meet firestopping requirements specified herein
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Seals
 - 1. Link-Seal by Thunderline Corporation
 - 2. CSD Sealing Systems
 - 3. O-Z/Gedney Inc.
- B. Firestopping Materials
 - 1. Hilti
 - 2. Tremco Sealants & Coatings
 - 3. 3M Fire Protection Products
 - 4. Dow Corning
 - 5. CSD Sealing Systems

PART 2 PRODUCTS

2.01 SLEEVES

- A. Sleeve material through floors and walls shall be machine cut rigid galvanized steel conduit.
- B. Sleeves installed in new construction shall have welded flange at mid-point of sleeve which functions as a water barrier and anchor collar.
- C. At the Contractor's option, steel wall sleeves by Link-Seal may be provided.

2.02 SEALS

- A. Modular Mechanical Type
 - 1. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between conduit and sleeve.
 - 2. Seal assembly shall have steel bolts and nuts and rubber sealing element for service and environment under which assembly will be used. Seal shall have a pressure resistance rating of 20 psig.
- B. Sealing Plug Type
 - 1. Seals shall consist of two (2) identical piece plugs made of synthetic rubber with one edge flanged, serrated profile on the outside and a series of ridges on the inside which compress and assures a tight seal. Seal shall have a pressure resistance of 15 psig at the plug base and 30 psig at the flange. Rubber grade shall be suitable for the service and environment under which sealing plug will be used.

2.03 WATERTIGHT SEALS

- A. Modular mechanical type watertight seals shall have zinc galvanized bolts and nuts with EPDM rubber sealing element. Seals shall be Link-Seal, Type C.
- B. Sealing plug type watertight seals shall be made of EPDM rubber. Seals shall be by CSD Sealing Systems.

2.04 FIRE RATED SEALS

- A. Modular mechanical type fire rated seals shall have zinc galvanized bolts and nuts with silicone rubber sealing element which provides a three hour fire resistance rating.
- B. Sealing plug type fire rated seals shall be made of FRR rubber for three hour fire resistance rating.

2.05 FIRESTOP MATERIALS

- A. Use only firestop products that have been UL 1479, ASTM E-814 tested for specific fire rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- B. Cast-in-place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems), or electrical cable bundles, penetrating concrete floors.
- C. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT).
- D. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles and plastic pipe.
- E. Foams, intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
- F. Non curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
- G. Wall opening protective materials for use with UL listed metallic and specified nonmetallic outlet boxes.
- H. Non curing, re-penetrable materials shall be used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
- I. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.

2.06 OIL RESISTANT SERVICE SEALS

- A. Modular mechanical type oil resistant service seals shall have zinc galvanized bolts and nuts with Nitrile rubber sealing element. Seals shall be Link-Seal, Type O.
- B. Sealing plug type oil resistant seals shall be made of Nitrile rubber. Seals shall be by CSD Sealing Systems.

2.07 CORROSIVE SERVICE SEALS

- A. Modular mechanical type corrosive service seals have stainless steel bolts and nuts with rubber sealing element having high resistance to most organic compounds, acids, alkalis and related chemicals. Seals shall be Link-Seal, Type S.
- B. Sealing plug type corrosive service seals shall be made by Viton rubber. Seals shall be by CSD Sealing Systems.

PART 3 EXECUTION

3.01 APPLICATION

- A. Provide sleeves for all conduit penetrations through walls, and through floors where above ground level. Sleeves are not necessary for slab-on-grade penetrations. (Refer to 26 00 30, Concrete Foundations, Supports, and Envelopes, for concrete collar requirements.)
- B. Provide one (1) spare sleeve of equal size in any area where more than three (3) conduits penetrate floor or wall.

3.02 INSTALLATION

- A. Sleeves
 1. Carefully coordinate and check locations of sleeves immediately before and after each concrete pour and masonry installation.
 2. Give the General Trades Contractor locations and sizes of all openings required for the installation of sleeves before construction of masonry or concrete walls is started. If it becomes necessary to cut into new work because of the failure of this Contractor to notify the General Trades Contractor, then the General Trades Contractor shall do any necessary cutting and patching required at this Contractor's expense.
 3. Cut sleeves through walls flush with each surface. Unused sleeves shall extend beyond wall surface and be provided with caps.
 4. Cut sleeves 3 1/2 inches above finished floors. Bottom of sleeve to be cut flush.
 5. Core drill holes for sleeves in existing construction.
 6. Patching shall be by the General Trades Contractor at this Contractor's expense.
- B. Seals and Firestops
 1. Clean surfaces and substrates of dirt, oil, loose materials and other foreign materials which may affect the proper bond or installation of seals and firestops.
 2. Do not apply seals and firestops to surfaces previously painted or treated with a sealer curing compound or similar product. Remove coatings as required in compliance with Manufacturer's instructions. Provide primers, as required, which conform to Manufacturer's recommendations for various substrates and conditions.
 3. Follow Manufacturer's written instructions for installation of seals and firestops.
 4. Install firestops with sufficient pressure to fill seal holes, voids and openings to ensure an effective smoke seal and to maintain the fire resistance rating of the assembly.
 5. Tool or trowel exposed surfaces. Remove excess firestop material promptly as work progresses and upon completion.
 6. Unused sleeves shall be filled with and surrounded by firestop material. Sleeve ends shall be capped. Blind sealing plugs may be used at Contractor's option.

7. Install watertight seals for all below grade penetrations of conduit into the building.
8. Install fire rated seals in all fire rated walls and floors.
9. Install oil resistant service seals in environment where oils, fuels, solvents and other petroleum-base products are used.
10. Install corrosive service seals in environments where organic materials, acids, alkalis and related chemicals are used.

3.03 INSPECTION

- A. Examine seals and firestops to ensure proper installation and full compliance with this Specification. Work shall be accessible until inspection and approval by the applicable code authorities.
- B. Correct unacceptable seals and firestops and provide additional inspection to verify compliance with this specification at no additional cost.

END OF SECTION

26 00 70
DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Perform demolition work of all electrical items as shown and/or described on the Drawings. Remove all items from site designated as scrap.
- B. Provide care so as not to damage adjacent construction designated to remain.
- C. All electrical items in good condition are to remain the property of the Owner. Verify with the Owner's Representative which items are considered scrap and are to be disposed of.

PART 2 PRODUCTS - (NOT APPLICABLE)

PART 3 EXECUTION

3.01 DEMOLITION

- A. Coordinate and schedule all work in a careful manner with all necessary consideration for the Owner, neighbors, and the public, avoiding interference with the use of, and passage to and from adjacent areas and facilities designated to remain in use during demolition. Coordinate work with other trades.
- B. Disconnect and remove all items as shown and described on the Drawings completely back to source, including:
 - 1. Luminaires, poles and bases
 - 2. Electrical equipment and pads
 - 3. Devices, boxes and plates
 - 4. Conduit and wires
- C. Maintain all existing circuits to items that are to remain in use.
- D. Existing outlets which are to be removed and have conduits rising from the floor slab shall have the conduits cut below floor level. Rework as required to provide feed-through service to other remaining outlets. Pull new wire between remaining outlets affected by feed-through. Patch floor as required to restore to original condition.
- E. All conduits not embedded in concrete are to be removed. Conduits protruding from concrete shall be cut below floor level. Patch floor as required to restore to original condition.
- F. Abandoned outlet boxes in walls to remain shall be closed with blank coverplates. If equipped with devices, the devices shall be removed and the conductors removed to the adjacent outlet or reconnected as required to provide feed-through service.

- G. Outlet boxes in walls, which are to remain and be resurfaced, shall be removed.
- H. Disconnect and remove electrical connections to equipment designated to be removed by other Trades.

3.02 RELOCATION

- A. Items designated to be relocated, shall be removed and stored until the construction is ready for their installation.
- B. All luminaires designated to be relocated shall be cleaned and relamped.

3.03 SALVAGE AND SCRAP

- A. Tag and identify all salvageable materials. Coordinate with Owner's Representative all items to be salvaged and store on site as directed. Removal of salvaged and stored items from site is to be by the Owner.
- B. Division 26 Contractor shall remove all scrap items from the building and arrange for disposal in accordance with State and Local regulations.
- C. Disposal of hazardous materials (ex: luminaire ballasts and lamps) shall be in accordance with Federal and State Environmental Protection Agency regulations. A signed statement signifying proper disposal shall be furnished to the Building Owner in the Record and Information Manuals.

3.04 EXISTING EQUIPMENT TO REMAIN

- A. All electrical items and luminaires designated to remain are to be cleaned and relamped. All outlet boxes shall have knockout plugs installed in unused openings. All panelboards are to have blank covers installed in unused circuit breaker spaces.
- B. All existing outlets, equipment, and associated wiring and conduit systems which interfere with the work of the General Trades, Structural, or Division 21, 22 and 23 Contractors shall be reworked as required to maintain system operation. Relocate conduits where they interfere with new work of other Trades.

END OF SECTION

26 00 75
ACCESS PANELS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish ceiling and wall access panels as necessary for access to pull boxes, junction boxes, remote ballasts, electrical equipment, etc., requiring service, adjustment or maintenance.

1.02 WORK NOT INCLUDED

- A. Access panels are to be turned over to the General Trades Contractor for installation.

1.03 COORDINATION

- A. This Contractor is responsible for providing the dimension and locations of all ceiling, wall, and floor openings for the access panels to the General Trades Contractor.
- B. Coordinate with other Contractors with respect to panel locations and group junction boxes, etc., in such a way as to be accessible from a single panel.

1.04 MANUFACTURERS

- A. Acceptable manufacturers include, but are not limited to: Milcor, Bilco, Zurn, Larsen's, Acudor, JL, Inland Ryerson, Nystrom, Mitco or Karp.

PART 2 PRODUCTS

2.01 CEILING ACCESS PANELS

- A. Drywall Ceilings: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with ceiling.
- B. Fire Rated Ceiling: 24" x 24", Milcor fire rated access door, UL approved, 16 gauge steel frame with 18 gauge recessed door panel, 20 gauge panel sides and 26 gauge panel hat channel, continuous hinge, self-latching cylinder lock, prime painted for finish painting.
- C. Plaster Ceilings: 24" x 24", Milcor Style AP with finish material same as ceiling material or Style K, 16 gauge galvanized steel frame with 18 gauge galvanized steel door panel. 24" x 24" and larger panels shall be reinforced, continuous hinge, cylinder lock, prime painting for finish painting to match ceiling.
- D. Acoustical Concealed Spline Ceilings: 24" x 24", Milcor Style AT, 16 gauge steel frame with an 18 gauge steel recessed door panel. 24" x 24" and larger panels shall be reinforced, continuous hinge, cylinder lock, prime painted for finish painting.

2.02 WALL ACCESS PANELS

- A. Drywall: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with wall.
- B. Masonry and Tile: 24" x 24", Milcor Style M Standard, 14 gauge steel frame and door panel, concealed spring hinges, cylinder lock, prime painted for finish painting with wall or Style M stainless.
- C. Fire Rated: 24" x 24", Milcor fire rated access door, UL approved, 1 1/2 hour, Class B rating, 16 gauge steel frame, 20 gauge insulated door panel continuous hinge, automatic door closer, cylinder lock, interior release mechanism, prime painted for finish painting with wall.
- D. Plaster: 24" x 24", Milcor Style K, 16 gauge steel frame with 14 gauge door panel and 22 gauge galvanized casing beads, concealed spring hinges, cylinder lock, prime painted for finish painting with wall.

PART 3 EXECUTION

3.01 COORDINATION OF INSTALLATION

- A. Coordinate size, location and installation of panels required to permit convenient access to electrical equipment requiring adjustment, service or maintenance. Mark locations of access panels on Record Drawings.

END OF SECTION

26 00 99
REQUIREMENTS FOR CONTRACT COMPLETION

PART 1 GENERAL

1.01 DESCRIPTION

- A. The following material must be submitted prior to Contract Completion:
 - 1. Spare parts
 - 2. Record and Information Manuals
 - 3. Accessories and miscellaneous equipment
 - 4. Keys for equipment
- B. Contractor shall use only the attached forms for Material Receipt and System Completion.

1.02 SUBMITTALS

- A. To be included in Record and Information Manuals:
 - 1. Certificate of Material Receipt for all required spare parts
 - 2. Certificate of System Completion for each system when required by individual Division 26 Specifications

PART 2 PRODUCTS

2.01 SPARE PARTS

- A. Furnish spare parts and devices as required by Division 26 Specifications.

PART 3 EXECUTION

3.01 SPARE PARTS AND KEYS

- A. Deliver spare parts and keys to Owner's Representative. Obtain a signed copy of the Certificate of Material Receipt (ATTACHED TO THE END OF THIS SPECIFICATION SECTION).

3.02 MANUFACTURER'S INSPECTION

- A. Arrange for inspection and approval by Equipment Manufacturer where required by Division 26 Specifications. Provide Manufacturer Representative's signature on the Certificate of System Completion (ATTACHED TO THE END OF THIS SPECIFICATION SECTION).

3.03 OPERATIONAL TEST

- A. At completion, Contractor shall operate the systems for a period of at least seven (7) days, to demonstrate fulfillment of the requirements of the Contract. During this time, adjust equipment so that it will perform as the Manufacturer intended, and so that systems will function as designed. Contractor shall sign the Certificate of System Completion (ATTACHED TO THE END OF THIS SECTION).

3.04 EQUIPMENT DEMONSTRATION

- A. After all system operational tests have been completed, schedule an instruction period with the Owner. Instruct designated personnel in the operation and maintenance of all systems and equipment. Use manuals to familiarize Owner with equipment and procedures. Allow time as necessary for this instruction. Schedule time convenient for the Owner and the Architect. All training sessions shall be videotaped for the Owners use in instructing future employees.

Instruction shall include:

1. Location of all components of the system and explanation of their function
2. Programming procedures for computer-based equipment
3. Maintenance and repair procedures
4. Review of documents in Record and Information Manuals

At the completion of instruction, have all attendees sign the Certificate of System Completion.

END OF SECTION

CERTIFICATE OF MATERIAL RECEIPT

PROJECT NAME: _____

DATE: _____

CONTRACTOR: _____

CONTRACTOR'S REPRESENTATIVE: _____

On the above listed date, the following pieces of equipment, as required by Division 26 Specifications, were delivered to the Owner's Representative:

Equipment	Quantity
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

(Attach a separate page for additional items)

Owner's Representative: _____ (PRINT)

_____ (SIGN)

CERTIFICATE OF SYSTEM COMPLETION

PROJECT NAME: _____

CONTRACTOR: _____

SYSTEM: _____

SPECIFICATION SECTION NUMBER: _____

A. MANUFACTURER'S INSPECTION AND APPROVAL (If required by Specification Section)

The above listed system has been inspected and approved as meeting the Manufacturer's written instructions for installation and operation.

Manufacturer's Representative: _____ Date: _____

B. TESTING

The above listed system has passed all testing required by Division 26 Specifications and has met the terms of the Contract. Written test results are attached.

Contractor's Representative: _____ Date: _____

C. EQUIPMENT DEMONSTRATION

The above listed system has been demonstrated to the following Owner's Representatives:

	<u>NAME</u>	<u>TITLE</u>	<u>DATE</u>	<u>SIGNATURE</u>
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

(ATTACH A SEPARATE PAGE FOR ADDITIONAL NAMES)

26 05 10
WIRE AND CABLE

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install all electrical conductors for service entrance, feeder and branch circuit wiring and control wiring.
- B. Refer to other Division 26 Specification Sections for additional wiring requirements.

1.02 QUALITY ASSURANCE

- A. Wire and cable furnished shall be in accordance with the following standards where applicable:
 - 1. UL Standard 44 for rubber insulated wires and cables
 - 2. UL Standard 83 for thermoplastic insulated wires and cables
 - 3. UL Standard 817 for flexible cords and cables
- B. Wire and cable shall be in accordance with applicable NEC Articles.
- C. Wire and cable shall be identified by surface markings indicating manufacturer, size, metal type, voltage rating, UL listing and cable type.

PART 2 PRODUCTS

2.01 TYPE "THHN/THWN" WIRING

- A. Wire shall be single conductor annealed uncoated copper with PVC insulation and nylon jacket. Insulation shall be heat and moisture resistant with light stabilized jacket. Wire shall be rated 600 volt, 90 degree C in dry locations, 75 degree C in wet locations.
- B. Conductors No. 10 AWG and smaller may be solid; No. 8 AWG and larger shall be stranded. Where stranded conductors of sizes 12 and 10 are used, appropriate crimp terminations shall be provided on the ends of each conductor for making connections to wiring devices, switches, etc.

2.02 TYPE "XHHW" WIRING

- A. Wire shall be single conductor annealed uncoated copper with heat and moisture resistant thermosetting cross-linked polyethylene insulation. Wire shall be rated 600 volt, 90 degree C in dry locations, 75 degree C in wet locations.

2.03 SPLICES

- A. Splices in No. 10 AWG and smaller wire shall be made with insulated connectors with metallic coil springs and contoured wings such as 3M "Scotchlok," Ideal Company "Wing Nut," Thomas & Betts Company "Piggy" connectors, or with mechanically-crimped sleeves as manufactured by T & B or Ideal Company, which shall be insulated with pressure sensitive vinyl plastic electrical tape equal to Scotch No. "33" or No. "88."
- B. All taps, terminations or splices, size No. 8 and larger shall be made with bolted-type pressure or compression connectors. Connectors shall be compatible with the conductor material. Insulate connectors with electrical tape to 150% of the insulating value of the conductor insulation. The tape shall have insulating properties equivalent to the conductor.
- C. All splices located in handholes shall be made with waterproof splice kits.

PART 3 EXECUTION

3.01 APPLICATION

- A. Service entrance conductors for underground installations in raceways shall be Type "XHHW."
- B. All branch circuits, feeders and control wiring shall be Type "THHN/THWN."
- C. Unless otherwise noted, minimum wire size for power branch circuits shall be No. 12 AWG and for control and auxiliary systems No. 14 AWG. Wire size for branch circuit homeruns shall be as indicated in the panelboard schedules. Remainder of branch circuit shall be No. 12 AWG, unless noted otherwise.
- D. MC cable is prohibited in all applications.

3.02 INSTALLATION

- A. Install electrical cables, wires and connectors as indicated, in compliance with Manufacturer's written instructions, applicable requirements of NEC and NECA'S "Standard Installation," and in accordance with recognized industry practices.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. No wire may be pulled until masonry and concrete is in place. Free ends and loops at boxes and enclosures are to be pushed back in box and protected by blank covers or other means until the interior painting and decorating work is completed.
- D. Leave at least 6 inches of free conductor at all outlets except where conductors are intended to loop without joints through outlets for luminaires or wiring devices hookups.

- E. Wire color and code shall be used as follows:

120/208 Volt

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green
Isolated Ground	Green w/White Stripe

Emergency: Same as normal, but with 1/2 inch red tape wrapped twice around wire at maximum 12 inch intervals at access points.

- F. All circuits shall have separate neutral conductors run for each phase conductor.
- G. Number of branch circuit conductors in a conduit including switch legs and neutral conductors shall not exceed nine (9) conductors. Conductors shall be derated in accordance with NEC Article 310 when more than three (3) current carrying conductors are installed in a raceway.
- H. Branch circuits shall be connected as numbered on the Drawings. Test and permanently tag by circuit number each circuit wire, except neutrals in panelboard gutter before connecting to panelboard. Numbered adhesive tapes may be used at Contractor's option.
- I. Where a feeder or branch circuit exceeds the terminating lug size, the Contractor shall use an appropriate adapter fitting to reduce cable size. Cutting of conductor strands is not permitted.
- J. Emergency circuit wiring and ground fault circuit breaker wiring shall be installed in separate conduits from all other wiring.
- K. Use pulling means, including fish tape, cable or rope and lubricant which will not damage raceway or deteriorate insulation.
- L. Conductor splices shall be kept to a minimum.
- M. Any equipment having multiple power connections shall have a warning label attached to each source where it connects to the equipment.
- N. Subsequent to wire and cable hookups, energize circuitry and demonstrate functioning in accordance with requirements.
- O. Division 26 Contractor shall provide cords and plugs for equipment furnished by General Trades Contractor which is intended or shown for connection to a receptacle but not furnished with the equipment.

3.03 TESTING

- A. Refer to Section 26 08 40, "Electrical Tests, Adjustments, Inspection."
- B. Prior to energization, test cable and wire for continuity of circuitry and for short circuits.

END OF SECTION

26 05 15
CABLE TELEVISION DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 REQUIREMENTS

- A. The Contractor shall comply with Section 26 00 00, "Division 26 - Electrical Introductory Statement" of Division 26 Specifications.

1.02 SCOPE OF WORK

- A. Division 26 Contractor shall furnish and install a complete and fully balanced cable television distribution system as shown on the Drawings and specified herein. Provide all accessories and equipment as necessary for a complete system.

1.03 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.04 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components.
 - 2. Wiring diagrams.
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal.
 - 2. Test results.
 - 3. Certificate of System Completion.

1.05 MANUFACTURERS

- A. Cable Television Distribution System Equipment:
 - 1. Blonder-Tongue Laboratories, Inc.
 - 2. Jerrold
 - 3. RCA

1.06 SYSTEM OPERATION

- A. Cable television distribution system shall provide good quality color reception of all channels provided by local cable carrier.

PART 2 PRODUCTS

2.01 SPLITTERS

- A. Splitters shall be passive, hybrid, with low insertion loss. Models SUV series.

2.02 TAP-OFFS

- A. Tap-offs shall be back matched inline, with 0.4 dB through line loss and 21 dB tap down. Model STB.

2.03 ISOLATION TAPS

- A. Isolation taps shall be flush wall mounted into standard device box. Valves shall be as required to deliver a signal between 12 dbmv to 18 dbmv at the outlet. Model Versatap V-3889.

2.04 CABLE

- A. Cable shall be RG59/U, 75 ohm coaxial with foam insulation, 20 gauge solid copper conductor, aluminum braid shield, plenum rated insulation. West Penn CL2.

2.05 RACK

- A. Rack shall be wall mounted, breezeway housing, 20" W x 27" H x 10.5" D. Model BH-1.

2.06 SURGE SUPPRESSORS

- A. Power line surge protector shall be a power line shutdown device with response time of 15 milliseconds. Model 4694.
- B. Coax surge suppressors shall be inline, flange mountable, 75 ohm, with 0.1 dB insertion loss, capable of 50,000 Ampere surge. Polyphaser IS-75F-C1.

2.07 AMPLIFIER

- A. Broadband amplifier shall be a Blonder-Tongue BIDA 550-30. The broadband amplifier shall be a high gain (32 dB), 50 MHz to 550 MHz solid state amplifier for use in television distribution systems. Broadband amplifier shall be located in equipment rack.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Division 26 Contractor shall install cable television distribution system as shown on the Drawings in accordance with Manufacturer's written instructions.
- B. All cables shall be tagged at each end.
- C. All unused cables shall have 75 ohm terminators on them.
- D. Provide attenuators, amplifiers, etc., as required for a completely balanced system with high picture quality with signal strength between 15 dbmv to 20 dbmv at each television outlet.

- E. Install coax surge suppressors inline before equipment rack and run a No. 6 AWG copper ground wire to nearest building ground.
- F. Provide conduit stub ups from each outlet location to above accessible ceiling space. Provide continuous conduits across exposed areas or areas of inaccessible ceilings. Provide conduits between isolated areas of accessible ceilings to provide a continuous pathway for wiring from main equipment location to each device.

3.02 TESTING

- A. Provide a complete functional test of all components in accordance with Manufacturer's recommendations.
- B. Operate system for a minimum of seven (7) consecutive days with no problems before claiming Contract Completion.
- C. Refer to Section 26 08 40, "Electrical Tests, Adjustments, Inspection."

3.03 EQUIPMENT DEMONSTRATION

- A. After all system tests have been completed, schedule an instruction period with the Owner. Instruction to be provided by Manufacturer's authorized field technician.
- B. Instruction shall include:
 - 1. Location of all components of the system and explanation of their function
 - 2. Demonstration of equipment
 - 3. Maintenance and repair procedures
 - 4. Programming procedures
 - 5. Review of documents in Record and Information Manuals
- C. Division 27 Contractor shall have all participants sign the Certificate of System Completion in Section 26 00 99, "Requirements for Contract Completion."

END OF SECTION

26 05 26
GROUNDING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install a complete grounding system as shown on the Drawings and specified herein. Provide all accessories as necessary for a complete system.
- B. All components of the electrical system shall be grounded and bonded including: raceways, enclosures, receptacles, motors, controllers, panelboards, contactors, luminaires, emergency generators, transfer switches, telephone systems, and all other electrical components and subsystems.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards and NEC Article 250.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components
 - 2. Ground resistance testing results (refer to Section 26 08 40, "Electrical Tests, Adjustments, Inspection")
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Exothermic Weld
 - 1. Cadweld by ERICO Products, Inc.
- B. Low Resistivity Backfill
 - 1. TerraFill by ALLTEC Corporation
 - 2. GEM by ERICO Products, Inc.
 - 3. Power Fill by LORESCO International, Inc.
- C. Electrolytic Ground Rod
 - 1. TerraDyne Electrolytic Grounding Systems by ALLTEC Corporation
 - 2. Lyn Cole Industries, Torrance CA

PART 2 PRODUCTS

2.01 DRIVEN GROUND ROD

- A. Ground rod shall be copper-clad steel, 3/4 inch minimum diameter, 10 foot length.

2.02 CONDUCTORS, CLAMPS AND CONNECTORS

- A. Refer to Section 26 05 10, "Wire and Cable."

2.03 EXOTHERMIC WELD

- A. Exothermic welds shall be powdered copper oxide and aluminum to form a molded homogeneous copper joint connection between the copper conductor and the material being bonded to.

2.04 SINGLE POINT GROUND BUS BAR

- A. Bus bar shall be minimum size 1/4" x 2" x 24" flat copper, wall mounted on standoff insulators.

PART 3 EXECUTION

3.01 INSTALLATION

A. System Grounding Connections

1. The service entrance conductors shall be grounded in accordance with NEC Article 250.24. The grounding electrode conductor shall be connected to the grounded service conductors at the terminal or bus at the main service disconnecting means. A grounding connection shall not be made to any grounded circuit conductor on the load side of the service disconnecting means.
2. A separately derived alternating current system, such as an emergency generator, shall be grounded and bonded as required in NEC Article 250.30.

B. Enclosure and Equipment Grounding

1. Metal enclosures or raceways for conductors or equipment shall be grounded.
2. Exposed noncurrent-carrying metal parts of fixed equipment likely to become energized shall be grounded.
3. Exposed noncurrent-carrying metal parts of switchboard frames and structures, motor frames, enclosures for motor controllers, and luminaires shall be grounded.

C. Method of Grounding

1. Equipment grounding connections at service equipment shall be made by bonding the equipment grounding conductor to the grounded service conductor and the grounding electrode conductor.
2. The grounding electrode conductor shall connect the equipment grounding conductors, the grounded service conductors and the service entrance enclosures to the grounding electrode.
3. A main bonding jumper shall connect the equipment grounding conductors and the service equipment enclosure to the grounded conductor within the service equipment.

4. Provide separate green insulated equipment grounding conductors for all feeders and branch circuits.
 5. Circuits shown with isolated ground devices shall have a completely separate isolated grounding conductor run in addition to equipment grounding conductor of the same size.
- D. Bonding
1. Bonding shall be provided and conform to all requirements of NEC Article 250 V and VII.
- E. Grounding electrode system shall consist of all of the following components exothermically bonded together:
1. The Steel Frame of the Building - At a column nearest to the service entrance equipment and at a point accessible to view.
 2. Driven Ground Rods - Two ground rods, installed vertically into earth near the service entrance point and spaced 20 feet apart, with top 8 feet encased with low resistivity backfill.
 3. Single Point Ground Bus Bar - Bus bar installed adjacent to the service entrance switch gear with each grounding electrode system component listed above bonded to it.
- F. Exterior luminaires and poles shall be grounded by the use of a manufacturer supplied ground lug or pigtail or by the use of ground clips fastened in bare metal that is free of paint. Poles shall be grounded to an equipment grounding conductor. Poles shall also have a driven ground rod installed at the bottom of their base excavation and bonded to pole.
- G. Separately derived systems such as transformers and emergency generators shall be grounded to the nearest building steel column. If building steel is not available, then ground to the nearest domestic cold water pipe. In addition, run a grounding electrode conductor back to the main service entrance ground point. Grounding electrode conductor shall be bonded to conduit at each end.
- H. Motor terminal boxes shall be grounded by the use of a manufacturer supplied ground lug or by drilling and tapping a hole for a ground screw. Remove paint prior to making the connection.
- I. Metal roofing and metal veneer siding shall be bonded to building steel or nearest grounding system connection with No. 6 AWG conductor every 100 feet.
- J. Metal piping systems such as compressed air, natural gas, lab gases, vacuum, hot water, heating and chilled water HVAC systems, shall all be bonded to the grounding electrode system with No. 2 AWG conductors.
- 3.02 GROUNDING SYSTEM TESTING
- A. Soil Resistivity
1. Measure soil resistivity and record

- B. Grounding System Resistance
 - 1. Ground system resistance measurements shall be taken and submitted to the Architect for approval before energizing equipment. Measurements shall be taken in dry weather, not less than 48 hours after rainfall.
 - 2. The test method used shall be the fall-of-potential method described in IEEE Standard 142. If it is not possible to use the fall-of-potential method, then the slope method of Dr. George Tag shall be used.
 - 3. Documentation shall include the following information:
 - a. Sketch of site showing building, ground connection and test locations
 - b. Location in feet of all test spikes
 - c. Graphs showing all recorded data plotted
 - d. A minimum of ten (10) data points shall be recorded

3.03 GROUNDING SYSTEM ADJUSTMENT

- A. Where grounding system resistance test results are above 25 ohms, install additional driven ground rods spaced 20 feet apart until such a reading is achieved.

END OF SECTION

26 05 29
HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install complete hangers, supports and concrete inserts as required for the installation of conduits, cabinets, transformers and equipment installed under Division 26.
- B. Provide all beam clamps, expansion anchors, threaded rod, framing steel and hardware as required.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.03 MANUFACTURERS

- A. Hangers, Supports and Inserts
 1. GTE/Unistrut International Inc.
 2. Superstrut
 3. Kindorf/Midland Ross Corporation
 4. Grinnell
 5. Tufstrut - Pilgrim Technical Inc.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Conduits or raceways shall be securely supported and anchored with proper devices, using lead shields in walls or sides of beams, expansion shields or other approved type device for direct down-pull loads. Minerallac type hanger shall be limited to above ceilings. Holes made in walls or ceilings for use with anchoring devices shall be covered by large steel washers. Include special hangers, as required. Minerallac type fittings shall not be permitted within 8 feet of the floor surface where exposed raceways are installed.
- B. Hangers shall be individual ring or clevis type, one hole straps or multiple trapeze hangers.

2.02 STRUCTURAL ATTACHMENTS

- A. Concrete: Use Grinnell Fig. 285, or equal, Light Weight concrete insert for loads up to 400 lbs., or Grinnell Fig. 282, or equal, Universal Concrete insert for loads up to 1430 lbs.
- B. Steel Beams: Where pipe size is 2 inches or less, use Grinnell Figure 87 or equal, Malleable iron C-Clamp and Retaining Clip. Where pipe size is over 2 inches, use Grinnell Figure 229, or equal.

- C. Intermediate Attachments: Continuous threaded rod shall be used wherever possible. No chain, wire or perforated strap shall be used. Up to 2 inches trade size pipe use 3/8 inch (minimum) rod, 2 1/2 inches and larger use 1/2 inch (minimum) rod.
- D. Pipe Attachments: For steel pipe use Grinnell Figure 115 Ring and Turnbuckle Adjuster, or Figure 260 Clevis.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Conduits shall be supported to meet the conditions as required using proper type and size straps, clamps, and hangers.
- B. Exposed conduits shall be installed parallel with or at right angles to building structure, fastened at least every 8 feet and at both sides of each outlet, except at one side only of conduit terminating outlets. Conduits shall be installed tight to structure and beams/joists. Coordinate exposed conduit routing with Architect prior installation.
- C. Conduit risers shall be supported with friction clamps with two point bearing anchored to building construction and at every floor.
- D. The following hanger methods are not permitted:
 - 1. Wood plugs
 - 2. Perforated band iron
 - 3. Hook chain supports
 - 4. Balling wire, etc.
 - 5. Minerallacs where previously mentioned
 - 6. Friction type clamps, such as hammer on clips
- E. Whenever possible, use supports, clamps, hangers, etc., designed especially for the equipment to be installed.
- F. The maximum permitted load on hanger rod, plain or all-thread, shall be as follows:
 - 1. 1/4 inch size - 750 pounds
 - 2. 3/8 inch size - 1000 pounds
 - 3. 1/2 inch size - 2000 pounds
 - 4. 5/8 inch size - 3000 pounds
 - 5. The minimum size hanger rod permitted is 1/4 inch size.
- G. Any supports exposed to weather, shall be cleaned, primed and painted.

END OF SECTION

26 05 33
CONDUIT AND FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Provide complete grounded conduit systems for all electrical conductors.
- B. All conduits shown on the Drawings shall meet NEC fill requirements for the conductors enclosed.
- C. Conduit raceway systems shall be made mechanically tight and electrically continuous throughout. All metal raceway systems shall be grounded.
- D. Refer to Section 26 05 43, "Underground Raceways" for all conduits located within or below slab-on-grade floors, and exterior to the building foundation.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Conduit shall be in accordance with applicable NEC Articles.

PART 2 PRODUCTS

2.01 RIGID (RMC) AND INTERMEDIATE METAL CONDUIT (IMC)

- A. Conduit shall be steel, hot dipped zinc galvanized (minimum 0.0008 inch thick) inside and out, with circular cross section, uniform wall thickness, continuously welded seams and chamfered threaded ends. Conduit shall be furnished in 10 foot standard lengths.

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. EMT shall be zinc galvanized (minimum 0.0008 inch thick) inside and out, with circular cross section, uniform wall thickness and continuously welded seams. EMT shall be furnished in 10 foot standard lengths.

2.03 FLEXIBLE METAL CONDUIT (FMC)

- A. Conduit shall be steel or aluminum, hot dipped zinc galvanized inside and out and made from one continuous length of high grade strip of uniform weight and thickness shaped into interlocking convolutions with smooth interior and exterior surfaces. Conduit shall be provided in standard coil lengths.

2.04 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Conduit shall be hot dipped zinc galvanized inside and out and made from one continuous length of high grade steel strip of uniform weight and thickness shaped into interlocking convolutions with smooth interior and exterior surfaces. Conduit shall be provided in standard coil lengths.
- B. Conduit shall have a continuous PVC jacket enclosing it.

2.05 CONDUIT FITTINGS

- A. All RMC, IMC, and EMT fittings shall be galvanized steel. Connectors and couplings shall be threaded, set screw or compression type, concrete-tight.
- B. Conduit bodies shall be threaded steel type. Provide neoprene cover gaskets for conduit body covers exposed to the weather.
- C. Expansion fittings, shall be O-Z/Gedney Type "AX" for RMC and Type "TX" for EMT. For IMC applications, a 15 inch minimum length of RMC shall be used with a Type "AX" expansion fitting. Provide O-Z/Gedney Type "BJ" bonding jumpers at all expansion fittings.
- D. Sealing fittings shall be Crouse Hinds Type EYD or Appleton Type EYD, with drain.
- E. RMC and IMC conduit bushings shall be of the insulated type with phenolic thermosetting insulation molded to a hot dipped galvanized steel body of the threaded type.
- F. EMT fittings shall be of the insulated throat type. Fittings larger than 2 1/2 inches shall have threaded bushings installed as described in Paragraph E above.
- G. Conduits larger than 1 inch shall have grounding type bushings.

2.06 ROOF PENETRATIONS

- A. Use prefabricated pipe flashing of ultra-violet resistant EDPM rubber with ribbed aluminum base.
- B. Pate, Shipman, or Thy-Curb.

PART 3 EXECUTION

3.01 APPLICATION

- A. All conduit shall be rigid metal conduit, unless noted otherwise below, minimum 3/4 inch trade size.

- B. EMT may only be used in these locations:
 - 1. Within interior partitions and exterior walls
 - 2. Above suspended ceilings inside building
 - 3. Exposed above 9 feet A.F.F. inside building (except in wet, hazardous, or corrosive locations)
 - 4. Exposed above electrical equipment above 7 feet in electrical and mechanical rooms.
- C. Intermediate metal conduit may be used at the Contractor's option in lieu of rigid steel conduit within the building interior.
- D. Flexible metal conduit up to 6 feet in length shall be used for connections to lighting fixtures. A green grounding conductor shall be installed in each flexible conduit as specified in Section 26 05 26, "Grounding." All runs shall be terminated in insulated flexible conduit fittings in accordance with NEC. Minimum size to be 1/2 inch.
- E. Liquid tight flexible metal conduit (up to 3 feet in length) and appropriate fittings shall be used for connections to motors, engine/generators, and vibrating equipment. A green grounding conductor shall be installed in each flexible conduit as specified in Section 26 05 26, "Grounding." All runs shall be terminated in insulated flexible conduit fittings in accordance with NEC. Minimum size to be 1/2 inch.

3.02 INSTALLATION

- A. Generally, all conduits shall be concealed with runs installed parallel and perpendicular to walls and floor. Exposed conduits below 9 feet will be permitted only in electrical and mechanical rooms. Anywhere else at the discretion of the Architect or where specifically noted on the Drawings. In these cases, install conduit escutcheon plates around conduit penetration, sized to cover the conduit sleeve. Submit proposed routing of exposed conduits in finished spaces with Architect prior to installation.
- B. Branch circuit conduits shall not be run within concrete floors except for short runs to floor boxes.
- C. Conduit shall be securely and rigidly fastened in place with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, or ceiling trapeze. C-clamps and beam clamps shall have strap or rod-type retainers.
- D. Conduit support fastenings shall be by:
 - 1. Wood screws to wood
 - 2. Toggle bolts in hollow concrete masonry units
 - 3. Expansion bolts in concrete or brick
 - 4. Machine screws, welded threaded studs on steel work
 - 5. Nail-type nylon anchors or threaded studs driven by a powder charge and provided with lock washers and nuts for concrete, brick or steel work
 - 6. Conduit shall not be supported using wire or nylon ties.

- E. In areas without ceilings, conduits shall be run as high as possible attached to the structure of the roof, or of the floor deck above. Do not attach directly to the metal deck. Conduits shall be run next to walls as inconspicuously as possible. In finished areas exposed to public view without ceilings, all work shall be installed in an aesthetically acceptable manner. The Architect reserves the right to require the Contractor to make changes as necessary to equipment installation that is unsuitable for public view due to poor workmanship.
- F. Install conduit sleeves for all conduit penetrations through floors, masonry walls, and fire rated walls. Refer to Section 03 30 00, "Concrete" for spacing requirements. Sleeves shall be spaced a sufficient distance apart to maintain fire ratings as required by the UL Fire Resistance Construction Manual.
- G. Conduit shall be independently supported from elements of the building and shall not rest on, nor be supported from suspended ceilings. Boxes shall be fastened to structure independently from conduit system. Conduits shall not be attached to metal decking forming the roof or floor slab above.
- H. Lay out conduit system to avoid crossing building expansion joints. Where crossings are necessary, use expansion fittings.
- I. All conduits shall be continuous from outlet to outlet or junction box, and installed complete before pulling conductors. Swab conduits free of dirt, grease and moisture before pulling conductors.
- J. Install bushings on all RMC and IMC conduit ends. Install insulated throat fittings on all EMT conduit ends. Fasten conduit to boxes and cabinets using locknuts. Provide two (2) locknuts where required by the NEC, where insulating bushings are used and where bushings cannot be brought into firm contact with the box.
- K. All conduits entering or leaving refrigerated or moisture-laden spaces shall be sloped away from equipment and secured with sealing fittings. Secure conduits with threaded hubs to prevent air circulation and condensation.
- L. Do not install conduits beneath nor above equipment generating heat such as boilers, heat exchangers or water heaters.
- M. Provide a high strength pull cord in all empty conduits and cap ends.
- N. Maintain minimum clearances of 6 inches from parallel hot water piping and 4 inches from crossovers.
- O. Provide conduit sleeves, seals and firestops in accordance with Section 26 00 55, "Sleeves, Seals and Firestops."
- P. Provide expansion joints in conduits run on roofs and exterior to building above grade.
- Q. Provide proper roof flashing and sealing when penetrating roofs.
- R. Install cable wedging plug type supports in all vertical conduit runs as required by NEC.

- S. Do not exceed four (4) 90 degree bends in any conduit run without a pulling point. Provide pullboxes as required. Locate pullboxes in accessible areas. Coordinate locations with all other building Trades.

END OF SECTION

26 05 34
OUTLET BOXES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Outlets shall be provided for devices, luminaires, motors, and equipment connections, systems equipment connections, special outlets, and as otherwise required.
- B. Outlet boxes shall be of sufficient size to provide free space for all conductors enclosed in the box. Boxes shall be not less than the minimum size required by NEC Article 314 for the number and size of conductors contained within.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

PART 2 PRODUCTS

2.01 OUTLET BOXES

- A. Interior Outlet Boxes: Provide galvanized flat rolled sheet steel interior outlet wiring boxes, of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices. Through-wall boxes shall not be used.
- B. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations. Choice of accessories is Installer's option.
- C. Weatherproof Outlet Boxes: Provide corrosion-resistant cast aluminum, weatherproof outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.
- D. Luminaire outlet boxes shall be standard 4 inch octagonal, minimum 1 1/2 inches deep.
- E. Flush device boxes in masonry walls to be masonry boxes designed for the purpose, or 4 inch square boxes with raised covers designed for masonry.
- F. Wiring device boxes for surface conduit work and located in potentially damp areas shall be FS series cast aluminum boxes.

- G. Where outlet boxes are to be cast in concrete slabs, they shall be boxes designed for concrete installation.
- H. Flush device boxes shall be 4 inch square, 2 1/8 inch deep boxes with plaster covers or gangable 2 1/2 inch deep boxes. Shallow 1 1/2 inch deep gangable boxes may be used only in demountable partitions and in other walls too thin for standard depth boxes.
- I. Flush boxes for low voltage cabling shall be 4 11/16 inches square x 2 1/8 inches deep for 3/4 inch and 1 inch conduits. Boxes shall be 5 inches square x 2 7/8 inches deep for 1 1/4 inch conduits.
- J. Flush boxes for low voltage cabling for 1 1/2 inch conduits shall be 6 inches x 6 inches x 3 inches deep with flush NEMA 1 screw cover. Provide grommited hole in cover.
- K. Flush boxes for low voltage cabling for 2 inch conduits shall be 6 inches x 6 inches x 4 inches deep with flush NEMA 1 screw cover. Provide grommited hole in cover. (Coordinate wall depth with General Contractor.)

PART 3 EXECUTION

3.01 INSTALLATION

- A. All outlet boxes upon which luminaires are to be installed, shall be equipped with 3/8 inch fixture studs. All outlet boxes shall be installed vertically plumb within 3 degrees.
- B. All boxes shall be rigidly supported from building structure independent of the conduit system. Boxes cast into masonry or concrete are considered to be rigidly supported. Framing members of suspended ceiling systems shall not be permitted as a support.
- C. Flush boxes shall finish within 1/4 inch of surface of non-combustible materials. Boxes shall not project beyond finished surfaces.
- D. Flush luminaires in lay-in ceilings shall have branch circuit conduit terminated in a junction box above ceiling, but accessible through ceiling opening and located at least one foot away from the luminaire.
- E. Locations of all outlets are approximate. Final location shall be verified with the Architect in the field prior to installation.
- F. Install knockout closures for unused openings.
- G. Outlet boxes installed on opposite sides of a fire rated wall shall have a minimum of 24 inch spacing between adjacent boxes.
- H. All outlet boxes shall use stud to stud box brackets with far side supports.
- I. "Through-wall" type boxes shall not be used.

- J. Boxes shall not be installed in a "back-to-back" manner. Boxes shall be spaced at least 10 inches apart where in opposite walls within the same stud cavity, unless a sound absorptive barrier is placed between boxes.

END OF SECTION

26 05 35
PULL AND JUNCTION BOXES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Pull or junction boxes shall be provided in all raceway systems where required to avoid an excessive number of bends, to facilitate wire pulling, or to afford required access to the raceway system. Maximum distance between boxes in raceway systems shall not exceed 100 feet.
- B. Pull and junction boxes shall provide adequate space and dimensions for the installation of conductors in accordance with NEC Article 314.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

PART 2 PRODUCTS

2.01 PULL AND JUNCTION BOXES

- A. Pull and Junction Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers, of types, shapes and sizes, to suit each respective location and installation. Minimum size shall be 4 inch square, 2 1/8" deep box.
- B. Concealed pull or junction boxes shall be flush in finished walls, located near the floor and provided with flush type covers; blank device plates in case of outlet type boxes and flat plates prime painted and secured with flat head screws in the case of larger boxes. Surface junction boxes in utility areas shall be without knockouts, shall have close fitting screw covers and shall be finished in medium gray enamel.
- C. Boxes exposed to the weather shall be weatherproof type as required by NEC.
- D. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes to suit respective uses and installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install pull and junction boxes, complying with Manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in compliance with recognized industry practices.

- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
- C. Pull and junction boxes shall be located in utility areas or above accessible ceiling systems wherever possible. Boxes located in exposed areas shall be brought to the attention of the Architect prior to installation.
- D. Pull and junction boxes shall be sized in accordance with the NEC for both contained conductors and conduit entrances and exits.
- E. Fasten boxes rigidly to structural surfaces, or solidly imbed electrical boxes in concrete or masonry.
- F. Boxes not otherwise accessible in ceilings and walls shall be made accessible by an access panel.
- G. Provide watertight boxes, slip expansions or bonding jumpers where dictated by construction conditions.

END OF SECTION

26 05 43
UNDERGROUND RACEWAYS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install all items necessary for a complete installation of underground and under slab raceway systems herein specified and as shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Concrete work shall conform to the requirements of ACI 301-89.
- C. Refer to Section 03 30 00, "Cast-in-Place Concrete."
- D. Refer to Section 26 00 25, "Excavation, Backfill, and Protection of Utilities" for backfill requirements.

PART 2 PRODUCTS

2.01 RACEWAY AND FITTINGS

- A. PVC conduit shall be rigid non-metallic, Schedule 40 heavywall, UL approved for direct earth burial.
- B. Rigid galvanized steel conduit and associated fittings shall be the same as specified under Section 26 05 33, "Conduit and Fittings."
- C. PVC conduit fittings shall be slip joint type with cement furnished and recommended by the Manufacturer.
- D. Conduit elbows shall be rigid metal and be long radius type.

2.02 CONCRETE ENVELOPES FOR RACEWAYS

- A. Concrete used for the encasement of raceways shall have a 28 day compressive strength of 3000 psi. Refer to Section 03 30 00, "Cast-in-Place Concrete" for information concerning concrete to be furnished under this Section.
- B. Colored Concrete
 - 1. Cement color shall be 95% pure mineral oxide (90% pure iron oxide) finely milled to pass a 325 mesh. Carbon added for darker shades shall be wettable and shall not exceed 3% of the weight of portland cement. Color pigments shall be light fast, wettable, weather resistant, alkali resistant, and free of deleterious fillers and extenders.
 - 2. Color shall be Solomon Grind #140 or equal.

PART 3 EXECUTION

3.01 APPLICATION

- A. Underground raceways shall be rigid galvanized steel conduit or Schedule 40 heavywall PVC. Use rigid galvanized steel only for:
 - 1. Raceways underneath electric equipment pads
 - 2. All elbows (45 degrees and greater)
 - 3. Metering conduit
 - 4. Where noted on the Drawings
- B. Underground raceways shall be encased in a concrete envelope for the following installations:
 - 1. In trenches below footings
 - 2. Secondary voltage electric service entrance raceways between service transformer and service entrance equipment
 - 3. Voice/data ductbanks
 - 4. Raceways between emergency generators and service equipment
 - 5. Where noted on the Drawings
- C. Underground raceways shall be a minimum of 1 inch.
- D. Branch circuit raceways (up to 1 1/2 inch size) may be run under slab-on-grade floors at bottom of gravel base. Only short raceways connecting to floor boxes are permitted within slab-on-grade floors.
- E. Raceways larger than 1 1/2 inch shall be run at 30 inches below finished grade or floor slab.

3.02 INSTALLATION

- A. All raceways shall have ends capped during construction to prevent entrance of mud or solids. Seal active raceways entering building from underground raceway system. Cap spare raceways. Mark ends of future raceways with a stake at ground surface. Provide pull cord in all spare raceways.
- B. Raceways shall be placed and sloped so that water will not enter into the building through them. Provide a pullbox in conduit runs to prevent water ingress where necessary.
- C. For conduits located under slab-on-grade concrete floors, conduits shall be routed in a single layer. Where conduits are routed in a stacked arrangement, concrete envelope shall be provided to prevent voids in the ductbank. In areas of high conduit concentration, such as under electrical switchgear, complete concrete backfill shall be provided to avoid compromising support of concrete floor.
- D. Refer to Section 26 00 55, "Sleeves, Seals and Firestops" for raceways installed through below grade walls and floors.

- E. Spacers shall be used to provide a minimum 7 1/2 inch separation between adjacent centers of raceways in ductbanks as shown in the National Electrical Code for all conduits, both exterior, and within the limits of the building foundation, regardless of voltage. Ductbanks shall be limited to only two (2) conduits wide arrays unless at ends of runs where turning up into electrical equipment.
- F. Unless otherwise noted on the Drawings, underground raceways systems shall be installed 30 inches below finished grade to top of raceways. Coordinate with other site utilities and run deeper, if necessary. Always run below gas lines.
- G. Where trench depths are noted on the Drawings, depths shall be considered to mean buried depth to top of underground raceways.
- H. PVC raceways, where not encased in concrete, shall snake from side to side of trench for expansion relief.
- I. Underground raceway systems with manholes shall be installed with a minimum 3 inches per 100 foot slope to manhole for positive raceway drainage. Do not slope conduits toward building penetrations.
- J. Where noted, concrete encased underground raceways in trenches shall have a 3 inch minimum concrete envelope between any raceway and edge of envelope.
- K. Underground raceways installed below footings shall be concrete encased for full width and height of trench, extending 1 foot beyond each edge of footing.
- L. Raceway envelopes shall be installed by monolithic pour method and vibrated in place to insure flow into voids and complete encasement of raceways. Raceways shall be bundled with twine on plastic spacers not over 5 feet on center and providing minimum conduit separation of 7 1/2 inches of center. Use steel reinforcing rods for alignment side stakes and support bottom of raceways on plastic base spacers not over 5 feet on center. Keep bottom of trench clean of debris and water. Envelope may be poured with side forms or "neat" excavated trench walls. Reinforce envelopes with rebar and wire ties.
- M. Identification
 - 1. Location of underground raceways shall be identified with underground warning tape. Refer to Section 26 00 25, "Excavation, Backfill and Protection of Utilities" for warning tape requirements.
 - 2. Concrete encased secondary service raceway envelope shall be placed using colored concrete. Mix color pigment with the concrete at a rate of approximately 4.5 lbs. per sack of cement. In no case shall the pigment weight exceed 10% of the weight of cement.
- N. Underground raceways run between equipment locations within the building shall be run within the confines of the building foundation walls.
- O. Raceways installed for parallel feeder conductors shall be installed so that each run is the same length as the others.

END OF SECTION

26 05 48
VIBRATION ISOLATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install complete vibration control devices as specified herein. Provide all accessories and equipment as necessary for a complete system.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Vibration Isolation
 - 1. Amber/Booth Company, Inc.
 - 2. Korfund Dynamics
 - 3. Kinetics Noise Control, Inc.
 - 4. Vibration Mountings and Control

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION MOUNT TYPES

- A. Type DNP (Double Neoprene Pads)
 - 1. Neoprene pad isolators shall be formed by two layers of 1/4 inch to 5/16 inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the Manufacturer's recommended range.
 - 2. Type DNP isolators shall be formed from one of the following products or approved equal:
 - Type NR Amber/Booth
 - Type Korpad Korfund Dynamics
 - Type NPS..... Peabody Noise Control
 - Series Shear Flex Vibration Mountings and Control

- B. Type HN (Hanger Neoprene or Glass Fiber)
 - 1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rods passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30 degree arc before contacting the hanger housing.
 - 2. Type HN isolators shall be one of the following products of approved equal:
 - Type BRD-A Amber/Booth
 - Type H Korfund Dynamics
 - Type RH or FH Peabody Noise Control
 - Type RHD or RFD Vibration Mountings and Control

2.02 FLEXIBLE ELECTRICAL CONNECTIONS

- A. Type A
 - 1. Flexible electrical connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wire way, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
 - 2. Flexible electrical connection Type A shall be Crouse-Hinds (Syracuse, NY) "XD" Expansion/Deflection Coupling.
- B. Type B
 - 1. Flexible electrical connection Type B shall be field fabricated using a minimum 2 foot length of flexible conduit or cable.
- C. Type C
 - 1. Flexible electrical connection Type C shall be field fabricated using a minimum 4 foot length of flexible conduit or cable.

PART 3 EXECUTION

3.01 APPLICATION

- A. Mechanical Equipment
 - 1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

3.02 INSTALLATION

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated.

- D. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the Manufacturer's Specifications for the unit in question.

- E. Flexible Electrical Connections
 - 1. Type C connections shall be installed in a grossly slack "U" shape or a 360 degree loop.
 - 2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION

26 05 53
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 NAME PLATES

- A. Furnish and install equipment identification nameplates on all pieces of electrical equipment including, but not limited to:
1. Safety Switches
 2. Motor Starters
 3. Panelboards
 4. Lighting Contactors
 5. Relays
 6. Each Switch, Circuit Breaker, Spare, and Space in new and existing Distribution Panelboards
 7. Emergency Generators
 8. Automatic Transfer Switches

Identify and label all existing circuits and equipment that are located within the contract construction area.

- B. Nameplates shall state the equipment name and number or letter as shown on the Drawings; voltage and phase; HP, ampacity or KW size; and source of power. Identification shall be as shown in the following examples:
1. Exhaust Fan "EF1"
208 Volt, 3 Phase
2 HP
Powered from Panel P1
 2. Panel "P1"
208/120 Volt, 3 Phase
225 Ampere
Powered from Transformer T1
 3. Electric Water Heater "EWH-1"
208 Volt, 3 Phase
4 KW
Powered from Panel P1
- C. In handholes and pull and junction boxes, identify each set of circuit conductors by permanent ink on plastic tags with circuit number, voltage and phase, wire size, source, and load information.
- D. Refer to Section 26 05 10, "Wire and Cable" for color code identification of wire and cable.
- E. Refer to Section 26 24 20, "Panelboards - Lighting and Appliance" for branch circuit identification.

1.02 SPECIAL INSTRUCTION AND WARNING SIGNS

- A. Furnish and install nameplates giving special instructions as follows:
 - 1. At emergency generator:
 - "Emergency generator"
 - "208/120 Volt, 3 Phase"
 - "Powers ATS"
 - 2. Where more than one (1) service equipment location exists in a building, a nameplate shall be installed at each location denoting the existence of multiple services, their voltage, and building areas served by each service. Refer to NEC 230.2.

1.03 JUNCTION BOX IDENTIFICATION

- A. Junction boxes in conduit runs shall be color coded and labeled as to the system that they have within. Each system shall have a different color or labeling scheme used. Do not color code in finished areas without ceilings.
- B. Electrical power and lighting branch circuit junction boxes shall be painted, but labeled with the circuit numbers contained within. Labeling may be done with paint stencils or permanent black felt-tip markers.
- C. Special systems shall have junction boxes painted as follows:
 - 1. Fire Alarm - Red
 - 2. Normal - Silver
 - 3. Life Safety System - Green
 - 4. Lighting - Black

PART 2 PRODUCTS

2.01 NAMEPLATES

- A. Nameplates shall be laminated plastic with letter type a minimum of 1/4 inch high.
- B. Color of nameplates shall be white with black letters for normal power systems and red with white letters for emergency power systems.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install nameplates on equipment using cadmium plated, steel, self-tapping screws or rivets.
- B. Nameplates shall be installed on the front cover or trim of each piece of equipment. Where not possible, install on wall next to equipment using hollow-wall anchors.
- C. Horsepower, ampacity, or kilowatt values shall be taken from the equipment as delivered in the field, not from the Drawings.

3.02 EXISTING EQUIPMENT IDENTIFICATION

- A. Provide nameplates on all existing equipment within building as listed in Paragraph 1.01.A. of this Specification Section.
- B. Provide updated panelboard directories in all existing panelboards within building as required for new panelboards per Section 26 24 20, "Panelboards-Lighting and Appliance," Paragraph 3.01.

END OF SECTION

26 08 40
ELECTRICAL TESTS, ADJUSTMENTS, INSPECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish equipment and perform as necessary all testing as required herein and called for in other Division 26 Specification Sections. Perform adjustments of equipment as required. Arrange for inspections by the authority having jurisdiction.

1.02 QUALITY ASSURANCE

- A. Testing equipment shall be UL listed and specially manufactured and appropriate for the intended type of testing to be performed.
- B. All testing shall be witnessed by Owner's Representatives. Provide five days advance notice.

1.03 SUBMITTALS

- A. For Review:
 - 1. Test results form (attached to the end of this Section) with all recorded data sheets and graphs
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Final Certificate of Inspection

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 TESTING

- A. Amperage Phase Balance
 - 1. Test and record amperage of each phase at each branch distribution panel, and all lighting and appliance panels.
- B. Continuity of Conduit System
 - 1. Test each run of metallic conduit for continuity of ground return path.
- C. Conductor Insulation Leakage
 - 1. Test each run of 600 volt cable for insulation leakage. Use the short-time method with readings taken at 30 and 60 seconds. Record results for conductors used for panelboard feeders.

- D. Grounding System Resistance
 - 1. Test and record grounding system resistance. Refer to Section 26 05 26, "Grounding" for test procedure.
- E. Operating Voltage
 - 1. Measure and record operating voltage at all panelboards with all systems in building operating normally.

3.02 ADJUSTMENTS

- A. Amperage Phase Balance
 - 1. Where Contractor has deviated from panelboard circuit arrangement as shown on the Drawings, perform a phase balancing within the panelboard by rearranging the position of selected circuit breakers. Record the changed circuits on the "As-Built" Drawings.
- B. Continuity of Conduit System
 - 1. Where the resistance of a conduit run is greater than two (2) ohms, disassemble all connections, clean, and reassemble to obtain an acceptable reading.
- C. Conductor Insulation Leakage and Impedance
 - 1. Where insulation leakage is above Manufacturer's stated values, replace conductor.
- D. Grounding System Resistance
 - 1. Refer to Section 26 05 26, "Grounding" for procedure for grounding system resistance adjustment.
- E. Operating Voltage
 - 1. Adjust taps of all high voltage, service and dry-type transformers when loaded voltage readings drop below nominal system voltages. Final voltage shall be at nominal or above.
- F. Other Adjustments
 - 1. Refer to Division 26 Specification Sections for additional adjustments.

3.03 INSPECTION

- A. Inspection shall be performed by:
 - 1. Local authorized inspection agency, or
 - 2. State division of Inspection
- B. Contractor shall arrange for periodic and final inspections in a timely manner and with due regard for the work of other Contractors and the Construction Schedule.
- C. Include final Certificate of Inspection in the Record and Information Manuals.

END OF SECTION

TEST RESULTS FORM

PROJECT NAME:

CONTRACTOR:

SYSTEM:

SPECIFICATION SECTION NUMBER:

TYPE OF TEST:

EQUIPMENT USED:

WEATHER CONDITIONS:

TEMPERATURE:

HUMIDITY:

PART OF SYSTEM TESTED:

SUMMARY OF TEST:

PERSON PERFORMING TEST: _____ DATE: _____

CONTRACTOR'S REPRESENTATIVE: _____

(Attach Recorded Testing Data Sheets To This Form)

CERTIFICATE OF SYSTEM APPROVAL

PROJECT NAME: _____

CONTRACTOR: _____

SYSTEMS COMPONENT: _____

SPECIFICATION SECTION NUMBER: _____

A. APPROVAL (If required by specification section)

The above listed system has been inspected and approved as meeting the specified instructions for installation.

Owner's Representative: _____ Date: _____

B. EQUIPMENT DEMONSTRATION

The above listed system has been demonstrated to the following Owner's Representatives:

	<u>NAME</u>	<u>TITLE</u>	<u>DATE</u>	<u>SIGNATURE</u>
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

(ATTACH A SEPARATE PAGE FOR ADDITIONAL NAMES)

26 24 20
PANELBOARDS-LIGHTING AND APPLIANCE

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install circuit breaker lighting and appliance panelboards as indicated in the panelboard schedules and as shown on the Drawings.
- B. Provide all circuit breaker devices and accessories as noted on the Drawings, herein specified, and as required.
- C. Short circuit ratings shall be as shown on the Drawings.
- D. Provide lug sizes as necessary for cable sizes as shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Branch circuit breakers shall be UL listed as SWD (switching duty) for single pole 15 and 20 Ampere circuits.
- C. Branch circuit breakers feeding HVAC equipment shall be "HACR" rated.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of panelboards and devices
 - 2. Schedules showing quantities, sizes, and arrangement of devices
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Accurate panelboard directories based on the schedules on the Drawings, but updated per as-built changes

1.04 MANUFACTURERS

- A. Panelboards
 - 1. Square D Company
 - 2. Cutler-Hammer Electric Corporation
 - 3. Siemens Energy & Automation, Inc.
 - 4. General Electric Company

PART 2 PRODUCTS

2.01 CIRCUIT BREAKER PANELBOARDS

A. Types

1. Panelboards shall be molded case circuit breaker type with dead front construction.
2. Panelboards for 208Y/120 volt, 3 phase, 4 wire service shall be Square D Type NQOD with Type "QOB" bolt on thermal magnetic molded case circuit breakers, (maximum depth of 5 3/4 inches). 22,000 AIC minimum.

B. Boxes

1. Boxes shall be constructed of commercial, galvanized, code gauge sheet steel, surface or flush mounted as scheduled on the Drawings.
2. Boxes for panelboards shall be sized to provide code gutters but to have minimum width of 20 inches and a maximum depth of 5 3/4 inches.
3. Boxes for double tub panels shall be same size in height.
4. Boxes shall have sufficient wire bending space to accommodate conductor sizes as shown on the Drawings.
5. Panelboard enclosures shall not have any openings that would compromise Arc-Flash safety levels.

C. Bussing

1. Bus bars shall be copper and arranged and drilled for sequence phasing.
2. Equipment ground bus shall be provided in each panelboard in addition to any neutral bus requirements. Bus to have same number, size, and type of anti-turn solderless lugs neutral assembly has. Ground bus to be factory bonded to panelboard tub.
3. Provide isolated ground bus, in addition to equipment ground bus for any isolated ground outlets.
4. Provide full size neutral bus with suitable lugs for each outgoing feeder requiring a neutral connection.
5. Provide through-feed lugs for all panelboards for future use.
6. Provide 200% rated neutral bus in panelboards where indicated on the Drawings and schedules.

D. Mains

1. Provide main breakers for panelboards of the type and class indicated on the Drawings. Panelboards without main breakers are to be provided with solderless type incoming lugs suitable for either copper or aluminum conductors sized to accommodate wiring as shown on the Drawings.

E. Arrangement

1. Panelboards shall have respective main and branch breakers including spares, provisions for future breakers and spaces arranged in accordance with panelboard schedule to facilitate field wiring and be in agreement with branch circuiting shown on the Drawings.
2. Panelboards equipped with multiple pole circuit breakers shall have circuit numbers based on single pole position. Multiple pole breakers and spaces shall be identified by top single pole position number of that breaker.

- F. Branch Circuit Breakers
 - 1. Thermal magnetic molded case circuit breakers with bolted bus connections.
 - 2. Breakers shall have an over center, trip-free, toggle-type operating mechanism with quick-make, quick-break action and positive handle indication.
 - 3. Ground fault circuit interrupter (GFCI) type circuit breakers shall be rated for 5 or 30 milliamp trip setting, up to 60 Amperes/2 pole configuration at 22,000 AIC. Five milliamp setting circuit breakers shall be used for personnel protection interior and exterior. Thirty milliamp setting circuit breakers shall be used for equipment protection only, exterior to the building (snow/ice melting equipment or pool/pond pumping and lighting equipment).
 - 4. Branch circuits shall be connected for sequenced phasing, i.e., circuits No. 1 and 2 connected to Phase A; circuits No. 3 and 4 connected to Phase B; etc. to conform with the branch circuit numbering system on the Drawings. "Polarity" or "Block" phasing will not be acceptable.
 - 5. Scheduled lock-on devices for certain branch circuits are to be furnished and installed which prevents manual operation of breaker handle but not impede trip-free capability of breaker.

- G. Trims
 - 1. Door and trim finish shall be Manufacturer's standard lacquer or enamel.
 - 2. All trim shall be made for surface or flush mounted panelboards as scheduled on the Drawings, and hinged to back box for "door in door" design. Doors shall be equipped with totally concealed hinges and trim clamps and flush chrome-plated combination locks and catches, all keyed alike. Fronts shall not be removable with door in the locked position.
 - 3. Furnish two (2) keys for each panelboard installed and one (1) pint of touch-up enamel paint.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate location of panelboards with the work of other Contractors. Installation shall meet the requirements of NEC Article 110.26.

- B. Securely install panelboards to building walls.

- C. Install panelboard cabinets (box) at a height such that highest circuit breaker does not exceed 6'-6" above floor.

- D. Panelboards mounted on perimeter outside walls shall be shimmed 1/2 inch from wall with washers to permit back ventilation.

- E. Furnish directory frames inside the door of each panel which shall contain a correct typewritten directory card, properly filled out to correspond to the circuit numbers on the Drawings and the room numbers of loads served. If room numbers assigned by the Owner do not match the room numbers on the Drawings, both sets of room numbers must be cross-referenced and identified in the panel directory.

- F. All flush panelboards shall have a 3/4 inch spare conduit rising and turning out of the wall above the ceiling line for every three (3) spares and spaces in the panelboard.
- G. Clean interior and exterior of equipment. Touch-up all scratched finishes. Vacuum out all debris in enclosure before energizing.
- H. Provide nameplates in accordance with Section 26 05 53, "Electrical Identification."
- I. Deliver keys and touch-up enamel to Owner's Representative. Refer to Section 26 00 99, "Requirements for Contract Completion."
- J. Panelboards installed in garages shall be mounted so that bottom of cabinet is higher than 18 inches above floor, to be above NEC hazardous area.

END OF SECTION

DISTRIBUTION PANELBOARDS-CIRCUIT BREAKER TYPE

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install equipment as shown on the Drawings, where located, and with all required accessories.
- B. Equipment shall be completely factory designed, constructed, assembled, and tested with all components in place.
- C. Short circuit ratings shall be as shown on the Drawings.
- D. Where distribution panelboards are used as service equipment, single phase protection shall be provided. Overcurrent protection device shall open when the voltage on any one phase leg drops below 70%.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Service entrance panelboards shall be UL labeled for service entrance use.
- C. Circuit breakers feeding HVAC equipment shall be "HACR" rated.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets on all components of panelboards
 - 2. Dimensioned shop assembly Drawings.
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Distribution Panelboards
 - 1. Siemens Energy & Automation, Inc.
 - 2. Cutler-Hammer Electric Corporation
 - 3. Square D Company
 - 4. General Electric Company

PART 2 PRODUCTS

2.01 PANELBOARDS

- A. Panelboard enclosure shall be dead front gray baked enamel steel with four (4) piece bolt on front panel with concealed self-adjusting trim clamps.
- B. Panelboard interior shall have factory assembled copper bussing, fully rated with ampacity and short circuit-interrupting rating as noted on the Drawings. Interrupting rating shall apply to entire panelboard as a unit. Enclosure and bussing shall be full height (90 inches) or as tall as will fit into the space where shown on the Drawings.
- C. Neutral bus shall be minimum 100% rated and ground bus shall be minimum 25% rated. Equipment ground bus shall be bonded to enclosure.
- D. Provide isolated ground bus and 200% neutral bus where noted on the Drawings.
- E. Provide cable lugs and wire bending space as required to match wiring as shown on the Drawings.
- F. Bussing for overcurrent protective devices shall be in a group mounted front accessible only arrangement. Main overcurrent protective devices shall be mounted at the top of the bus. Backfed devices are not permitted.
- G. Enclosures shall not have any openings that would compromise Arc-Flash safety levels.

2.02 CIRCUIT BREAKERS

- A. Refer to Section 26 28 19, "Circuit Breakers."

2.03 SPARE DEVICES

- A. Provide the following spare over current protection devices in ADDITION to those shown on the Drawings:
 - 1. One 225 Ampere, 3 pole

PART 3 EXECUTION

3.01 APPLICATION

- A. Service entrance main circuit breakers shall have single phase protection and shall open when the voltage on any one phase leg drops below 70%.

3.02 INSTALLATION

- A. Install panelboards at the locations shown on the Drawings. Top of panelboard shall be mounted a minimum of 6 feet above finished floor, but at height so that highest circuit breaker handle will not exceed 6 1/2 feet.

- B. Panelboards shall be bolted to wall and shimmed 1/2 inch from wall with washers for ventilation.
- C. Where bottom of panelboard would be less than 6 inches above finished floor, set panelboard on a nominal 4 inch concrete housekeeping pad. Limits of concrete pad shall exceed dimensions of panelboard by 3 inches on front and both sides.
- D. Tighten connectors and terminals, including screws and bolts, in accordance with Equipment Manufacturer's published torque tightening values. Where values are not available, comply with torques specified in UL Standard 486A.
- E. Clean exterior of equipment of dirt and smudges and dirt from interior compartments. Touch-up all scratched finishes. Vacuum out all debris in enclosure before energizing.
- F. Provide nameplates for panelboard, circuit breakers, spares and spaces in accordance with Section 26 05 53, "Electrical Identification."

END OF SECTION

26 27 19

PREWIRED MULTIPLE OUTLET SURFACE RACEWAY ASSEMBLY

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install prewired multiple outlet surface raceway assembly in lengths/locations where shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards and NEC Articles 386 and 380.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of multiple outlet surface raceways and fittings
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Multiple Outlet Surface Raceway Systems
 - 1. The Wiremold Company

PART 2 PRODUCTS

2.01 PREWIRED MULTIPLE OUTLET SURFACE RACEWAY SYSTEMS

- A. Multiple outlet surface raceway system shall consist of 20 Ampere, 125 volt, 2 pole, 3 wire factory wired type single receptacles mounted in a two piece steel surface raceway.
- B. Single and dual circuit raceways where shown on the Drawings shall have receptacles spaced at 6 inch intervals. Dual circuit raceway shall have receptacles alternately wired.
- C. The two piece steel surface raceway shall consist of a base section with 1/2 inch trade size knockouts for power feed and mounting hole knockouts. Base sections shall be furnished in 3, 4, 5, or 6 foot base lengths to accomplish lengths as shown on the Drawings.
- D. Base and cover sections shall be provided with an ivory scuff coat baked enamel finish, which is capable of being over painted in the field if required.
- E. Provide elbows, tees, couplings, wire clips, blank end fittings, entrance end fittings, connectors, wiring devices and all other accessories required for a complete system.

- F. All raceway systems shall be mechanically continuous and connected to all electrical outlet boxes and cabinets. Grounding wire shall run continuous through channel, from outlet-to-outlet and bonded to each section for a positively grounded enclosure. Grounding wire shall be connected to outlet box with separate screw-on clip.
- G. Multiple outlet surface raceway system shall be Wiremold Series.

PART 3 EXECUTION

3.01 INSTALLATION

- A. On stud and drywall walls attach raceway with screws at each stud.
- B. On metal lath and plaster walls attach raceway with hollow wall anchors or wing type toggle bolt anchors at 16 inch (maximum) mounting centers.
- C. On brick, block, or concrete walls or concrete floors attach raceway with suitable wall anchors and screws at 24 inch (maximum) mounting centers.
- D. Where raceways are installed above countertops, they shall be installed directly above counter backsplash, unless noted otherwise on the Drawings.
- E. Vertical drops of exposed conduit/raceway feeding multi-outlet assemblies shall occur in locations directed by Architect in field.

END OF SECTION

26 27 26
WIRING DEVICES AND PLATES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install wiring devices and plates as specified herein and as shown on the Drawings.
- B. Specialty switches and outlets required for auxiliary systems shall be specified under those Sections or as shown on the Drawings.
- C. All devices shall be ganged together where shown grouped on the Drawings.
- D. All normal power devices shall be the same color.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. All wiring devices and plates shall be furnished by one of the Manufacturers listed. No mixing of Manufacturer's products shall be permitted unless otherwise noted herein or on the Drawings.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets for wiring devices and plates
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Wiring Devices (except dimmers) and Plates
 - 1. Cooper
 - 2. Pass and Seymour
 - 3. Hubbell
 - 4. Leviton
- B. Cover Assemblies
 - 1. TayMac Corporation
 - 2. Intermatic Inc.
 - 3. Carlon Electrical Products
- C. Occupancy Sensors
 - 1. Watt Stopper Inc.
 - 2. Novitas Inc.

PART 2 PRODUCTS

2.01 SWITCHES

- A. Switches shall conform to NEMA Heavy Duty Standards and shall be Specification Grade, general use AC quiet type, 20 Ampere, 120-277 volt, back and side wired with white handles, unless noted otherwise.
- B. Switches shown on the Drawings adjacent to doors with glass walls or windows shall actually be located in the door frame, unless noted otherwise. Switches shall be 20 Ampere, 120-277 volt with white handles, end wired.

2.02 RECEPTACLES

- A. All convenience and power receptacles shall conform to NEMA Heavy Duty Standards and shall be Specification Grade, grounding type.
- B. Convenience duplex receptacles shall be 20 Ampere, 125 volt, back and side wired, 3 wire grounding, UL listed as complying with the requirements of NEC Article 250.146, NEMA 5-20R configuration.
- C. Ground-fault circuit-interrupting (GFCI) duplex receptacles shall be 20 Ampere, 125 volt "feed-through" type, NEMA 5-20R configuration.
- D. Weatherproof Duplex Receptacles shall be 20 Ampere, 125 volt or 250 volt, UL listed as weather resistant type per NEC 406.
- E. All receptacles shall be ivory, unless on emergency power, in which case receptacles shall be red.
- F. Refer to the Drawings for specification of specialty receptacles.

2.03 PLATES

- A. Plates for flush devices in interior partitions shall be thermoplastic ivory.
- B. Plates for flush devices on concrete block walls shall match others but be "Jumbo" plates.
- C. Plates for devices in surface fittings shall be cadmium plated steel surface covers. Covers shall fit without overlap and have round corners.

2.04 COVER ASSEMBLIES

- A. Wiring devices in wet locations shall have hinged, gasketed cast aluminum coverplates of a color matching adjacent wall finish.
- B. Wiring devices subject to wet locations while in use shall be provided with NEMA 3R cover assemblies UL listed for wet locations while in use. Cover assemblies shall use a vertically-lifting "canopy" to protect the wiring device(s). Cover assemblies shall be standard size, one (1) or two (2) gang as required with gaskets between the hinged cover and mounting plate/base to assure proper seal.

2.05 OCCUPANCY SENSORS

- A. Ceiling mounted low voltage dual technology occupancy sensors shall contain both PIR and ultrasonic technologies, adjustable 15 second to 15 minute time delay, integrated adjustable light level sensor, adjustable sensitivities, LED indicator for both technologies, isolated relay, 24 VDC operable, 120 volt power pack, 360 degree coverage. Watt Stopper DT-300, white color. Provide minimum one (1) power pack for every room.
- B. Wall mounted line voltage passive infrared occupancy sensor shall have adjustable 30 second to 30 minute time delay, manual off switches for bilevel lighting control, integrated adjustable light level sensor, adjustable sensitivity, LED indicator, 900 square feet - 180 degree coverage. Color shall be ivory. Watt Stopper DW-100.
- C. Power packs shall be 120 volt primary with self contained transformer and 20 Ampere relay contacts. Watt Stopper A277-E.

PART 3 EXECUTION

3.01 APPLICATION

- A. Provide outlets as noted on the Drawings and herein described.
- B. Provide GFCI type outlets in all bathrooms, anywhere within 6 feet of sinks.
- C. Provide GFCI type outlets for all 120 volt devices located in kitchens.
- D. Provide weatherproof "in use" covers on GFCI outlets exterior to the building.

3.02 INSTALLATION

- A. Install wiring devices as indicated, in compliance with the Manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of wiring devices with other work, including painting, electrical box and wiring work, as necessary.
- C. Install wiring devices only in electrical boxes, which are clean, free from excess building materials, dirt and debris.
- D. All devices shall be connected to conductors using the side wiring terminal screw connections. Devices with voltages higher than 120 volt shall have two (2) layers of electrical tape applied over the exposed side terminals.
- E. Delay installation of wiring devices and wall plates until after painting work is completed. Wiring devices may be installed prior to painting where protective plastic covers are used.

- F. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Contract Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.
- G. Provide electrically continuous, tight grounding connections for wiring devices, as required by NEC Article 250.
- H. Install matching device plates on all devices. Devices shown grouped on the Drawings shall be ganged together with one plate.
- I. Ceiling mounted occupancy sensors shall not be installed within 6 feet of a HVAC diffuser. Provide lens shields as required to prevent nuisance operation of occupancy sensors. Locate or aim sensors so they do not sense areas of the room.
- J. Install engraved flush switch plates at all locations indicating function of switches for special applications and at every location where more than two switches are ganged together. Engraved switch plates shall have 1/8 inch black filled letters.
- K. Provide permanently installed barriers between switches ganged in outlet boxes where the voltage between adjacent switches exceeds 300 volts.
- L. All wiring devices and covers shall be clean and free of paint upon completion of work.
- M. Receptacle plates shall be labeled with permanent marker on the back with panelboard and circuit number.
- N. All unused outlet boxes shall have blank coverplates installed.
- O. Wiring from ground-fault circuit-interrupters shall not occupy the same raceways with wiring from non-ground-fault interrupting type devices.
- P. Occupancy sensors to be initially set at 75% maximum sensitivity and 5 minute time delay.
- Q. Locate all occupancy sensor power packs and slave packs above lay-in ceiling at room entry location.
- R. Wiring between sensors and power/slave packs shall be three (3) conductor, No.18 AWG, stranded, UL classified plenum rated.

3.03 OCCUPANCY SENSOR OPERATION VERIFICATION

- A. Contractor shall verify proper operation of every occupancy sensor in building at completion of project. Provide appropriate masking on sensor where line-of-site extends out of room and causes nuisance operation when room is vacant.

3.04 SPARE PARTS

- A. Furnish spare occupancy sensors in a quantity of 5% of total (of each type) used in building (minimum of two (2) of each type).

- B. Division 26 Contractor shall include in his/her bid an allowance for furnishing and installing five (5) additional occupancy sensors of each type (with average length of conduit and wire) at completion of the project as directed by the Architect. If all are not used, remaining value shall be credited to the Owner or turned over to the Owner as additional spares per Owner's discretion.
- C. Two screwdrivers for any specialty fasteners used.

3.05 TESTING

- A. Prior to energizing circuitry, test wiring devices for electrical continuity, short circuits, and proper polarity connections.
- B. Verify that occupancy sensors are turning off lighting when spaces are unoccupied. Each sensor shall be tested for proper operation with HVAC system operational.

END OF SECTION

26 28 13
FUSES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install 600 volt and 250 volt fuses as herein specified and sized as shown on the Drawings.
- B. Provide all accessories as specified.
- C. All fuses shall be provided by the same Manufacturer.
- D. For fuses greater than 600 volts, refer to appropriate equipment Specification Section.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of fuses and accessories
 - 2. Fuse curves and selectivity ratio charts
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Certificate of Material Receipt

1.04 MANUFACTURERS

- A. Fuses
 - 1. Bussmann
 - 2. Littelfuse

PART 2 PRODUCTS

2.01 FUSES - 600 AMPERES AND BELOW

- A. Fuses shall be rated 600 volt for nominal 480 volt systems and 250 volt for nominal 240 or 208 volt systems. Fuses shall be UL Class RK, current limiting, 200,000 Ampere interrupting rating, dual element, with minimum time delay of 10 seconds at 500 percent rating.
 - 1. Bussmann LPN-RK (250 volt) or LPS-RK (600 volt)
- B. In-line fuse and fuse holders for high intensity discharge luminaires shall be 600 volt, UL Class CC, current limiting, 200,000 Ampere interrupting rating, single element non-time delay fuses in a waterproof single or two (2) pole fuse holder.
 - 1. Bussmann KTK-R in HEB or HEY holder

- C. Motor control circuits shall use 600 volt, UL Class CC, current limiting, 200,000 Ampere interrupting rating, single element, non-time delay fuses.
 - 1. Bussmann KTK-R
- D. In-line fuse and holder combination units for fluorescent luminaires shall be glass ferrule fuses in a two (2) piece insulating fuse holder with 6 inch pigtail conductors.
 - 1. Bussmann GLR with HLR holder

2.03 FUSE REDUCERS

- A. Fuse reducers shall be Bussmann 200-R or 600-R Series.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fuses in all fusible devices with name and fuse size facing outward.
- B. Install fuse reducers in equipment where required.

3.02 SPARE PARTS

- A. Provide spare fuses in the following quantities:
 - 1. 600 Amperes and below - 10% of quantity used (minimum three (3)) of each voltage and current rating and UL Class
- B. Refer to Section 26 00 99, "Requirements for Contract Completion."

END OF SECTION

26 28 16
SAFETY SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install safety switches where shown on the Drawings, and where required including all accessories and mounting hardware.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of safety switches
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Safety Switches
 - 1. Square D Company
 - 2. Cutler-Hammer Electric Corporation
 - 3. Siemens Energy & Automation, Inc.
 - 4. General Electric Company
- B. Equipment shall be furnished by the Manufacturer supplying major components of the electrical distribution system.

PART 2 PRODUCTS

2.01 SAFETY SWITCHES - NON-FUSIBLE

- A. Safety switches shall have heavy-duty, single-throw, quick-make, quick-break, visible knife blade operators mounted in hinged cover steel enclosure. Lugs shall be listed for 75 degrees C ampacity aluminum or copper wire.
- B. Switches shall be clearly labeled for "ON" and "OFF" handle positions. Cover shall have defeatable safety interlock with handle to prevent inadvertent opening when in the "ON" position. Handle shall be pad lockable in the "OFF" position.
- C. Safety switches to be horsepower rated 600 volt AC.
- D. Switches shall have ground lug kit and neutral when required.

2.02 SAFETY SWITCHES - FUSIBLE

- A. Fusible safety switches shall be as specified in Paragraph 2.01 and with the following additional features:
 - 1. Safety switches rated 600 Amperes and less shall have spring reinforced, plated fuse clips with rejection feature for Class R fuses.
 - 2. Safety switches rated larger than 600 Amperes shall have provisions for Class L fuses.
 - 3. Short circuit-interrupting rating shall be 200,000 Amperes RMS symmetrical.
 - 4. Safety switches to be horsepower rated 240 volt AC for 208 or 240 volt usage, and 600 volt AC for 480 volt usage.

PART 3 EXECUTION

3.01 APPLICATION

- A. Provide the following NEMA rated enclosure types in these locations:
 - 1. Interior - 1
 - 2. Exterior - 3R
- B. Provide AC manual toggle disconnect switch in NEMA 1 enclosure for disconnecting means located at instantaneous electric water heaters.

3.02 INSTALLATION

- A. Use flexible conduit to and from safety switches where vibration isolation is required.
- B. Install safety switches securely to building structure. Install safety switches on freestanding metal framing system support where mounting to building structure is not feasible or where shown on the Drawings.
- C. Safety switches located downstream of variable frequency drives shall have auxiliary control power interlock switch on handle. Run wiring to variable frequency drives.
- D. Provide fuses sized in accordance with Equipment Manufacturer's data plate.
- E. Provide nameplates in accordance with Section 26 05 53, "Electrical Identification."
- F. Touch-up all scratches on enclosure after installation.

3.03 SPARE DEVICES

- A. Provide the following spare devices:
 - 1. Two 30 Ampere non-fusible safety switches.

END OF SECTION

26 28 19
CIRCUIT BREAKERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install circuit breakers in distribution panelboards and separate enclosures for overcurrent protection for panelboards and equipment, as shown on the Drawings and specified herein. Provide all accessories as necessary.
- B. Short circuit ratings shall be as shown on the Drawings.
- C. Refer to Section 26 24 20, "Panelboards – Lighting and Appliance" for circuit breakers in panelboards.
- D. Provide frame size of circuit breaker with lug size as required to accommodate feeder size as shown on the Drawings.
- E. Provide frame size, plug size, and trip units as necessary to meet short circuit ratings, and to provide selective coordination (down to 0.01 seconds) on emergency power distribution systems.
- F. All circuit breakers shall be fully rated for short circuit levels indicated. Series ratings are not permitted.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets for all circuit breakers and components
 - 2. Wiring diagrams
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Test results
 - 3. Manufacturer Representative's signed Certificate of Inspection and Approval

1.04 MANUFACTURERS

- A. Circuit Breakers
 - 1. Siemens Energy & Automation, Inc.
 - 2. Cutler-Hammer/Eaton Corporation
 - 3. Square D Company
 - 4. General Electric Company

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKERS WITH THERMOMAGNETIC TRIP

- A. Molded case circuit breakers shall be bolt-on type operated by a toggle type handle and shall have quick-make/quick-break over-center switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions.
- B. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Arc extinction must be accomplished by means of arc chutes.
- C. Molded case breakers shall be of the thermal magnetic standard type that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element.
- D. Single phase circuit breakers shall be balanced among the three (3) phases.
- E. All circuit breakers shall have an integral lock-out/tag-out means.

2.02 MOLDED CASE CIRCUIT BREAKERS WITH SOLID STATE TRIP

- A. Circuit protective devices shall be molded case type circuit breakers UL Listed for 80% continuous current with full function trip system. Frame/Sensor ampere ratings shall be as shown on the Drawings. The ampere rating shall be clearly marked on the front of the circuit breaker. Circuit breakers shall be of fixed construction.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material providing high dielectric strength. Current carrying components shall be completely isolated from the trip unit and accessory mounting area. Breakers shall have common tripping of all poles and shall be trip free. The breakers shall have quick-make/quick-break contacts with an over center toggle operating mechanism. All circuit breakers shall be equipped with electrical accessories as noted on the Drawings.
- C. The integral electronic trip system shall be independent of any external power source and shall contain electronic components to measure and time the output from internal current sensors and initiate automatic tripping action. The continuous ampere rating of the circuit breaker shall be determined by the combination of the ampere rating switch position, and the frame/sensor size of the circuit breaker. The resulting ampere rating shall be clearly marked on the face of the circuit breaker. Provide a means to seal the trip unit adjustments to discourage unauthorized tampering to meet the requirements of NEC Article 240.6.

- D. Provide the following time/current curve shaping adjustment to maximize system selective coordination. Each adjustment shall have discrete settings and shall be independent from all other adjustments:
 - 1. Adjustable Long Time Ampere Rating and Delay
 - 2. Adjustable Short Time Pickup and Delay (delay includes I^2t in and I^2t out)
 - 3. Fixed Instantaneous Trip
 - 4. Ground fault trip (where shown on one line diagram)
- E. Provide local visual trip indication for overload, short circuit occurrences. The trip system shall include a memory circuit to detect intermittent overcurrent conditions. Each circuit breaker trip system shall be equipped with an externally accessible test port for use with a Universal Test Set. No disassembly of the circuit breaker is required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.
- F. All circuit breakers shall have an integral lock-out/tag-out means.

2.03 ENCLOSURES

- A. Enclosures shall have padlocking provisions for locking circuit breakers in the "OFF" positions.
- B. Enclosure types shall be as follows:
 - 1. NEMA 1 - Gray baked enamel on galvanized steel
 - 2. NEMA 3R - Gray baked enamel on galvanized steel with drain holes, lockable door, securable in the open position
 - 3. NEMA 4X - Stainless steel with gasketed cover
- C. Enclosures shall be flush mounted in gypsum board walls and surface mounted on concrete walls.

PART 3 EXECUTION

3.01 APPLICATION

- A. 15 Ampere through 250 Ampere circuit breakers shall be molded case with thermomagnetic trip sensor and mechanism.
- B. 300 Ampere and above through 1600 Ampere circuit breakers shall be molded case with solid state trip sensor and mechanism.
- C. Service entrance main circuit breakers shall have single phase protection and shall open when the voltage on any one phase leg drops below 70%.
- D. Provide the following NEMA rated enclosure types for single circuit breakers in these locations:
 - 1. Interior - 1
 - 2. Exterior - 3R

- E. Provide electronic trip circuit breakers for switchboards where two levels of ground-fault protection are used.
- F. Provide auxiliary contacts on circuit breakers used to feed elevator equipment.

3.02 INSTALLATION

- A. Install circuit breakers in switchboards, distribution panelboards or enclosures as shown on the Drawings and in accordance with Manufacturer's written instructions.
- B. Provide nameplates in accordance with Section 26 05 53, "Electrical Identification."

3.03 TESTING

- A. Perform a complete functional test of all features of circuit breakers in accordance with Manufacturer's recommendations. Submit written documentation in Record and Information Manuals.

END OF SECTION

26 29 13
MOTOR CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install motor starters and combination motor starter/disconnect switches as shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Motor starters shall be sized in accordance with NEMA Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets
 - 2. Wiring diagrams
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
- C. Fuses
 - 1. Refer to Section 26 28 13, "Fuses."

1.04 MANUFACTURERS

- A. Motor Controllers
 - 1. Siemens Energy & Automation, Inc.
 - 2. Cutler-Hammer Electric Corporation
 - 3. Square D Company
 - 4. Allen - Bradley Company, Inc.
 - 5. General Electric Company

PART 2 PRODUCTS

2.01 FRACTIONAL HORSEPOWER MANUAL STARTERS

- A. Fractional horsepower manual starters shall be toggle type quick-make/quick-break switch with double break silver alloy contacts, melting alloy type thermal overload relay, red pilot light, in flush or surface mounted with stainless steel coverplate and handle guard/lockoff.

2.02 MAGNETIC MOTOR STARTERS

- A. Magnetic motor starters shall be across-the-line magnetic type with double break silver alloy contacts, molded coil and solid state type overload relay with phase loss protection. Starters shall have four (4) external field convertible auxiliary contacts. Refer to Sequence of Operation in Division 23 for type.
- B. Starters shall be 3 pole, 3 phase with solid state overload relays, 3 position hand-off-auto (H-O-A) switch, reset button, oversized control power transformer (50 watts extra capacity) with primary and secondary fusing, and green pilot light in NEMA rated enclosure.

2.03 COMBINATION MOTOR STARTER/DISCONNECT SWITCHES

- A. Combination motor starter/disconnect switches shall be across-the-line magnetic type with double break silver alloy contacts, molded coil, solid state overload relay with phase loss protection. Starters shall have four (4) external field convertible auxiliary contacts. Refer to Sequence of Operation in Division 23 for type.
- B. Combination motor starter/disconnect switches shall be 3 pole, 3 phase with solid state overload relays, three position hand-off-auto (H-O-A) switch, reset button, oversized control power transformer (100 watts extra capacity) with primary and secondary fusing, and green pilot light in NEMA rated enclosure.
- C. Combination motor starters shall have a visible blade disconnect switch with fuse blocks. The disconnect handle used on combination motor starters shall always be in control of the disconnect device with the door opened or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "ON" or "OFF," and shall include a two (2) color handle grip, the black side visible in the "OFF" position indicating a safe condition and the red side visible in the "ON" position indicating an unsafe or danger condition.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Motor locations shown on the Drawings are approximate. Obtain exact location of motors from Contractor installing the motor driven equipment. DO NOT ROUGH-IN BY SCALING THE ELECTRICAL DRAWINGS.
- B. Final connections to equipment shall be made using liquid-tight flexible steel conduit.
- C. Install fabricated steel floor stands for mounting starters where loads are in the center of a room. Floor stands shall be metal framing system or 2 inch steel angle with galvanized finish.
- D. Wall-mounted switches and motor starters shall be grouped together and installed on a 3/4 inch fire retardant plywood backboard.

- E. Provide appropriate solid state overload relay sized to match each motor nameplate rating. Overload relay for motors with power factor correction shall be adjusted according to ammeter readings of motor circuit.
- F. Provide fuses in all fuse holders in accordance with Section 26 28 13, "Fuses."
- G. Provide the following NEMA rated enclosure types in these locations:
 - 1. Interior - 1
 - 2. Exterior - 3R
- H. Provide nameplates in accordance with Section 26 05 53, "Electrical Identification."
- I. Provide control wiring as shown and/or described on the Drawings.

END OF SECTION

26 32 10
EMERGENCY GENERATOR

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install a complete natural gas fueled standby Emergency Generator as shown on the Drawings and specified herein. Provide accessories and equipment as required for a complete system. Emergency Generator shall be completely factory built and tested and delivered to the site ready for installation. All equipment herein specified shall be supplied as an integral package by one (1) supplier.
- B. As a minimum, equipment ratings shall be as shown on the Drawings. Actual equipment size shall be determined by the Manufacturer based on computer-generated calculations for building loads in steps as follows:

Step 1

Lighting:	40 kW @ 0.95 pf
Heating:	9 kW @ 1.00 pf
Receptacle & Misc.:	75 kW @ 0.80 pf
Motors (Listed):	40 kW, 208V, 3 phase
	0.5 HP, 120V, 1 phase
	0.5 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
	0.25 HP, 120V, 1 phase
Spare Capacity:	20 kW

Calculations shall be based on the following operating conditions:

Maximum Motor Starting Voltage Dip:	30%
Altitude:	900 feet
Ambient Temperature Range:	-10 degrees F to 105 degrees F
Engine Speed:	1800 RPM
Maximum Loading:	80%

- C. Emergency generator shall meet the following criteria as defined by NFPA 110:
 - Type 10 (10 second maximum time of power outage on emergency system)
 - Class X (No minimum on-site fuel storage)
 - Level 1 (life safety requirements)

D. Division of work shall be as indicated below:

ITEM	SPECIFICATION DIVISION		
	Furnished Under	Installed Under	Connected Under
1. Engine Generator and Radiator	26	26	(See Below)
2. Electric Starting Motor, Automatic Start/Stop Panel and Cranking Panel	26	26	26
3. Batteries, Battery Electrolyte, Charger and Lube Oil	26	26	26
4. Gauges and Instrument Panels	26	26	26
5. Natural Gas, Fuel Piping, and Shut-Off Valve	22	22	22 and 26
6. Muffler, Connectors and Piping	26	26	26
7. Ethylene Glycol	26	26	26
8. Steel Spring Vibration Isolators (95%)	26	26	26
9. Fuel Filters, Fuel Piping Flex and Connectors	26	26	26
10. Concrete for Housekeeping Pads & Inertia bases	3*	3*	3*

* Division 26 Contractor is responsible for coordinating the concrete pad requirements with the General Trades Contractor.

1.02 QUALITY ASSURANCE

- A. Emergency generator and all components shall be UL Listed and labeled, manufactured in accordance with applicable ANSI and NEMA Standards, and in accordance with the following codes:
 - 1. NEC Article 700
 - 2. NFPA 110 Emergency and Standby Power Systems
- B. Emergency generator shall be EPA certified.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components
 - 2. Dimensioned Drawings of emergency generator
 - 3. Computer generated sizing results
 - 4. Wiring Diagrams
 - 5. Operating parameters
 - 6. Installation instructions

- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Factory test report
 - 3. Certificate of System Completion

1.04 MANUFACTURERS

- A. Emergency Generator
 - 1. Generac
 - 2. Kohler
 - 3. Cummins
 - 4. Caterpillar

1.05 OPERATION

- A. Emergency generator shall be signaled to start by each automatic transfer switch and shall reach stable voltage and frequency and pickup load within 10 seconds after loss of normal power.

PART 2 PRODUCTS

2.01 ENGINE

- A. Engine shall be stationary internal combustion, spark ignition, 1800 RPM, liquid cooled, turbo charged, intercooled, 4 stroke, natural gas fueled.
- B. Governor shall be isochronous electronic providing voltage regulation between $\pm 2.0\%$ and 0% deviation in frequency regulation.
- C. Cooling system shall consist of engine-mounted radiator and pusher-type blower fan, water pump, thermostat, shroud, and water filter. Provide 50% concentration of ethylene glycol.
- D. Starting system shall be 12 VDC electric with lead acid batteries of capacity to provide 90 seconds of cranking power at -20 degrees F. System shall be complete with battery rack and cables.

- E. Battery charging system shall consist of 12 VDC, engine mounted alternator, and 120 volt automatic current limiting battery charger. Charger shall feature overload protection, DC ammeter and voltmeter, fuse, float/equalize switch, 2% voltage regulation. Charger shall be capable of fully recharging the batteries within 24 hours.
- F. Thermostatically controlled, 4000 watt, 208 volt, engine jacket water heater shall be provided with unit, connected through oil pressure switch for automatic cut-out during engine operation. Heater shall maintain temperature of engine at a minimum of 90 degrees F.
- G. Positive displacement, mechanical full pressure lubrication oil pump, full flow oil filters with replaceable elements, pressure relief valve, dipstick oil level indicator, and oil drain valve with hose extension.
- H. Dry type air cleaner with replaceable element.
- I. Fuel system shall include pressure regulator, filters, solenoid and shutoff valves. Provide wire reinforced flexible fuel lines at engine.
- J. Exhaust System
 - 1. Exhaust Silencer - Provide a critical grade silencer, including stainless steel flexible exhaust fittings, properly sized according to the Manufacturer's recommendation.
- K. Engine/generator shall be mounted on a steel base.
- L. Engine shall be capable of single step load pickup of 100% nameplate kW.
- M. Batteries shall be set on 120 volt mat heaters with thermostat designed to maintain a minimum battery temperature of 50 degrees F and a maximum of 90 degrees F.

2.02 GENERATOR

- A. The AC generator shall be: synchronous, four pole, 12 lead reconnectable, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s). The stator shall have skewed laminations of insulated electrical grade steel. The rotor shall have amortissure (damper) windings. The rotor shall be dynamically balanced. The exciter shall be brushless, 3 phase, with full wave silicon diodes mounted on the rotating shaft and a surge suppresser connected in parallel with the field winding.
- B. All insulation system components shall meet NEMA MG1 standard temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees C. The main generator and exciter insulation systems must be suitably impregnated for operation in severe environments for resistance to sand, salt and sea spray.
- C. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short-circuit current for selective operation and coordination of system overcurrent devices.

- D. The automatic voltage regulator shall be temperature compensated, solid-state design, equipped with 3 phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. Over-voltage protection shall sense the AC generator output voltage and in the event of regulator failure or loss of reference, shut down regulator output on a sustained over voltage of one (1) second duration. Over-excitation protection shall sense regulator output and shut down regulator output if overloads exceed 10 seconds duration. Both over-voltage and over-excitation protection shutdowns shall be latched, requiring the AC generator to be stopped for reset.
- E. Generator shall be capable of providing 300% of rated current for 10 seconds in a short circuit condition for selective tripping of downstream overcurrent protection devices.
- F. Generator shall have 120 volt strip heater.
- G. Mainline circuit breaker shall be molded case thermomagnetic rated at 140 degrees F and sized as shown on the Drawings. Circuit breaker shall have an interrupting rating adequate for the emergency generator. Breaker shall have a 12 VDC shunt trip operator wired through engine safety shutdowns. Generator/Exciter field circuit breakers shall not be used for these requirements.
- H. Total harmonic distortion shall not exceed 5% of rated voltage with no single harmonic exceeding 3%. Telephone influence factor shall not exceed 50 per NEMA MG-1-22 .43.

2.03 INSTRUMENT PANEL AND CONTROL

- A. Instrument panel shall be mounted on the generator with vibration isolators and have the following functions and displays:
 - 1. Panel Illumination Lamp with ON/OFF Switch
 - 2. Engine Oil Pressure Gauge
 - 3. Coolant Temperature Gauge
 - 4. DC Voltmeter
 - 5. Battery Charging Ammeter
 - 6. Running Time Meter
 - 7. Voltage Adjusting Rheostat
 - 8. AC Voltmeter
 - 9. AC Ammeter
 - 10. Frequency Meter
 - 11. Phase Selector Switch for Voltmeter and Ammeter
 - 12. Overcrank Shutdown Indicating Lamp
 - 13. Overspeed Shutdown Indicating Lamp
 - 14. Low Oil Pressure
 - 15. High Engine Temperature Shutdown Indicating Lamp
 - 16. Low Oil Pressure Shutdown Indicating Lamp
 - 17. Low Engine Temperature Indicating Lamp
 - 18. Controls Switch - Not in Automatic Position - Indicating Lamp
 - 19. NFPA 110 Alarm Horn
 - 20. High Engine Temperature Pre-Alarm Indicating Lamp

21. Battery Charger Malfunction Indicating Lamp
22. Battery Low Voltage Indicating Lamp
23. Lamp Test Switch
24. Auxiliary Alarm Contact
25. Alarm Silence Switch
26. Low Fuel Pressure Indicating Lamp

- B. Instrument panel shall be battery set powered.
- C. Instrument panel shall control the emergency generator in the following manner:
1. RUN/STOP/AUTO Control Toggle Switch
 2. 15 second Crank/Reset - 75 Second Lockout Cranking Cycle
 3. Engine lockout due to overcrank, overspeed, low oil pressure, high engine temperature, or remote manual stop.

2.04 REMOTE ANNUNCIATOR

- A. Remote Annunciators shall be flush mounted located where shown on the Drawings and have the following functions and displays:
1. Normal Power Available Indicating Light
 2. Emergency Generator Running Indicating Light
 3. High Battery Voltage Indicating Light
 4. Low Battery Voltage Indicating Light
 5. Normal Battery Voltage Indicating Light
 6. Battery Charger Malfunction Indicating Light
 7. Alarm Horn Silence Switch
 8. Alarm Horn
 9. Light Test Switch
 10. Overcrank Shutdown Indicating Light
 11. Low Engine Temperature Indicating Light
 12. High Engine Temperature Pre-Alarm Indicating Light
 13. High Engine Temperature Indicating Light
 14. Low Oil Pressure - Pre Alarm Indicating Light
 15. Low Oil Pressure Indicating Light
 16. Overspeed Shutdown Indicating Light
 17. Low Fuel Pressure Indicating Light
 18. Control Switch Not In AUTO Position Indicating Light
 19. Emergency Generator Supplying Load Indicating Light

2.05 EMERGENCY GENERATOR REMOTE STOP BUTTON

- A. NEMA 12 non-metallic box with maintained contact pushbutton with flip lid covers. Pilla electrical products model GS120RP2.

2.06 OUTDOOR WEATHER HOUSING

- A. Emergency Generator shall be enclosed with a 14 gauge steel insulated housing and hinged and key-locked panels. Housing panels shall be factory assembled to emergency generator base and radiator cowling. All steel shall be primed and enameled.

- B. Housing shall have within it a 120 volt incandescent luminaire and toggle switch located adjacent to controller.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install Emergency Generator as shown on the Drawings and in accordance with Manufacturer's written instructions.
- B. Install all accessories and wiring not factory installed including:
 - 1. Batteries, Cables and Rack
 - 2. Battery Charger
 - 3. Remote Annunciator Panels
- C. Provide power to jacket water heaters, battery mat heaters, generator strip heater and battery charger from a normal power panelboard.
- D. Provide power to enclosure luminaires from an emergency power panelboard.
- E. Provide all control wiring to remote annunciator.
- F. Provide a remote manual stop station adjacent to the door leading to the emergency generator in accordance with NFPA 110, Paragraph 5.6.5.6.
- G. Provide control wiring run in a separate conduit from power wiring from each automatic transfer switch and fire pump controller transfer switch to emergency generator for engine start signal.
- H. Install muffler, connectors and piping to engine.
- I. Provide a sign mounted on the service entrance equipment indicating the type and location of on-site emergency power sources as required in NEC 700.8.
- J. Provide a sign mounted on the door leading to the emergency generator warning of excessive noise when generator is operating. Sign shall read as follows: "WARNING: PROTECTION REQUIRED AT EMERGENCY GENERATOR."
- K. Provide a sign mounted adjacent to the main natural gas shut off valve feeding the natural gas pipe to the emergency generator. Sign shall read as follows: "THIS VALVE WILL SHUT OFF FUEL TO EMERGENCY GENERATOR."
- L. Provide three (3) sets of eye and ear protective devices in a wall mounted cabinet.
- M. Provide a full instruction manual in the wall mounted cabinet.
- N. Provide a unit battery pack light with two (2) quartz halogen heads with 90 minute capacity, mounted in the emergency generator housing powered from an emergency power panelboard.

- O. Provide a sign at the emergency generator grounding point as required by NEC 700.8.
- P. Contractor shall file for permit with Environmental Protection Agency for installation and operation of emergency generator.
- Q. Bond generator frame to building steel.

3.02 TESTING

- A. Provide a certified factory production test record indicating all of the following testing results on the emergency generator:
 - 1. Maximum Power Generated
 - 2. Voltage and Frequency Regulation
 - 3. Governor Response
 - 4. Single Step Load Pickup and Voltage Dip
 - 5. Safety Shutdown Devices Operation
- B. Provide on-site acceptance testing as described below. All testing shall be performed under the supervision of a factory-trained technician. The Contractor shall give 48 hours notice to the Architect, Engineer, the Inspecting Authority having jurisdiction, and the Owner, for their attendance option. Provide OSHA required safety equipment for all personnel present during the test period. Provide resistive load banks as required. The testing procedure shall be as follows:

COMPONENT AND FUNCTIONAL TEST

- 1. Perform all manufacturer recommended tests to insure that all safety shutdowns and control devices are wired and function properly, including manual shutdowns.
- 2. Perform a "cycle crank" test to verify crank/rest/lockout control functions.
- 3. Perform testing as required by Section 26 36 23, "Automatic Transfer Switches" and in accordance with Manufacturer's recommendations to insure all safeties function properly.
- 4. Verify that failure of normal power to each automatic transfer switch will cause emergency generator to start and pickup that load, and the subsequently shutdown the emergency generator (after cool down) once normal power is restored.

LOAD TEST

- 1. With emergency generator in a "cold start" condition and load banks equal to 100% of emergency generator capacity, initiate a normal power failure by opening the normal power disconnecting means feeding the emergency branch.
- 2. Observe and record the time-delay on start.
- 3. Observe and record the cranking time until starting occurs.
- 4. Observe and record the time required to achieve operating speed.
- 5. Observe and record the voltage and frequency overshoot.
- 6. Observe and record the time required to achieve steady state condition with all transfer switches on emergency.
- 7. Observe and record the voltage, frequency and amperes.
- 8. Observe and record the oil pressure, coolant temperature, battery charge rate at 5 minute intervals.

9. Continue test for a duration of 2 hours, switching load bank settings where possible and causing automatic transfer switches to transfer on and off the emergency generator. Record effects on voltage and frequency.
10. Restore normal power and observe and record the time delay on re-transfer to normal for each switch, and the cool down period on the emergency generator.
11. Permit emergency generator to cool for 5 minutes. Set all automatic transfer switch-delays to minimum, so that all loads will transfer as one step.
12. Open the normal power disconnecting means feeding the emergency branch.
13. Observe and record data listed in Paragraphs 3 through 8 above initially and every 15 minutes for a duration of 2 hours. If this test is aborted for any reason, restart from Paragraph 11 above.
14. After test completion, reset all automatic transfer switch delays, such that minimum voltage dip is achieved.
15. Disconnect load banks and connect building load as shown on the Drawings.

OPERATIONAL TEST

1. At the time of Contract Completion, perform an operational test of the emergency power system with as-designed building loads connected. Test each automatic transfer switch by opening the normal power disconnecting means to that automatic transfer switch for a 5 minute period and observing the proper operation of the emergency power system including a 5 minute rest period for the emergency generator between each automatic transfer switch test.

EPA CERTIFIED TEST

1. If the proposed generator is not EPA Certified, provide an EPA compliant on site certified testing. Allow for all required exhaust components for certification.

3.03 EQUIPMENT DEMONSTRATION

- A. After all system tests have been completed, schedule an instruction period with the Owner. Instruction to be provided by Manufacturer's authorized field technician.
- B. Instruction to include:
 1. Location of all components of the system and explanation of their function.
 2. Demonstration of Equipment
 3. Maintenance and Repair Procedures
 4. Programming Procedures
 5. Review of Documents in Record and Information Manuals
- C. Contractor shall have all participants sign the Certificate of System Completion in Section 26 00 99, "Requirements of Contract Completion."

3.04 WARRANTY

- A. Provide a five (5) year warranty against defects in materials and workmanship.

END OF SECTION

26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install automatic transfer switch of size as shown on the Drawings and specified herein. Provide all accessories and equipment as necessary for complete systems.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards and in accordance with NEC Article 700.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheet of all components
 - 2. Wiring diagrams
 - 3. Complete dimension and installation information
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal
 - 2. Test results
 - 3. Certificate of System Completion

1.04 MANUFACTURERS

- A. Automatic Transfer Switches
 - 1. Russelectric Inc.
 - 2. Cummins-Onan Corporation
 - 3. ASCO Inc.

1.05 SYSTEM OPERATION

- A. Automatic transfer switches shall monitor the voltage level of the normal source, and when it drops below a pre-selected level, will initiate start of the emergency generator after a pre-determined time delay (typically 3 seconds).
- B. Automatic transfer switches shall monitor voltage and frequency of the emergency generator, and when at an acceptable level shall initiate load transfer to the emergency source after a pre-selected time delay (typically 1 second).
- C. Automatic transfer switches with dual operators shall transfer load to center off position and hold momentarily based on a pre-determined time setting (typically 2 seconds).
- D. Automatic transfer switches shall transfer load back to normal source when it has been restored after a pre-selected time delay (typically 5 minutes). Dual operator automatic transfer switches shall hold momentarily in center OFF position based on a pre-determined time setting (typically 2 seconds).

- E. Automatic transfer switches shall signal emergency generator to stop after a pre-determined cool down period (typically 5 minutes).

PART 2 PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCHES

- A. Automatic transfer switches shall be rated for continuous duty in a non-ventilated enclosure and shall be capable of switching all classes of loads. Unless otherwise noted on the Drawings, automatic transfer switches shall be 4 pole.
- B. Automatic transfer switches shall be electrically operated capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.
- C. Automatic transfer switches shall be double throw, inherently interlocked mechanically and electrically, and actuated by two (2) electrical operators. These operators shall provide a time delay in the "OFF" position, between the opening of the closed contacts and the closing of the open contacts, to allow for the demagnetizing of motor and transformer loads. Time delay shall be set at a minimum of 2 seconds and shall be adjustable 0-2 minutes. The delay shall be accomplished under all transfer conditions, including, but not limited to, single phase and brown out conditions, failure of emergency source and manual operations. Switch mechanism shall provide a "quick-make" and "quick-break" operation of contacts.
- D. The normal and emergency contacts shall be positively interlocked mechanically and electronically to prevent simultaneous closing. Mechanical interlock shall be separate from the operating mechanism so as to provide positive interlocks in the event of operator failure. Operating mechanism shall be metal. Plastic or phenolic type components subject to breakage are not acceptable.
- E. The transfer switch shall be equipped with safe operators capable of manually transferring switches under load. The manual operator shall provide the same contact opening and closing speed as the electrical operator.
- F. All relays, timers, and accessories shall be front mounted and accessible for ease of maintenance. Control wiring shall be flame retardant 600 volt with numbered sleeve identification on each end.
- G. Main contacts shall be mechanically locked in position in both the normal and emergency positions and shall be silver tungsten alloy protected by arcing contacts with magnetic blowouts on each pole.
- H. Automatic transfer switches shall be rated to withstand the RMS symmetrical short circuit current available at the automatic transfer switch terminals as shown on the Drawings, but not less than the minimum values as follows:
 - 1. 0-600 Amperes 50,000 RMS Amperes sym
- I. The automatic transfer switch shall be mounted in a NEMA Type 1 enclosure, unless otherwise indicated on the Drawings.

- J. The automatic transfer switch shall conform to the requirements of NEMA Standard ICS2-447-AC and UL 1008 and shall be UL listed as follows:
1. For use in emergency systems in accordance with the National Electrical Code
 2. Rated in amperes for total system transfer including control of motors, electric-discharge lamps, electric-heating and tungsten-filament lamp loads
 3. Transfer switches rated 400 Amperes and less shall be suitable for 100% tungsten-filament lamp load. Switches rated above 400 Amperes shall be suitable for 30% or 400 Amperes tungsten-filament lamp load, whichever is higher.
- K. Automatic transfer switches rated 400 Amperes and less shall be suitable for 100% tungsten-filament lamp load. Switches rated above 400 Amperes shall be suitable for 30% or 400 Amperes tungsten-filament lamp, load, whichever is higher.
- L. Control sections shall be de-energizable for maintenance by a control disconnect plug.
- M. Automatic transfer switches shall have a three (3) position test switch labeled "OFF/LOAD TEST/AUTO" to disengage automatic control, to simulate normal power failure and automatic position.
- N. Automatic transfer switches shall have two (2) auxiliary sets of contacts that are closed with switch in normal, and two (2) sets of contacts that are closed with switch in emergency.
- O. Functional Operation
1. For 3 phase switches all phases of the normal shall be monitored line-to-line. Close differential voltage sensing shall be provided. The pickup voltage shall be adjustable from 90% to 95% of nominal and the dropout voltage shall be adjustable from 80% to 85% of the pickup value. The transfer to emergency will be initiated upon reduction of the normal source to 85% of nominal voltage and retransfer to normal shall occur when normal source restores to 95% of nominal.
 2. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0 to 2 minutes and factory set at three seconds at which time a contact will close to initiate engine starting so that the generator will be on line no later than ten seconds after power failure.
 3. Independent single phase voltage and frequency sensing of the emergency source. Transfer to emergency upon normal source failure when emergency source voltage frequency is 90% or more of nominal.
 4. A time delay on transfer to emergency. Initially set at zero but field adjustable up to two minutes for controlled timing of load transfer to emergency if required.
 5. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and set for one minute.
 6. An unloaded running time delay for emergency generator cool-down. The time delay shall be field adjustable from 0 to 20 minutes and factory set at five minutes.
 7. Unit shall have top cubicle with bus extension and lugs to make unit "front access only" required.

PART 3 EXECUTION

3.01 APPLICATION

- A. Provide automatic transfer switches of minimum ampacity values as shown on the Drawings and meeting the noted withstand ratings. Increase nominal size of automatic transfer switch where necessary to achieve adequate withstand ratings.

3.02 INSTALLATION

- A. Install automatic transfer switches as shown on the Drawings in accordance with the Manufacturer's written instructions.
- B. Wall mounted automatic transfer switches shall be bolted securely to a wall. Floor mounted switches shall be bolted to a nominal 4 inch concrete housekeeping pad. Limits of pad shall exceed dimensions of equipment by 3 inches on all sides.
- C. Provide control wiring between automatic transfer switches, emergency generator and the emergency generator remote annunciator as required.
- D. Provide nameplates in accordance with Section 26 05 53, "Electrical Identification."

3.03 TESTING

- A. Provide a full functional test of all components of automatic transfer switch in accordance with Manufacturer's recommended procedure, and testing as specified in Section 26 32 14, "Emergency Generator."
- B. Adjust all settings of automatic transfer switches to coordinate with emergency generator settings to provide NFPA 110 Level 1 performance.
- C. Operate system for a minimum period of seven (7) consecutive days with no problems before final acceptance by Owner.

3.04 EQUIPMENT DEMONSTRATION

- A. After all system tests have been completed, schedule an instruction period with the Owner. Instruction shall be provided by Manufacturer's authorized field technician.
- B. Instruction shall include:
 - 1. Location of all components of the system and explanation of their function
 - 2. Demonstration of equipment
 - 3. Maintenance and repair procedures
 - 4. Programming procedures
 - 5. Review of documents in Record and Information Manuals
- C. Contractor shall have all participants sign the Certificate of System Completion in Section 26 00 99, "Requirements of Contract Completion."

3.05 EXTENDED WARRANTY

- A. Provide a five (5) year extended Parts and Labor Warranty on all automatic transfer switches.

END OF SECTION

26 43 13
TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install Transient Voltage Surge Suppressor (TVSS) units as shown on the Drawings and herein specified.

1.02 QUALITY ASSURANCE

- A. Surge suppressors shall be UL Listed and labeled under UL 1449.
- B. Surge suppressors shall be tested to ANSI C62.41 and C62.45 Standards.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components
 - 2. All operating parameters including UL 1449 voltage category
 - 3. Test results
- B. To be Included in Record and Information Manuals:
 - 1. One (1) copy of each approved submittal

1.04 MANUFACTURERS

- A. Transient Voltage Surge Suppressors
 - 1. Cutler-Hammer (Clipper)
 - 2. Siemens Sentron TPS
 - 3. Square D Company
 - 4. General Electric Company

PART 2 PRODUCTS

2.01 TRANSIENT VOLTAGE SURGE SUPPRESSORS

- A. Transient Voltage Surge Suppressor (TVSS) units where shown within switchgear shall be integral mounted in an enclosed compartment, separate from the internal busbars with a hinged lockable door and provided with disconnect means. Diagnostic lights shall be mounted in front door.
- B. Transient Voltage Surge Suppressor (TVSS) units shall be self-contained, wall mountable, solid-state devices in an NEMA 12, enameled steel enclosure with hinged door and locking handle.

3.02 EQUIPMENT DEMONSTRATION

- A. After all system tests have been completed, schedule an instruction period with the Owner. Instruction to be provided by Manufacturer's authorized field technician.
- B. Instruction shall include:
 - 1. Location of all components of the system and explanation of their function
 - 2. Demonstration of equipment
 - 3. Maintenance and repair procedures
 - 4. Programming procedures
 - 5. Review of documents in Record and Information Manuals
- C. Contractor shall have all participants sign the Certificate of System Completion in Section 26 00 99, "Requirements for Contract Completion."

3.03 EXTENDED WARRANTY/SPARE PARTS

- A. Provide a five (5) year Extended Warranty or a complete spare parts package in accordance with Manufacturer's standard arrangement.

END OF SECTION

26 51 13
LUMINAIRES, LAMPS AND BALLASTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install luminaires, lamps, ballasts and in-line fuses as herein specified and shown on the Drawings.
- B. Luminaire Manufacturer and model numbers shall be as scheduled on the Drawings. Luminaires not bearing a letter symbol shall match adjacent luminaire in space.
- C. All lamps and ballasts for a given luminaire type shall be by the same Manufacturer.

1.02 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards.
- B. Ballasts shall be certified by ETL and CBM. Ballasts shall match lamps with appropriate ANSI code.

1.03 SUBMITTALS

- A. For Review:
 - 1. Luminaires
 - a. Product data sheets for each fixture.
 - b. Lamp product data sheets for each fixture.
 - c. Ballast product data sheets for each fixture.
 - 2. Construction Drawings for custom luminaires
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy each of approved submittal
 - 2. Spare lamp inventory list
 - 3. Certificate of Material Receipt

1.04 MANUFACTURERS

- A. Luminaires
 - 1. Refer to Luminaire Schedule on the Drawings.
- B. Lamps
 - 1. Fluorescent
 - a. General Electric Company
 - b. Osram/Sylvania Corporation
 - c. Philips Lighting Company
 - 2. High Intensity Discharge (HID)
 - a. Osram/Sylvania Corporation
 - b. Philips Lighting Company
 - c. Venture

- C. Ballasts
 - 1. Electromagnetic
 - a. General Electric Company
 - b. Advance Transformer Company
 - c. Universal Lighting Technologies
 - d. Osram/Sylvania Corporation
 - 2. Electronic
 - a. Advance Transformer Company
 - b. Universal Lighting Technologies
 - c. General Electric Company
 - d. Osram/Sylvania Corporation
 - e. Robertson Inc.
- D. Fuses
 - 1. Refer to Section 26 28 13, "Fuses."

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Luminaires shall be as scheduled on the Drawings.
- B. Recessed incandescent luminaires shall have integral thermal protection.

2.02 LAMPS

- A. Unless specifically indicated otherwise, all fluorescent lamps shall be energy saving, T8 Type with 3500 degree Kelvin color temperature and minimum of 75 CRI.
- B. All high intensity discharge lamps shall be phosphor coated unless Manufacturer indicates photometrics are based on clear lamps. Lamp operating position shall match the luminaire orientation. Metal halide lamps used in open luminaires shall be UL listed for full rupture containment.
- C. Unless specifically indicated otherwise, all compact fluorescent lamps shall have a color temperature of 3000 degrees Kelvin, and a minimum of 82 CRI. Lamp base shall match luminaire socket.

2.03 FLUORESCENT BALLASTS

- A. Electronic ballasts for T8 lamps shall meet the following criteria:
 - 1. Minimum power factor of 95%.
 - 2. UL listed class "P."
 - 3. Class "A" sound level.
 - 4. Current crest factor < 1.7.
 - 5. Input total harmonic distortion (THD) < 20%.
 - 6. Parallel wire lamp connection with programmed start operation.
 - 7. High frequency operation.
 - 8. 50 degree F or Zero degree F starting temperature.
 - 9. Ballasts shall have end of lamp life fault mode shutdown protection.

- B. Compact fluorescent electronic ballasts shall be energy saving, high power factor (minimum 95), Class "A" sound rating, high frequency Class "P" ballast protection, CSA certified, 0 degree F starting temperature, current crest factor <1.5, input total harmonic distortion (THD)<10%, with integral end of lamp life fault mode shutdown protection.
- C. Fluorescent emergency ballasts shall be integral mounted, ninety (90) minute capacity, sealed maintenance free nickel cadmium battery and integral charger, operate one (1) or two (2) lamps "T8" to 1300 lumens, or compact fluorescent lamps to 600 lumens, and have remote mountable charging indicator light and test switch. Ballasts shall feature a self-diagnostic circuit that automatically tests unit and reports failure with an audible and visual alarm. Bodine B50ST.

2.04 HIGH INTENSITY DISCHARGE BALLASTS

- A. High intensity discharge (HID) magnetic ballasts shall be core and coil type, high power factor, constant wattage autotransformer (CWA) type capable of starting at minus 20 degrees F. Ballasts other than 480 volt input shall be multi-tap. Encased and potted ballasts shall have a class "B" sound rating and thermal protection.

2.05 LUMINAIRE ACCESSORIES

- A. Luminaires located in mechanical and electrical rooms shall have appropriate guards provided with each luminaire.
- B. Luminaires located in gypsum board (drywall) or plaster ceilings shall have appropriate plaster rings provided with each luminaire.
- C. Luminaires provided by the Manufacturer with cords attached shall be coordinated by the Division 26 Contractor so that cord lengths are of appropriate lengths for each luminaire installation.
- D. Luminaires shall be provided with all required mounting hardware for a complete installation.
- E. Exterior luminaires shall be installed on concrete bases.

PART 3 EXECUTION

3.01 APPLICATION

- A. Ballasts
 1. Fluorescent ballasts in luminaires located exterior to the building and in unheated spaces shall have a 0 degree F starting temperature.
 2. Fluorescent ballasts located within the building shall have a 50 degree F starting temperature.
 3. Electronic ballasts shall be used in all luminaires where available.
- B. Single and multiple lamp ballasts shall be provided in luminaires as required to permit lamp switching configurations as shown on the Drawings.

- C. New fluorescent lamps must be burned-in (seasoned) at full intensity for 100 hours (before dimming for extended periods). Without these operating hours, lamps may fail prematurely.
- D. Each ballast shall have a disconnecting means located within 24 inches of the ballast.

3.02 INSTALLATION

- A. Luminaires shall be securely mounted to elements of the building structure such that they will be square, plumb, and rigid, and will not fall or sag. Flush luminaires shall be furnished with installation provisions compatible with the suspended acoustical system furnished by the General Trades Contractor. This Contractor shall verify the actual suspension system to be used and make all adjustments in luminaire installation provisions.
- B. All open type fluorescent troffers shall be shipped from the Manufacturer with the louver enclosed in plastic wrap. The Contractor shall install the luminaires with the plastic wrap intact and only remove the wrap after the work environment is clean. Contractor shall patch any holes in the wrap to keep dirt out of the luminaire during construction.
- C. All luminaires mounted in suspended acoustical tile ceilings shall be securely attached to the ceiling grid system by removable grid clips or fasteners. Recessed "can" type luminaires shall have bar hangers attached to the ceiling grid system.
- D. All luminaires mounted on suspended acoustical tile ceilings shall be mounted to junction boxes with bar hangers attached to the ceiling grid system. In addition, luminaires heavier than ten (10) pounds shall have hangers attached to the ceiling grid system.
- E. All luminaires that are wall mounted or surface mounted to other than suspended acoustical tile ceilings shall be attached to outlet boxes that are securely supported to the building structure and UL listed for luminaire support.
- F. All surface mounted and recessed fluorescent luminaires and all high intensity discharge luminaires installed in suspended acoustical tile ceilings, shall have a supplemental support means attached to the building structure consisting of chain or cable, installed with 6 inches of slack. This support means shall be attached from the structure to the luminaire at each end and shall be capable of suspending the luminaire in the event the ceiling grid at the luminaire is removed.
- G. Clean both inside and outside surfaces of luminaires after installation. No luminaires shall be installed until the painting work of the General Trades Contractor is completed. Damaged, deformed or defective luminaires are to be replaced.
- H. Install lamps in all luminaires in accordance with the Luminaire Schedule.
- I. Only the number of lamps required to provide adequate lighting for work yet to be done, in each area, and acceptable temporary lighting elsewhere shall be installed by this Contractor at the time luminaires are installed and tested. Remaining lamps to be installed not more than ten (10) days prior to date of Contract Completion of the project. Replace lamps used for temporary lighting with new lamps not more than ten (10) days prior to date of Contract Completion of the project.

- J. All lamps are to be in working order at the time of Contract Completion. This Contractor shall replace all defective lamps with new lamps up until the time of Contract Completion.
- K. Prewired flush luminaire shall have minimum 90 Degree C wiring. Junction box capacity shall be sufficient for the circuit wiring requirements.
- L. Furnish all required installation accessories for the luminaires as required for specific location whether or not included in the Manufacturer's catalog number. Such accessories include plaster frames, rings, flanges, canopies, stem hangers, and suspension straps. REFER TO ARCHITECTURAL ROOM TREATMENT SCHEDULE.
- M. Designated night light, emergency egress, and exit signage luminaires shall be connected ahead of any switching.
- N. Luminaires provided by the Manufacturer with cords attached shall be coordinated by the Division 26 Contractor to assure adequate cord length for each individual luminaire installation.
- O. Luminaire supports used in fire rated ceiling assemblies shall be in conformance with that assembly's UL listing requirements.
- P. Remote mounted HID ballasts shall have metal enclosures. Install ballasts to building structure in an accessible location within Manufacturer's maximum distance limitation. Provide all wiring between ballasts and HID lamps and Quartz restrike lamps per Manufacturer's Drawings.
- Q. Install in-line fuse and fuse holders in all high intensity discharge luminaires on the line side of the ballasts. Install two (2) fuse holders or a double pole fuse holder for ballasts on 208 volt single phase circuits. Fuse holders shall be installed at a location convenient for changing fuses.
- R. Install in-line fuse and fuse holders in all fluorescent luminaires on the line side of the ballasts.
- S. Install in-line fuse and fuse holders in all fluorescent luminaires that are powered from an emergency source, on the line side of the ballasts.
- T. Coordinate exact wiring requirements to luminaire ballasts with Manufacturer.
- U. Flexible conduit or cord run down to suspended luminaires shall be installed along side of the suspension chain and neatly attached along its entire length.
- V. Fixture whips shall be of a minimum size as specified in Section 26 05 10 and 26 05 33.

3.03 SPARE PARTS

A. Lamps

1. Provide spare lamps of each wattage as follows:

LAMP TYPE	TOTAL NUMBER OF LAMPS INSTALLED IN PROJECT	NUMBER OF SPARES
HIGH INTENSITY	1-10	1
DISCHARGE	11-20	2
	21-UP	4
FLUORESCENT	1-10	1
	11-20	4
	21-50	10
	51-200	20
	200-UP	40

B. Division 26 Contractor shall include in his/her bid an allowance for furnishing and installing three (3) additional exit sign luminaires (with average length of conduit and wire) at completion of project as directed by the Architect. If not all used, remaining value shall be credited to Owner or turned over to Owner as additional spares per Owner's discretion.

3.04 WARRANTY

A. Fluorescent electronic ballasts shall have a Manufacturer's full warranty for five (5) years.

END OF SECTION

26 81 10
FIRE ALARM SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. Division 26 Contractor shall furnish and install all equipment and accessories for a complete local, manually and automatically actuated, electrically operated, device annunciated, double supervised, non-coded 24 VDC fire alarm system as described herein and as shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. Fire alarm installation shall conform to the requirements of the NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
- B. All equipment shall be UL listed and labeled, and in accordance with applicable NEMA and ANSI Standards.
- C. All devices and installation shall be in accordance with the Americans with Disabilities Act.
- D. Class B wiring is permitted.

1.03 SUBMITTALS

- A. For Review:
 - 1. Product data sheets of all components.
 - 2. Riser/wiring diagrams and plans of entire system showing all devices, quantity and size of wires, conduit sizes, zone schedule, sound levels, types of audible devices.
 - 3. Power supply, amplifier and battery calculations indicating operating time and spare capacity for additional devices.
- B. To be included in Record and Information Manuals:
 - 1. One (1) copy of each approval submittal
 - 2. Certificate of Material Receipt
 - 3. Certificate of System Completion
- C. Submit shop Drawings to the appropriate Building Authority's office for review after approval by the Architect. These drawings shall include the following statement:

Korda/Nemeth Engineering, Inc., 1650 Watermark Drive, Suite 200, Columbus, Ohio 43215 as shown on the Construction Documents and as required by the OBC, designed the fire protective signaling system for this project. The **[Insert Company Name]** project Drawings are provided with Manufacturer's installation and wiring recommendations to assist in the installation. Korda/Nemeth Engineering, Inc., Job # _____.

[Insert Designer Name]
[Insert Company]
[Insert City, State]
NICET Level _____
Fire Protection System Designer
[Insert, Name]
[Certification # _____, valid through _____]

1.04 MANUFACTURERS

- A. Fire alarm system components shall be as manufactured and/or certified by Manufacturer to work as a complete and functional system.
 - 1. Simplex-Grinnell
 - 2. Edwards System Technology
 - 3. Notifier
 - 4. Siemens

1.05 SYSTEM OPERATION

- A. Operation of any manual pull station or the actuation of any automatic device shall cause immediate and continuous operation of fire alarm signal and alarm indication at the control panel and remote annunciators until the actuated device is restored to normal and the control panel is manually reset.
- B. Fire alarm control panel shall send a signal to the remote monitoring service organization via leased telephone lines to indicate alarm or trouble condition.
- C. The remote annunciator panel shall audibly and visually annunciate both alarm and trouble as well as visually indicate the affected device.
- D. In the event of operating power failure, an open, or grounded circuit in the system, a trouble signal and trouble lamp shall be activated until the system is restored to normal. The trouble signal may be silenced by means of a switch mounted on the control panel door. Upon restoration of the system, the trouble signal shall resound until the trouble silence switch is restored to the NORMAL position.
- E. The incoming power to the system shall be supervised so that any power failures must be audibly and visually indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and the remote annunciator.
- F. Sprinkler waterflow and tamper switches shall be supervised for alarm and trouble conditions. Tamper switches and flow switches are located schematically. Coordinate exact location with Division 21 Contractor in field.
- G. All air handling units shall shut down when smoke is detected by return air duct mounted smoke detectors at the unit, unless unit is an integral part of a smoke control system. Shutdown shall be achieved by relay closure signaled by the fire alarm panel. Exact location of smoke detectors shall be coordinated with Division 23 Contractor.

- H. Fire alarm system shall have an auxiliary relay module for each air handling unit (AHU). This relay shall close upon smoke detection by any smoke detector associated with that air handler in ductwork or at fan powered VAV terminal boxes. Division 23 shall wire to temperature control system.
- I. Each fan powered VAV HVAC terminal box or fan coil unit shall have a duct mounted smoke detector installed in the return air duct, with auxiliary relay base. Shutdown wiring is by Division 23.

PART 2 PRODUCTS

2.01 FIRE ALARM PANEL

- A. Fire Alarm Panel shall have separate zones for every addressable device. Panel shall be modular with solid state, microprocessor based electronics, expandable, semi-flush mounted cabinet with glass window and locking door. Program shall be stored in non-volatile memory. Features shall include:
 - 1. 80 character English readout dynamic LCD display
 - 2. Battery supervision
 - 3. Multiple operator access levels
 - 4. 800 event historical logging
 - 5. Zone selectable alarm verification
 - 6. Individual circuit disable
 - 7. Alarm, trouble, power on, and supervisory service LED indicators
 - 8. Alarm acknowledge, supervisory acknowledge, trouble acknowledge, alarm silence, and system reset buttons
 - 9. Programmable "tone-alert" horn
 - 10. Printer communication module
 - 11. Remote station transmitter module for connection to 24 hour supervisory service
 - 12. Synchronizing module for synchronized strobe visual devices.
- B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with five (5) minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic with 100% recharge within twelve (12) hours.
- C. All external circuits requiring system operation power shall be 24 VDC and shall be individually fused at the control panel.
- D. Printer shall be UL Listed for use by the FACP. Provide a UPS to power the printer during power failure.
- E. Digital communicator shall be four (4) channel, dual phone line with twenty-four (24) hour automatic test, and automatic overload protection reset.
- F. Panel shall have spare capacity for twenty-five (25) additional initiating devices.

- G. Fire alarm system shall contain a relay module for each air handler. Relay shall be programmed to close upon smoke detection by any smoke detector associated with that air handling system. Refer to Division 23 Drawings.
- H. All hardware, software and firmware installed under this Contract, individually and in combination with each other shall function free of any fault in processing dates, and any information related to dates, (including calculating, comparing and sequencing information and/or functions which depend on dates) through and beyond January 1, 2029. Such fault free operation shall not require any modification after the system is installed and it shall be transparent to the user. If the hardware and/or software installed under this Contract interacts with any existing systems which do not already have this feature, this Contractor is to notify the Owner, in writing and in a timely manner, of the specific changes which the Owner must make to the existing systems to bring the combined system into compliance with this requirement.

2.02 REMOTE ANNUNCIATOR

- A. Remote annunciator to have an eighty (80) character LCD display with English language readout, tone alert horn, control switches for alarm silence, system reset, alarm acknowledge, key switch, and black painted flush mounted steel cabinet.

2.03 SMOKE DETECTORS

- A. Area smoke detectors shall be analog addressable smoke sensor type photoelectric devices that communicate smoke density values to the fire alarm control panel. Sensors shall have integral insect screens and RFI shielded electronics in a white plastic head and base. Detector base shall be addressable. Bases shall have LED status indicating light and locking tamper resistant screw. Detectors performing auxiliary control function such as elevator lobby, hoistway, and machine room detectors shall be associated with a Programmable Relay Module.
- B. Duct mounted smoke detectors shall be similar to area smoke detectors but with sampling tube as required to span HVAC duct width, and remote key operated test/reset station. Addressable relay control module shall be provided for equipment shutdown. Housing shall be gasketed and weatherproofed with internal heating means for applications where detector is located in an unheated space or on roofs.

2.04 HEAT DETECTORS

- A. Heat detectors shall be analog addressable combination rate-of-rise and fixed temperature (135 degree F) sensing with RFI shielded electronics. Base shall have an LED status indicating light and locking tamper resistant screw.

2.05 MANUAL PULL STATIONS

- A. Manual pull stations shall be red lexan semi-flush mounted push type double action with pull handle. Unit shall lock in the pulled position requiring a key to reset. Unit shall be individually addressable on the system.

- B. Manual pull stations shall have clear lexan tamper resistant cover over top, with integral battery and horn.
- C. Manual pull stations in gymnasiums shall have wireguard.

2.06 AUDIBLE/VISUAL DEVICES

- A. Visual devices (strobes) shall be multi-candela, 24 VDC, xenon flash unit, red semi-flush base assembly stating "FIRE," clear tamper resistant lexan lens.
- B. Audible/visual devices installed on the exterior of building or in high humidity areas shall be electro mechanical and have weatherproof gasketing.
- C. Provide synchronizing flash rate module on each notification device circuit. All strobes in the system will be synced.
- D. Audible/visual devices in gymnasiums shall have wireguard over face.

2.07 WATERFLOW AND TAMPER SWITCHES

- A. Sprinkler water flow and supervisory tamper switches shall be provided by Division 21. Provide addressable input monitor module to monitor each water flow switch and supervise each tamper switch.

2.08 CONTROL DEVICES

- A. Addressable output control modules shall provide relays with isolated contacts for controlling mechanical equipment.

2.09 REMOTE NOTIFICATION APPLIANCE CIRCUIT (NAC) POWER EXTENDER PANELS

- A. Remote Notification Appliance Circuit (NAC) power extender panels shall be wall mountable, with locking hinged door cabinet. The panels shall contain batteries, charging circuit, and power supply.
- B. The Notification Appliance Circuit panel shall be addressable or controlled by programmable relay modules. Strobe sync circuitry shall be built into each panel.
- C. Each Notification Appliance Circuit panel shall have a minimum of 6 Amperes of notification circuit power and shall have a minimum of four (4) zones.

PART 3 EXECUTION

3.01 APPLICATION

- A. Smoke detectors shown on the Drawings are located schematically. Maximum spacing between multiple smoke detectors in an area shall be 30 feet. No walls shall be more than 15 feet from a smoke detector. Smoke detectors shall not be installed within 3 feet of a HVAC diffuser. Wall mounted smoke detectors shall be installed at 12 inches from ceiling.

- B. Programming shall be done by the Manufacturer's authorized representative. Division 26 Contractor shall include in the bid sufficient funds to cover three (3) visits of eight (8) hours duration each for programming changes to include re-burning of electronic hardware components, to be done at the completion of the project after the life safety test.
- C. Tamper and waterflow switches are located schematically. Coordinate exact locations with Division 21 Contractor.
- D. Visual device types shall be located as follows:

	<u>Candela Level</u>
Corridors	15/75
Rooms < 400 SF	15/75
All other spaces	110

- E. Visual device types shall be located within 15 feet of end of corridor and within 15 feet of corridor doors.

3.02 INSTALLATION

- A. Follow Manufacturer's written instructions regarding mounting, wiring, and testing the fire alarm system. Installers shall be certified for fire alarm work by State Agencies.
- B. Conductors shall be twisted pair No. 14 AWG solid copper for annunciation circuits. Provide minimum No. 18 AWG shielded twisted pair solid copper wiring for initiation circuits and riser loops. Installation shall be in accordance with the Manufacturer's wiring diagrams, recommendations, and in compliance with practices set forth by local, State and National fire codes. Color code and tag all wires at all junction points. Do not exceed 40% conduit fill capacity.
- C. Duct mounted smoke detectors shall be installed in return ducts as directed by the mechanical equipment supplier under the supervision of the Division 23 Contractor, in a location that is accessible. Provide wiring to mechanical control equipment as necessary to achieve equipment control upon smoke detection. Install remote test stations at 60 inches above finished floor on adjacent wall in utility spaces, or in ceiling below duct detectors. Install label on each station identifying application.
- D. All wiring shall be installed in conduit and independent of all other systems. Paint all junction boxes with red paint and label "Fire Alarm."
- E. Provide 3/4 inch conduit from digital communicator to telephone terminal board. Provide two (2) Category 6 cables from telephone board.
- F. Install tamper switches on sprinkler system post indicating valves. Install addressable modules inside of the building.
- G. Provide 120 volt branch circuits for power to fire alarm control panel, equipment racks, remote control panels, power supplies.

- H. Exterior cover of all fire alarm wiring shall be red.
- I. Install printer jack and wiring from main panel in a location to be determined in the field.
- J. The system shall be programmed by the Manufacturer to operate as described in Paragraph 1.05 - System Operation. In addition, the following sensitivity shall be programmed for smoke detectors in the following areas:

General Areas	2.5%
Duct Mounted Smoke Detectors	1.0%
Mechanical/Electrical/Telephone Rooms	1.0%
Computer Areas	1.0%
- K. Signaling device circuits shall be loaded to no more than 75% of capacity.
- L. Panel shall be programmed to use slow "whoop" tone for annunciation before verbal message on voice system.
- M. Provide relay modules and wiring connection from the fire alarm system to all security system controllers to cause stairway door locks, exterior doors, and other egress doors to be released. Coordinate location with security contractor.
- N. Provide relays as required to connect fire alarm system to auxiliary systems as specified in other Sections and noted on Drawings.
- O. Fire alarm system shall monitor emergency generator and report failure as a trouble condition.
- P. Smoke detector bases shall be labeled with programmed address visible from floor when head is removed.
- Q. Provide an area type smoke detector within HVAC ductwork for each HVAC smoke damper shown on the HVAC Drawings. Detector shall be located within 5 feet of damper at access door location. Provide two (2) smoke detectors for ducts between 36 inches and 72 inches wide. Provide three (3) smoke detectors for ducts greater than 72 inches wide. Provide a system relay adjacent to smoke damper for signal damper to close.

3.03 TESTING

- A. Each zone in the fire alarm control panel and remote annunciator and each device shall be individually tested as installed in the building under the supervision of an authorized Manufacturer's Representative. Division 26 Contractor shall include in his/her bid, time for testing after normal work hours.
- B. The complete fire alarm system shall be tested by the Division 26 Contractor as required by the Fire Marshal inspecting authority in the presence of the Owner's representative. Division 26 Contractor shall make all modifications as required by the Fire Marshal. Division 26 Contractor shall include in bid a second fire alarm system test of modifications made.

- C. Operate system for a minimum of seven (7) consecutive days with no trouble conditions before claiming contract completion.

3.04 SPARE PARTS

- A. Provide spare parts as follows:
 - 1. Smoke Detectors 5
 - 2. Manual Pull Stations 2
 - 3. Audio Visual Devices 2
- B. Division 26 Contractor shall include in his/her bid, an allowance for furnishing and installing (with average length of conduit and wire), the following, at completion of project as directed by the Architect. If not all used, remaining labor and material shall be credited to Owner:
 - 1. Audiovisual Devices 5
 - 2. Manual Pull Stations 1
 - 3. Tamper/Waterflow switches 2
 - 4. Duct Smoke Detectors 1
 - 5. Area Smoke Detectors 2
 - 6. Re-Programming Time 2 visits of 4 hours
- C. Furnish ten (10) keys to open panels, pull stations and annunciators.
- D. Obtain a signed copy of the Certificate of Material Receipt from Section 26 00 99, "Requirements for Contract Completion."

3.05 EQUIPMENT DEMONSTRATION

- A. After all system operational tests have been completed, schedule an instruction period with the Owner. Instruction to be provided by Manufacturer's authorized field technician. Include four sessions of four hours.
- B. The instruction is to include the following:
 - 1. Location of all components of the system and explanation of their function
 - 2. Demonstration of equipment
 - 3. Maintenance and repair procedures
 - 4. Programming procedures
 - 5. Review of documents in Record and Information Manuals
- C. All participants shall sign the Certificate of System Completion from Section 26 00 99, "Requirements for Contract Completion."
- D. Training sessions shall be videotaped and two copies provided to owner on DVD in MPEG 3 format.

3.06 SMOKE DETECTOR SENSITIVITY TEST

- A. All area and duct mounted smoke detectors shall have a sensitivity test conducted at the time of completion and during the eleventh month after date of Contract Completion. Sensitivity test shall be conducted by the Manufacturer's Representative. Clean all detectors that are out of their listed sensitivity range. Provide written documentation of test results.

3.07 WARRANTY OF WORK

- A. The Division 26 Contractor shall warrant all materials, equipment and workmanship for a period of one (1) year from date of completion. Refer to Section 26 00 00, "Division 26 - Electrical Introductory Statement."

END OF SECTION