SPECIFICATIONS

FOR

LAMAR COUNTY COURTHOUSE
HVAC SYSTEM RENOVATION – PHASE 1

119 NORTH MAIN
PARIS, TEXAS

Prepared by

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ISSUE FOR BIDS

LAMAR COUNTY COURTHOUSE
HVAC SYSTEM RENOVATION – PHASE 1
119 North Main
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DESIGN PROFESSIONAL RESPONSIBILITY

The specification sections authenticated by my seal and signature are limited to the following:

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03300	Concrete

DIVISION 5: *METALS*

05500	Metal Fabrications

DIVISION 9: *FINISHES*

09910	Painting

DIVISION 15: *MECHANICAL*

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M106	Mechanical Schedules
E000	Electrical - Demolition - Basement Floor Plan
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SECTION 03300 - CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. Perform all Work required to complete the cast-in-place concrete indicated by the Contract Documents and furnish all supplementary items necessary for its proper installation.

B. Applicable requirements of the following Sections of this Project manual apply to all work under this Section.

1. Uniform General Conditions
2. Supplementary General Conditions
3. Special Conditions

1.2 SHOP DRAWINGS

A. Shop drawings, showing all dimensions necessary for fabrication and placing of the reinforcing steel and accessories, without reference to the project drawings, shall be submitted for approval. Approval shall be obtained before fabrication.

1.3 REFERENCE SPECIFICATIONS

A. The specifications of the American Society for Testing and Materials referred to in these specifications are declared to be a part of these specifications the same as if fully set forth elsewhere herein.

1.4 ACI AND CRSI STANDARDS

A. Detailed recommendations for acceptable practices, while not a part of these Specifications, are available as standards and recommendations of the American Concrete Institute and the Concrete Reinforcing Steel Institute.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cements: Each of the following types of cements shall conform to the appropriate specifications, as indicated.

1. Portland: 'Specifications for Portland Cement' (ASTM C150).
2. Air-Entraining Portland Cement: 'Specifications for Air-Entraining Portland Cement' (ASTM C175).
3. Portland Blast-Furnace Slag Cement: 'Specifications for Portland Blast-Furnace Slag Cement' (ASTM C205).
4. Portland-Pozzolan Cement: 'Specifications for Portland-Pozzolan Cement' (ASTM C340).

B. These different cements shall not be used interchangeably in the same element or portion of the work.

C. Unless otherwise permitted or required, cement shall be Type I, ASTM C150, or Type II, ASTM C150 at the Contractor's option.

D. Admixtures: Each of the following admixtures shall be used when required and may be used when permitted. They shall conform to the appropriate specifications as indicated.

1. Air-Entraining Admixtures: 'Specifications for Air-Entraining Admixtures for Concrete' (ASTM C260).
2. Calcium Chloride: 'Specifications for Calcium Chloride (ASTM D98).
3. Chemical Admixtures: 'Tentative Specifications for Chemical Admixtures for Concrete' (ASTM C494).

E. Two or more admixtures may be used in the same concrete, provided such admixtures are added separately during the batching sequence and provided further that the admixtures used in that combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

F. Water: Mixing water for concrete shall be fresh, clean, and potable. Nonpotable water may be used only if it produces mortar cubes having 7- and 28-day strength equal to the strength of similar specimens made with distilled water, when tested in accordance with 'Method of Test for Compressive Strength of Hydraulic Cement Mortars' (ASTM C109).

G. Aggregates:

1. Aggregates for concrete of normal weight shall conform to 'Specifications for Concrete Aggregates' (ASTM C33).
2. Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall conform to the grading requirements of the appropriate ASTM specifications.

2.2 STORAGE OF MATERIALS

A. Detailed recommendations are given in "Recommended Practice for Measuring, Mixing, and Placing Concrete' (ACI 304).

B. Cement shall be stored in weathertight buildings, bins, or silos which will provide protection from dampness and contamination and will minimize warehouse set.

C. Aggregates stockpiles shall be arranged and used in a manner to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. To insure that this condition is met, any test for determining conformance to requirements for cleanliness and grading shall be performed on samples secured from the aggregates at the point of batching. Stockpiles shall be built in successive horizontal layers not exceeding 3 feet in thickness, with each layer being completed before the next is started. Frozen or partially frozen aggregates shall not be used. Unless predampening is not considered desirable by the manufacturer or is considered impractical by the Engineer, dry lightweight aggregates shall be uniformly predampened by water sprays as necessary.

2.3 PROPORTIONING

A. Concrete for all parts of the work shall be homogeneous and, when hardened, shall have the required strength, resistance to deterioration, durability, resistance to abrasion, watertightness, appearance and other specified properties.

B. Type: Concrete shall be of the type or types designated by the project specifications, as follows:

1. Working Stress Type Concrete: For use in structures or structural elements which have been analyzed and proportioned by working stress (straight line) theory.
2. Ultimate Strength Type Concrete: For use in structures or structural elements which have been analyzed and proportioned by ultimate strength design theory.

C. Strength: The strength of the concrete for each portion of the structure shall be as designated on the project drawings. Strength requirements shall be based on 28-day compressive strengths, unless high early strength is specified, in which case required strengths shall be obtained at 7 days.

D. Durability: Concrete which will be subject to potentially destructive exposure (other than wear or loading) such as freezing and thawing, severe weathering or chemicals shall contain entrained air as indicated in Table 2.03B. For any such concrete, the water-cement ratio shall not exceed 6 gal. per sack of cement. Lightweight concrete shall contain not less than 6 percent air by volume (total entrapped and entrained).

E. Slump:

1. Slump of concrete of normal weight, as determined by 'Method of Test for Slump of Portland Cement Concrete' (ASTM C143), shall be in accordance with Table 2.03A.

TABLE 2.03A -- SLUMPS FOR VARIOUS KINDS OF CONSTRUCTION

KINDS OF CONSTRUCTION	SLUMP, IN.* MAXIMUM.	MINIMUM
Reinforced Footings	3	1
Plain Footings/Caissons/Substructure Walls	3	1
Slabs, Beams, Reinforced Walls	4	1
Columns	4	1

*For Concrete to be vibrated

2. The minimum slump shall be waived on concrete used in ramps, folded plates or other sloping construction.
3. Slump of lightweight concrete, as determined by 'Method of Test for Slump of Portland Cement Concrete' (ASTM C143), shall not exceed 3 in., unless otherwise permitted.

F. Maximum Size of Coarse Aggregate:

1. The nominal maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least. In columns the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.
2. Coarse aggregates in concrete of normal weight may be of one size for all concrete placed in 1 day when quantities to be placed are too small to permit economical use of more than one

mix design. When a single mix design is so used, the maximum nominal size shall be as required for the most critical condition of concreting, in accordance with the requirements of the preceding section.

3. The nominal maximum size of coarse aggregates in lightweight concrete shall not exceed 3/4 in.

G. Air Entrainment: If air entrainment is required in concrete of normal weight, the air content of the concrete shall conform to Table 2.03B. The air content shall be determined by either of the ASTM standard methods of test.

TABLE 2.03B -- TOTAL AIR CONTENT FOR VARIOUS SIZED OF COARSE AGGREGATES

NOMINAL MAXIMUM SIZE OF COARSE AGGREGATE, IN	TOTAL AIR CONTENT, PERCENT BY VOLUME
3/8	6 to 10
1/2	5 to 9
3/4	4 to 8
1	3.5 to 6.5
1-1/2	3 to 6
2	2.5 to 5.5
3	1.5 to 4.5

H. Admixtures: If required or permitted, admixtures shall be used as follows:

1. Air-entraining Admixtures, and Proprietary Chemical Admixtures: In accordance with the Recommendation of the manufacturer.
2. Calcium Chloride: In accordance with 'Recommended Practice for Winter Concreting' (ACI 604).

I. If required or permitted an approved accelerator may be used in the proportions recommended by the manufacturer when the temperature of the concrete as placed is less than 40°F. Detailed recommendations for use of calcium chloride in cold weather are given in 'Recommended Practice for Winter Concreting' (ACI 604) Calcium Chloride shall not be used without the approval of the Engineer.

2.4 FORMWORK

A. Design of Formwork:

1. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the contractor.
2. The formwork shall be designed for the loads and lateral pressure outlined in Part 3, Section 102 of 'Recommended Practice for Concrete Formwork' (ACI 347) and wind loads as specified by the controlling local building code. Design considerations and allowable stresses shall meet section 103 of the above reference and the applicable requirements of the controlling local building code.
3. Temporary openings shall be provided at the base of the column forms and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is deposited.

4. Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be commercially manufactured typed. Wire is not acceptable. The portion remaining within the concrete shall leave no metal within 1 in. of the surface when the concrete is exposed to view. Spreader cones on ties shall not exceed 1 in. diameter.

B. Tolerances: Formwork shall be constructed so as to insure that the concrete surfaces will conform to the tolerances of Section 203.1, Recommended Practice for Concrete Formwork (ACI-347).

C. Preparation of Form Surfaces:

1. Forms shall be sufficiently tight to prevent leakage of grout or cement. Board forms having joints opened by shrinkage of the wood shall be swelled until closed by wetting before concrete is place.
2. Plywood and other wood surface not subject to shrinkage shall be sealed against absorption of moisture from the concrete be either (1) a field applied commercial form oil or sealer, or (2) a factory applied nonabsorption liner.
3. When steel forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess material shall be not allowed to stand in puddles in the forms nor allowed to come in contact with concrete against which fresh concrete will be place.
4. Where cast finishes are required, materials which will impart a stain to the concrete shall not be applied to the form surfaces. Where the finished surface is required to be painted. The material applied to form surfaces shall be compatible with the type of paint to be used.
5. All form surfaces shall be cleaned before reused.

D. Removal of Forms:

1. Formwork for columns, walls, sides of beams and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.
2. Formwork for beam soffits and slabs and other parts that support the weight of concrete, shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified or permitted.

E. Reshoring: When reshoring is permitted or required the operations shall be planned in advance and shall be subject to approval.

2.5 REINFORCEMENT

A. General: Details of concrete reinforcement not covered herein shall be in accordance with 'building Code Requirements for Reinforced Concrete' (ACI 318), and 'Manual of Standard Practice for Detailing Reinforcing Concrete Structures' (ACI 315).

B. Reinforcing Steel:

1. All reinforcing steel except No. 2 bars and column spirals shall be deformed as defined in 'Building Code Requirements for Reinforced Concrete' (ACI 318).
2. All reinforcing steel shall be of the grade as indicated on the project drawings.
3. Welded wire fabric shall be electrically welded wire fabric of cold-drawn wire (70,000 psi yield point) of gage and mesh size shown on the drawings or required and shall conform to 'Specifications for Welded Steel Wire Fabric for Concrete Reinforcement' (ASTM A185).

C. Placing: Detailed recommendations are given in the Concrete Reinforcing Steel Institute's 'Recommended Practice for Placing Reinforcing Bars 1959' and 'Recommended Practice for Placing Bar Supports, Specifications and Nomenclature 1963.'

1. All reinforcing bars shall be supported and wired together to prevent displacement by construction loads. On ground and where necessary, supporting concrete block may be used. Over formwork, concrete, metal, plastic or other approved bar chairs and spacers shall be furnished. Where the concrete surface will be exposed to the weather in the finished structure or where rust would impair architectural finishes the portions or all accessories in contact with the formwork shall be galvanized or shall be made plastic.
2. Welded wire fabric shall be lapped at least 1-1/2 meshes plus end extension of wires but not less than 12 in. in structural slabs. It shall be lapped at least 1/2 mesh plus end extension of wires but not less than 6 in. in slabs on ground. The mesh shall be extended across supporting beams and wall. In lieu of adequate support for mesh, the mesh shall be lifted during placing of concrete so that it is completely surrounded by concrete and not less than 2 in. above the bottom of slabs on ground or 1/2 in. above formwork.
3. Vertical bars in columns shall be offset at least one bar diameter at slices. To insure proper placement, templates shall be furnished for all column dowels.
4. All splices not shown on the project drawings shall be approved.
5. Unless permitted, reinforcement shall not be bent after being partially embedded in hardened concrete.

2.6 JOINTS AND EMBEDDED ITEMS

A. Construction Joints:

1. Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall be approved. In general, they shall be located near the middle of the spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams or girders and at the top of footings or floor slabs. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
2. All reinforcing steel and mesh shall be continued across the joints. Keys and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1-1/2" in. deep shall be provided in all joints in walls.
3. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed.
4. When required or permitted, bond shall be obtained by one of the following methods:

    a. The use of an approved adhesive.
    b. The use of an approved chemical retarder which delays but does not prevent setting of the surface mortar. Retarded mortar shall be removed within 24 hours after placing to produce a rough exposed aggregate bonding surface.
    c. By roughening the surface of the concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.

B. Waterstops: The material, design, and location of waterstops in construction joints and expansion joints shall be as indicated in the project specifications and drawings.

C. Other Embedded Items:

1. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its supports shall be placed prior to concrete, unless noted otherwise.
2. All Contractor's whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.
3. Expansion joint material, waterstops, and embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

PART 3 - EXECUTION

3.1 MIXING

A. Detailed recommendations are given in 'Recommended Practice for Measuring, Mixing and Placing Concrete' (ACI 304).

B. Ready-mix concrete shall be mixed and transported in accordance with 'Specifications for Ready-Mix Concrete' (ASTM C94).

C. Retempering:

1. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be retempered but shall be discarded.
2. Indiscriminate addition of water to increase slump shall be prohibited.

    a. The ingredients shall be cooled before mixing, or well-crushed ice may be substituted for all or part of the mixing water if, due to high temperature, any difficulties described in the section entitled 'Placing Temperature', are encountered.

D. Weather Conditions:

1. Cold Weather: Detailed recommendations are given in 'Recommended Practice for Winter Concreting' (ACI 305).

    a. To maintain the temperature of the concrete above the minimum placing temperature required by the section entitled 'Placing Temperature' the as-mixed temperature shall not be less than 55°F when the mean temperature falls before 40°F.
    b. If water or aggregate has been heated, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be added to mixtures of water and aggregate when the temperature of the mixture is greater than 100°F.

2. Hot Weather: Detailed recommendations are given in 'Recommended Practice for Hot Weather Concreting' (ACI 305).

    a. The ingredients shall be cooled before mixing if necessary to maintain the temperature of the concrete below the maximum placing temperature required by the section entitled 'Placing Temperature'.

3.2 PLACING

A. Preparation Before Placing:

1. Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.
2. Formwork shall have been completed. Ice and excess water shall have been removed. Reinforcement shall have been secured in place. Expansion joint material, anchors, and other embedded items shall have been positioned. The entire preparation shall have been approved.
3. Semiporous subgrades shall be sprinkled sufficiently to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.

B. Conveying: Detailed recommendations are given in 'Recommended Practice for Measuring, Mixing, and Placing Concrete' (ACI 304).

1. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent separation or loss of ingredients and in a manner which will assure that the required quality of the concrete is obtained.
2. Conveying equipment shall be of size and design to insure a continuous flow of concrete at the delivery end and shall be approved.

C. Depositing: Detailed recommendations are given in 'Recommended Practice for Measuring, Mixing and Placing Concrete' (ACI 304).

1. General: Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on crete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located at points as provided for in the drawings or as approved. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign material shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.
2. Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic.
3. Segregation: Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation.

D. Consolidation: (Detailed recommendations are given in 'Consolidation of Concrete' (ACI 306)). Where a surface mortar is to be the basis of the finish, the coarse aggregate shall be worked back from the forms with a suitable tool so as to bring a full surface of mortar against the form, without the formation of excessive surface voids. All concrete shall be consolidated by vibration, spading, rodding, or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes or weakness.

E. Weather Conditions:

1. Protection:

a. Unless adequate protection is provided and/or approval is obtained, concrete shall not be place during rain, sleet, or snow.
b. Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.

F. Placing Temperature:

1. Cold Weather: (Detailed recommendations are given in 'Recommended Practice for Winter Concreting' (ACI 306)). When the mean daily temperature falls below 40°F, the minimum temperature of concrete as placed shall be 50°F.
2. Hot Weather: (Detailed recommendations are given 'Recommended Practice of Hot Weather Concreting' (ACI 305)). Concrete deposited in hot weather shall have a placing temperature which will not cause difficulty from loss of slump, flash set, or cold joints (usually somewhat less than 90°F.).

3.3 REPAIR OF SURFACE DEFECTS

A. Removal: After forms have been removed, any concrete which is not formed as shown on the plans, or which is out of alignment or level beyond specified tolerances, or which shows a defective surface which cannot be properly repaired or patched shall be removed.

B. Repairing and Patching:

1. All tie holes and all repairable defective areas shall be patched immediately after form removal.
2. Defective Areas:

a. All honeycombed and other defective concrete shall be removed to sound concrete, but in no case to a depth of less than 1 inch. The area to be patched and an area at least 6 in. wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bond of neat Portland cement and water and, if permitted, some fine sand passing a No. 30 mesh sieve, shall be mixed to the consistency of thick cream and shall then be well brushed into the surface.
b. The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the concrete aggregate shall be omitted, and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the gray Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.
c. The quantity of mixing water shall be not more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition to water, until it has reached the stiffest consistency that will permit placing.
d. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least 1 hr. before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

3. Tie Holes: After being cleaned and thoroughly dampened, the tie holes shall be filled solid with patching mortar.
4. Proprietary Patches: If permitted or required, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations.

3.4 FINISHING OF FORMED SURFACES

A. General: After removal of forms the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the project drawings and/or the project specifications or as specified in the section entitled 'Selection of Finishes'.

B. As-Cast Finishes:

1. Rough or Board Form Finish: Rough or board form finish surfaces shall be reasonably true to line and plane with no specific requirements for selected facing materials. Tie holes and defects shall be patched and fins exceeding 1/4 in. in height shall be rubbed down with wooden blocks. Otherwise, surfaces shall be left with the texture imparted by the forms.
2. Plywood Finish: Plywood finish shall be produced in the same manner as rough or board form finish, except as follows:

    a. Concrete shall be cast against forms constructed of plywood not less than 5/8 in. or of boards lined with tempered hardboard not less than 3/16 in. thick.
    b. The arrangement of plywood sheets or liner sheets shall be orderly and symmetrical, and sheets shall be in as large sizes as are practicable.
    c. Sheets showing torn grain, worn edges, patches of holes from previous use, or other defects which will impair the texture of concrete surfaces shall not be used.
    d. All fins on the surface shall be completely removed.

C. Rubbed Finishes: The following finishes shall be produced on concrete which has been cast against plywood-faced forms:

1. Smooth Rubbed Finish: Smooth rubbed finish shall be produced on green concrete. All necessary patching shall have been done immediately after forms have been removed and rubbing shall be completed not later than the following day. Surfaces shall be wetted and rubbed with carborundum brick or other abrasive until a uniform color and texture are produced. No cement grout or slush shall be used other than the cement paste drawn from the green concrete itself by the rubbing process.

D. Selection of Finishes: Unless indicated otherwise on the drawings, the following finishes shall be used as applicable.

1. Rough or Board Form Finish: For all concrete surface not exposed to public view, including concrete in utility spaces.
2. Smooth Rubbed Finish: For all other exterior surfaces and interior vertical surfaces.
3. Plywood Finish: For all other interior overhead surfaces.

E. Related Unformed Surfaces: Unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

3.5 FLATWORK

A. Edge Forms and Screeds:

1. Edge forms and intermediate screed strips shall be set accurately to produce the designed elevations and contours in the finish surface and shall be sufficiently strong to support vibrating bridge screeds or roller pipe screeds if the nature of the finish specified required the use of such equipment. The concrete shall be aligned to the contours of screed strips by the use of strike-off templates or approved compacting type screeds.
2. When the formwork is cambered, screeds shall be set to a like camber to maintain the proper concrete thicknesses.

B. Jointing: Joints in slabs on grade shall be located and detailed as indicated in the project drawings and specifications. If saw-cut joints are required or permitted, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates being dislodged by the saw and shall be completed before shrinkage stresses have developed sufficiently to induce cranking.

C. Consolidation: Concrete in slabs shall be thoroughly consolidated. Internal vibration shall be used in beams and girders of framed slabs and along the bulkheads of slabs on grade. Consolidation of slabs and floors shall be obtained with vibrating bridge screeds, roller pipe screeds, or other approved means. concrete to be consolidated shall be as dry as practicable and the surface thereof shall not be manipulated prior to finishing operations.

D. Finishes:

1. Scratched Finish: After the concrete has been placed, struck off, consolidated and leveled the surface shall be roughened with stiff brushes or rakes before final set.
2. Floated Finish: After the concrete has been placed, struck off, consolidated, and leveled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared, and/or when the mix has stiffened sufficiently to permit proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats of the impact type except in thin sections such as pan slab. Hand floating with wood or cork-faced floats shall be used in location inaccessible to the power-driven machine. Trueness of surface shall be rechecked at this stage with a 10-ft. straight-edge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce planes checking true under the straight edge in any direction, with tolerances not exceeding 1/8 in. in 10 ft. The slab shall then be refloated immediately to a uniform, smooth, granular texture.
3. Troweled Finish: Where a troweled finish is specified, the surface shall be finished first with impact power floats, as specified above where application then with power trowels, and finally with hand trowels. The first troweling after power floating shall be done by a power trowel and shall produce a smooth surface which is relatively free of defects, but which may still contain some trowel marks. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks and shall be uniform in texture and appearance on surfaces intended to support floor coverings. Any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

4. Broom or Belt Finish: Sidewalk slabs, and slabs in other locations so specified, shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface. This operation shall follow immediately after floating. Floating shall be performed as outlined in the section entitled 'Floated Finish'.
5. Nonslip Finish: Where a nonslip finish is specified, the surface shall be given a "dry shake" application, as specified above, of crushed ceramically bonded aluminum oxide or other specified selected abrasive particles. The rate of application of such material shall be not less than 25 lbs. per 100 sq. ft.
6. "Dry Shake" Finish: Where "dry shake" application of a selected metallic or mineral aggregate is specified, the aggregate, selected or approved by the Engineer, shall be blended with portland cement in the proportions recommended by the manufacturer of the aggregate. The surface shall be given a float finish in accordance with Section 11.7.2. Approximately two-thirds of the blended material for required coverage shall be applied to the surface by a method that ensures even coverage without segregation. Floating shall be immediately after application of the first "dry shake". After this material has been embedded by floating, the remainder of the blended material shall be applied to the surface at right angles to the previous application. The second application shall be heavier in any areas not sufficiently covered by the first application. A second floating shall follow immediately. After the selected material has been embedded by the two floatings, the operation shall be completed with a broomed, floated, or troweled finish, as designated in the contract documents.

E. Selection of Finishes:

1. Unless indicated otherwise on the drawings, the following finishes shall be used, as applicable.

    a. Scratched Finish: For surfaces intended to receive bonded applied cementitious applications.
    b. Floated Finish: For surfaces intended to receive roofing or waterproofing membranes.
    c. Troweled Finish: For floors intended as walking surfaces or for reception of floor coverings.
    d. Broomed or Belted Finish: For sidewalks, and ramps.
    e. Nonslip Finish: For all stair tread, and mechanical room or electrical room floor surfaces.

3.6 CURING AND PROTECTION

A. Curing:

1. General: Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures and shall be maintained without drying at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete.
2. Initial Curing: Initial curing shall immediately follow the finishing operation. Concrete shall be kept continuously moist at least overnight. One of the following materials or methods shall be used:

    a. Ponding or continuous sprinkling.
    b. Absorptive mat or fabric kept continuously wet.
    c. Sand or other covering kept continuously wet.
    d. Conditions steam (not exceeding 150°F) or vapor mist bath.

e. Curing compounds conforming to 'Specifications for Liquid-Membrane-Forming Compounds for Curing Concrete' (ASTM C309). Such compounds shall be applied in accordance with the recommendations of the manufacturer and shall not be used on any surfaces against which additional concrete or other cementitious finishing materials are to be bonded, or over surfaces to receive waterproofing, nor on surfaces on which such curing is prohibited by the project specifications.

3. Final Curing: Immediately following the initial curing and before the concrete has dried, additional curing shall be accomplished by one of the following materials or methods:

a. Continuing the method used in initial curing.
b. Waterproof paper conforming to 'Specifications for Waterproof Paper for Curing Concrete' (ASTM C171).
c. Other moisture-retaining coverings as approved.

4. Duration of Curing: The final curing shall continue until the cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of the air in contact with the concrete is above 50°F has totaled 7 days. If high early strength concrete has been used, the final curing shall continue for a total of 3 days. Rapid drying at the end of the curing period shall be prevented.

B. Temperature:

1. Cold weather (detailed recommendations are given in 'Recommended Practice for Cold Weather Concreting' (ACI 306)). When the mean daily temperature of the atmosphere is less than 40°F, the temperature of the concrete shall be maintained between 50°F and 70°F for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing shall be made in advance of placement and shall be adequate to maintain the required temperature the moisture conditions without injury due to concentration of heat.
2. Hot weather (detailed recommendations are given in 'Recommended Practice for Hot Weather Concreting' (ACI 305)). When necessary, arrangement for installation of wind breaks, shading, fog spraying, sprinkling, ponding or wet covering of a light color shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.
3. Excessive Temperature Changes: Changes in temperature of the concrete shall be a uniform as possible and shall not exceed 5°F. in any 1 hour or 50°F. in any 24-hour period.

3.7 TESTING

A. Routine testing of materials, of proposed mix designs, and of resulting concrete for compliance with technical requirements of the specifications shall be the duty of the testing agency employed by the Owner.

B. Testing required because of changes in materials or proportions of the mix requested by the Contractor, as well as any extra testing of concrete or materials occasioned by their failure to meet specification requirements, shall be at the Contractor's expense.

3.8 TESTING SERVICES

A. The designated testing agency shall:

1. Test the Contractor's proposed materials for compliance with the Specifications.

2. Review and check test the Contractor's proposed mix design.
3. Secure production samples of materials at plants or stockpiles during the course of the work and test for compliance with the Specifications.
4. Check batching and mixing operations to the extent deemed necessary to assure compliance with the specifications.
5. Check slump consistency and uniformity of concrete to the extend deemed necessary to assure compliance with the Specifications.
6. Conduct strength tests of the concrete in accordance with the following procedures:

    a. Secure composite samples in accordance with "Method of Sampling Fresh Concrete," (ASTM C172). Each strength test shall be obtained from a different batch of concrete on a representative, truly random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement. When pumping or pneumatic equipment is used, samples shall be taken at the discharge end.
    b. Mold three specimens from each sample in accordance with "Method of Making and Curing Concrete Compression and Flexure Specimens in the Field," (ASTM C31), and cure under standard moisture and temperature conditions in accordance with Section 7 (a) of the above ASTM method.
    c. Test three specimens at 28 days in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders," (ASTM C39). The 28-day test result shall be the average of the strengths of the three specimens, except that if one specimen in test manifests evidence of improper sampling, molding, or testing, it shall be discarded, and the remaining two strengths averaged. Should more than one specimen in a test show any of the above defects, the entire test shall be discarded. When high early strength is required, the specimens shall be tested at 7 days.
    d. Make one strength test for each 100-cu. yd. or fraction thereof for each mix design of concrete placed in any 1 day, except that in no case shall a given mix design be represented by less than five tests.

7. Determine air content of concrete of normal weight on a regular and frequent basis in accordance with either ASTM test method.
8. Determine air content and unit weight of lightweight concrete on a regular and frequent basis in accordance with "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method" (ASTM C173) for air content, and "Method of Test for Weight per Cubic Foot, Yield, and Air Content (Gravimetric) for Concrete" (ASTM C138) for unit weight.
9. Report temperature of concrete at time of placing on a regular and frequent basis.
10. Report total water quantity added to concrete batches, including that added after departure of concrete trucks from batch plant.
11. Report all test results to the Engineer and the Contractor on the same day that tests are made.

3.9 AUTHORITY AND DUTIES OF TESTING AGENCY

A. Technicians representing the testing agency shall inspect the materials and the manufacture of concrete and shall report their findings to the Engineer and the Contractor. When it appears that the material furnished or work performed by the Contractor fails to fulfill specification requirements, the technician shall direct the attention of the Engineer and the Contractor to such failure.

B. The technician shall not act as foreman or perform other duties for the Contractor. Work will be checked as it progresses, but failure to detect any defective work or material shall not be in any way prevent later rejection when such defect is discovered, not shall it obligate the Engineer for

final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirement of the specifications, nor to approve or accept any portion of the work.

3.10 RESPONSIBILITIES AND DUTIES OF CONTRACTORS

A. The use of testing services shall in no way relieve the Contractor of his responsibility to furnish material and construction in full compliance with the plans and specifications.

B. To facilitate testing services, the Contractor shall:

1. Secure and deliver to the Engineer or his testing agency, without cost, preliminary representative samples of the materials he proposes to use, and which are required to be tested.
2. Submit through the testing agency to the Engineer the concrete mix design he proposes to use and make written request for approval.
3. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
4. Advise the testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
5. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test cylinders on the project site for the first 24 hours as required by ASTM C31.
6. Furnish copies of mill test reports of all shipments of cement and reinforcing steel to the Engineer and the testing agency, if required.

3.11 EVALUATION

A. For evaluation of potential strength and uniformity, each specified strength of concrete shall be represented by at least five tests.

B. Concrete strengths shall be considered satisfactory if the average of any three consecutive strength tests of the laboratory cured specimens representing each specified strength of concrete is equal to or greater than the specified strength, and if not more than 10 per cent of the strength tests have values less than the specified strength.

C. If strength tests fail to meet the minimum requirements, the concrete represented by such tests shall be considered questionable and shall be subject to further testing at the expense of the Contractor.

D. Additional tests of questionable concrete shall be conducted at the expense of the Contractor in accordance with 'Methods of Securing, Preparing, the Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths' (ASTM C42).

END OF SECTION 03300

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop fabricated metal components.
2. Guardrails and handrails.
3. Cast metal column covers.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. American Welding Society (AWS) D1.1 - Structural Welding Code - Steel.

B. ASTM International (ASTM):

1. A36/A36M - Standard Specification for Carbon Structural Steel.
2. A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
3. A48/A48M - Standard Specification for Gray Iron Castings.
4. A108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
5. A123/A123M - Standard Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.
6. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
7. A307 - Standard Specification for Carbon Steel Externally Threaded Standard Fasteners.
8. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
10. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
11. A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
12. A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High - Strength, Low-Alloy and High-Strength Low-Alloy with Improved Formability.
13. E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.

C. Society for Protective Coatings (SSPC) - Painting Manual.

D. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.3 SYSTEM DESCRIPTION

A. Minimum design loads:

1. Ladders:

a. Uniform load of 100 PSF.
b. Concentrated load of 300 pounds.
c. Maximum deflection under loading: L/240.

2. Guard Rails and Handrails:

a. 50 pounds per linear foot applied in any direction at top, transferred via attachments and supports to building structure.
b. Concentrated 200-pound load applied in any direction at any point along top, transferred via attachments and supports to building structure.
c. Maximum deflection under loading: L/120.

3. Gutter Supports:

a. Sufficient strength to remain intact when full of water.
b. Achieve minimum load requirements per SMACNA.

4. Concentrated and uniform loads do not need to be applied simultaneously.
5. Perform design under direct supervision of Professional Structural Engineer licensed in State in which project is located, with minimum 2 years' experience in work of this Section.

B. Fabricate guard rails and handrails in accordance with ASTM E985

1.4 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Show dimensions, metal thicknesses, finishes, joints, attachments, and relationship of work to adjacent construction.

B. Samples: 4 x 4 finish samples from manufacturer.

C. Quality Control Submittals:

1. Certificate of Compliance from Professional Structural Engineer performing system design.

PART 2 – PRODUCTS

2.1 MATERIALS – STEEL

A. Shapes: ASTM A36/A36M.

B. Plate: ASTM A283.

C. Sheet: ASTM A1008/A1008M.

D. Galvanized Sheet: ASTM A653/A653M, Structural Quality, G90 coating class, 24 gage core steel unless noted otherwise.

E. Pipe: ASTM A501.

F. Tube: ASTM A500.

G. Bars: ASTM A108.

2.2 MATERIALS – IRON

A. Cast Iron: ASTM A48/A48M, Class 30, or ASTM A47/A47M.

2.3 MATERIALS – ALUMINUM

A. Cast Aluminum; ASTM B26 or B85, alloy and temper best suited to application.

2.4 ACCESSORIES

A. Exposed Screws: Same material as metal being fastened; Phillips flat head, countersunk, unless noted otherwise.

B. Bolts: ASTM A307, hexagonal head type.

C. Primer Paint: SSPC Paint 15, Type 1, red oxide.

D. Anchoring Cement: Non-shrink cementitious type.

2.5 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of component except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

F. Conceal fastenings where possible.

G. Welding to conform to AWS D1.1.

1. Use welds for permanent connections where possible. Grind exposed welds smooth.
2. Tack welds prohibited on exposed surfaces.

2.6 FINISHES

A. Exterior Ferrous Metal: Galvanized; ASTM A123/A123M, to 2.0 ounces per square foot.

B. Interior Ferrous Metal:

1. Shop painted except steel to be encased in concrete and surfaces to be welded.
2. Surface preparation: SSPC SP2 – Hand Tool Cleaning or SP3 – Power Tool Cleaning.
3. Application: One coat; follow coating manufacturer's instructions.
4. Minimum dry film thickness: 2.0 mils.

2.7 STEEL TYPES AND LOCATIONS

A. Primed and Painted: For interior use. Fully painted where exposed to view.

B. Galvanized: For exterior use other than window lintels and masonry relieving angles.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install items in accordance with approved Shop Drawings.

B. Install components plumb, level, and rigid.

C. Welding: AWS D1.1. Continuously weld connections. Grind and fill exposed welds; finish smooth and flush.

D. Make bends uniform and free from buckles and other defects.

E. Cut intersections square to within 2 degrees and to length within 1/8 inch. Remove burrs from cut ends. Miter and cope intersections within 2 degrees, fit to within 1/8 inch.

F. Install sleeved components with anchoring cement.

G. Prevent contact of exterior aluminum and dissimilar metals by use of zinc rich paint, bituminous coating, or non-absorptive gaskets.

H. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

I. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

J. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with non-shrink, non-metallic grout.

3.2 ADJUSTING

A. Clean and touch up damaged primer paint with same product as applied in shop.

B. Clean and touch up galvanized coatings at welded and abraded surfaces in accordance with ASTM A780, Annex A2.

3.3 SCHEDULE

A. This Schedule includes principal items only; refer to Drawings for additional items not listed.

B. Guardrails and Handrails: Steel, basis of design: Julius Blum & Co., Inc. (www.juliusblum.com) or approved substitute.

1. Fabricate from steel stock of sizes and types indicated.
2. Make bends uniform and free from buckles and other defects.
3. Cut intersections square to within 2 degrees and to length within 1/8 inch. Remove burrs from cut ends.
4. Miter and cope intersections within 2 degrees, fit to within 1/8 inch.
5. Continuously weld connections.
6. Where length exceeds that suitable for shipping and handling, fabricate in sections with concealed internal sleeves forming slip joints. Extend sleeves minimum 2 inches on both sides of joint; field weld and grind smooth.

C. Exposed Balcony Columns: Cast aluminum, basis of design: Kenton Column by Allen Architectural Metals (www.allenmetals.com) or approved substitute.

1. Size to cover existing steel columns where indicated.

END OF SECTION 05500

SECTION 09910 - PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Texturing of gypsum board.
2. Surface preparation and field application of paints.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 08 0381 – Wood Door Restoration
3. Section 08 0382 – Metal Window Restoration
4. Section 08 0383 – Wood Window Restoration

1.2 REFERENCES

A. ASTM International (ASTM) D4442 - Standard Test Method for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

B. Master Painters Institute (MPI) - Architectural Painting Specification Manual.

C. Society for Protective Coatings (SSPC) - Painting Manual.

1.3 SUBMITTALS

A. Submittals for Review:

1. Product Data: Manufacturer's data on materials proposed for use including:

   a. Product designation and grade.
   b. Product analysis and performance characteristics.
   c. Standards compliance.
   d. Material content.
   e. Mixing and application procedures.

2. Samples:

   a. 3 x 6 inch samples of each coating system on representative substrate. Step back successive coats so that all coats remain exposed. Indicate type of material used for each coat.
   b. 12 x 12 inch texture samples on gypsum board backing.

3. Paint Schedule: Indicate types and locations of each surface, paint materials, and number of coats to be applied.

B. Quality Control Submittals:

1. Qualifications: Applicator qualifications, including previous projects.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Minimum 5 years' experience in work of this Section.
2. Successful completion of at least 3 projects of similar scope and complexity within past 5 years.

B. Materials, Preparation, and Workmanship: Conform to MPI Painting Manual.

C. Mockup:

1. Mockup a full window and door (interior and exterior finishes).
2. Show: Each color and texture.
3. Locate where directed.
4. Field samples and mockup to be approved by Architect and THC representative prior to commencing the work.

1.5 DELIVERY, STORAGE AND HANDLING

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

B. Paint Materials: Store at ambient temperature from 45 to 90 degrees F in ventilated area, or as required by manufacturer's instructions.

1.6 PROJECT CONDITIONS

A. Do not apply materials when surface and ambient temperatures or relative humidity are outside ranges required by paint manufacturer.

B. Maintain ambient and substrate temperatures above manufacturer's minimum requirements for 24 hours before, during. and after paint application.

C. Do not apply materials when relative humidity is above 85 percent or when dew point is less than 5 degrees F different than ambient or surface temperature.

D. Provide lighting level of 80 footcandles at substrate surface.

1.7 MAINTENANCE

A. Extra Materials: 1 gallon each color and sheen.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Benjamin Moore and Co. (www.benjaminmoore.com)
2. The Comex Group. (www.thecomexgroup.com)
3. Devoe Paint Co. (www.devoepaint.com)
4. Glidden. (www.gliddenprofessional.com)
5. Kelly-Moore Paints. (www.kellymoore.com)
6. PPG Architectural Finishes, Inc. (www.pittsburghpaints.com)
7. Pratt and Lambert Paints. (www.prattandlambert.com)
8. Sherwin Williams. (www.sherwin-williams.com)
9. Tnemec Co., Inc. (www.tnemec.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Paints:

1. As scheduled at end of Section, or approved substitute.
2. Free from all forms of lead and mercury.

2.3 ACCESSORIES

A. Accessory Materials: Paint thinners and other materials required to achieve specified finishes; commercial quality.

B. Patching Materials: Latex filler.

C. Fastener Head Cover Materials: Latex filler.

2.4 MIXES

A. Deliver paints pre-mixed and pre-tinted.

B. Uniformly mix to thoroughly disperse pigments.

C. Do not thin in excess of manufacturer's recommendations.

D. Re-mix paint during application; ensure complete dispersion of settled pigment and uniformity of color and gloss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test shop applied primer for compatibility with subsequent coatings.

B. Measure moisture content of surfaces using electronic moisture meter. Do not apply coatings unless moisture content of surfaces are below following maximums:

1. Gypsum board and plaster: 12 percent.
2. Wood: 15 percent, measured to ASTM D4442.

3.2 PREPARATION

A. General:

1. Protect adjacent and underlying surfaces.
2. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
3. Correct defects and clean surfaces capable of affecting work of this section.
4. Seal marks that may bleed through surface finishes with shellac.

B. Impervious Surfaces: Remove mildew by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water and allow to dry.

C. Gypsum Board:

1. Fill minor defects with filler compound. Spot prime defects after repair.
2. Apply texture that closely matches adjacent surfaces.

D. Plaster:

1. Fill hairline cracks, small holes, and imperfections with latex patching plaster. Finish smooth and flush with adjacent surfaces.
2. Wash and neutralize high alkali surfaces.

E. Galvanized Steel: SSPC Method SP1 - Solvent Cleaning.

F. Aluminum: SSPC Method SP1 - Solvent Cleaning.

G. Uncoated Ferrous Metals:

1. SSPC Method SP2 - Hand Tool Cleaning or Method SP3 - Power Tool Cleaning.
2. Spot prime paint after repairs.

H. Shop Primed Ferrous Metals:

1. SSPC Method SP2 - Hand Tool Cleaning or Method SP3 - Power Tool Cleaning.
2. Feather edges to make patches inconspicuous.
3. Prime bare steel surfaces.

I. Interior Wood:

1. Wipe off dust and grit.
2. Seal knots, pitch streaks, and sappy sections with sealer.
3. Fill nail holes and cracks after primer has dried, sand between coats.

J. Exterior Wood:

1. Remove dust, grit, and foreign matter.
2. Sand and remove previous polyurethane finishes on exterior wood door components.
3. Seal knots, pitch streaks, and sappy sections with sealer.
4. Fill nail holes and cracks after primer has dried, sand between coats.

K. Other Existing Surfaces:

1. Remove loose, flaking, powdery, and peeling paints.
2. Lightly sand glossy painted surfaces.
3. Fill holes, cracks, depressions and other imperfections with patching compound; sand flush with surface.
4. Remove oil, grease, and wax by scraping; solvent wash and thoroughly rinse.
5. Remove rust by wire brushing to expose base metal.
6. Where indicated, completely strip existing metals down to bare metal. Sand stripped surfaces to blend into adjacent surfaces.

3.3 APPLICATION

A. Apply paints in accordance with MPI Painting Manual, Premium Custom Grade finish requirements.

B. Apply primer or first coat closely following surface preparation to prevent recontamination.

C. Do not apply finishes to surfaces that are not dry.

D. Apply coatings to minimum dry film thickness recommended by manufacturer.

E. Apply each coat of paint slightly darker than preceding coat unless specified otherwise.

F. Apply coatings to uniform appearance without laps, sags, curtains, holidays, and brush marks.

G. Allow applied coats to dry before next coat is applied.

H. Sand between coats on interior wood and metal surfaces.

I. Match final coat to approved color samples.

J. When required on deep and bright colors apply an additional finish coat to ensure color consistency.

K. Continue paint finishes behind wall-mounted accessories.

L. Mechanical and Electrical Components:

1. Paint factory primed equipment.
2. Remove unfinished and primed louvers, grilles, covers, and access panels, paint separately.
3. Paint exposed and insulated pipes, conduit, boxes, ducts, hangers, brackets, collars, and supports unless factory finished.
4. Do not paint name tags or identifying markings.
5. Paint exposed conduit and electrical equipment in finished areas.

6. Paint duct work behind louvers, grills, and diffusers flat black to minimum of 18 inches or beyond sight line.

M. Do not Paint:

1. Surfaces indicated on Drawings or specified to be unpainted or unfinished.
2. Surfaces with factory applied finish coat or integral finish.
3. Architectural metals, including brass, bronze, stainless steel, and chrome plating.

3.4 ADJUSTING

A. Touch up or refinish disfigured surfaces.

3.5 CLEANING

A. Remove paint from adjacent surfaces.

3.6 PAINT SCHEDULE

A. Types of paint listed herein are set forth as standard of quality and type of coating required for each type of surface.

1. Paint exposed surfaces of types listed in Paint Schedule.
2. Paint other exposed surfaces not specifically listed with not less than two coats of appropriate type of coating.
3. Match existing paint color and finish

B. Prime coat consists of touch up on shop primed and existing surfaces with intact coatings.

SUBSTRATE	MANUFACTURER	PRIMER	TOP COATS
Exterior Surfaces:			
Metal: ferrous (steel)	Sherwin Williams	Spot prime Duration Exterior Acrylic Latex	One coat Duration Exterior Acrylic Latex
Metal clad doors, frames, and louvers	Sherwin Williams	Spot prime Duration Exterior Latex Gloss K34 Series	One coat Duration Exterior Latex Gloss K34 Series
Plaster (flat finish)	Sherwin Williams	One coat Loxon Concrete & Masonry Primer	One coat Duration Exterior Acrylic Flat K32-200 Series
Wood (opaque)	Sherwin Williams	Spot prime Duration Exterior Acrylic Latex	One coat Duration Exterior Acrylic Flat
Wood (transparent)	Sherwin Williams	None	One coat SuperDeck Exterior Oil-Based Semi-Transparent Stain Three coats pure Tung Oil

Interior Surfaces:

Plaster and gypsum board (flat finish) Latex Primer	Sherwin Williams	One coat Promar 200 Zero VOC Interior Paint	Two coats ProMar 200 Zero VOC Interior Latex
Plaster and gypsum board (enamel finish)	Sherwin Williams	One coat Promar 200 Zero VOC Interior Latex Primer	Two coats ProMar 200 Zero VOC Interior Latex Egg-Shell Enamel
Ferrous & galvanized metals	Sherwin Williams	One coat All Surface Enamel Latex Primer	Two coats ProClassic Alkyd Semi-Gloss Enamel
Wood (opaque)	Sherwin Williams	Spot prime Harmony Wall Primer Interior Latex	Two coats ProMar 200 Zero VOC Interior Latex Semi-Gloss Enamel
Wood (transparent)	Rust-oleum	None	Watco Danish Oil

END OF SECTION 09910

SECTION 15000 - GENERAL PROVISIONS FOR MECHANICAL AND ELECTRICAL

PART 1 - GENERAL

1.1 SPECIAL NOTE

A. The Architectural and Structural Plans and Specifications, including the supplements issued thereto, Information to Bidders, and other pertinent documents issued by the Architect, are a part of these specifications and the accompanying mechanical and electrical plans, and shall be complied with in every respect. All the above is included herewith, will be issued separately or is on file at the Architect's office, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of drawings. Where the Supplementary General Conditions conflict with the General Conditions, the Supplementary General Conditions shall govern.

1.2 CHECKING DOCUMENTS

A. The drawings and the specifications are numbered consecutively. The Contractor shall check the drawings and specifications thoroughly and shall notify the Architect of any discrepancies or omissions of sheets or pages. Upon notification, the Architect will promptly provide the Contractor with any missing portions of the drawings or specifications. No discrepancies or omissions of sheets or pages of the contract documents will relieve the Contractor of his duty to provide all work required by the complete contract documents.

1.3 GENERAL

A. In general, the lines and ducts to be installed by the various trades under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping, conduit and ductwork for the mechanical and electrical trades shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.

C. Piping, ductwork, conduits and raceways may be run exposed in machinery and equipment spaces, where serving as connections to motors and equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. All conduits in any space where they are exposed shall run parallel with the building walls. They shall enter the concealed areas perpendicular with the walls, ceilings or floors. Fittings shall be used where necessary to comply with this requirement.

E. The Contractor shall thoroughly acquaint himself with the details of the construction and finishes before submitting his bid as no allowances will be made because of the Contractor's unfamiliarity with these details. Place all inserts in masonry walls while they are under construction. All concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

F. The mechanical and electrical plans do not give exact details as to elevations of lines and ducts, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other installation details. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

G. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the method of circuiting and controlling them. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections, and in all cases shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in location of any outlet or apparatus before installation (within 10 feet of location shown on drawings) or after installation if an obvious conflict exists, without additional cost to the Owner.

H. The mechanical plans do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections. Minor relocations necessitated by the conditions at the site or as directed by the Architect shall be made without any additional cost accruing to the Owner.

I. The Contractor shall be responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Architect before submitting his bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such necessary changes at his (the Contractor's) own expense.

J. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans, which shall be checked by the Architect before the work is started, and interferences with the structural conditions shall be corrected by the Contractor before the work proceeds.

K. Order of precedence shall be observed in laying out the pipe, ductwork, material, and conduit in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:

1. Items affecting the visual appearance of the inside of the building such as lighting fixtures, diffusers, grilles, outlets, panelboards, etc. Coordinate all items to avoid conflicts at the site.
2. Lines requiring grade to function such as sewers.
3. Large ducts and pipes with critical clearances.
4. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.

L. Piping, ducts, and conduits serving outlets on items of equipment shall be run in the most appropriate manner. Where the equipment has built-in chases, the lines shall be contained therein. Where the equipment is of the open type, the lines shall be run as close as possible to the underside of the top and in a neat and inconspicuous manner.

M. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention before the contract is signed. Otherwise, the Contractor shall be responsible for any and

all changes and additions that may be necessary to accommodate his particular apparatus, material, or equipment.

N. The Contractor shall distinctly understand that the work described herein and shown on the accompanying drawings shall result in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

O. Each bidder shall examine the plans and specifications for the General Construction. If these documents show any item requiring work under Division 15 or 16 and that work is not indicated on the respective "M", "P" & "E" drawings, he shall notify the Architect in sufficient time to clarify before bidding. If no notification is received, the Contractor is assumed to require no clarification, and shall install the work as indicated on the General Plans in accordance with the specifications.

1.4 DIMENSIONS

A. Before ordering any material or doing any work, the Contractor shall verify all dimensions, including elevations, and shall be responsible for the correctness of the same. No extra charge or compensation will be allowed on account of differences between actual dimensions and measurements indicated on the drawings. Any difference which may be found shall be submitted to the Architect for consideration before proceeding with the work.

1.5 INSPECTION OF SITE

A. The accompanying plans do not indicate completely the existing mechanical and electrical installations. The bidders for the work under these sections of the specifications shall inspect the existing installations and thoroughly acquaint themselves with conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work in the present building and underground serving to and from that structure. Failure to comply with this shall not constitute grounds for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work.

1.6 ELECTRICAL WIRING

A. All electric wiring of every character, for power supply, for communications, etc. will be done under Division 16 of these specifications. The Contractor for each section shall erect all his motors in place ready for connections. The Contractor, under Division 16, shall mount all the starters and controls, furnishing the supporting structures and any required outlet boxes. The Temperature Control Contractor shall include in his bid and shall furnish all wiring required for control, including line (120v/1phase/60hz) voltage wiring and low voltage control wiring. All wiring shall be in conduit. Include extending line voltage electrical to a space in the nearest electrical panel (or as shown on the drawings) and providing breakers as required to terminate all power required to make temperature controls functional.

B. Every electrical current consuming device furnished as a part of this project or furnished by the Owner and installed in this project, shall be completely wired up under Division 16, and is a part of this contract. Verification of exact location, method of connection, number and size of wires required, voltage requirements, and phase requirements is the responsibility of the Contractor under Division 16. If conflicts occur between the drawings and the actual requirements, actual requirements shall govern. The contractor shall coordinate the voltage of all motors and any associated variable frequency drives with the Division 16 contractor prior to ordering the devices.

C. Where no temperature control scope is shown in the documents, it shall be the responsibility of the Division 16 contractor to provide wiring, conduit and switches for the manual control of equipment, unless specifically noted to the contrary on the drawings and specifications.

1.7 MOTORS AND CONTROLS

A. All motors furnished under any of the several sections of these specifications shall be of recognized manufacture, of adequate capacity for the loads involved and wound for the current characteristics shown on the electrical drawings. All motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturers' Association as shown in their latest publications. They shall further be listed by Underwriters Laboratories.

B. Unless otherwise noted, the Contractor under Division 15 shall furnish each motor with a starter and all controls of the types specified or required. These starters shall be of the totally enclosed type, of capacity rating within the required limits of the motors which they are to serve, shall be suitable for the motor current characteristics and shall provide solid state overload protection, providing protection against single-phase events. All starters shall be standard of manufacture and performance of the National Electrical Manufacturers' Association. They further shall be listed by Underwriters Laboratories. Provide overload protection in each phase wire.

1.8 PROGRESS OF WORK

A. The Contractor shall keep himself fully informed as to the progress of the work and do his work at the proper time without waiting for notification from the Architect or Owner.

1.9 FACTORY STARTUP OF EQUIPMENT

A. The Contractor shall provide factory startup or factory authorized startup for certain equipment furnished for this project. Equipment requiring factory startup shall include the following: Chillers. Contractor shall submit the manufacturer’s startup checklist substantiating that the equipment has been started and is operating in accordance with the manufacturer’s instructions. The startup shall be performed by a person in the direct employ of the manufacturer or by an authorized agent. If the startup is performed by an authorized agent, the startup report shall be accompanied by a letter from the manufacturer identifying the agent as one who is certified to perform factory startup on the equipment furnished. As a minimum, submit the startup checklist with any comments or deficiencies noted during startup. Submit the report with certification letter (as required) to the Commissioning Agent for inclusion in the commissioning documentation. If there is no Commissioning Agent for the project, submit the startup reports as a submittal package to the Architect.

1.10 MANUFACTURER'S DIRECTIONS

A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer. All items of equipment provided shall be piped in strict accordance with its manufacturer’s written installation instructions. Note that details on the drawings may be for equipment that is ultimately not furnished for the project and is for bidding purposes. Exact configuration shall match manufacturer’s installation instructions.

1.11 MATERIALS AND WORKMANSHIP

A. All materials shall be new unless otherwise specified and of the quality specified. Materials shall be free from defects. All materials of a type for which the Underwriters Laboratories, Inc. have

established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, the Contractor shall submit a sample to the Architect before proceeding.

C. The Architect reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Architect's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection. This shall be limited to lighting fixtures, wiring devices, plumbing brass, grilles, registers, ceiling outlets and similar items and shall not be applicable to major manufacturers' items of equipment.

D. The Contractor shall be responsible for transportation of his materials to and on the job and shall be responsible for the storage and protection of these materials and work until the final acceptance of the job.

E. The Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.

F. The workmanship shall in all respects be of the highest grade and all construction shall be done according to the best practice of the trade.

1.12 SUBSTITUTION OF MATERIALS

A. Where a definite material of a specific manufacturer is mentioned in these specifications, it has been done in order to establish a base for competitive bidding, and each bidder shall include in his bid sum the cost of the named materials or manufactured items.

B. Where practical, in mentioning the name of a specific manufacturer, the specifications list alternate manufacturers whose products are acceptable. In each such case, the bidder shall list the equipment item and opposite it shall list the name of the manufacturer whose product he proposes to use. This list of manufacturers shall be submitted with his proposal and shall be a part thereof.

C. It is recognized that acceptable materials are offered by manufacturers other than those named in the specifications. Each bidder may therefore submit, with his proposal, all requests for substitutions which he desires to make, together with the adjustment to be made in his bid sum in each case should the substitute be accepted. Requests for permission to make substitutions will not be considered subsequent to the opening of bids except in the case of an emergency which would result in delay of the project.

D. The successful bidder shall be prepared to furnish complete descriptive literature and complete operation and performance data on all substitute materials. The Architect will investigate such requests for substitutions, consult with the Owner when necessary and render final decisions prior to the signing of the Contract.

1.13 SHOP DRAWINGS

A. Wherever shop drawings are called for in these specifications, they shall be furnished by the Contractor for the work involved after review by the Architect as to the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job and failure on the part of the Contractor to comply shall render him liable to

stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary details. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary and should there be any charges in connection with this, they shall be borne by the Contractor.

B. Shop drawings will be reviewed by the Architect for general compliance with the design concept of the project and general compliance with the information given in the contract documents. Review by the Architect and any action by the Architect in marking shop drawings is subject to the requirements of the entire contract documents. Contractor will be held responsible for quantities, dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of all trades and the satisfactory performance of his work.

C. Shop drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission of individual items shall designate the exact item offered and shall clearly identify the item with the project.

D. All shop drawings shall be submitted at one time where possible. If hard copy is submitted, it shall consist of a bound catalogue of all shop drawings under each section. Electronic submittals are preferred. Submit ONE .pdf file per specification section, named as follows: Jobname_15XXX_SpecSectionName.pdf. Include a cover letter from the contractor as the first sheet of the submittal, certifying that the submittal has been properly indexed and has been checked by the Contractor. Each item submitted shall include a cover letter by the material supplier, clearly indicating exact model numbers and details to be furnished for each item specified in the section.

E. The omissions of any material from the shop drawings which has been shown on the contract drawings or specified, even though reviewed by the Architect, shall not relieve the Contractor from furnishing and erecting same.

1.14 PROTECTION OF APPARATUS

A. The Contractor shall at all times take such precautions as may be necessary to properly protect his new apparatus from damage. This shall include the erection of all required temporary shelters to adequately protect any apparatus stored in the open on the site, the cribbing of any apparatus above the floor of the construction, and the covering of apparatus in the incompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Architect will be sufficient cause for the rejection of the pieces of apparatus in question.

1.15 PERMITS, FEES, ETC.

A. The Contractor under each section of these specifications shall arrange for a permit from the local authority. The Contractor shall arrange for all utility services, including sewer, water, gas and electric services as applicable. If any charges are made by any of the utility companies due to the work on this project, the Contractor shall pay these charges, including charges for metering, connection, street cutting, etc. The Contractor shall pay for any inspection fees or other fees and charges required by ordinance, law, codes and these specifications.

1.16 TESTING

A. The Contractor under each division shall at his own expense perform the various tests as specified and required by the Architect and as required by the State and local authorities. The Contractor shall furnish all fuel and materials necessary for making tests.

1.17 LAWS, CODES AND ORDINANCES

A. All work shall be executed in strict accordance with all local, state and national codes, ordinances and regulations governing the particular class of work involved, as interpreted by the inspecting authority. The Contractor shall be responsible for the final execution of the work under this heading to suit those requirements. Where these specifications and the accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect, shall prepare any supplemental drawings required illustrating how the work may be installed so as to comply and, on approval, make the changes at no cost to the Owner. On completion of the various portions of the work the installation shall be tested by the constituted authorities, approved and, on completion of the work, the Contractor shall obtain and deliver to the Owner a final certificate of acceptance.

1.18 TERMINOLOGY

A. Whenever the words "furnish", "provide", "furnish and install," "provide and install", and/or similar phrases occur, it is the intent that the materials and equipment described be furnished, installed and connected under this Division of the Specifications, complete for operation unless specifically noted to the contrary.

B. Where a material is described in detail, listed by catalogue number or otherwise called for, it shall be the Contractor's responsibility to furnish and install the material.

C. The use of the word "shall" convey a mandatory condition to the contract.

D. "This section" always refers to the section in which the statement occurs.

E. "The project" includes all work in progress during the construction period.

F. In describing the various items of equipment, in general, each item will be described singularly, even though there may be a multiplicity of identical or similar items.

1.19 COOPERATION AND CLEANING UP

A. The contractor for the work under each section of these specifications shall coordinate his work with the work described in all other sections of the specifications to the end that, as a whole, the job shall be a finished one of its kind, and shall carry on his work in such a manner that none of the work under any section of these specifications shall be handicapped, hindered or delayed at any time.

B. At all times during the progress of the work, the Contractor shall keep the premises clean and free of unnecessary materials and debris. The Contractor shall, on direction at any time from the Architect, clear any designated areas or area of materials and debris. On completion of any portion of the work, the Contractor shall remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all obstructions and hindrances.

1.20 COORDINATION OF TRADES

A. The Contractor shall be responsible for resolving all coordination required between trades. For example, items furnished under Division 15 which require electrical connections shall be coordinated with Division 16 for:

1. Voltage
2. Phase
3. Ampacity
4. No. and size of wires
5. Wiring diagrams
6. Starter size, details and location
7. Control devices and details

B. Items furnished under various sections which require plumbing connections shall be coordinated for services, pressure, size and location of connections, type of fuel, clearances for service, auxiliary devices required, etc.

C. Items requiring insulation shall be fully insulated and that insulation shall be checked against manufacturer's directions and job requirements for suitability, coverage, thickness and finish.

D. Items installed in/on finished ceilings shall be coordinated with the ceiling construction. The Contractor under each section shall conform to the reflected ceiling plan and shall secure details and/or samples of the ceiling materials as necessary to insure compatibility. Any device not conforming to this requirement shall be replaced by the Contractor at his expense.

E. All items specified under Divisions 15 and 16 shall be installed tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

1.21 CUTTING AND PATCHING

A. The Contractor for work specified under each section shall perform all structural and general construction modifications and cut all openings through either roof, walls, floors or ceilings required to install all work specified under that section or to repair any defects that appear up to the expiration of the guarantee. All of this cutting shall be done under the supervision of the Architect and the Contractor shall exercise due diligence to avoid cutting openings larger than required or in wrong locations. Verify the scope of this work at the site and in cooperation with all other trades before bidding.

B. No cutting shall be done to any of the structural members that would tend to lessen their strength, unless specific permission is granted by the Architect to do such cutting.

C. The Contractor for work under each section shall be responsible for the patching of all openings cut to install the work covered by that section and to repair the damage resulting from the failure of any part of the work installed hereunder.

D. Before bidding, the Contractor shall review and coordinate the cutting and patching required under the respective section with all trades.

E. In all spaces where new work under Division 15 and 16 is installed and no other alteration or refinishing work is shown or called for, existing floors, walls and ceilings shall be restored to match existing conditions. All cutting and patching shall be done by workmen skilled in the affected trade.

F. Where openings are cut through masonry walls, the Contractor under each respective section shall provide and install lintels or other structural supports to protect the remaining masonry and adequate support shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the size, shape, and installed as directed by the Architect.

1.22 PAINTING

A. Painting for Divisions 15 and 16 shall be as follows:

1. If the factory finish on any apparatus or equipment is marred, it shall be touched up and then given one coat of half-flat-half-enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.
2. Paint all exposed pipe, conduit, boxes, cabinets, hangers and supports, and miscellaneous metal.
3. Paint all exposed sheet metal.
4. Paint all insulated surfaces exposed to view, including piping, equipment, etc. Surfaces until a smooth, non-grainy surface is obtained.

B. Generally, painting is required on all surfaces such that no exposed bare metal or insulation surface is visible.

1.23 SEALING

A. The Contractor installing pipes, conduits, ducts, etc., shall seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors by packing fire resistant rope and fire-resistant cement. The packing shall effect a complete fire and/or air seal where pipes, conduits, ducts, etc., pierce walls, floors or partitions.

1.24 LARGE APPARATUS

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through windows, doorways or shafts, shall be brought to the job by the Contractor involved and placed in the space before the enclosing structure is completed.

1.25 ACCESS PANELS

A. Wherever mechanical and/or electrical equipment is installed and where future access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, the Contractor shall provide Milcor Style "M" access doors at least 12 inches by 12 inches in size or larger if required for access. Provide access doors for all fire dampers, smoke dampers, valves, etc.

1.26 SCHEDULE OF WORK

A. Under no condition shall any work be done in the present building that would interfere with its natural use during its normal hours of occupancy, unless special permission is granted by the Owner. This is particularly applicable where new connections are to be made to present lines or items of equipment in that building or where present equipment items in that building are to be relocated or modified in any way. The Contractor shall include this scheduling requirement in his proposal as no additional compensation for overtime work will be granted.

1.27 WORKING TIME

A. All work required by these installations shall be done during normal working hours, except in such cases as are specifically excepted hereinbefore. The Owner reserves the right to direct, at his own discretion, that any other parts of the work be done at other than normal working hours; in which case the Contractor involved shall be reimbursed by an amount equal to the excess cost of such overtime labor above the value of the same at regular rates.

1.28 RELOCATION OF EXISTING INSTALLATION

A. There are portions of the existing plumbing system, heating, ventilating and air conditioning system and electrical System which shall remain in use to serve the finished building in conjunction with the indicated new installations. By actual examination at the site, each bidder shall determine those portions of the remaining present installations which must be relocated to avoid interferences with the installations of new work of his particular trade and that of all other trades. All such existing installations which interfere with new installations shall be relocated by the Contractor under the Division in which the existing material normally belongs, and in a manner as directed by the Architect. For example:

1. Existing Plumbing piping, etc. shall be relocated under Division 15 where it interferes with the installation of new work.
2. Where existing piping, ductwork, etc. interferes with the installation of new work, it shall be relocated under Division 15.
3. Where existing conduit and electrical equipment interferes with the installation of new work, it shall be relocated under Division 16.

B. Failure to become familiar with the extent of the relocation work involved shall not relieve the Contractor of responsibility and shall not be used as a basis for additional compensation.

1.29 EXISTING WASTE AND DRAIN LINE

A. Special care and precaution shall be used where existing waste or drain lines are to be opened. The following procedure shall be adhered to at all times when opening existing waste or drain lines: Before opening, prepare a solution of one part household bleach to nine parts water. At every inlet to the affected piping run, add 2 gallons of the solution to flush out the piping. Any worker who has cuts or open skin breaks shall be prevented from working with the waste or drain piping. Workers shall wear approved face shields, gloves, aprons, boots, etc. for protection. In addition, existing piping shall be thoroughly washed inside and out with bleach solution prior to handling by unprotected persons. The safety director or Owner's representative shall be notified prior to commencing work on any existing waste or drain lines.

1.30 SALVAGE MATERIALS

A. The Contractor shall remove existing equipment, piping, duct, grilles, conduit, wire, junction boxes, light fixtures and other items associated with the mechanical, plumbing and electrical systems where shown on the drawings. Where such items are exposed to view or uncovered by any cutting or removal of general construction and has no continuing function (as determined by the Architect), they shall be removed by the contractor under the section in which the item normally falls.

B. Existing items (see above) where concealed in/above construction, which is not disturbed, abandon in place. Plug, cap, disconnect or otherwise render harmless all such items.

C. All items or materials removed from the project shall be made available for the Owner's inspection. The Owner retains the option to claim any item or material. Contractor shall deliver any claimed item or material in good condition to the place designated by the Owner. All item not claimed become the property of the contractor and shall be removed from the site.

1.31 INSTALLATION DRAWINGS

A. It shall be incumbent upon the Contractor to prepare special drawings as called for elsewhere herein or as directed by the Architect to coordinate the work under each section, to illustrate changes in his work, to facilitate its concealment in finished spaces to avoid obstructions or to illustrate the adaptability of any item of equipment which he proposes to use.

B. These drawings shall be used in the field for the actual installation of the work. Unless otherwise directed, they shall not be submitted for approval, but three copies shall be provided to the Architect for his information.

1.32 ROUGH-IN AND MAKE FINAL CONNECTION FOR EQUIPMENT

A. The shop drawings for all equipment are hereby made a part of these specifications. The Contractor under each section of the specifications shall rough-in for the exact item to be furnished on the job, whether in another section of the specifications or by the Owner. The Contractor shall refer to all drawings and other sections of the specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.

B. Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Architect and finally connect as directed by the Architect.

C. Should any shop drawings not be available for equipment furnished under other contracts or by the Owner, the Contractor under each section of these specifications shall bid the work as detailed on the drawings.

D. Minor differences in the equipment furnished and that indicated on the drawings will not constitute ground for additional payment to the Contractor.

1.33 MARKING OF PIPE

A. The Contractor shall mark all accessible piping systems. The identification of a piping system shall be made by a positive identification of the material content of the system by lettered legend, giving the name of the content in full or abbreviated form. This mark shall be conspicuously placed at frequent intervals on straight runs, close to all valves, at changes of direction and where pipes pass through walls, floors or ceilings. Arrows shall be used to indicate direction of flow. Markers shall be painted on using stencils.

B. Markers shall be placed on piping at each connection to an item of equipment, at each pump, and on each drop to an outlet. Markers shall be placed on each run of piping at intervals not exceeding 50 feet where exposed in a room and 25 feet when installed above removable ceilings, except that no exposed line shall enter a room without being identified therein. Marker on lines above removable ceilings shall be applied on the undersides of the lines and in other areas shall be applied to be most visible. Also supply directional flow indicators adjacent to identification markers.

C. Size of Identification:

Outside Diameter	Size of Legend of Pipe or Covering Letters (" Height)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4

1.34 IDENTIFICATION AND LABELING

A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the drawings. For example, pumps will be identified as P-1, P-2, P-3, etc.; exhaust fans will be EF-1, EF-2, etc.; AC Units will be AC-1, AC-2, etc.

B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

1. Boilers
2. Chillers
3. Pumps
4. AC Units
5. Convertors
6. Air Conditioning Control Panels and Switches
7. Exhaust and Return Air Fans
8. Miscellaneous - similar and/or related items

1.35 OPERATING INSTRUCTIONS

A. The Contractor for each section of the work hereunder shall, in cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system. During the balancing and adjusting of systems, the Owner's representative shall be made familiar with all procedures.

1.36 OPERATING MANUALS

A. Prepare and submit 3 copies of the operating manuals bound in hard covers. Three weeks prior to completion of the work, the Architect will check the manuals and any additional material necessary to complete the manuals shall be furnished and inserted by the Contractor.

B. Manuals shall contain the following data:

1. Catalogue data of all equipment.
2. Shop drawings of all equipment.
3. Temperature control drawings (reduced in size)

4. Start-up instructions for major equipment.
5. Trouble shooting procedures for major equipment.
6. Wiring diagrams.
7. Recommended maintenance schedule for equipment.
8. Parts list for all items.
9. Name and address of each vendor.

1.37 GUARANTEE

A. Unless a longer period is specified elsewhere, the contractor shall guarantee all workmanship and materials for a period of one year from date of final acceptance.

1.38 COMPLETION REQUIREMENTS

A. Before acceptance and final payment, the Contractor under each Division of the specifications shall furnish:

1. Accurate "as built" drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work. Drawings shall be filed with the Architect when the work is completed.
2. All manufacturers' guarantees.
3. All operating manuals.
4. Guarantees.
5. Test and Balance Report.

1.39 CONTRACTOR'S RESPONSIBILITY FOR FINAL INSPECTION

A. Before calling for the final inspection, the Contractor under each Division shall carefully inspect his work to be sure it is complete and according to plans and specifications.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION 15000

SECTION 15200 - SITE UTILITIES

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. Perform all layout, trenching, excavation, backfill, shoring and similar work and provide and install all materials and appurtenances necessary for the installation and final connection of all utilities.

1.4 EXISTING UTILITIES: Prior to beginning work, manually locate and stake all utility lines existing at the site.

A. The Contractor shall not rely solely on the scale drawings in determining the scope of the work.

B. The drawings are not certified surveys and are not guaranteed for accuracy of location or elevation of existing lines or completeness. Before bidding, each bidder shall by personal examination of the project satisfy himself as to the existing conditions which prevail.

C. Reasonable differences in actual jobsite dimensions and the drawings shall not be considered justification for a change in the contract sum.

D. Interruptions: Conduct operations to minimize service outages. When interruption is unavoidable, schedule the interruption in consultation with the Architect and Owner to occur at a time of least demand for the utility. Notify the Owner of requested interruption time at least 24 hours in advance of outage.

E. Disconnections: Provide where indicated on the drawings. Where not so indicated provide disconnections at appropriate locations as selected by the Contractor to facilitate his work. Cap terminal ends of active utility branches.

F. Utilities to Remain: Protect from damage due to construction operations. Repair or replace portions so damaged as directed by the Architect.

G. Utilities to be Relocated: Move, raise or lower utilities as indicated on the drawings, or where conflicts occur which cannot be otherwise resolved.

H. Utilities to Be Removed: Remove all existing utility lines which are disconnected so, that no dead lines remain at the site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All piping materials for every purpose shall be furnished and installed as hereinafter specified.

B. All pipe and fittings shall be new and unused unless specifically indicated otherwise.

C. Underground steel piping shall be cleaned and primed with Humble "Rust-Ban" and wrapped with a double thickness of 3M Scotch "51" vinyl tape over pipe and fittings.

D. Factory coated pipe "X-Tru-Coat" or epoxy coated pipe with wrapped fittings will be considered equal.

2.2 GAS LINES

A. Plastic Gas Piping: Polyethylene, Type III, Grade 3, (PE 3406-3408), resin conforming to ASTM D1248-7A, pipe construction conforming to ASTM D2513 (SDR 11).

B. Mechanical Joints: Where steel lines connect to plastic lines 2" and smaller in size, use Continental Style 5 extra heavy duty malleable iron couplings with stiffeners.

C. Flanges: Where steel lines valves or accessories connect to plastic lines 2-1/2" and larger, use polyethylene and steel flat face flanges with full face gaskets.

D. Casing: Encase plastic lines under streets in schedule 40 galvanized steel pipe extending 36" beyond paving with a vented riser on both ends.

E. Service Risers: General Plastic "Corrosion Guard" type CGR-2.

F. Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswire. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of the type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape shall bear a continuous printed inscription describing the specific utility.

PART 3 - EXECUTION

3.1 LAYOUT OF UTILITY LINES

A. Before starting excavation, Contractor shall:

1. Uncover and determine the elevation at beginning and end terminals of each line.
2. Compute and verify depth of all lines and grade of sewer lines and submit figures in writing.
3. Stake route of each line.
4. Arrange utility connections with authorities.
5. Locate and identify any conflicting underground structures and adjust grade or routing to accommodate installation of the lines.

B. Laying Pipe:

1. Lay pipe to the lines and profiles required by conditions at the site and the drawings. Keep pipe trenches free of water and dry during the bedding, laying and jointing operations. Install fittings and valves at the required locations, with joints centered and with valve stems vertical. Handle pipe carefully to avoid damage to dimensioned ends. Remove pipe with damaged ends which cannot be suitably repaired. Keep interior of piping and accessories clean.
2. Proximity of Water and Sewer Lines: Unless otherwise required by drawings, lay parallel water lines and sewer lines in separate trenches at least 10 feet apart. Insofar as possible place water line at a higher elevation than the sewer. Where water lines and sewer lines cross each other, the water line shall be at least 3 feet above the sewer, or if this is not possible, amount of clearance between the lines may be reduced to 12" out to out clearance provided the sewer line is cast iron for at least 10 feet on each side of the water line.

3.2 EXCAVATION FOR OUTSIDE UTILITIES

A. The Contractor shall perform any excavations of every description and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of his work.

B. Trench Width: The minimum width of the trench shall be the outside diameter of the pipe plus 12" and the maximum width shall be the outside diameter of the pipe plus 18". The trenching equipment shall be maintained on a sufficiently level road bed to provide substantially vertical trench walls from bottom of trench to the top of the trench.

C. Bell Holes: Bell holes shall be provided at each joint to permit the joint to be made properly.

D. Pipe Clearance in Rocks: Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least 6" below and on each side of all pipes, valves and fittings for pipes 24" in diameter or less and 9" for pipes larger than 24" in diameter. The specified minimum clearances are the minimum clear distances that will be permitted between any part of the pipe and appurtenances being laid and any part, projection, or point of such rock, boulder, or stone.

E. Trench Excavation: The trench shall be excavated to the depth required so as to provide a uniform and continuous bearing and support for the pipe on solid and undisturbed ground at every point between bell holes, except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of 18" near the middle of each length of pipe by withdrawal of pipe slings or other lifting tackle. There shall be no classification of or extra payment for excavated materials, and all materials encountered shall be excavated as required.

F. Bury: Nonmetallic pipe shall be buried with 36" minimum cover; metallic pipe shall have minimum 24" cover.

G. Bracing and Sheeting: Open-cut trenches shall be sheeted and braced as required by OSHA and as may be necessary for the safety of the workmen or protection of property.

H. Piling of Excavated Materials: All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire and police call boxes, or other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural water courses shall not be obstructed. Segregate topsoil for replacement. Unused material shall be removed from the site.

I. Trenching Methods: Trench digging machinery may be used to make trench excavations except where operation of same would cause damage to existing structures, or plants either above or below ground; in such instances hand methods shall be employed.

J. Barricades and Safety Provisions: To protect persons from injury and to avoid property damage, adequate barricades, construction signs, warning lights and guards as required shall be placed and maintained during progress of the construction work. All material, piles, equipment, pipe, and open trenches that may serve as hazards to vehicular or pedestrian traffic shall be protected by barricades or fences and warning lights.

K. Protection of Property and Structures: Temporary support, adequate protection, and maintenance of all underground and surface structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his expense and under the direction of the Architect. Any structures that have been disturbed shall be restored upon completion of the work.

3.3 BACKFILLING

A. The trenches shall not be backfilled until all required tests are performed and until the utilities systems as installed conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with the excavation materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones deposited in thoroughly and carefully rammed 6" layers, until the pipe has a cover of not less than one foot for water mains and two feet where possible for other lines.

B. The remainder of the backfill material shall then be returned to the trench, moistened and tamped in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Settling the backfill with water will be permissible and will be a requirement when so directed. Any trenches improperly backfilled or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

C. Open trenches across roadways or other areas to be paved shall be backfilled as specified above, except that the entire depth of the trench shall be backfilled in 6" layers, each layer moistened and compacted to a density at least equal to that of the surrounding earth in such manner as to permit the rolling and compaction of the filled trench together with the adjoining earth to provide the required bearing value, so that paving of the area can proceed immediately after backfilling is completed. Along all other portions of the trenches, the ground shall be graded to a reasonable uniformity and the mounding over the trenches left in a uniform and neat condition.

3.4 BORED CROSSINGS UNDER WALKS

A. Crossings beneath walks may be bored rather than open-cut but casing is not required. The trench may be open cut to within three feet of the edge of the pavement. Boring shall proceed from a pit provided for the boring equipment and workmen. The use of water or other fluids in connection with the boring operation will be permitted only to the extent required to lubricate cuttings. Jetting will not be permitted. Care shall be taken to keep the bore on proper line and grade.

3.5 CONCRETE WORK

A. All concrete work pertaining to the various concrete structures hereinafter specified to be furnished and installed by the Contractor shall be done in strict accordance with the applicable provisions of the General Specifications for plain and reinforced concrete work.

3.6 PROTECTION OF WORK, PROPERTY AND SERVICES OF OWNER

A. The Contractor shall maintain adequate protection of the project from damage and protect the Owner's property from injury or loss arising from activities conducted in connection with the Project. The Contractor shall under all circumstances make good any such damage, injury or loss.

B. Under no circumstances shall the Contractor use, interrupt, dismember, diminish or discontinue any service of the Owner unless written permission to do so has been secured in advance from the Architect.

C. In the conduct of the work of this Project, the Contractor shall exercise care to protect the Owner's drives, walks, trees and shrubs. Any damage done to walks and drives shall be repaired by the Contractor in a manner which meets the approval of the Owner's duly appointed representative. Particular care shall be exercised in protecting trees. If in the judgement of the Architect, circumstances warrant such an action, the Contractor shall construct protective enclosures for trees. If limbs must be cut from trees, they shall be cut only by tree surgeons designated by the Owner. If shrubbery interferes with the progress of the work, the Owner shall be duly notified. If, in the judgement of the Owner, the shrubbery needs to be preserved, it will be removed by the Owner's staff. If the shrubbery is not to be preserved, it shall be removed by the Contractor.

D. Great care shall be exercised at all times in order that the Owner's equipment or services may not be jeopardized by cutting, excavating, fitting, digging or patching conducted by the Contractor.

E. When the whole or a portion of the project is suspended, the Contractor shall protect with care such parts of the Project liable to sustain injury.

3.7 EXCAVATION, GRADING AND SITE WORK

A. Furnish all necessary equipment, labor and materials and complete all excavation, backfill and finish grading for the work. Cut and remove all concrete or other structures necessary for the installation of the work.

B. All excavations shall be carried down to the depth required for walls, piers, underpinning, slabs and pits, etc. as shown on drawings. Where forms are required, excavation shall be wide enough to permit the construction and removal of the forms.

C. Site Work; Order of Procedure: Before proceeding with any work which will interfere with the normal operation of utilities, traffic, etc., the Contractor shall schedule such work with the Owner through the Architect, and provide all temporary barricades and protection measures necessary to afford safety to the public and the minimum of utility interruption.

D. General Protective Provisions: Where construction provisions require openings to be cut into existing structures or utilities, the work shall not be started until the Contractor has made all necessary provisions for protection against weather and other conditions which might affect the Owner's property and operations and only then upon approval of the Architect.

E. Trees: All trees that are adjacent to the construction areas, and that are subject to damage during construction operations shall be protected with wood barricades as directed by the Architect.

F. Removal of Existing Structures: The Contractor shall remove, as directed, all existing curbs, walls, pavements and structures as required for the installation of new work under this contract. All debris from these operations shall be removed from the site immediately and disposed of by the Contractor.

G. Excavation; General: Excavations shall be of sufficient size and depth to permit access to structures and repair of same. All cuts shall be smooth and straight and shall be left clear of all debris.

H. The Contractor shall verify, establish, and maintain all general lines and levels. Any errors or inconsistencies shall be reported to the Architect before commencing work.

I. Excavations for slabs that are poured on the ground shall be carried to the proper depth to accommodate the thickness required by the drawings.

J. Opening and Reclosing Pavement: Where excavation requires the opening of existing walks, streets, drives or other existing pavement, that pavement shall be cut as required to install new lines and to make new connections to existing lines. The size of the cut shall be held to a minimum consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surface and shall be level with them. The patched surface shall be in a condition equal to or better than the adjacent paving. Provide a 6" thick reinforced concrete protective slab 4'0' wider than the ditch under the patch.

K. All such work shall be done under the direction of the Owner of the pavement and to his complete satisfaction.

L. Water in Excavation: The Contractor shall keep all excavations dry by diverting or pumping seepage or surface water from excavations. Provide pumps and appurtenances, if necessary, to effect this condition.

M. Blasting: No blasting will be allowed.

N. Stock Piles: Soil from excavation operations that is satisfactory to the Architect for backfill and finish grading may be stock-piled at the site. Such stock-piling shall be limited to the amount which can be located immediately adjacent to the excavations. All surplus material shall be deposited elsewhere in a location designated by the Owner's Representative.

O. Bracings and Shorings: The Contractor shall do all bracing and shoring necessary to support adjoining pavement or structures or retain earth banks and prevent caving in and displacement of adjacent soil, furnishing all necessary timbers, cribbing, planking or sheet piling for that purpose. All bracing shall be subject to the approval of the Architect and shall be removed from the site when so directed by him. Bracing shall in no case be placed in such a manner as to thrust against any portion of a building.

P. Backfill: All backfill, and finish grading shall be accomplished with topsoil. In the event site materials are insufficient to complete this operation, the Contractor will provide topsoil from an off-site source. All backfill will be placed in 6 – 8-inch layers and puddled to settle thoroughly. Care shall be exercised to protect waterproofing during placing. Under sidewalks, curbs and gutters and drives, the backfill shall be tamped to 95% of original compaction.

Q. Finish Grading: After the backfill has been finally settled, the Contractor shall spread a suitable loam over the entire area and dress the surface to meet existing grades. On completion, the finish grades shall meet the tops of curbs and sidewalks, drain surface water away from the building, and present a clean raked appearance, free of washes, sinkages, and debris. Compacted areas shall be tilled, harrowed and graded and made ready for seeding.

R. Limits of Operation: Contractor's access to the work will be limited to the areas shown on the drawings and within 20 feet on either side of ditches which are opened. Open excavations shall be continuously barricaded and lighted in such manner that access to the construction by handicapped persons is impossible. Review these requirements with the Owner's Representative before beginning any construction.

3.8 TOPSOIL

A. Strip topsoil to whatever depths encountered, in such manner so as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

B. Topsoil is defined as Amarillo fine sandy loam soil found in a depth no greater than 18". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 3/4" in diameter, and without weeds, roots, and other objectionable material.

C. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.

D. Stockpile topsoil in storage piles within limits of construction and separate from other excavated materials. Construct storage piles to freely drain surface water.

E. All fill material to be used around the perimeter of the building in areas to receive landscaping shall be topsoil and shall be hand raked to finish grade and ready for seeding.

3.9 PROTECTION OF WORK, PROPERTY AND SERVICES OF OWNER

A. The Contractor shall take precaution to protect existing facilities and features within the designated construction limits and along the access to the construction site.

B. The Contractor shall maintain adequate protection of the project from damage and protect the Owner's property from injury or loss arising from activities conducted in connection with the Project. The Contractor shall under all circumstances make good any such damage, injury or loss.

C. Under no circumstances shall the Contractor use, interrupt, dismember, diminish or discontinue any service of the Owner unless written permission to do so has been secured in advance from the Architect.

D. In the conduct of the work of this Project, the Contractor shall exercise care to protect the Owner's drives, walks, trees and shrubs. Any damage done to walks and drives shall be repaired by the Contractor in a manner which meets the approval of the Owner's duly appointed representative. Particular care shall be exercised in protecting trees. If in the judgement of the Architect, circumstances warrant such an action, the Contractor shall construct protective enclosures for trees. If limbs must be cut from trees, they shall be cut only by tree surgeons designated by the Owner. If shrubbery interferes with the progress of the work, the Owner shall be duly notified. If, in the

judgement of the Owner, the shrubbery needs to be preserved, it will be removed by the owner's staff. If the shrubbery is not to be preserved, it shall be removed by the Contractor.

E. Great care shall be exercised at all times in order that the Owner's equipment or services may not be jeopardized by cutting, excavating, fitting, digging or patching conducted by the Contractor.

F. When the whole or a portion of the project is suspended, the Contractor shall protect with care such parts of the Project liable to sustain injury.

G. The Contractor shall protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. The Contractor shall provide temporary fences, barricades or guards as required to protect trees and vegetation to be left standing.

H. The Contractor shall water trees and other vegetation which are to remain within the limits of the construction area as required to maintain their health during the course of construction operations.

I. All damage to existing trees will be evaluated by the Director of Grounds Maintenance using the International Shade Tree Conference Standards and charges will be assessed the Contractor for damage to trees incurred during the construction process.

J. The formula to be used is as follows: Measurement of a cross section of the trunk of the damaged tree will be made at a point 2 ft. above existing ground level to determine square inches of the cross section. Assessment for damage will be $11 per square inch.

K. The Contractor shall protect all portions of the underground sprinkler system located within the designated limits of construction area. Any damage incurred to the system shall be repaired or replaced by the Contractor as directed by the University Representative at the Contractor's expense.

3.10 REMOVAL OF DEBRIS AND WEED CONTROL

A. The Contractor shall keep the streets and construction area free of rubbish and debris and all weeds within the limits of the construction area shall be kept to a height of no more than 12" to comply with the City Code and with environmental safety regulations.

3.11 PARKING

A. The Contractor shall maintain parking facilities for construction personnel within the limits of the construction area.

3.12 DISPOSAL OF WASTE MATERIALS

A. The Contractor shall remove all combustible and non-combustible waste materials completely from the Owner's property and legally dispose of same.

B. Burning of any materials will not be permitted within the boundaries of the Owner's property.

3.13 CONSTRUCTION FENCE

A. The Contractor at his own expense shall erect and maintain a construction fence at the location designated on the plans outlining the construction limits. This fence shall be chain link or woven

wire erected to a minimum height of 6'0" to physically limit and retard pedestrian access. The Construction shall not be dismantled until such time as the work has been accepted and the Contractor vacates the premises.

3.14 UTILITY SERVICES

A. Storm Sewer: Refer to the drawings for connection details.

B. Gas: Extend and connect to the existing gas service as shown on the drawings.

3.15 TESTING

A. Gas: Before backfilling, test under air pressure at 50 PSIG for 24 hours. There shall be no pressure drop, except for correction for temperature variation. If any pressure drop occurs, soap test every joint, correct the leaks and retest.

END OF SECTION 15200

SECTION 15300 - PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications pertains to all labor, materials, equipment and service necessary for and incidental to the piping and accessories as shown on the drawings and/or specified herein.

1.4 INSPECTION

A. All pipe, valves, fittings, and other accessories shall be inspected upon delivery and during the course of the work. Any defective materials found during field inspection or during hydrostatic and leakage tests shall be removed from the site of the work and replaced by the Contractor.

1.5 PROTECTION DURING STORAGE

A. The interior of all pipes, fittings, and other accessories shall be kept free from dirt and foreign matter at all times. Valves and fittings shall be drained and stored in a manner that will protect them from damage by freezing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be manufactured or fabricated in the United States of America.

B. Materials shall conform to the listed standards. Refer to specific sections for materials to be used under that section. The following tabulation is for reference only to identify the applicable standard.

PVC Soil Pipe and Fittings	ASTM D3034, Type PSM Max. SDR = 35
PVC Soil Fittings – Elastomeric	ASTM D3212
Copper Tubing	ASTM B88
Wrought Copper Solder Fittings	ANSI Bl6.22
Cast Bronze Solder Fittings	ANSI B16.18
Steel Pipe	ASTM A120, A53, A106
Butt Weld Fittings	ANSI B16.9
Socket Weld Fittings	ANSI B16.11
Steel Flanges	ANSI B16.5
Malleable Iron Threaded Fittings	ANSI B16.3

C. Unions in Ferrous Lines: 150-pound malleable iron, screwed pattern, ground joint with brass to iron seat; equal to Crane.

D. Insulating Fittings: Equal to Maloney.

E. Unions in Copper or Brass Lines: 125 pound all brass, screwed pattern, ground joint, equal to Chase, Crane, or Mueller.

F. Mechanical Couplings: Victaulic Style 77

2.2 PREINSULATED PIPING

A. All underground and under floor chilled and hot water supply and return distribution piping shall be factory pre-insulated as manufactured by **INSUL-PIPE SYSTEMS, INC. Austin, Texas**.

B. Carrier pipe shall be black, steel A-53 Grade B, schedule 40. Fusion welding shall join fittings and straight runs for all piping sizes. Insulation shall be foamed-in-place polyurethane with a density of not less than 2.5 lbs. per cubic foot to a thickness specified. Insulation shall be completely encased within a seamless PVC jacket of not less than .060 inches thick for jacket sizes up to 16" and within a seamless low pressure rated High Density Polyethylene (HDPE) jacket for sizes 18" and larger, and able to withstand H-20 highway loading.

C. Insulation at each end of each length of pipe shall be protected with a mastic end seal bonded both to the carrier pipe and the outer jacket. Piping cuts made in the field must be provided with end-seals equal to factory type.

D. Coupling joints on straight runs shall be field insulated by wrapping the coupling with a PVC wrap, pouring polyurethane insulation into the annular space, cleaning off the excess, and sealing with tape provided. Fittings shall be field insulated by wrapping a PVC fitting cover around the fitting, pouring polyurethane foam insulation into the annular space, cleaning off the excess, and sealing with tape provided. Vapor barrier jacketing material for fittings and joints shall be of the same material as the pipe jacketing. Installation shall be as per manufacturer's instructions.

E. Backfilling shall be carefully done with a layer of clean washed sand or pea gravel, 6" thick, completely surrounding the buried pipes.

F. Piping System: Underground, pre-insulated chilled and hot water supply and return piping system.

G. Carrier Pipe: STEEL-ASTM A-53Grade B, SCH 40. Beveled ends for welded fittings and connections.

H. Outer Jacket: Polyvinylchloride (PVC) white, low pressure rated, seamless, ASTM D-1784, Class 12454-B for jacket sizes up to 16" and within a HDPE jacket for sizes 18" and larger. Able to withstand H-20 highway loading. Thickness as shown below.

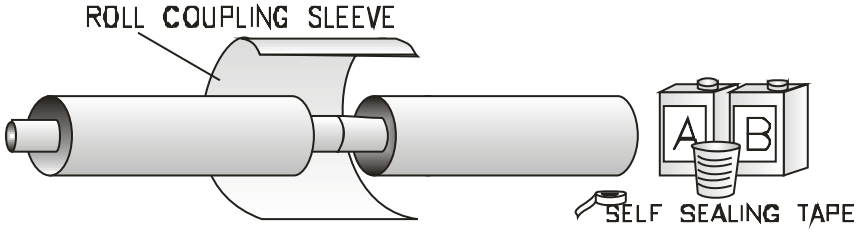
I. Insulation: Polyurethane, conforming to ASTM C-591, 2.5 PCF density per ASTM D1622, 90 to 95% closed cell content per ASTM D2856, poured in place, "K" = .14 per inch @ 75 degrees F per ASTM C 518, compressive strength of 30 psi minimum, flexural strength of 25 psi minimum per ASTM D790, water absorption of 2% of volume maximum per ASTM D2842, and water permeability of 3 perm inches maximum per ASTM E96. Thickness shown below.

J. End Seals: Factory applied, waterproof mastic covering the urethane insulation at each end of each joint of pipe and bonded both to the carrier pipe and the outer jacket.

K. Joint Covers: Couplings are field insulated by covering with a PVC wrap, pouring polyurethane foam insulation into the annular space, cleaning off the excess, and sealing with tape provided.

L. Fittings: Fittings shall be field insulated by wrapping a PVC fitting cover around the exposed fitting, pouring polyurethane insulation into the annular space, cleaning off the excess, and sealing with tape provided.

Nominal Pipe Size	Insulation Thickness Inches	Jacket O.D. Inches	Jacket Thickness Inches	Insulation "R" Value	Heat Transfer BTU/LF/FDT
6	1.69	10.20	.100	12.07	.1446



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M. Below Ground Installation of Field Insulation Kits for Pipe with Plain End Couplings: Read these important instructions carefully.

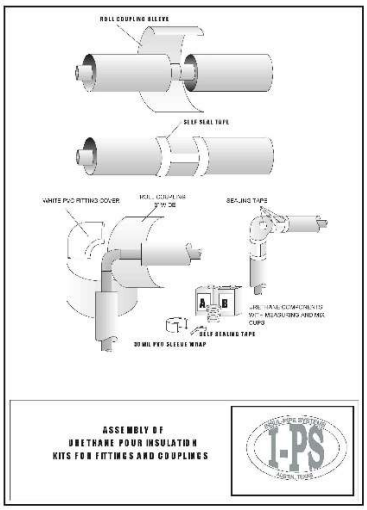
1. Following Assembly and Testing:

   a. Seal exposed end of insulation with mastic provided by I-PS at all field cuts.
   b. Insulation materials for coupling joints consist of a HDPE wrap, A&B Component Pour Urethane, and sealant tape.
   c. Insulation material for fittings consists of an A&B Component Pour Urethane, PVC fitting covers, and sealant tape.

2. Fittings:

   a. Step one: Position and strap Roll PVC Fitting Extension over Jacket of adjacent pipe seal seams with self seal tape.
   b. Step two: Create 2" hole in and wrap molded PVC cover over the fitting and extensions and tape in place. Fitting cover should overlap a few inches onto extension and create a mold for the pour between adjacent pipes over the fitting.
   c. Step three: Measure urethane components according to attached chart in equal amounts in preparation for mixing in separate bucket. Stir with paint mixer stick or electric drill for volume of 2 quarts or more in clean mixing bucket. Wait until the foam reacts (starts to cream) and pour quickly into mold. Insure that foam has completely filled mold and spills out of hole. Second pour, if necessary, into any voids.
   d. Step four: After foam has hardened, trim off any excess and seal the fitting cover with self-sealing tape provided by I-P S. Inspect seams for possible release of foam, trim and spiral wrap cover with tape provided.

3. Couplings: Cover coupling with roll HDPE provided, sealing seams with tape provided. Poke a hole in sleeve and pour urethane foam into the annular space. Wait for it to react, then clean off the excess and seal with tape provided.



N. Disclaimer:

1. Insul-Pipe Systems Pipe meets or exceeds all applicable standards and specifications. Conformance is insured through a rigorous quality control program that provides a superior pipe product.
2. Warranty: Insul-Pipe Systems warrants its products against defects as to workmanship of product failure to the extent that should defects appear within one year from date of shipment from our factory, that are proven to be the fault of the manufacturer, we will replace the item. This warranty does not include any costs related to removal or reinstallation of these products nor does it include any costs for damages that might arise from defective materials or workmanship. There is no warranty expressed or implied other than that stated above.
3. Disclaimer: Technical data contained in this installation guide is furnished without charge or obligation and is given and accepted at the recipient's sole risk. Every effort has been made to verify the information contained within this installation guide. However, Insul-Pipe Systems makes no representation about and is not responsible or liable for use of information contained herein under circumstances or conditions of use different from those described herein, or for which this guide was not intended. In no event shall Insul-Pipe Systems be liable for incidental or consequential damages.
4. Handling and Storage:

    a. Insul-Pipe Systems sections should be handled with care when being unloaded and placed on the jobsite. Damage to the carrier pipe or jacketing may occur if the material is dropped or handled roughly. Webbing belt lifting slings should be used on sections too heavy to be handled by hand.
    b. Handle with care: Check shipment for damage when received. Make note of any damaged goods on the freight bill. Keep a signed copy of the freight bill for filing a claim through the Freight Company.
    c. Storage at the Job site: If the pipe is not ready to be installed immediately when received on the job, then it may be stockpiled. Store on level ground and protect ends from debris, dirt, etc. Do no stack more than six layers high. Store in a convenient location away from possible damage from construction equipment and vehicles.

5. Stringing the pipe: Pipe when strung, should be placed as near the trench as possible and on the opposite side of the excavated earth. When pipe gaskets are received separate from the pipe, install them in the gasket race at the time of assembly.

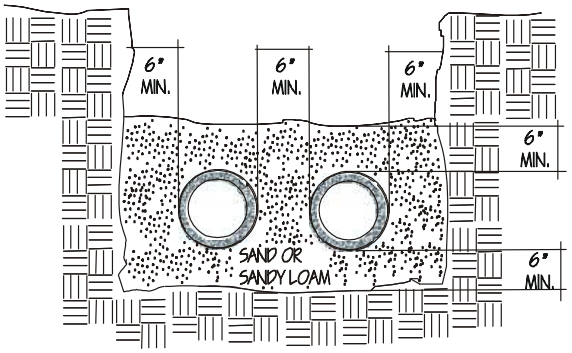
O. Installation Instructions for Carrier Pipe Field Connections:

1. Joints in the Field: Full joints may be cut to desired length in the following manner:

   a. Determine the exact length of carrier pipe desired.
   b. Measure, mark and cut pipe all the way through at using the proper cut-off tool for the type of pipe being used.
   c. Cut off 4" to 6" of the jacket and insulation to allow room for fitting installation (see amount on factory end). **Do not cut into the carrier pipe.** Jacket may be cut with a hacksaw or carpenter's saw. Insulation should be cut with a knife down to the carrier pipe. Remove cut –off insulation and jacket, clean exposed carrier pipe and proceed with installation.
   d. Seal exposed end of insulation with material provided by Insul-Pipe Systems.

P. Trench Preparation: Normally trenching for Insul-Pipe Systems will not require special preparation other than that usually recognized as good trenching practice. It is advisable to trench no more than the installation crews can install in one day.

1. Foundation: Unstable soil conditions may be encountered when trenching below ground water level. The bottom of the trench must be stabilized before laying the pipe. This can be accomplished by lowering the water table level approximately 12" below the trench bottom and/or bringing it to grade with a stable fill material.
2. Widths: Two important factors must be considered concerning trench width. First is the earth load imposed on the pipe? Always remember; "the wider the trench at/or below the top of the pipe the greater the earth load." Factor number two is working space. If the trench is too narrow, a proper cementing job is almost impossible. When installing gasketed pipe allow sufficient room for alignment and assembly. A simple rule of thumb for determining trench width is o.d. of pipe plus 2 feet.
3. Depths: Depths of trenches vary with jobsite conditions. Adhere to depths recommended by design engineer.



Q. Bedding and Backfilling: Bedding material shall be of clean washed sand or pea gravel surrounding the pipe on all sides a minimum of 6 inches to assure no sharp edged or large diameter materials will damage the pipe system. The initial bedding or backfill shall be placed under the lower quadrants of the pipe in a manner that will hold it in position. Backfill shall be in layers of 4" to achieve minimum cover. Compaction shall be controlled to prevent shifting of the pipe. Service

lines and laterals must be assembled so that no strain is placed on the pipe during or after backfill operations. After laying of the pipe is completed, it shall be center loaded with backfill and bedding to prevent arching or whipping under pressure. Center loading should be done carefully so that joints will be completely exposed for examination.

R. Jetting: Jetting may be used as a method of compacting the backfill where the natural soil and the backfill material are coarse enough to allow free drainage. The initial backfill shall be placed to approximately 12” over the top of the pipe. Water is flushed through the material by inserting the hose nozzle to the trench bottom at ten-foot intervals. Continue until fill is completely settled. Do not allow the pipe to float.

S. Testing:

1. After backfilling, the pipeline shall be tested for leaks in accordance with contract specifications. Prior to performance of the test, air shall be slowly expelled from the pipeline. This may be accomplished by means of air relief valves, blowoff valves, hydrants, or other means.
2. After the pipe has been laid and center loaded, a test pressure equal to the working pressure of the pipe may be applied. After the specified pressure has been reached, the pump shall be stopped and all exposed pipe, fittings, valves, hydrants, joints, and appurtenances examined for leaks. Any visible leaks shall be repaired.
3. In the event air is admitted to the pipeline after being expelled for the hydrostatic tests, the owner shall remove such air prior to completion of the system and acceptance. The air may be removed by the methods described above. In no case shall the system be placed in operation prior to the removal of air.

T. Final Backfill: Backfill from 6” minimum above the top of the pipe to the original grade shall be in accordance with contract specifications.

2.3 VALVES

A. General Service Valves: 3" and smaller, all bronze, screwed; 3-1/2" and larger, flanged, iron body, bronze trimmed, equal to the following Crane Nos:

Type	Fluid Pressure Below 125 PSIG	Fluid Pressure Above 125 PSIG
Gate 2" and smaller	428	424
Gate 2-1/2" and larger	465-1/2	7-1/2 E
Globe 2" and smaller	1	14-1/2 P
Globe 2-1/2" and larger	351	21E
Angle 2" and smaller	2	16-1/2 P
Angle 2-1/2" and larger	353	23E

B. Where valves have discs, select the discs for the intended service using materials as recommended by the valve manufacturer. Provide extended stems for valves in insulated lines, so that the handle clears the insulation and jacket.

C. Acceptable General Service Valve Manufacturers: Stockham, Jenkins, OIC, Walworth, Hammond.

D. Check Valves: Use "Silent" check valves at the discharge of circulating water pumps. Unless specifically noted to the contrary, use horizontal swing check valves in all other locations.

E. Silent Check Valves 1-1/2" and Smaller: Bronze body; bronze trim; stainless steel spring; equal to Combination Pump Valve Company No. 36, or Metraflex No. 700 BS-N, or Meuller 303AP, 200 psig rated.

F. Silent Check Valves 2" and Larger: Iron body, bronze trim, stainless steel spring, equal to Combination Pump Valve Company No. 10B or 20B up to 125 psi 11B, or 21B up to 250 psig; Nibco F-910 up to 125 psig, Nibco F-960 up to 250 psig.

G. Butterfly Valves: Ductile iron body, flanged or with drilled and tapped lugs, SS Grade CF8M discs, stainless steel shafts with 316SS bushings, resilient EPDM seats and O-rings, "Bubble Tight" shut-off at 250 psi pressure. On valves 4" and smaller, handle shall be infinite position with memory stops. On valves 8" and larger, provide geared operators. Valves shall be equal to Demco NE-C-5122031. The following valves will be acceptable: Centerline Series LT, Crane 42-SSZ, Demco, Grinnell WD-8271, Keystone 122, Norris R-3011.

H. Ball Valves: Bronze threaded body, chrome plated full port bronze ball, teflon seats and O-rings, bronze shafts, and infinite position handle with memory stops. Memory stops may be deleted for domestic water service. Valve shall be three piece break away for in-line service. Apollo, Crane, Jamesbury and Stockham are acceptable. Ring type two-piece ball valves are not acceptable, except for drain line service. Where valves are installed in insulated lines, provide extended stems to clear the insulation and jacket.

I. Gas Valves: Iron body, lubricated plug valves equal to Nordstrom Fig. 143 in sizes 2-1/2" and larger. Valves 2" and smaller equal to Crane No. 270 or Lee 10685 iron body flat-head threaded gas stop.

J. Gate Valves OS&Y Pattern: Valves shall be furnished as an internal part of the backflow preventer assembly. Valves shall be full port, resilient wedge, outside screw and yoke pattern valves conforming to ASTM A126 Class B Iron Body Valves. The assembly shall be rated for a pressure of 175 psig.

2.4 GAUGE COCKS AND GAUGES

A. Where gauge connections are installed in insulated lines, install a ConBraCo No. 41-380 T-handle gauge cock on a nipple of sufficient length that the cock handle will be free of the pipe insulation, and position each cock in relation to surrounding piping and equipment so that the gauge may be easily read, and so that a gauge having a 6" diameter dial can be screwed into and out of the cock.

B. Install gauge cocks at pumps as close to pump suction and discharge connections as possible. Where drilled and tapped gauge connections are provided in the pump casing by the manufacturer, use these tappings.

C. Pressure Gauges: Phosphor bronze, seamless Bourdon spring type with phosphor bronze bushed rotary movement and link; 4-1/2" dial, nickel plated ring, free standing cast aluminum case; equipped with micrometer adjustment pointer. Furnish each gauge with scale range suitable for the duty.

D. Water Pressure Gauges: Equal to Weksler No. BA14-I with cast aluminum case, or EA-14 with stainless steel case; Weksler, Weiss, and Trerice acceptable.

2.5 THERMOMETER WELLS

A. Furnish and install brass or stainless steel closed separable thermometer wells for all thermometer and controller bulbs which are designated for liquid measurements. Whenever a thermometer or controller bulb is inserted in a pipe for either remote or local temperature indication or control, locate the thermometer well so that it will be completely surrounded by flowing fluid. Such thermometer locations as shown on the drawings are diagrammatic only-install thermometer wells for maximum effectiveness and in the case of locally indicating instruments, for easy readability.

B. Test Wells: Test wells for use with etched stem thermometers shall be Bolton No. 615 brass, with a threaded brass plug and keeper chain. Install these test wells so that they can be filled with oil to facilitate temperature measurements.

2.6 MERCURIAL THERMOMETERS

A. Industrial type with Cycolac plastic cases, glass fronts, 9" scale, adjustable straight or angle pattern as required for ready readability. Furnish thermometers with 2-1/2" stem extensions where they are installed in insulated lines. Select scale ranges for maximum readability at the design temperature of the medium being measured. Thermometer equal to Weksler No. AA5H9.

B. Acceptable Manufacturers: Weksler, Trerice, Weiss, Moeller.

2.7 COMBINATION PRESSURE/TEMPERATURE PORT

A. Furnish and install where indicated "Pete's Plug" a 1/4" MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with valve core of neoprene fitted with cap with gasket. Furnish an extended stem as required to extend through pipe insulation where installed in insulated lines.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SYSTEMS

A. Install runs of piping essentially as indicated on the drawings and/or as required. The location, direction and size of the various lines are indicated on the drawings.

B. Make up all systems straight and true and properly graded for correct flow of contained materials and to provide drainage. Cut pipes accurately to measurements established at the building and work into place without forcing or springing. Except as required for specified grading, run all piping above ground parallel with the lines of the building.

C. Make all changes in pipe sizes with reducing fittings. Use no long screws or bushings.

D. Install and support piping systems with loops, bends, expansion joints and/or flexible connectors as required for flexibility, to accommodate expansion and contraction of piping due to temperature changes in the contained fluids and in the surrounding space, and to minimize the transmission of vibration to the building structure.

E. Provide unions in the lines assembled with screwed and soldered fittings, at points of connection to equipment, and elsewhere as indicated or required to permit proper connections to be made, or

to permit valves, equipment items, etc. to be removed. Provide unions also in welded lines at connections to equipment where flanges are not provided. Provide insulating unions where ferrous material joins non-ferrous material.

F. In piping systems assembled by welding, use factory-fabricated welding fittings of the same material and the same schedule or weight as the piping in which they are installed, except that branches or take-offs of sizes not exceeding 2/3 of the nominal diameter of the mains may be made with Bonney Weldolets or Threadolets. Mitering of pipe to form elbows, notching of straight runs to form tees, and any similar construction will not be permitted.

G. In general, use listed materials in fabricating the various piping systems. The method of assembly may be varied only to meet special conditions where it is impossible to comply with the specified method of joining piping. Where special classes of piping are involved and are not listed, request exact instructions as to the class of material involved and the method of fabricating it before ordering materials.

3.2 FLASHING

A. Flash around all pipes passing through the roof with sheet lead not less than 4 lbs. per square foot, built a minimum of 8" in all directions from the outside of the pipe into the waterproofing. Flashing shall be run up the pipe and turned over into the pipe cavity. Flashing at roof drains shall be 36" square.

B. Pitch Pans: Small lines thru the roof shall be installed thru pitch pans. Pans shall be 18-gage galvanized, welded, 3" deep, 8" X 8" or larger, packed with lead wool and filled with pitch.

3.3 ESCUTCHEONS, CEILING PLATES

A. Except as otherwise noted provide and install concealed hinge, chrome plated escutcheons or ceiling plates with spring catches around each pipe passing through any wall, floor, or ceiling in any space, except in underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe, or against the outside of the insulation on lines which are insulated.

B. No floor plates will be required around the iron pipe sleeves on exterior walls.

3.4 INTERIOR TRENCHING

A. Trenches for underfloor lines inside the building shall be properly excavated, following in general the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped, and settled with water.

B. Where necessary to cut floors for installation of underfloor lines, the floor shall be saw cut and patched back to a flush and level condition.

C. All surplus materials removed in these trenching operations shall be disposed of as directed by the Architect.

3.5 PROTECTION OF UNDERGROUND PIPING

A. Underground steel piping shall be cleaned and primed with Humble "Rust-Ban" and wrapped with a double thickness of 3M Scotch "51" vinyl tape over pipe and fittings.

3.6 ELECTRICAL HEAT TRACING FOR PIPELINES

A. Install all above ground chilled water piping located outdoors.

B. Furnish and install a complete UL listed system of heaters, components, and controls to prevent pipelines from freezing.

1. The self-regulating heater shall consist of two (2) 16 AWG nickel coated-coated bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.
2. In order to provide conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
3. The heater shall operate on line voltage of 208 volts without the use of transformers.
4. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50°F.
5. The heater shall be XL-Trace as manufactured by Raychem Corporation.
6. Power connection, end seal, splice and tee kit components shall be applied in the field.
7. The system shall be controlled by an ambient sensing thermostat (AMC-1A) set at 40°F either directly or through an appropriate contactor. This devices shall sense outside air temperature and enable heat tape below 40°F.
8. Ground fault circuit breaker shall be provided as required by Section 427-22 of the NEC-1987.

C. Installation:

1. Apply the heater linearly on the pipe after piping has been successfully pressure tested. Secure the heater to piping with cable ties or fiberglass tape.
2. Apply "electric traced" signs to the outside of the thermal insulation.

D. Tests:

1. After installation and before and after installing the thermal insulation, subject heat to testing using a 2500 VDC megger. Minimum insulation resistance should be 20 megohms regardless of length.
2. The installer shall test for both heating cable bus wires to verify the connection of any splices or tees.

3.7 FABRICATION OF PIPE JOINTS

A. Copper Tubing: Cut tubing square and deburr. Clean insides of fittings and outsides of tubing with sand cloth before assembly. Exercise care to prevent annealing of fittings and hard drawn tubing. Make all joints with solid string or wire solder, using non-corrosive paste flux of the proper type for each application. No cored solder will be permitted. Use 95-5 solder (95% tin, 5% antimony) or Silvabrite 100 solder (95.5% tin, 4% copper, .5% silver composition) for all copper tubing. Under no circumstances will solder with any lead content be permitted on the jobsite. Where flanges are shown or are required for connection to equipment, they shall be 150 psi flanges.

B. Welded Joints: Make all welded joints by the metallic arc process. Use base material conforming to ANSI B31.1 for welded pipe ASTM A106 and ASTM A53. Use filler material conforming to ASTM A233 and in accordance with ANSI B31.1. Machine the ends of the material to be joined or gas cut. Make the cut smooth in order that good fit can be made, and a full penetration weld made. Use direct current for welding with the electrode positive. Limit the depth of deposit to 1/8" per pass. Remove all slag or flux remaining on any bead of welding before laying down the next successive bead of welding. Remove any cracks or blow holes that appear on the surface of any bead of welding by chipping or grinding before depositing the next successive bead of welding.

C. Mechanical Couplings: Mechanical couplings and fittings shall be used to connect mechanical equipment and piping systems where specified. Rigid couplings shall have angle-pad design equal to Victaulic Style 07, Zero-Flexible. Couplings shall be equal to Victaulic Style 77 where system flexibility is desired. Couplings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12 or malleable iron conforming to ASTM A-47, Grade 32510. Gaskets shall be Grade "E" EPDM compound conforming to ASTM D-2000 designation 2CA615A25B24F17Z. Coupling bolts shall be Zinc plated (ASTM-B-633) heat-treated carbon steel track head conforming to physical properties of ASTM A-183. Unless specifically designated otherwise on the drawings, all couplings shall be flexible type at pump connections and in Mechanical Rooms.

D. Pipe Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, or malleable iron conforming to ASTM A-47, Grade 32510. Where malleable fitting pattern is not available, fittings fabricated from Schedule 40 steel pipe or standard wall seamless weld fittings with grooved ends may be used.

E. Before assembly of couplings, lightly coat gasket with lubricant to facilitate installation.

F. Pipe grooving shall be in accordance with the manufacturer's specifications contained in the latest published literature.

G. Flanged Joints: Flanged joints shall be made using bolts and gaskets as specified. Faces of the flanges shall be cleaned of all dirt, rust or other foreign matter. The pipe, valve, or fitting shall be properly aligned and free to move while bolting, and the bolts shall be gradually tightened at a uniform rate around the entire flange. No strain shall be put on the flanges in making up the joint.

H. Solvent Weld Plastic Joints: Solvent welded according to manufacturer’s instructions.

I. Testing:

1. The Contractor shall have a minimum of 10 percent of all welds made by each welder examined and inspected by radiography. If a faulty weld is discovered, the Contractor shall perform radiographic inspection on all welds made by that welder. Any faulty welds shall be repaired and reinspected at the Contractor's expense.
2. The system shall be hydrostatically tested at 1.5 times the design pressure, as specified in Chapter VI ASME Code B31.1-1986 for Power Piping, and carefully checked for leaks. After leaks are repaired, retest system; repeat repair and test until proved tight. Equipment shall be isolated from hydrostatic testing of piping.
3. Welds which cannot be hydrostatically tested, e.g., branch connections made to existing piping, shall be radiographed per Chapter VI, ASME Code B31.1-1986 at Contractor's expense. The Owner at his option may allow visual inspection of these welds in lieu of radiographs.

3.8 REVISIONS AND RELOCATION OF EXISTING SYSTEMS

A. Where conflicts occur between the new work and the existing piping systems which cannot be resolved, the Contractor shall relocate the existing piping system. Relocated positions of piping shall be tested for new work. All piping systems shall be free from leaks.

3.9 REPAIR OF LEAKS

A. All leaks in piping systems shall be corrected as follows:

1. Repair leaks in solder joints by remaking the joint; no soldering or brazing over existing joints will be permitted.
2. Repair leaks in screwed joints by tightening the joint; remake the joint if the tightening fails to stop the leak.
3. Leaks in caulked joints may be stopped by additional caulking of the joint; but if that fails, remake the joint.
4. Repair leaks in welded joints by removing the defective weld completely through the base metal and grind smooth. Re-weld, accomplishing 100% penetration of the base metal. The repair weld should in no case be less than 4" in length.

B. When any defect is repaired, retest that section of the system.

3.10 HANDLING OF MATERIAL

A. Hauling: All materials furnished by the Contractor shall be delivered and distributed at the site by the Contractor.

B. Loading and Unloading: Pipe, fittings, valves, and accessories shall be loaded or unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. Each piece shall be unloaded opposite or near the place where it is to be installed. No material shall be unloaded where it will block any road, drive, building entrance, or walkway or where it will be a hazard to safe vehicular or pedestrian traffic.

C. Care of Pipe Coating and Lining: Pipe shall be so handled that the coating and lining shall not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense. If satisfactory repair cannot be made, the Contractor shall replace the damaged pipe.

3.11 ALIGNMENT AND GRADES

A. General: All pipe shall be laid and maintained to the required lines and grades with fittings, valves, at the required locations; spigots centered in bells; and all valve stems plumb. All pipes shall be installed straight and true to line.

B. Deviations Occasioned by Other Structures: Whenever obstructions not shown on the plans are encountered during the progress of the work, the lines and/or grades shall be adjusted so to not interfere with existing obstructions.

END OF SECTION 15300

SECTION 15350 - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications requires the furnishing and installation of all equipment, labor, materials, transportation, tools and appliances and in performing all operations in connection with the installation of the plumbing systems.

PART 2 - PRODUCTS

2.1 MATERIALS: Refer to Section "Piping and Accessories".

A. Interior Sanitary Soil, Waste and Drain Lines: PVC-DWV Plastic pipe and fittings conforming to ASTM D-2665-68, assembled with solvent cement conforming to ASTM D-2564-67.

B. Sanitary Fixture Waste Arms: Fixtures served by sanitary soil waste and drain lines shall be connected using cast iron pipe and fittings, red brass pipe, Type L hard copper tubing with cast brass drainage fittings or lead. Use brass soldering nipples or ferrules as required.

C. Sanitary Vent Lines: PVC-DWV Plastic pipe and fittings conforming to ASTM D-2665-68, assembled with solvent cement conforming to ASTM D-2564-67.

D. Domestic Water Lines (Hot, Cold and Recirculating): All water lines underground or under slabs on grade shall be of Type K hard drawn copper tubing. All interior water lines shall be Type L hard drawn copper tubing. Where connections are made between copper tubing and cast-iron pipe, use adapters. Copper tubing shall be assembled using solder-joint fittings. No lead solder will be permitted. All flanges shall be 150 psig rated.

E. Domestic Water (Hot, Cold and Recirculating): For above grade lines, at the Contractor’s option, use Press-Connect fittings equal to NIBCO Press or Viega ProPress copper and cast copper alloy. Fittings shall conform to ASME B16.51, NSF 61 and NSF 372. EPDM elastomeric sealing elements. All connections shall bear full insertion marks on the tubing. Press Connect fitting shall have Leak Detection as standard feature to detect unpressed fittings during the testing process. There shall be no mixing of manufacturers. The manufacturer’s installation instructions shall be strictly adhered to. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer’s installation manual. Then full pressure test to 1.5 times design pressure. Installers shall be credentialed by manufacturer. Approved manufacturers: NIBCO, Viega.

F. Gas Lines: Schedule 40 black steel with 150 lbs. banded malleable iron fittings.

G. Gas Lines: At Contractor's option NIBCO Bench PressG or Viega MegaPressG steel fittings may be used: Fittings shall conform to ANSI LC-4/CSA 6.32. HNBR elastomeric sealing elements. All connections shall bear full insertion marks on the tubing. Press Connect fitting shall have Leak Detection as standard feature to detect unpressed fittings during the testing process. There shall be no mixing of manufacturers. The manufacturer's installation instructions shall be strictly adhered to. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer's installation manual. Then full pressure test to 1.5 times design pressure. Installers shall be credentialed by manufacturer. Approved manufacturers: NIBCO, Viega

H. Drain Lines: PVC-DWV Plastic pipe and fittings conforming to ASTM D-2665-68, assembled with solvent cement conforming to ASTM D-2564-67. Smaller lines may be Schedule 40 PVC pipe and fittings.

I. Miscellaneous Lines: Such as pilot lines, bleed lines, control and sampling lines, equalizer lines, drains from air vents and relief vents, etc. shall be fabricated of the materials used in the systems to which they are connected.

PART 3 - EXECUTION

3.1 ISOLATION VALVES

A. The water supplies to each group of fixtures shall have an isolating valve in each line serving the riser. These isolation valves shall be installed at an accessible location. Where these valves are not accessible thru removable ceilings or otherwise, provide access doors in the ceiling or chase.

3.2 INSTALLATION OF PIPING SYSTEMS

A. Refer to PIPING AND ACCESSORIES for requirements for installing pipes. In addition, the following specifications shall apply.

1. Drain Lines and Sanitary Waste: Grade down toward the sewer connection at a uniform slope of 1/4" per foot to serve individual fixtures or not less than 1/8" per foot to serve multiple stacks or outlets. Slope shall be greater where possible and shall never be less than required to produce a flow velocity of 2 feet per second.
2. Vents: Grade up to the vent thru the roof. Terminate not less than 10" above the roof.
3. Gas Lines: All gas piping shall run exposed unless specifically detailed otherwise on the drawings, with special venting provisions.
4. A gas "drip pocket" or "dirt leg" shall consist of a nipple and screwed cap on the bottom of the riser and shall be installed at connections to equipment, at the low point of the system and at the natural gas line entrance to the building (with the "gas cock" shut off valve). Install as required by the International Fuel Gas Code.
5. Provide a gas cock, union and gas pressure regulator at each connection to a gas consuming appliance.
6. All gas piping on the roof shall be supported on Miro Pillow Block pipe stands, Model 02 for 2" and below, Model 24-R for piping 2" to 4" and Model 48-R for 5" and above. Pans shall be mopped to roof. Pipes shall be strapped to supports with galvanized strap.
7. Identification: For other than black steel pipe, exposed gas piping shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm). The marking shall not be required on pipe located in the same

room as the appliances served. All tubing carrying medium-pressure gas shall be marked with a label at the beginning and end of each tubing section.

3.3 TESTING

A. Test all pipes before they are concealed in furrings or chases, insulated, painted, or otherwise covered up or rendered inaccessible. Accomplish testing by sections of lines or systems, as required by conditions during construction. Clean all piping and equipment before testing.

B. Gas Lines: Test with 50 psig air pressure for 24 hours with no pressure drop (except for temperature correction). If any drop occurs, soap test all joints, correct leaks and retest.

END OF SECTION 15350

SECTION 15360 - CHILLED WATER SYSTEM

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications pertains to all labor, materials, equipment and service necessary for and incidental to the chilled water systems as shown on the drawings and/or specified herein.

B. Install chilled water circulating piping complete and connect to coils, pumps, and other equipment. Include drain lines where shown or required.

PART 2 - PRODUCTS

2.1 MATERIALS: Refer to Section "Piping and Accessories".

A. Chilled Water Lines:

1. Standard weight black steel. Use Victaulic couplings on lines 4" and larger. Weld smaller lines. Lines 2" and smaller may be screwed using malleable iron banded fittings.

a. Steel Pipe: At the Contractor’s option, NIBCO Bench Press or Viega MegaPress steel fittings may be used: Fittings shall conform to IAPMO PS 117. EPDM elastomeric sealing elements. All connections shall bear full insertion marks on the tubing. Press Connect fitting shall have Leak Detection as standard feature to detect unpressed fittings during the testing process. There shall be no mixing of manufacturers. The manufacturer’s installation instructions shall be strictly adhered to. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer’s installation manual, then full pressure test to 1.5 times design pressure. Installers shall be credentialed by manufacturer. Approved manufacturers: NIBCO, Viega.

2. At the Contractor’s option, lines 2” and smaller may be joined using Type L hard drawn copper tubing joined with solder joint fittings. No lead solder will be permitted.

a. Copper Tubing: At the Contractor’s option, NIBCO Press, Viega ProPress or equal, copper and cast copper alloy fittings may be used: Fittings shall conform to ASME B16.51, NSF 61 and NSF 372. EPDM elastomeric sealing elements. All connections shall bear full insertion marks on the tubing. Press Connect fitting shall have Leak Detection as standard feature to detect unpressed fittings during the testing process. There shall be no mixing of manufacturers. The manufacturer’s installation

instructions shall be strictly adhered to. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer's installation manual, then full pressure test to 1.5 times design pressure. Installers shall be credentialed by manufacturer. Approved manufacturers: NIBCO, Viega.

B. Drain Lines: Schedule 40 galvanized steel pipe assembled with 150-pound malleable iron, banded pattern, screwed fittings or, at the Contractor's option, may be type L hard copper assembled with wrought copper solder joint fittings. Do not mix the two materials.

C. Automatic Air Vents: ASME labeled; equal to Crane No. 976. Crane and Sarco acceptable. Pipe discharge to a floor drain or as directed.

D. Relief Valves: ASME labeled: equal to Bell and Gossett No. 250 having a relief setting of 125 pounds; Bell and Gossett, Taco or Thrush acceptable. Provide a relief valve in each closed water piping system.

E. Strainer: "Y" pattern Dunham Bush Type "MUL" or "SS-A". Vertical pattern McAlear Series 800.

2.2 EXPANSION TANK – Bladder type, existing to remain. Relocate as shown.

2.3 SHOT FEEDER

A. Provide and install a two-gallon shot feeder across the supply and return mains of the closed water circulating system. The feeder shall be installed with ball valves on either side of the feeder. Provide an air cock, funnel, fill valve and drain valve.

PART 3 - EXECUTION

3.1 INSTALLATION OF SYSTEMS

A. Lay all water circulating lines on an even slope throughout to insure freedom from air locks and traps. Grade the system downward to the circulating pumps with valved drain connections from the low points to floor drains. Where additional low points are unavoidable, provide service drains to permit the complete drainage of the system.

B. Provide automatic air vents at all high points of the system. Where horizontal mains change size, employ eccentric reducing couplings so installed as to keep the tops of coupled pipes on the same level.

C. Install drains from each pump base and from each air unit pan to the nearest floor drain in each case. Provide any other drain lines indicated on the drawings or required.

D. Install manual valves where required to segregate individual items of equipment or sections of circulating systems or where indicated on the drawings or required.

3.2 CLEANING

A. Fill the system with a solution consisting of either one pound of caustic soda or three pounds of trisodium phosphate per 100 gallons of water. Eliminate all air and circulate this solution for 48 hours. Drain the system and thoroughly flush it with fresh water. Clean out all strainers. Refill the system with fresh water.

3.3 TESTING

A. Before insulating or concealing any lines, test all piping. Test all lines at 150% of the system working pressure or 100 psig, whichever is greater, for not less than 4 hours with no leaks.

3.4 CHEMICAL TREATMENT

A. The Contractor shall provide and install the initial chemical treatment and the first-year supply of chemical. Provide chemical analysis report to Architect indicating system condition after initial fill.

END OF SECTION 15360

SECTION 15500 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. The Contractor for the work covered by each section of the specifications shall furnish and install all hangers, supports and isolation required by pipe or equipment included in this work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be provided for the support of all piping and equipment. The following tabulation lists materials suitable for this duty. Equal materials manufactured by Fee and Mason, Carpenter-Patterson, Grinnell or Modern will be considered.

MATERIAL	SERVICE	FEE AND MASON CAT.
Hanger	Copper Tubing 4" and Larger	364 copper plated
Hanger	Copper Tubing 3" and smaller	361 copper plated
Hanger	Steel Lines 3" and smaller	215 or 199
Hanger	Steel lines 4" and larger	239
Hanger	Outside Insulation-all lines	239
Hanger	Cast Iron Lines	239
Hanger	Plastic Pipe	108 + 109
Hanger	Refrigerant Pipe	102
Hanger	Glass Pipe	375
Wall Bracket	All	150, 151, or 155
Saddles	Steel Lines on Rollers	71, 1710, 1712, 172, 173
Conc. Inserts	New Construction	185
Rollers	Steel Piping	161, 272
Pipe Clamps	2" and Smaller	304
Pipe Clamps	3" and Larger	241
Pipe Rest	All	295 or 291
Exp Shield	Concrete	374
Beam Clamps	All	249, 254, 255, 282, 280
Adjuster	All	2381

2.2 HANGER RODS

A. All individually suspended horizontal pipes shall be supported by steel rods sized as follows:

Rod Diameter	Size of Steel Pipe or Copper Tube Supported	Size of Cast Iron Pipe Supported
3/8"	2-1/2" and smaller	3" and smaller
1/2"	3" and 4"	4" through 6"
5/8"	5" through 8"	8" through 10"
3/4"	10" and larger	12" and larger

2.3 HANGER SPACING

A. All hangers shall be so located as to properly support horizontal lines without appreciable sagging of these lines. The following table gives minimum spacing for copper, and steel lines, but hangers shall be more closely spaced where necessitated by conditions or the type of pipe involved or required by code.

Size of Line	Hanger Spacing in Feet
3/4" and smaller	5
1" through 1-1/2"	7
2" and larger	10
All cast iron lines	5 (Minimum two per joint)

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTS

A. All pipes shall be adequately supported. All piping shall be installed with due regard to expansion and contraction, and the type of hanger, method of support, location of supports, etc. shall be governed in part by this consideration. Transmission of vibration and noise shall also be considered and any special suspension with vibration dampeners required to minimize transmissions shall be used where specified or required.

B. All exposed vertical risers running near walls shall be supported from the walls. Each line shall have a minimum of 2 supports, not greater than 10'0" on centers, with the additional provision that there shall be a support near the top of the riser. All supports shall be aligned.

C. All vertical pipes shall be supported with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper supports, furnish and install anchor base fittings or other approved supports.

D. Where vertical lines run down to a point near the floor and a support is needed, they may be supported by means of a pipe leg welded to the pipe, extending down to the floor and terminating in a capped end resting on the floor.

E. Where pipes other than those specified hereinbefore, are running along walls, they shall be supported using hangers as described hereinbefore, but suspended from brackets bolted to the wall. Specially fabricated clips or U-braces may be used where commercially manufactured items are not available in the proper size.

F. Where pipes or equipment are suspended under existing concrete construction, drill and use Grinnell Fig. 117 expansion case or Phillips concrete fasteners in sizes not exceeding 1/2" and for loads of 200 lbs. or less. For larger rods or loads above 200 lbs. drill through the beam above the bottom steel and bolt a Grinnell Fig. 202 bracket to the side of the beam for support. Size brackets per manufacturer's recommendations. Use pipe stands where required.

G. Where multiple lines are run horizontally at the same elevations and grades, they may be supported on trapezes formed for sections of Unistrut, angle iron, or channels suspended on rods or pipes. Trapeze members, including the suspension rods, shall be properly sized for the number, size and loaded weight of the lines they are to support. Trapeze spacings shall be in accordance with the preceding table for the smallest line supported on or from the trapezes.

H. Hangers supporting insulated lines which are specified to be finished with a vapor seal shall be fitted outside the insulation. The insulation or horizontal lines shall be protected by low compression insulation shields. On all pipes the shields shall be Fee and Mason Fig. 81 or rolled 14-gauge galvanized. The shields on horizontal lines shall be positioned so that they encompass the bottom of the pipe and are centered on the hanger or support. On vertical lines there shall be two shields of the same type full encompassing the pipe at each clamp. Shields shall be secured with a 3/4" wide lacquered steel band at each end.

3.2 COOPERATION BETWEEN TRADES

A. Where pipes specified under different sections may possibly be racked on the same supporting structure, each trade shall cooperate with the others involved to properly locate the supporting members and shall furnish a proportionate share of the labor and materials involved in the installation.

B. Any other special hangers and supports shall be provided and installed as indicated on the drawings, specified elsewhere herein or required by conditions at the site.

3.3 DUCT HANGERS

A. All ductwork shall be supported in accordance with standards published by Sheet Metal and Air Conditioning Contractors National Association Inc.

3.4 DUCT SUPPORTS

A. Product Name: DUCT SUPPORTS MODEL NO. 6-DS, 6-DSA, 8-DS AND 8-DSA. NOTE: Duct Supports are given model numbers which correspond to the allowable loads. 6-DS and the 6-DSA are used for lighter, smaller duct and 8-DS and the 8-DSA are for heavier, larger duct. All duct supports are manufactured custom at the MIRO Industries plant.

B. Design Emphasis: The 6-DS, 6-DSA, 8-DS and 8-DSA duct support has been designed specifically for square and round duct work. The versatility of the design for this product enables it to expand to hold any number of duct running along the roof for maximum efficiency and cost savings to customers, contractors, and owners. Thus, this duct support product can be used to hold ganged duct or stacked duct across and at varying heights above the roof. See below.

C. Manufacturer: MIRO INDUSTRIES, INC., 2700 South 900 West, Salt Lake City, Utah 84119; Phone (800) 768-6978; Fax (800) 440-7958

D. Product Description: A frame constructed of strut and MIRO's patented bases are used to support duct on flat roofs. Unique design allows a sturdy support without penetrating or causing damage to the roof membrane. Ducts rest on a 1-5/8" x 1-5/8" or 1-5/8" x 7/8" strut and are adjustable in height. All 6-DSA and 8-DSA models are manufactured in a 12-gauge telescoping design for maximum adjustability in length and height. The duct support base is made of stainless steel, hot-dip galvanized steel or polycarbonate plastic and all other metal parts are made of hot-dip galvanized steel.

E. Product Performance: The frame system serves to keep the duct system directly over and beneath the frame without binding and allows for some lateral expansion of the duct system. The base is gently rounded to prevent gouging. Drainage ports are provided to prevent ponding within the device.

F. Compatibility: MIRO Duct Supports are recommended for use on and are compatible with all current types of decking and with all commonly used built-up and single-ply roofing membranes where roof-mounted ducts occur. With heavier loads it is prudent to use a MIRO Support Pad or other traffic pad to further protect the roof membrane.

G. Load Weight:

1. 6-DS: Maximum load weight not to exceed 300 lbs. per duct support or 150 lbs. on each base
2. 6-DSA: Maximum load weight not to exceed 150 lbs. per duct support or 75 lbs. on each base or 20" spiral duct
3. 8-DS: Maximum load weight not to exceed 700 lbs. per duct support or 350 lbs. on each base
4. 8-DSA: Maximum load weight not to exceed 300 lbs. per duct support or 150 lbs. on each base or 26" spiral duct

H. Composition and Materials: The pipestand consists of two major components: (1) Two roof deck bases of stainless, hot-dip galvanized steel or polycarbonate plastic which set upon the roof membrane, (2) A braced strut or telescoping assembly which is supported by, rests upon, and is connected to the two bases.

I. Size: Support Models are made as follows: Each of the two deck bases 12" x 16", 9" x 15.25", 12.07" x 16", 9" x 31.69" or 18" x 16". The 6-DS has a bar width which allows at least 10" between strut assembly and can adjust in height to support duct from a low of 12" to a desired height. The 6-DSA has a bar width which allows at least 18" between strut assembly and can adjust in height to support duct from a low of 10" to a high of 24". The 8-DS-SB has a bar width which allows at least 16" between strut assembly and can adjust in height to support duct from a low of 12" to a desired height. The 8-DS-DB has a bar width which allows at least 12" between strut assembly and can adjust in height from a low of 12" to a desired height. The 8-DSA has a bar width that allows at least 24" between strut assembly and can adjust in height to support duct from a low of 10" up to a high of 36". The strut is 1-5/8" x 7/8" or 1-5/8" square, the telescoping is 1-5/8" and is constructed at various heights to give duct clearance adjustment above the roof plus or minus. The 6-DSA and the 8-DSA are also adjustable by width.

J. Adjustable Height: The Models 6-DS, 6-DSA, 8-DS and 8-DSA and its related configurations allow adjustable height as desired or required by the code or roof system. Each model can be configured to allow plus or minus height above the roof. Cross-bracing two pipestands every 4th or 5th pipestand is recommended and required for elevations 36" and higher. Purchasers should specify desired heights upon ordering the duct supports.

K. Installation Process: (1) Center the duct support beneath the duct so that the frame allows the duct to be squarely over and through the horizontal bar. (2) Adjust the duct support to the desired height and to even load with other duct supports. Make certain the horizontal support strut is level. (3) Set the duct in the horizontal bar without dropping or causing undue impact. For heavier loads it is prudent to install an additional sheet of roofing material, a MIRO Deck Plate, or MIRO Support Pad beneath the duct support. For built-up roofs, all loose aggregate from an area 2" larger than each base should be removed from the area directly beneath the duct support and then follow the installation directions set forth above. Care should be taken to install each duct support, so it supports a proportional and equal amount of weight at each duct support.

OPTIONAL METHOD OF INSTALLATION (Not Recommended): Where code requires or as desired, the duct supports may be attached to the roof structure by appropriate and compatible rooftop fasteners through holes then drilled in the bases' pitchpan at the time of installation. After attachment has been made to the roof, the pitchpan may be filled with asphalt material or cement to help seal the areas around the fasteners.

L. Spacing: Manufacturer's recommended spacing is not to exceed 8-foot centers depending upon the load. Do not exceed load weight and make certain each duct support is adjusted in height to even load at all duct supports.

M. Availability: Duct Supports are marketed throughout the United States through representatives and distributors.

N. Maintenance: Normally maintenance is not required. Semi-annual inspection is required to check duct support position and set duct alignment, weight distribution and improper installation which may cause duct support damage or failure.

O. Technical Services: Please call MIRO INDUSTRIES, INC.: (800) 768-6978 or visit our website *www.miroind.com* for technical information and for graphic and CAD drawing downloads.

3.5 PRE-FABRICATED EQUIPMENT MOUNTING SUPPORTS

A. Provide ThyCurb equipment mounting supports or approved equal of 18 ga. galvanized construction with continuously welded corner seams and a 3" cant, supports to be internally reinforced with a factory installed wood nailer and 18 ga. counterflashing. Supports to be a minimum of 8" above the finished roof and of the style and design to mate the roof deck.

B. Supports shall be level at the top, with pitch built into supports where roof slopes 3/8 of an inch per foot or more and supports must have certified load bearing data. Supports must span a minimum of 2 joists and more if equipment length requires it. Supports to be used for all roof mounted equipment, HVAC units, condensing units and roof mounted piping.

END OF SECTION 15500

SECTION 15550 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 NOTE

A. Conform with applicable provisions of the General Conditions, Special Conditions, General Requirements, and Supplemental Conditions.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. The Contractor for the work covered by each section of the specifications shall furnish and install all vibration isolation required by pipe or equipment included in this work.

PART 2 - MATERIALS

2.1 ISOLATION

A. Mechanical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and required to minimize transmission of vibrations and structure borne noise to building structure or spaces.

B. All rotating equipment shall be balanced both statically and dynamically. The equipment supporting structure shall not have any natural frequencies within plus or minus 30% of the operating speeds. The equipment when mounted and placed in operation shall not exceed a self-excited vibration velocity of 0.10" per second when measured with a vibration meter on the bearing caps of the machine in the vertical, horizontal and axial directions or measured at the equipment mounting feet if the bearings are concealed.

C. Isolation shall be stable during starting and stopping of equipment without any traverse and eccentric movement of equipment that would damage or adversely affect the equipment or attachments.

D. Isolation shall be selected for the lowest operating speed of equipment.

E. Isolation shall be selected and located to produce uniform loading and deflection even if equipment weight is not evenly distributed.

F. Fiberglass Isolators: Fiberglass isolators shall consist of a high-density matrix of precompressed molded glass fibers enclosed in a resilient neoprene jacket. Fiberglass isolators shall be equal to Consolidated Kinetics Corporation isolators. Isolators shall be selected for the actual loads of equipment served and generally shall be 90% efficient or better.

G. Neoprene Pads: Neoprene pads shall be of cross ribbed or waffle design and a minimum of 5/16" thick. Where concentrated load bearing is encountered, steel-bearing plates shall be bonded to

neoprene pads to spread the load. The neoprene pads shall be sized for a load of 50 pounds per square inch.

H. Spring Isolators: Spring isolators shall be free standing, laterally stable without any housing, and complete with neoprene acoustical friction pads, a minimum of 1/4" thick between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment or base. Coil outside diameters shall not be less than 0.8 of the operating height of the spring. Spring shall have an additional travel to solid equal to 50% of the operating deflection. The horizontal stiffness of spring isolators shall be not less than 0.8 of the vertical axial stiffness. All spring isolators shall be selected for 1" initial deflection or more. Isolators for air units shall be selected for 2" deflection. Isolators shall be galvanized where installed outside.

PART 3 - EXECUTION

3.1 VIBRATION ISOLATION HANGERS AND SUPPORTS FOR PIPES AND DUCTS

A. Furnish vibration isolation in accordance with the following:

1. Each pipe connected to equipment mounted on vibration isolators shall have a minimum of 3 spring hangers.
2. Hanger vibration isolators shall be selected for not less than the deflection provided for the equipment to which the piping is connected. The vibration isolator units selected shall accommodate the thermal movement of the piping systems.

3.2 SCHEDULE OF VIBRATION ISOLATION

EQUIPMENT	PRIMARY ISOLATION	SECONDARY ISOLATION
Chiller	Neoprene Pads	

END OF SECTION 15550

SECTION 15600 - INSULATION

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications comprises the furnishing of all labor, materials, transportation, tools and appliances and in performing all operations in connection with the installation of thermal insulation, coverings, jackets, supports, shields, etc. as described herein and/or as shown on the accompanying drawings, or reasonably implied therefrom. All surfaces which may vary from the ambient temperature shall be insulated unless specifically accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. In describing the various materials, application procedures, and finishes, each item will be described singularly, even though there may be a multiplicity of identical applications. Also, where the description is only general in nature, exact dimensions, arrangements and other data shall be determined by reference to plans, schedules, and details, including those provided by equipment manufacturers.

B. Where materials are described under other sections of the specifications and are pertinent to this section, they shall be installed hereunder as though they were repeated herein.

C. All insulation shall have composite fire and smoke hazard ratings as tested by procedure NFPA 225, not exceeding flame spread 25, smoke developed 50. Accessories such as adhesives, mastics, cement, tape, cloth, etc. shall have these same component ratings.

D. All materials installed under this section of the specifications shall be manufactured in the United States of America.

2.2 VAPOR BARRIER JACKETS

A. Factory-applied vapor-barrier jackets shall be laminated of flame resistant white kraft paper and .001-inch aluminum foil reinforced with glass fiber fabric between the foil and the paper. The foil and paper shall be adhered with a flame-resistant latex adhesive.

B. Where specified, insulate valves and fittings with two fiberglass inserts and preformed Manville "Zeston" covers with taped seams.

C. Where metal jackets are specified, they shall be 0.016" thick No. 5005 tempered aluminum secured with machine drawn 0.020" stainless steel bands.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation of all thermal insulation shall be performed by a recognized firm regularly engaged in the insulation business, using skilled insulation mechanics and using insulation materials which are the product of reputable manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Any insulation which is not applied in a workmanlike manner will be rejected and replaced. All coverings shall be smooth, flush, dressed to line and tight. Mastic shall be neatly applied and tooled. The Architect reserves the right to reject any insulation whose appearance he deems unacceptable.

3.2 APPLICATION OF INSULATION

A. Apply insulation and pipe covering after all work has been tested, found to be tight and accepted as such by the Architect. Thoroughly clean and dry all surfaces to be covered.

B. Apply rigid insulation board on flat sheet metal surfaces with Foster No. 85-60 or Childers CP-127 adhesive and additionally secure with Graham pins or adhesive clips on 12" centers. No penetration of the metal will be permitted. Fill all joints with seam filler and strip with an open woven glass fabric tape. Trowel Foster No. 30-65 or Childers CP-34 vapor barrier coating over all joints and clips to a 1/8-inch thickness and wipe to eliminate pinholes.

C. On glass fiber pipe covering with factory-applied vapor-barrier jacket, lap the jacket on the longitudinal seams and seal with vapor barrier lap adhesive equal to Foster 85-60 or Childers CP-82 or use self-sealing lap. Tightly butt the ends and cover butt joints with a 4" wide band of vapor barrier jacket secured with the same adhesive.

D. Except where insulation is cloth jacketed, band all pipe insulation, following the completion of painting operations. Bands shall be aluminum not less than ¾-inch wide. Space bands a maximum of 12" on centers, with three bands per section of covering. Where sections of insulation are overlapped as at flanges, apply a band at each of the overlapping sections and one on the basic line covering immediately adjacent to the end of the overlap. Provide bands also on each side of each valve, fitting, etc. and at the end terminal where the insulation is beveled off as specified herein. Also band the hanger shields on insulated cold lines with a band at each end of each shield.

E. Exclusions: No insulation shall be applied to:

1. The cooling leg at a steam trap--the piping from the scale pocket ahead of the trap to the line on the outlet of the union following the trap.
2. Expansion tanks.
3. Exposed chrome plated lines.

3.3 INSULATION ON EQUIPMENT AND PIPING SYSTEMS

A. The following describes materials, thicknesses and finishes for insulation and coverings. In the following, the word "exposed" shall apply to any line, duct, or other material or surface in any room

above the lowest floor in any building unit, exterior to the building and above ground, and/or in equipment rooms; the word "concealed" shall apply to any line, duct, or other material or surface in other underfloor areas, ceiling spaces furrings and chases.

B. Also included in this section is the requirement for patching and repair of existing insulation where new connections are made.

1. Domestic Cold-Water Lines: All cold-water lines throughout with those exceptions noted hereinbefore, shall be insulated with 1" thick Manville "Micro-lok APT 650" molded glass fiber pipe covering with factory applied vapor barrier jacket. Insulate valves and fittings with Manville preformed "Zeston" PVC covers over fiberglass insulation.
2. Interior Chilled Water Lines: Insulate with molded sectional glass fiber pipe covering with factory applied all-purpose vapor barrier jacket equal to Manville "Micro-Lok APT 850". Insulation shall be 1-1/2" thick. Insulate valves and fittings with fiberglass inserts and "Zeston" PVC covers.
3. Underground Chilled Water Lines: Refer to Piping and Accessories for preinsulated piping.
4. Exterior Chilled Water Lines: All chilled water lines shall be insulated with Pittsburg-Corning "Foamglas" insulation. Insulation shall be single thickness molded pipe insulation according to the following sizes.

    a. Pipe below 8" nominal diameter, 1-1/2" thick Pipe 8" and larger nominal diameter, 3" thick
    b. Specific instructions of the manufacturer shall be secured and followed. Extreme care shall be exercised to preserve the vapor barrier.
    c. Procedure: Butter on joints with an approved sealer such as Foster 95-50, Childers CP-76 or Pittsburgh Corning's Pittcote 300 asphalt based or equal sufficiently to vapor seal the joints. Apply Foamglas insulation to clean dry surface of pipe with joints tightly butted and secure with bands. Bands shall be on 9" centers with 18" lengths of insulation and on 12" centers for 24" lengths. Seals or bands shall be carefully embedded into the insulation prior to receiving additional vapor barrier mastic and final covering material.
    d. Finish: Completely cover insulation with Foster 30-65 or Childers CP-34 (indoors) vapor barrier mastic in a thick coat. Fill any void or chinks with cut pieces of foamglas insulation and coat with vapor barrier mastic. Fill voids in shields with foamglas insulation and cover open ends and entire saddle with vapor barrier mastic. If applying Foamglas outdoors, completely cover insulation with Foster 30-80 or Childers CP38 vapor barrier coating.
    e. Covering: A jacket of .016 aluminum shall be applied over the insulation. Provide a minimum 3" overlap and fasten snugly with .020 SS bands, at overlap and not less than 24" on centers.
    f. Valves and Fittings: Fitting insulation shall be applied in the same manner as adjacent pipe insulation with sufficient bands to hold securely in place. Where it is impractical to finish fittings the same as adjoining pipe insulation (metal jacket), fittings may be finished with glass fabric and cutback, and painted to match jacket, where approved by the Architect.
    g. Fittings and valves shall be insulated with urethane 1" thick. Where available in correct configuration, factory mold kits shall be used with insulation foamed in place and wrapped with Butyl tape. Otherwise insulate with block urethane, vapor sealed and wrapped with Butyl tape.
    h. Exercise caution in installation to avoid damage to the insulation during installation. Piping having damaged insulation will be rejected.

5. Heating Water Supply and Return Lines: Insulate with molded sectional glass fiber pipe covering with factory applied all-purpose vapor barrier jacket equal to Manville "Micro-Lok APT 650". Insulation shall be 1” for lines 1.5 inches and smaller. Insulation shall be 1.5” thick for larger lines. Insulate valves and fittings with fiberglass inserts and "Zeston" PVC covers.
6. Roof Drains: Insulate bodies of roof drain with one coat insulating cement to thickness of adjacent covering and cover with vapor barrier jacket of kraft paper and aluminum foil with glass fiber reinforcing fabric. Hubs shall be covered by building up layers of insulation until they are covered. The insulation shall overlap the adjacent insulation by a minimum of 2", bevel the ends and seal with glass fiber reinforced vapor barrier asphaltic adhesive.
7. Water Chiller: Factory insulated.
8. Duct Insulation: Refer to Section 'AIR DISTRIBUTION' for duct liner and exterior duct specification.
9. Interior Ducts:

    a. Insulate the supply, return and fresh air ducts with 0.75 lb. density, 2" thick Manville "Microlite R Series" glass fiber flexible insulation having a factory applied FSKL vapor barrier jacket.
    b. This insulation shall be secured, vapor barrier side out, to sheet metal. On horizontal runs, lap top and bottom sheets over edges of side pieces. Butt joints tightly. Except on ducts handling warm air only, seal all joints, punctures, breaks and fasteners with 3” wide pressure sensitive foil type applied with moving pressure using an appropriate sealing tool. Staples shall be outward clinch, maximum 6” on center. Install with not more than 25% compression in accordance with manufacturer's installation instructions.
    c. Cover all joints, punctures and breaks with three-inch wide facing strip.
    d. Ducts handling warm air only need not be vapor sealed.

END OF SECTION 15600

SECTION 15700 - EQUIPMENT

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data and shop drawings on all items specified.

1.3 SCOPE

A. This section of the specifications pertains to all labor, materials, equipment and service necessary for and incidental to the mechanical equipment as shown on the drawings and/or as specified herein.

B. This section requires the furnishing of all equipment specified and/or shown on the drawings. Equipment referred to singularly shall mean each item, and the total number of items shown or specified shall be furnished. All equipment shall be manufactured in the USA.

C. All appurtenances and auxiliary equipment necessary to the function of any specified item of equipment shall be furnished with the item of equipment, whether specifically mentioned or not. Each item of equipment shall perform the function for which it is intended, and all work necessary to provide a complete functional system shall be provided.

D. This specification requires that all items of equipment be completely installed, finally connected, tested and placed in service.

E. It shall be the responsibility of the Contractor to verify all requirements of the equipment and the contract and certify with the submittal of the shop drawings that all requirements have been met, including:

1. Space requirements
2. Electrical requirements (voltage, phase, wires - no. and size)
3. Capacities
4. Clearance for maintenance
5. Quality
6. Quantity

PART 2 - PRODUCTS

2.1 MOTORS

A. Motors shall be furnished for all motor driven equipment. Motors with special operating conditions such as multiple speed or in hazardous locations shall be as specified under the equipment served. General service motors driving through flexible couplings or belts shall conform to the following requirements:

1. Less than 1/6 HP: Split phase, 40 degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.0. Provide with inherent thermal overload protection.
2. Fractional larger than 1/6 HP: Capacitor start, 40-degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.0 or greater. Provide with inherent thermal overload protection.
3. Integral Horsepower, Single Phase: Capacitor type, 40-degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.15.
4. Three Phase: High efficiency continuous duty squirrel cage type, 40 degree C ambient, dripproof or totally enclosed fan cooled as required by exposure with a service factor of 1.15. Power factor shall be 85% or greater. Motors shall be equal to Gould E-Plus.

2.2 MOTOR STARTERS

A. Except where starters are shown integral to motor control centers (see electrical drawings), the Division 15 Contractor shall furnish all motor starters (controllers) and control equipment for equipment specified under Division 15. The Contractor under this section of the specifications shall be responsible for coordinating starter sizes, characteristics, heater element sizes and all other details. All starters shall be combination starter/disconnect devices, and shall include control transformers, hand-off-auto switches, and pilot lights.

B. All individual starters shall be the product of a single manufacturer and submitted for review at the same time.

C. Where starters are specified with items of equipment, the starters shall be factory mounted and wired.

D. Magnetic Starters (Full Voltage): Starters shall be individual units, combination starter/molded case circuit breaker units, combination starter/fused disconnect switch units or combination starter/unfused disconnect switch units unless otherwise indicated.

E. Units shall be of General Electric, Square D, Westinghouse, Federal or Gould manufacture with the proper enclosures.

F. Provide pilot lights and either pushbutton stations or hand-off-automatic switches as required for the control of each item of equipment. Generally, pushbutton stations shall be used only where no interlock or remote functions are specified. Control devices shall be in the starter cover unless otherwise indicated.

G. Provide auxiliary contacts on starters to accomplish interlocks and control as specified. Starter disconnecting means shall have auxiliary contacts to disconnect all control circuits when the starter is disconnected.

H. Provide all three phase starters with solid state overloads which provide protection against single-phase events.

I. Equip each starter unit with a control power transformer, with 120-volt secondary, a secondary fuse in one leg and the other secondary leg grounded.

J. Manual Starters: Where manual starters are indicated, they shall consist of a horsepower rated on-off switch, or hand-off-auto switch with a pilot light and overload element(s) in the same enclosure. Where the starter is installed in public areas, it shall be in a recessed box with a stainless steel coverplate.

2.3 WATER CIRCULATING PUMPS

A. Pumps shall be as indicated in the schedule on the drawings. Each shall be of the type, rotational speed, and have the flow rate and characteristics listed. The name and model number listed for each pump establishes a standard which the pump furnished must equal to exceed.

B. Acceptable makers of scheduled pumps are Allis-Chalmers, Buffalo, Weinman, Peerless, Aurora and Paco.

C. Pumps, casings and glands shall be suitable for operation under 150 psig static heads.

D. Rotational speeds shall not exceed those scheduled. Under no circumstances shall a pump be offered with an impeller radius greater than 90% of the distance from the shaft centerline to the cutoff in the casing, except in the case of in-line circulators.

E. The head capacities are listed for bidding purposes only. The Contractor shall carefully calculate the head of each pump, taking into consideration the pressure drops in all equipment, exact lengths of pipe, valves, fittings, etc. These calculations shall take into account actual routing of the piping and all other factors that would determine the actual pumping head of each system and shall form the basis of final pump selection.

F. Motors shall be constant speed, drip proof motors, and shall be so sized with relation to the pump impeller that the required brake horsepower will not exceed the rated motor horsepower at any point on the pump curve. Copies of manufacturer's performance curve shall be submitted as shop drawings on each pump. Each curve shall be clearly marked to indicate the diameter of the impeller and the selection point. All pump motors shall have 1.15 service factor.

G. All pumps shall have gauge tappings.

H. Pumps baseplates shall be of cast iron or welded structural steel shapes and shall have a raised lip and threaded drain connection. Each baseplate on a pump handling chilled water shall be of sufficient size to extend under and catch the drip from connecting flanges and the outboard bearing.

I. All pumps shall be factory enameled.

2.4 SPLIT COUPLED VERTICAL IN-LINE PUMPS

A. Provide Vertical In-Line (VIL) pumps, single stage, single or double suction type, with pump characteristics which provide rising heads to shut off. Refer to pump schedule for pump flows and heads and motor speed, enclosure, efficiency and power requirements and other system conditions. Provide Armstrong Series 4300 split-coupled type VIL units, with rigid spacer type coupling.

B. Pump Construction: Pump Casing - Cast Iron with 125 psig ANSI/PN16 flanges for working pressure below 175 psig (12 bar) at 150°F (65°C) and Ductile Iron with 250 psig ANSI/PN25 flanges for working pressures to 375 psig (25 bar) at 150°F (65°C). Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

C. Impeller - Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.

D. Shaft - Provide Stainless Steel pump shaft.

E. Coupling - Rigid spacer type of high tensile aluminum alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.

F. Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate. Provide factory installed flush line with manual vent.

G. All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.

H. Seal flush line accessories, if required to improve seal chamber cleanliness: Supply in the flush line to the mechanical seal a 50-micron cartridge filter and sight flow indicator, to suit the working pressure encountered.

I. Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the owner.

J. Alternately, a maintenance-free accessory needing pump differential pressures exceeding 70 ft./30 psig/200 kPa for effective operation: Supply in the flush line to the mechanical seal a maintenance-free sediment separator, with sight flow indicator.

2.5 CLOSE COUPLED PUMPS

A. Pump construction shall consist of cast iron casing and bronze impeller. The shaft shall be carbon steel with renewable bronze wear rings. Ball bearings shall be 100,000-hour average life and grease lubricated. Provide with mechanical seals. Motor shall be NEMA c-face standard per Hydraulic Institute.

2.6 FILTERS

A. Provide all filters specified herein and/or scheduled or shown on the drawings. All filters shall be erected in holding frames, tight fitting, with no bypass path.

B. All filters of every type shall be UL listed Class I or II.

C. Every air-handling device which supplies air to any space shall have a filter bank. No., size, and type of filters, shall be as scheduled on the drawings.

D. All frames shall be fitted with new media at final acceptance. In addition, provide 100% spare filters.

2.7 MAGNAHELIC GAUGES

A. Provide and install a Dwyer model 2002, 0-2” water column differential pressure gauge across every filter bank. Unit shall have 0.05” minor divisions. Provide copper tubing to each side of the filter bank. Mount the gauge to the filter housing, adjacent duct, or air handling unit.

2.8 DISPOSABLE MEDIUM EFFICIENCY FILTERS

A. Filters shall be medium efficiency (30-35% based on ASHRAE 52-68) at a velocity of 500 FPM. Media shall be pleated, non-woven reinforced cotton fabric supported by a welded wire grid with 95% open area. Frame shall be heavy-duty waterproof chipboard. Filter shall have not less than 4.5 square feet of media per foot of face area. Filters shall be equal to Farr 30/30 series.

PART 3 – EXECUTION

Not Used

END OF SECTION 15700

SECTION 15705 - AIR COOLED PACKAGED CHILLER

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of this Section shall conform to the general provisions of the Contract, including General and Supplementary Conditions, Conditions of the Contract, and Contract Drawings.

1.2 SCOPE

A. Provide Microprocessor controlled, multiple scroll compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:

1. Chiller package
2. Charge of refrigerant and oil
3. Electrical power and control connections
4. Chilled liquid connections
5. Manufacturer start-up

1.3 QUALITY ASSURANCE

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and installed in compliance with applicable sections of the following Standards and Codes:

1. AHRI 550/590 – Water Chilling Packages Using the Vapor Compression Cycle
2. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
3. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
4. ANSI/ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
5. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
6. ANSI/NFPA 70 – National Electrical Code (N.E.C.)
7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
8. OSHA – Occupational Safety and Health Act
9. Manufactured in facility registered to ISO 9001
10. Conform to Intertek Testing Services for construction of chillers and provide ETL/cETL Listed Mark

B. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization.

D. Warranty: Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of eighteen (18) months from date of shipment or twelve (12) months from date of start-up, whichever occurs first.

1.4 DELIVERY AND HANDLING

A. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.

B. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures.

C. Unit shall be stored and handled per Manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CHILLER MATERIALS AND COMPONENTS

A. General: Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled scroll compressor chiller(s) as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD 34 Number Designation and Safety Classification of Refrigerants. Chiller shall include not less than two refrigerant circuits above 50 tons (200kW), scroll compressors, direct-expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components and special features as specified herein or required for safe, automatic operation.

B. Cabinet: External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5% salt spray test, yields minimum ASTM 1654 rating of "6".

C. Operating Characteristics: Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 30°F to 115°F (-1°C to 46°C) ambient temperature. [Optional: -10°F to 125°F (-23°C to 52°C) ambient.]

D. Service Isolation valves: Discharge (ball type) isolation valves factory installed per refrigerant circuit. Includes a system high-pressure relief valve in compliance with ASHRAE15.

E. Pressure Transducers and Readout Capability:

1. Discharge Pressure Transducers: Permits unit to sense and display discharge pressure.
2. Suction Pressure Transducers: Permits unit to sense and display suction pressure.
3. High Ambient Control: Allows units to operate when the ambient temperature is above 115°F (46°C). Includes discharge pressure transducers

2.2 COMPRESSORS

A. Compressors: Shall be hermetic, scroll-type, including:

1. Compliant design for axial and radial sealing.
2. Refrigerant flow through the compressor with 100% suction cooled motor.
3. Large suction side free volume and oil sump to provide liquid handling capability.
4. Compressor crankcase heaters to provide extra liquid migration protection.
5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
6. Initial oil charge.
7. Oil level sight glass.
8. Vibration isolator mounts for compressors.
9. Brazed-type connections for fully hermetic refrigerant circuits.

10. Compressor Motor overloads capable of monitoring compressor motor current. Provides extra protection against compressor reverse rotation, phase-loss and phase-imbalance.

2.3 REFRIGERANT CIRCUIT COMPONENTS

A. Each refrigerant circuit shall include: a discharge service ball type isolation valve, high side pressure relief, liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.

2.4 HEAT EXCHANGERS

A. Evaporator:

1. Evaporator shall be brazed-plate stainless steel construction capable of refrigerant working pressure of 650 psig (3103 kPa) and liquid side pressure of 150 psig (1034 kPa) [Option for 300 psig (2068 kPa) available].
2. Brazed plate heat exchangers shall be UL listed.
3. Exterior surfaces shall be covered with 3.4" (19mm), flexible, closed cell insulation, thermal conductivity of 0.26k ([BTU/HR-Ft² - °F]/in.) maximum.
4. Water nozzles shall be provided with grooves for field provided ANSI/AWWA C-606 mechanical couplings.
5. Evaporator shall include vent and drain fittings and thermostatically controlled heaters to protect to -20°F (-29°C) ambient in off-cycle.
6. A 20-mesh, serviceable wye-strainer and mechanical couplings shall be provided for field installation on evaporator inlet prior to startup.
7. Evaporator shall be provided with piping extension kit and mechanical couplings to extend liquid connection from evaporator to edge of unit. Thermal dispersion type flow switch shall be factory installed in the evaporator outlet pipe extension and wired to the unit control panel. Insulation and heat trace on piping shall be responsibility of installing contractor. Extension kit nozzle connections shall be ANSI/AWWA C-606 (grooved).

B. Air-Cooled Condenser:

1. Coils: Condenser coils shall be constructed of a single material to avoid galvanic corrosion due to dissimilar metals. Coils and headers are brazed as one piece. Integral sub cooling is included. Coils shall be designed for a design working pressure of 650 PSIG (45 bar). Condenser coil shall be washable with potable water under 100 psi (7 bar) pressure.
2. Low Sound Fans: Shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise, full-airfoil cross section, providing vertical air discharge and low sound. Each fan shall be provided in an individual compartment to prevent crossflow during fan cycling. Guards of heavy gauge, PVC (poly- vinylchloride) coated or galvanized steel shall be factory installed.
3. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class “F”, current protected, Totally Enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

2.5 CONTROLS

A. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

B. Power/Control Enclosure: Rain and dust tight NEMA 3R powder painted steel cabinet with hinged, latched, and gasket sealed door.

C. Microprocessor Control Center:

1. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pumpdown at system shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from -10°F to 125°F (-23°C to 52°C) ambient. Automatic reset to normal chiller operation after power failure.
2. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real-timeclock (RTC) memory for minimum 5 years.
3. Forty-character liquid crystal display, descriptions in English (or Spanish, French, Italian, or German), numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.
4. Programmable Setpoints (within Manufacturer limits): display language; chilled liquid temperature setpoint and range, remote reset temperature range, daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
5. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, liquid temperature reset via a 4-20milliamp or 0-10 VDC input, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.
6. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. System Safeties include: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
7. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation.
8. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
9. BAS Communications: YORKTalk 2, BACnet MS/TP, Modbus and N2 communication capabilities are standard. Unit shall communicate with Johnson Controls Metasys BAS. Coordinate all details of interconnectivity prior to bid.

D. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.6 POWER CONNECTION AND DISTRIBUTION

A. Power Panels:

1. NEMA 3R/12 rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.

2. Power supply shall enter unit at a single location, be 3 phase of scheduled voltage, and connect to individual terminal blocks per compressor. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.

B. Compressor, control and fan motor power wiring shall be located in an enclosed panel or routed through liquid tight conduit.

2.7 ACCESSORIES AND OPTIONS

Some accessories and options supersede standard product features. Your Johnson Controls representative will be pleased to provide assistance.

A. Microprocessor controlled; Factory installed Across-the-Line type compressor motor starters as standard.

B. Low Ambient Control: Permits unit operation to -10°F ambient. Standard unit controls to 30°F ambient.

1. High Ambient Control: Permits unit operation above 115°F ambient.

C. Power Supply Connections:

1. Single Point or Multiple Point Disconnect: Single or Dual point Non-Fused Disconnect(s) and lockable external handle (in compliance with Article 440-14 of N.E.C.) can be supplied to isolate the unit power voltage for servicing. Separate external fusing must be supplied, by others, in the incoming power wiring, which must comply with the National Electric Code and/or local codes.

D. Control Power Transformer: Converts unit power voltage to 120-1-60 (500 VA capacity). Factory-mounting includes primary and secondary wiring between the transformer and the control panel.

E. Protective Chiller Panels (Factory or Field Mounted)

1. Louvered/Wire Panels: Louvered steel panels on external condenser coils painted as per remainder of unit cabinet. Heavy gauge, welded wire-mesh, coated to resist corrosion, around base of machine to restrict unauthorized access.

F. Thermal Dispersion Flow Switch (Factory installed and wired in piping extension kit): Normally open, 30bar pressure rating, stainless steel 316L construction, IP67, -4°F to 158°F ambient rating.

G. Hot Gas By-Pass: Permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity (depending on both the unit & operating conditions) by introducing an artificial load on the evaporator. Hot gas by-pass is installed on only one refrigerant circuit.

H. Low Temperature Process Glycol: Leaving chilled liquid setpoint range 10°F to 50°F (-12°C to 10°C)

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 16).

E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

END OF SECTION 15705

SECTION 15800 - TESTING, ADJUSTING AND BALANCING MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SCOPE

A. The contractor shall include in his bid an amount necessary to perform and submit a certified TAB report. This section of the specifications comprises the furnishing of all labor, materials, transportation, tools and appliances and in performing all operations in connection with the testing, balancing and adjusting of various systems and portions thereof to produce proper flows of air and water, correct setting of regulation devices, and other end results as more fully described hereinafter.

B. Upon completion of the installation and start-up of the mechanical equipment, check, adjust, and balance systemic components to obtain optimum conditions in each conditioned space to the building.

C. Prepare and submit to the Engineer complete reports on the balance and operation of the system.

D. Make inspections in the building during the opposite season from that in which the initial adjustments were made and at those times make any necessary modifications to the initial adjustments required to produce optimum operation of the systemic components, to produce the proper conditions in each conditioned space.

E. In all fan systems, the air quantities shown on the plans may be varied as required to secure a maximum temperature variation of 2 degrees within each separately controlled zone, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drives and/or motors, if necessary, without cost to the Owner, to attain the specified air volumes.

F. Before final acceptance is made, furnish the following data:

1. A tabulation of the simultaneous temperature of all spaces on each separately controlled zone, together with the outside temperature at time of measurement.
2. A listing of the measured air quantities at each outlet corresponding to the temperature tabulation specified above.
3. Air quantities at each return and exhaust air handling device.
4. Flow rate and temperature at each coil and heating device.
5. Static pressure readings entering and leaving each supply, and exhaust fan, and other components of the system. These readings shall be related to fan curves in terms of CFM handled.
6. Motor current readings at each fan and pump. The voltages at the time of the reading shall be listed.

G. The above data shall be neatly entered on appropriate forms together with any typed supplements required to completely document all results. Written explanations of any abnormal conditions shall be included. All this shall be assembled into a document and submitted electronically.

H. When opposite season modifications are made, additional data sheets indicating new settings, readings, etc., shall be prepared and submitted.

1.3 INSTRUCTIONS

A. During the test periods instruct the building operating personnel in the operation and maintenance of all equipment.

B. Deliver to the Owner 3 complete instruction manuals covering the maintenance and operation of the system components. In addition, provide schematic wiring diagrams of each piece of equipment framed under glass and mounted on the wall as directed. Provide complete data on all equipment, including for each item a parts list, and the name and address of the vendor where replacement parts can be purchased.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION 15800

SECTION 16010 – BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SCOPE

A. The work included in Division 16 of the Specifications includes all electrical work, interior and exterior to the project. Provide all materials, labor, equipment, transportation, tools, permits, fees, and supervision to install, test and make operational the complete electrical systems.

1.3 QUALITY ASSURANCE

A. Referenced Standards: Provide and install products in accordance with referenced standards. Comply with the standards listed in each section.

B. Codes: The electrical work shall be in accordance with latest edition of the following codes:

1. National Electrical Code
2. National Electrical Safety Code
3. Life Safety Code
4. International Building Code
5. City of Paris Electrical Ordinance
6. State of Texas codes as applicable
7. National Fire Protection Association
8. Other codes as referenced in individual sections

C. Material Standards: Materials and equipment shall be listed or labeled as defined in Article 100 of the National Electrical Code (NEC), by a testing agency acceptable to the Owner. Materials shall be marked for their intended use.

D. Permits and Inspections: Obtain all permits and inspections for the installation of the work and pay all charges incident thereto. Deliver to the Owner all certificates of inspections issued by authorities having jurisdiction.

1.4 SUBMITTALS

A. Provide submittals for equipment as listed in each Section.

B. Submittals shall include descriptive material, catalog sheets, diagrams, performance curves, and charts published by the manufacturer to show conformance with drawings and specifications.

C. Provide complete electrical characteristics for all equipment. Lighting submittals shall include photometric data.

D. Submittals shall be clearly marked showing the individual item offered.

E. All electrical submittals shall be bound in a book, indexed by specification section, and certified that they have been checked by the contractor.

F. Omissions from the submittal of any material which has been shown on the drawings or specified, does not relieve the contractor from furnishing and installing the item.

1.5 WARRANTY

A. The contractor warrants the material and equipment installed to be free from defects for a period of one year after acceptance by the owner. All defects in labor or materials occurring during this period shall be repaired or replaced.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. The electrical equipment specified and shown on the drawings is based on information available at the time of design. If the equipment furnished has different electrical requirements, the contractor shall make the required changes to the wire, conduit, controls, overcurrent protection, switchgear, and installation as required to accommodate the equipment supplied, without additional charge to the owner. The cost for such adjustments shall be assigned to the respective section of this Specification under which the equipment is furnished.

2.2 MATERIALS

A. All materials shall be UL labeled where a Standard exists for the product. If the product does not bear the UL label, the manufacturer shall submit documentation from an independent testing laboratory, acceptable to the authority having jurisdiction, showing evidence that the product is suitable for the installation.

B. Materials and equipment shall be the standard products in current production of manufacturers regularly engaged in the production of such equipment.

C. All materials shall be new and free from defects. Materials of the same type shall be the product of one manufacturer.

D. All material and equipment shall be installed, applied, and handled in accordance with the manufacturer's recommendations and standards.

E. Where no specific material is mentioned, provide the required material from a reputable manufacturer. The material shall conform to the project requirements, and shall be suitable to the engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. Fabricate, erect, and install the complete electrical systems in accordance with accepted good practice by qualified personnel who are licensed and experienced in such work. Proceed in an orderly manner so as not to impede the progress of the project.

3.2 DRAWINGS

A. The electrical drawings are diagrammatic. Carefully coordinate the work with structural, architectural, and mechanical conditions. Make adjustments to avoid conflicts.

B. The locations shown for electrical equipment is approximate and not intended to convey the exact details of installation. Exact locations are to be determined in the field by actual measurements.

C. The contractor is responsible for fitting the equipment and material into the space. If the equipment furnished requires different space conditions than shown on the drawings, the contractor shall arrange for such space and shall submit a drawing indicating the exact details of installation prior to construction.

D. Do not scale drawings. Layout electrical equipment using dimensions obtained from the manufacturer of the equipment and from field measurements.

3.3 SITE INVESTIGATION

A. Prior to submitting bids, visit the site and become aware of existing conditions that may affect the cost of the project. Include in the bid the work required to remove, extend, relocate, reconnect or modify existing equipment or systems, and to restore them to their original condition.

3.4 MATERIALS HANDLING AND STORAGE

A. Handle materials in accordance with the manufacturer's standards and recommendations.

B. All materials, except those specifically designed to be installed outdoors, shall be stored in an enclosed, dry building or trailer. Protect all stored equipment from damage. Remove damaged materials from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment and materials. They shall be protected from water, direct sunlight, cold and heat unless designed for such conditions.

3.5 CUTTING AND PATCHING

A. Sleeve or cut all openings in walls, floors, ceilings and roof required to install the electrical work.

B. Do not cut structural members unless specific permission is granted by the structural engineer.

C. Patch all openings after installation of the work, and repair any damage caused by this activity. Restore the surface to its original condition.

3.6 PAINTING

A. Refer to PAINTING Section of these Specifications.

B. Touchup scratched or marred surfaces of all electrical equipment with paint obtained from the equipment manufacturers specifically for that purpose. Remove all oil, dirt, grease and foreign material before painting and prepare the surface as recommended by the manufacturer.

C. Where plywood backboards are used to mount equipment, paint backboards with two coats of light gray semi-gloss paint.

3.7 TESTING

A. Provide all field-testing specified in the individual specification sections.

3.8 RECORD DOCUMENTS

A. Provide record documents as required in Division 1 of the specifications.

3.9 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Provide Operation and Maintenance manuals as required in Division 1 of the specifications.

B. Before final inspection, instruct the owner's personnel in operation of the systems under this Division. Use the Operation and Maintenance Manual as basis for the instruction. Review the contents of the manual in detail and explain all aspects of operation and maintenance.

C. Prepare and insert additional data in the manual when need for such data becomes apparent during instruction.

END OF SECTION 16010

SECTION 16110 – RACEWAYS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all conduits and fittings.

1.3 SCOPE

A. Furnish and install all conduits, wireways, raceways, and fittings for all systems interior and exterior to the building.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. American National Standards Institute (ANSI)
   - C-80.1 Rigid Galvanized Conduit
   - C-80.3 Electrical Metallic Tubing
3. Underwriters Laboratories, Inc. (UL)
   - UL 1 Flexible Metal Conduit
   - UL 5 Surface Metal Raceways and Fittings
   - UL 6 Rigid Metal Conduit
   - UL 651 Rigid PVC Conduit
   - UL 797 Electrical Metallic Tubing
   - UL 1242 Intermediate Metal Conduit
   - UL 360 Liquid-Tight Flexible Steel Conduit
4. National Electrical Manufacturers Association (NEMA)
   - RN1 Externally PVC Coated GRS and IMC Conduit

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Metal Conduit and Fittings:

   a. Allied

b. Wheatland
c. Appleton
d. Raco
e. Killark
f. O-Z / Gedney

2. PVC Conduit and Fittings:

a. Carlon
b. Certainteed

3. PVC Coated Metal Conduit: Robroy Industries

2.2 METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit (GRS):

1. Rigid, threaded, galvanized inside and outside or galvanized outside with protective coating inside.
2. Factory made steel threaded couplings.

B. Intermediate Metal Conduit (IMC):

1. Rigid, threaded, thin wall steel, galvanized outside with protective coating inside.
2. Factory made steel threaded couplings.

C. Electrical Metallic Tubing (EMT):

1. Steel tubing, galvanized outside with slick corrosion resistant interior coating.
2. Steel compression couplings and box connectors.

D. Flexible Metal Conduit:

1. Spirally wound with interlocking galvanized steel strips. Aluminum is not permitted.
2. Flexible conduit shall be approved for use as equipment grounding conductor.
3. Connectors shall be steel, suitable for grounding continuity.

E. Liquidtight Flexible Metal Conduit:

1. Spirally wound with interlocking galvanized steel strips with PVC cover extruded over the exterior to make the conduit liquidtight.
2. Shall be approved for use as equipment grounding conductor.
3. Shall be steel, suitable for grounding continuity, liquidtight.

2.3 PVC CONDUIT AND FITTINGS

A. PVC conduit shall be Schedule 40 unless noted otherwise.

B. Exterior underground conduit encased in concrete ductbank shall be type EB.

C. Conduit fittings shall be the same material as the conduit supplied by the same manufacturer.

2.4 PVC COATED METAL CONDUIT AND FITTINGS

A. The PVC coated rigid galvanized steel conduit must be UL Listed. The PVC coated conduit shall be hot dip galvanized inside and out. The PVC coated conduit factory-cut threads shall be protected with hot galvanized threads and a clear urethane coating. Thread protectors shall be used on the exposed threads of the PVC coated conduit. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid galvanized steel conduit. The PVC coating shall be gray, 40 mils in thickness, continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit.

B. The PVC coated rigid galvanized steel conduit must be certified and authorized to apply the ETL Verification Mark “ETL Verified to PVC-001”. ETL Verified to: Intertek ETL SEMKO High Temperature H20 PVC Coating Adhesion Test Procedure.

C. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to PVC coating must be UL listed. The PVC coating shall be gray, 40 mils in thickness, and be free of blisters, bubbles, or pinholes. Applicable UL standards may include: UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes; UL 886 Standard for Safety for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

D. Form 8 conduit bodies, 1/2" through 2" diameters, shall have a tongue-in-groove, V-Seal gasket to effectively seal against corrosive elements, and be supplied with plastic encapsulated stainless steel cover screws.

E. A PVC sealing sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening, except unions. The inside sealing sleeve diameter shall be matched to the outside diameter of the conduit.

F. The PVC coating on the outside of conduit couplings shall be 40 mils in thickness and have a series of raised longitudinal ribs to protect the coating from tool damage during installation.

G. A red, green, or gray urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2-mil thickness. Conduit or fittings having pinholes or areas with thin or no coating shall be unacceptable.

H. All male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of a red, green, or gray urethane coating.

I. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the PVC coated conduit.

J. Independent certified test results shall be available to confirm coating adhesion under the following conditions:

K. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

L. Installation of the PVC coated conduit system shall be performed in accordance with the manufacturer's installation manual. PVC coated conduit installers shall be certified by the PVC coated conduit manufacturer before the installation can begin.

M. All PVC coated conduit, fittings, and accessories must be new, unused material.

N. All PVC coated conduit, fittings, and accessories shall be supplied by the same manufacturer.

O. Material brands of PVC coated conduit systems known to meet the above specifications:

1. Plasti-Bond
2. Perma-Cote
3. KorKap

PART 3 – EXECUTION

3.1 EXCAVATION

A. Perform all excavation work required in connection with the installation of the work under this Section. After the electrical work has been installed, tested and approved, backfill all excavations with suitable material under the direction of the Architect. Include the cutting of all sidewalks, streets, and other pavement and repairing the openings in them to return the surface to approximately its original condition.

B. Perform all excavations of every description of whatever substances encountered and to the depths required for installation of the work under this Division.

C. During excavation, stack material suitable for backfilling in an orderly manner a sufficient distance from the banks to prevent slides or cave-ins. Remove all excavated material not required or suitable for backfill. Control grading to prevent surface water from flowing into excavations, and remove any water accumulating therein by pumping.

D. Make trenches the necessary width for proper installation of the lines.

E. Grade the bottom of trenches accurately to provide uniform bearing and support for conduit or duct on undisturbed soil at every point along its entire length.

F. Where excavation requires the opening of existing walks, streets, drives or other existing pavement, cut the pavement as required. Hold the size of the cut to a minimum consistent with the work to be accomplished. After the installation of the new work is completed, and the excavation has been backfilled, patch the paving using materials to match those cut out. Take care that the patches are level with the original surfaces and thoroughly bond with them.

3.2 BACKFILLING

A. Carefully backfill trenches with earth, sandy clay, soft shale or other approved material free from large clods of earth deposited in thoroughly and carefully rammed 6-inck layers.

B. Do not use broken concrete or pavement as backfill material.

C. Settling the backfill with water is permissible and will be a requirement when so directed.

D. Re-open any trenches improperly filled or where settlement occurs to the depth required for proper compaction, then refill, mound over and smooth off.

E. Install continuous identification tape as specified in ELECTRICAL IDENTIFICATION.

F. Backfill open trenches across roadways or other areas to be paved as specified above except that the entire depth of trench shall be backfilled in 6-inch layers, each layer moistened and compacted to a density of not less that 95% Standard Proctor in such manner as to permit the rolling and compaction of the filled trench together with the adjoining earth to provide the required bearing value and permit paving the area immediately after backfilling as completed.

3.3 INSTALLATION OF UNDERGROUND DUCTS

A. Concrete between ducts and earth, and with 3 inches of concrete between adjacent ducts. Provide at least 30 inches of cover from top of concrete encasement to finished grade. Install with uniform slope for drainage, with no low pockets to collect water.

B. Build up duct banks completely in the trench before any concrete is poured, using factory-fabricated plastic conduit spacers in staggered configuration to provide the proper horizontal and vertical spacings, and securing the entire assembly with heavy twine or cord to insure rigidity during pouring. Do not use metal for this purpose. Assemble conduits with staggered adjacent couplings so that no two couplings will lie in the same transverse plane, in a vertical direction. Use solvent cement as directed by the duct manufacturer in making up all joints.

C. Fabricate duct runs with standard factory-made fittings, elbows and accessories. Make all changes of direction, horizontal or vertical, with long sweep bends having a minimum radius of 25 feet, except that manufactured bends at or near the ends of the runs may be used on short runs of 100 feet or less. Make long sweep bends with one or more curved or straight sections of duct. Manufactured bends, where permitted, shall have a minimum radius of 10 times the nominal duct diameter. Where manufactured ducts of greater than a 30-degree angle are required, use rigid hot dipped galvanized steel conduit bends. During construction, protect partially completed duct lines from entrance of dirt and debris by means of suitable factory-made duct plugs. After completion of installation, seal all ends of spare ducts with factory made duct plugs.

D. Where ducts enter in or under buildings, change from plastic duct to rigid galvanized steel conduit below grade outside the structure, using suitable factory adapters. At the point of change of materials, extend the concrete envelope to enclose at least 2 feet of steel conduit. Wrap all steel conduits and fittings buried in earth as specified elsewhere herein, or use PVC coated steel conduits.

E. Install the concrete envelope for a given duct run in one pour where possible. Use concrete of 3000 psi compressive strength. In pouring concrete, do not allow heavy masses of concrete to fall on ducts. Direct flow of concrete down sides of assembly to bottom, forcing it to flow to center of bank and then to rise up in middle, filling all spaces uniformly. Spade concrete liberally and carefully with a long, flat slicing bar between vertical rows to eliminate voids. Weight or brace the duct bank assembly if necessary, to prevent the assembly from floating. Because of the fact that plastic conduits may expand considerably during construction, each run and its concrete envelope shall be installed starting at one end and proceeding toward the other with any necessary adjustments to length being made at the end toward which the work is progressing.

F. After ducts are installed, complete with envelope, and before pulling any cable, pull a mandrel through every duct to check for alignment and clear passage. Use an iron-shod mandrel with a diameter of 1/4 inch less than the nominal size of the duct and a length equal to the duct diameter. Mandrel shall have a leather or rubber gasket slightly larger than the duct hole. After testing the ducts with the mandrel, pull a stiff-bristled brush through each duct until it is clear of all particles of earth, sand or gravel; then install duct plugs immediately.

3.4 INSTALLATION OF UNDERGROUND PLASTIC CONDUIT

A. Install at least 30 inches below finished grade unless noted to the contrary. Assemble and install raceways in accordance with manufacturer's instructions. Make joints with couplings and solvent cement. Fabricate bends of 30 degrees or more with factory-made elbows, or make field bends with proper heating equipment. Bends showing signs of overheating or flattening are unacceptable. Ream ends of all conduit before joining.

B. "Snake" plastic conduit in trench, from side to side, with a complete cycle every 40 feet to allow for expansion and contraction. Maintain this configuration during backfilling.

C. Where conduit turns up out of earth, or floor slabs, change from plastic to rigid galvanized steel conduit below grade and outside of such structures. Do not extend any plastic conduit above grade. Make similar change from plastic to rigid galvanized steel conduit at connections to underground pull or junction boxes. Wrap all steel conduits and fittings buried in earth as specified elsewhere herein, or use PVC coated steel conduits.

3.5 INSTALLATION OF UNDERGROUND STEEL CONDUIT

A. All steel conduit in earth shall be rigid galvanized steel conduit. Wrap such conduit with 3M Company 0.020-inch thick No. 51 "scotchrap" vinyl plastic tape, half lapped to give a double thickness wrap. Remove all oil, grease and dirt from conduit with a suitable solvent, and clean and dry conduit before wrapping. If conduit is pre-wrapped in the shop and then cut and joined on the job, wrap all joints on the job, overlapping pipe wrapping 3" on both sides of joints.

3.6 INSTALLATION OF PVC COATED CONDUITS

A. During installation, visually examine the conduit for cuts. Patch these areas with a paste containing a PVC solvent obtained from the conduit manufacturer. The patch shall be built up to the original thickness of the coating and feathered out on all sides of the damaged area a minimum of l/2 inch to provide a complete bonded seal over the damaged area.

3.7 INSTALLATION OF BUILDING RACEWAYS

A. All wiring of every description shall be run in conduit or electrical metallic tubing unless noted or specified otherwise. Conduits may be run exposed in machinery and electrical rooms and unfinished areas. All other conduits shall be run concealed unless otherwise noted. All exposed runs shall be installed parallel to the surface of the building in a neat and orderly manner.

B. Types: All conduits installed in wet or damp locations, or on roofs shall be rigid galvanized steel conduits. Above grade interior conduits shall be rigid galvanized steel conduit, intermediate metal conduits or electrical metallic tubing. Conduits installed below grade in slabs or buried in earth shall be PVC or PVC coated rigid galvanized steel or wrapped rigid galvanized steel.

C. Sizes: Size and install raceways so that conductors may be drawn in without injury or excessive strain. Make field bends with approved bending devices. Do not install bends or offsets in which conduit is crushed, deformed or otherwise injured.

D. Connections: Use lengths of flexible metal conduit, not less than 12" long at final connections to all motors, generators, controls and other devices subject to movement because of vibration or mechanical adjustment. Use flexible metal conduit also at connections to recessed lighting fixtures, and elsewhere as required. In damp or wet locations, and where installed outdoors, use liquidtight flexible metal conduit.

E. Around Heat Producing Equipment: Do not install raceways within 3" of steam and hot water pipes, breeching and flues, except where crossings are unavoidable, and then keep raceways at least 1" from insulation on the pipe, breeching or flue crossed. Wherever possible, avoid installing raceways directly above or in close proximity to boilers and other like objects operating at high temperatures.

F. Damp or Wet Locations: In damp or wet locations make every effort to avoid installing raceways in a manner which will create moisture traps. Where they must be so installed, seal both ends of raceways with an approved sealing compound to prevent "breathing" and moisture condensation within the raceways.

G. Different Systems: In systems operating at more than 300 volts between phase conductors, where different phase conductors are to be run to a common gang wall switch box, install a separate conduit for each different phase wire and its return switch leg, and provide substantial barriers between adjacent switches in the box so that two different phase wires will not be the same compartment.

H. Joining Rigid Conduits: Join with threaded couplings. Ream out all conduit ends after threading. Secure rigid conduits at panel boxes, junction boxes, pull boxes, switchboards, support boxes, or sheet metal outlet boxes by galvanized locknuts, inside and outside, with insulating bushing inside. Unthreaded set screw type couplings or connectors are not acceptable in rigid conduit systems. No running threads shall be used anywhere in conduit systems.

I. Protection of Raceways: Seal ends of all raceways with blank discs ("pennies"), push pennies or other approved closers during construction. Do not pull any conductors into raceways until all plastering in the vicinity is completed. Swab out all raceways before pulling in conductors.

J. Penetrations: Wherever raceways pass through floors, walls partitions, etc., carefully fill any space between the outside of the raceway and the building material to prevent passage of air, water, smoke and fumes. Filling material shall be fire-resistive and installed to meet requirements of the UL Fire Resistance Directory.

3.8 CONDUIT SUPPORTS

A. Support Spacing: Use minimum spacing as directed by National Electrical Code, but space hangers more closely where required by conditions.

B. Vertical Conduit Risers: Support vertical conduits at each floor by means of riser clamps or U-bolts, clamping them to a steel channel bridging the opening in the floor.

C. Individual Conduits: Support conduits running vertically or horizontally with galvanized malleable iron one hole clamps. Carry individually supported horizontal conduits l-1/4" and

larger on Kindorf No. 150 or Steel City No. C-149 hangers. Use no perforated strap iron as hanger material. Where conduits smaller than 1-1/4" are installed above metal lath and plaster ceilings or mechanically suspended dry ceilings of the non-removable type, they may be supported on ceiling runner channels. Where conduits smaller than 1-1/4" are installed above removable ceilings, attach them to the structure or bar joists (where present) or support them on threaded hanger rods with clips. Do not use any wire to support conduits or to attach conduits to supporting members. Locate conduits a sufficient distance above the ceiling to permit removal of the ceiling panels. Locate them so as not to hinder access to mechanical and electrical equipment through the ceiling panels.

D. Multiple Conduits: Where multiple raceways are run horizontally at the same elevations, they may be supported on trapezes formed of sections of Unistrut angle iron or channels suspended on rods or pipes. Size trapeze members including the suspension rods for the number size and loaded weight of the conduits they are to support. Space them as required for the smallest conduit supported.

END OF SECTION 16110

SECTION 16120 – WIRES AND CABLES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit catalog data sheets on all conductors and cables and wire.

1.3 SCOPE

A. Under this Section, furnish and install all building wires and cables (600 volts and below) complete with connectors and terminations. Exterior branch circuits and feeders are also included in this section. Wiring for communication and alarm systems are included in their respective sections unless they reference this Section.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products which comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (U.L.)
   UL 44 Thermoset-Insulated Wires and Cables
   UL 83 Thermoplastic-Insulated Wires and Cables
   UL 486 Wire Connectors and Soldering Lugs
   UL 510 Insulating Tape

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. Insulated Cable:

   a. Southwire Co.
   b. Senator Wire & Cable Co.
   c. Okonite
   d. Anaconda
   e. Pirelli Cable Co.

2. Electrical Spring Connectors:

   a. Scotch
   b. Ideal
   c. Buchanan

3. Compression Connectors:

   a. Burndy
   b. Scotch
   c. Ilsco

4. Mechanical Connectors:

   a. Burndy
   b. Scotch
   c. Ideal

5. Insulating Kits:

   a. Raychem
   b. Scotch

6. Insulating Tape: Scotch

2.2 CONDUCTORS

A. Type: Soft drawn copper, UL listed, rated at 600 volts, free from flaws and imperfections. Conductors no. 10 and smaller shall be solid. Conductors larger than no. 10 shall be stranded.

B. Insulation: Unless otherwise indicated on the drawings, otherwise specified in other Sections, or otherwise required by the National Electrical Code, conductors shall have type THHN/THWN or XHHW insulation.

C. High Temperatures: Use type RHH or RHW-2 for wiring in proximity to boilers and other devices subject to high temperatures.

D. Markings: Conductors shall be marked on the surface with rated voltage, size, type, and manufacturer. The size shall be repeated at intervals not exceeding 24 inches, with the remaining data repeated at intervals not exceeding 40 inches.

E. Performance: Conductors shall be electrically continuous and free from shorts or grounds. All open or shorted conductors shall be replaced. All conductors with damaged insulation shall be removed and replaced with new conductors free from defects.

F. Conductors and cables installed open in ceiling plenums shall be plenum-rated.

2.3 JOINTS AND SPLICES

A. Solid Conductors (No. 10 AWG and smaller): U.L. approved, screw-on, electrical spring connectors, 600 volt, 105C, insulated.

B. Stranded Conductors (No. 8 and Larger): Crimp type compression connectors properly selected for the conductor size and material. All connectors shall be applied with properly sized dies and tools as recommended by the manufacturer. Insulate the splice with an insulating kit providing 600 volt, 90C rating.

2.4 COLOR CODING

A. Equipment Grounding Conductors:

1. Equipment grounding conductors shall be green. Grounding conductors from isolated grounding system shall be green with yellow stripes.
2. Equipment grounding conductors, no. 6 awg and smaller shall have continuous color-coding the entire length of the conductor. Sizes larger than no. 6 awg shall be permitted to be identified at each end, and at every point where the conductor is accessible. The marking shall consist of green tape, or green adhesive labels.

B. Neutral Conductors:

1. Neutral conductors shall be white or natural gray.
2. Where systems of different voltages are installed, the neutral of the lower voltage shall be white or natural gray, and the neutral of the higher voltage shall have three continuous white stripes on other than green insulation.
3. Sizes no. 6 awg, or smaller shall have continuous color-coding the entire length of the conductor. Larger sizes shall be permitted to be identified at each end, and at every point where the conductor is accessible. The marking shall consist of white tape or stripped tape or white adhesive labels.

C. Phase Conductors:

1. Conductors no. 10 awg and smaller shall have continuous color-coding the entire length of the conductor. Larger sizes shall be permitted to be identified at each end, and at every point where the conductor is accessible. The marking shall consist of colored tape, or colored adhesive labels.
2. The color-coding system employed shall be permanently posted on the inside door of each branch-circuit panelboard. The posting shall identify the color-coding of each phase conductor and shall be applied to the inside of the door with adhesive.
3. 120/208 volt, 3 phase system:
   Phase A – Black
   Phase B – Red
   Phase C – Blue
4. 277/480 volt, three phase system:
   Phase A – Yellow
   Phase B – Brown
   Phase C – Orange

PART 3 – EXECUTION

3.1 INSTALLATION OF WIRING

A. Install all wiring in raceways unless specified otherwise.

B. Wire Pulling: Provide suitable installation equipment for pulling conductors into raceways or conduits. Use ropes of polyethylene, nylon or other suitable material to pull in conductors. Attach pulling lines to conductors by means of woven basket grips or by pulling eyes attached directly to conductors. All conductors to be installed in a single conduit shall be pulled in together. Use U.L. listed cable pulling compound where necessary.

C. Cable Lubricants: All cable lubricants shall be UL listed, and shall be certified by their manufacturer to be non-injurious to the insulation on which they are used.

D. Wire Sizing:

1. No wire shall be smaller than no. 12, except for signal and control circuits, or lighting fixture taps.
2. Receptacle and motor branch circuits – Use no. 12 conductors unless noted or scheduled otherwise.
3. 120 volt, 20 amp lighting and receptacle branch circuits – Where the length of run from panelboard to first lighting outlet or receptacle exceeds 85 feet use no. 10 conductors; otherwise use no. 12.
4. 277 volt, 20 amp lighting branch circuit – Where the length of run from panelboard to first lighting outlet exceeds 175 feet, use no. 10 conductors; otherwise use no. 12.
5. Where more than three current-carrying conductors are installed in the same conduit or raceway, the conductors shall be increased in size as required to maintain the required ampacity after application of the adjustment factors of NEC Table 310-15(b)(2)(a).
6. All branch circuit wiring connected to the load side of dimmers shall have an individual neutral installed with each circuit.

E. Joints and Splices:

1. Make joints and splices only where necessary and only at outlet boxes, wiring troughs and other enclosures permitted by the NEC. All joints shall be mechanically and electrically secure.
2. Do not splice conductors in panelboards, safety switches, switchboards, motor control centers or motor control enclosures.
3. Conductors for use with insulated spring connectors shall be twisted together prior to application of the connector.

F. Terminations: Tighten electrical connections and terminations in accordance with the manufacturer's published values. A calibrated tool shall be used to insure proper torque values.

G. Bundling: Bundle all conductors in panelboards, cabinets, pullboxes and the like using nylon straps made for this purpose. Bundle conductors larger than no. 10 in individual circuits. Bundle smaller conductors in larger groups.

H. Identification: Refer to ELECTRICAL IDENTIFICATION SECTION.

1. Mark conductors to clearly identify each circuit by number. Securely attach to each conductor in each junction box, pull box, panelboard, etc.
2. The cover of each junction box and pullbox shall be marked with the designations of each circuit contained therein.
3. Where colored plastic tape is applied to conductors for identification, use half-lapped turns for a distance of 6 inches from the terminal points and in boxes where taps and splices are

made. Apply the last two turns with no tension to prevent unwinding. Use 1-inch wide tape applied to avoid obscuring cable identification markings.

3.2 FIELD TESTING

A. Tests and procedures shall be in accordance with the applicable IPCEA standards. Furnish all instruments, equipment and personnel required for testing. Submit test data to the engineer on data sheets in a format that can be compared with future testing. All test data shall be included in the project operating manual.

B. Test wires and cables for electrical continuity and short circuits.

C. Prior to terminating, check each service and feeder conductor with megohmmeter to determine the insulation resistance with respect to ground and other phases. Applied potential shall be 1000 volts dc for 1 minute.

D. Test cable mechanical connections to the manufacturer's recommended values using calibrated torque wrench.

E. Energize circuits and demonstrate proper operation.

END OF SECTION 16120

SECTION 16130 – BOXES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit catalog data sheets for all boxes.

1.3 SCOPE

A. Furnish and install electrical boxes in accordance with the requirements of the National Electrical Code.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   No. 514 Outlet boxes and fittings
   No. 50 Enclosures for Electrical Equipment
3. National Electrical Manufacturers Association (NEMA)
   No. OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   No. FB 1 Fittings and Supports for Conduit and Cable Assemblies

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. Sheet Steel Outlet and Device Boxes:

   a. Raco
   b. Steel City
   c. Appleton

2. Cast Metal Device Boxes:

   a. Crouse Hinds
   b. Appleton

c. Pyle National

2.2 OUTLET AND DEVICE BOXES

A. All boxes shall be UL listed.

B. Sheet steel boxes shall be not lighter than 14 gauge, galvanized after fabrication.

C. Cast metal boxes shall be cast iron or cast alloy.

D. Outlet boxes for switches, receptacles and communications use shall be 4” square with proper square cornered tile wall cover, plaster cover or finishing plate, except where construction will not permit or the device requires a larger box. Box depth shall be as required by NEC for device and wiring volume requirements, but not smaller than 1-1/2 inches.

E. Boxes for devices mounted flush in concrete block walls shall be single gang masonry boxes, 3-1/2” deep.

F. Boxes installed in poured concrete shall be concrete-tight type.

G. Boxes for surface mounted or pendant fixtures shall be 4”octagonal by 1-1/2” minimum depth.

H. Boxes for flush mounted fixtures shall be 4” by 4” size with cover installed above the ceiling and accessible by removing ceiling panel or fixture. Connection to fixture shall be with flexible conduit.

I. Boxes for interior exposed work shall be cast metal boxes (Cast iron or cast alloy).

J. Boxes for outdoors shall be cast metal boxes with gasketed covers.

2.3 PULLBOXES AND JUNCTION BOXES

A. Sheet steel galvanized inside and outside, with galvanized covers.

B. Dimensions shall be as required by NEC for the number, size and locations of conduits entering the box.

C. Boxes installed above ceilings shall be accessible by removing ceiling panels, installing access door in hard ceiling, or flush mounting the cover on the ceiling.

D. Boxes installed flush in walls in finished areas shall have overlapping trim with hinged door and lock to match the appearance of electrical panelboard.

E. All boxes shall have covers.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide at each outlet or device of whatever character a metal outlet box in which conduits shall terminate.

B. All pull and junction boxes shall be accessible after construction is complete. Install access panels in the construction as required to make the box accessible.

C. Fasten all boxes securely to the building construction, independent of conduit systems.

D. Where outlet box on grid ceiling supports surface or suspended fixture, provide box with fixture stud and secure the box to ceiling members with steel channel.

E. Outlet boxes for devices shown back to back shall be offset a minimum of 6 inches.

F. All boxes shall have covers and unused conduit openings shall be covered.

END OF SECTION 16130

SECTION 16140 – WIRING DEVICES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all wiring devices.

1.3 SCOPE

A. Furnish and install in suitable outlet boxes, the wiring devices indicated complete with coverplates. All shall be properly connected to conductors so as to be operable.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
   WD 1 General Requirements for Wiring Devices
   WD 6 Wiring Devices – Dimensional requirements
3. Underwriters Laboratories (UL)
   UL 20 General-Use Snap Switches

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Hubbell
2. Leviton
3. Pass & Seymour
4. General Electric
5. Bryant

2.2 CLASSIFICATION

A. All wiring devices shall be UL listed.

B. All wiring devices shall be specification grade.

2.3 COLORS

A. All devices shall have **white** finish where mounted in walls finished in light colors and a brown finish where mounted in walls finished in dark colors.

B. All devices connected to the emergency power system shall be **red**.

2.4 SWITCHES

A. The catalog numbers listed are of Hubbell manufacture. Equivalent devices from listed manufacturers are acceptable. Furnish switches in colors specified above even though the numbers listed may not contain the correct suffix.

1. Single pole wall switch – 1221.
2. Three-way wall switch – 1223.
3. Four-way wall switch – 1224.
4. Pilot-lighted switch – 1221-PLC.
5. Momentary contact switch – 1556.

2.5 RECEPTACLES

A. The catalog numbers listed are of Hubbell manufacture. Equivalent devices from listed manufacturers are acceptable. Furnish receptacles in colors specified even though the numbers listed may not contain the correct suffix.

1. Duplex receptacle: 20 amp, 125 volt, grounding (NEMA 5-20R) – No. 5362.
2. Ground Fault Interrupter Receptacle (GFI) – No. GF-5362.
3. Special Receptacles: Furnish devices in the NEMA configuration listed on the drawings.

2.6 WEATHERPROOF DEVICES

A. Provide the specified device in weatherproof cast box with gasketed coverplate.

2.7 COVERPLATES

A. Provide coverplates for all wiring devices, including telephone, signal outlets and other devices. Coverplates shall be one piece single or multi-gang type as required.

B. Indoor Flush Devices:

1. High impact plastic plates matching the color of the device covered.
2. Where installed in masonry walls, use jumbo plates.

C. Indoor Surface Devices: For indoor devices use zinc-coated metal with rounded or beveled edges, same size as the box.

D. Outdoor devices: TayMac

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install wiring devices plumb and level.

B. Install SPST wall switches with OFF position down.

C. Wall switches shall be installed on the strike side of the door as finally hung.

D. Install receptacles with grounding pole on top.

E. Install devices within outlet boxes to allow coverplates to be in full contact with the wall on all sides.

F. After connection of each wiring device, install two full wraps of electrical insulating tape around the side terminals prior to installation in the box.

G. Replace broken devices and plates with new.

H. Clean all paint, plaster and dirt from wiring devices and plates.

3.2 MOUNTING HEIGHTS

A. Where mounting heights are indicated on the drawings, the device shall be installed with the centerline of the device at the indicated height.

B. Devices noted to be installed above counters or millwork shall be installed above the backsplash.

C. Unless otherwise noted on the drawings, or directed by architect, install devices at the following heights above finished floor:

DEVICE	MOUNTING HEIGHT
Wall switch	46”
Receptacle	18”

3.3 IDENTIFICATION

A. At each wiring device mark the inside of the coverplate with the panel and circuit number to which the device is finally connected. Use black indelible marker.

3.4 FIELD TESTING

A. Energize lighting circuits and operate each wall switch to verify proper operation.

B. Energize receptacle circuits and test each receptacle with circuit tester to verify the device is energized and has correct polarity.

C. Test TRIP and RESET buttons on GFI receptacles. In addition, test GFI receptacles with a GFI tester to verify it trips at 4ma of ground current.

END OF SECTION 16140

SECTION 16170 – GROUNDING AND BONDING

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all grounding equipment.

1.3 SCOPE

A. Furnish and install grounding equipment and systems as specified herein. Also refer to, and comply with specific grounding requirements contained in other Sections.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Institute of Electrical and Electronic Engineers (IEEE)
   Standard 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
3. Underwriters Laboratories, Inc. (UL)
   UL 467 Grounding and Bonding Equipment

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Grounding Products:
   Chance / Hubbell
   Copperweld Corp
   Erico Inc.
   Ideal Industries, Inc.
   ILSCO
   Kearney / Cooper Power Systems
   Superior Grounding Systems, Inc.
   Thomas and Betts
   Raco, Inc.
   Burndy

2.2 CONDUCTORS

A. Equipment Grounding Conductors:

1. Use insulated conductors that comply with WIRES AND CABLES Section.
2. Equipment grounding conductors shall be green.
3. Isolated ground conductors shall be green with yellow stripes.
4. No. 6 AWG and smaller shall have continuous color-coding the entire length of conductor. Larger sizes shall be identified with color-coded plastic tape at each end, and at every point where the conductor is accessible. For equipment grounding conductors use green tape. For isolated ground conductors use alternating bands of green and yellow tape with a minimum of three bands of green and two bands of yellow.

B. Grounding Electrode Conductors: Insulated stranded cable complying with WIRES AND CABLES Section.

C. Underground Ground Conductors: Bare conductors installed underground shall be tinned, stranded complying with ASTM B8.

D. Bonding Conductors:

1. Bonding cable: 28 kcmil, 14 strands of no. 17 AWG, copper.
2. Bonding Conductor: Bare stranded copper.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors terminated with copper ferrules.

2.3 GROUND RODS

A. Ground rods shall be one-piece or sectional type, copper-clad steel, 5/8” in diameter by 10 feet long.

2.4 GROUND CONNECTORS

A. Compression Connectors:

1. Suitable for direct burial, embedded in concrete, or above grade applications, equal to Burndy Hyground.
2. Connectors shall be equivalent in current-carrying capacity to the maximum size copper conductors being joined.
3. Equipment shall be in accordance with the connector manufacturers recommendation. This shall include cable preparation, installation tools and dies, and the required number of crimps.

B. Bolted Connectors:

1. UL listed for grounding.
2. Above grade applications.
3. Provide equipment in accordance with connector manufacturers’ recommendations for the application.

C. Welded Connectors:

1. Exothermic-welded type, UL listed for grounding connections.
2. Provided in kit form and selected for the specific types, sizes, conductors and other items to be connected.

PART 3 – EXECUTION

3.1 SERVICE GROUNDING

A. Provide adequate and permanent service neutral and equipment grounding in accordance with the NEC.

B. Connect the service ground and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. From the common point of connection of the service ground and equipment ground, run in conduit a combined service and equipment grounding conductor (grounding electrode conductor) without joint or splice to the grounding electrode system. At each end point of connection, attach the metal conduit containing the grounding electrode conductor to the grounding electrode, or bond the grounding electrode conductor to its conduit as it exits the conduit with a fitting selected for this purpose. Separate bonding jumpers are not permitted for bonding the conduit to the electrode.

3.2 GROUNDING ELECTRODE SYSTEM

A. Ground rods

B. Building steel

C. Water service line

D. Concrete-encased electrode (Ufer ground)

3.3 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250 for types, sizes and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install a separate, green-insulated, equipment grounding conductor in each feeder and each branch conduit. Install the grounding conductor in the same raceway with related phase and neutral conductors, and connect to pull boxes or outlet boxes at intervals of 100 feet or less. Where paralleled conductors in separate raceways occur, provide a grounding conductor in each raceway. Connect the grounding conductors to bare grounding bars in panelboards, and ground busses in service equipment to the end that there will be an uninterrupted grounding circuit from the point of a ground fault to the point of connection of the equipment ground and system neutral.

C. Install equipment grounding conductors in nonmetallic raceways unless they are designated for telephone or data cables.

D. Install equipment grounding conductors in all flexible metal conduit and liquid-tight flexible metal conduit.

3.4 INSTALLATION

A. Ground Rods:

1. Install at least 3 rods spaced at least one rod length from each other and located at least the same distance from the other grounding electrodes.
2. Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
3. Interconnect ground rods with no. 2/0 bare, tinned, stranded copper 24” below grade. Attach with exothermic welds except at test wells.

B. Metallic Water Service Pipe:

1. Clean contact surfaces thoroughly to assure good metal to metal contact.
2. Where a dielectric fitting occurs on the water main, connect the grounding conductor on the street side of the fitting.
3. Connect to the pipe with a grounding fitting designed to attach the grounding conductor and its conduit to the pipe.

C. Grounding Building Steel: The building structural steel frame shall be grounded to the grounding electrode system.

3.5 FIELD INSPECTION AND TESTING

A. Inspection:

1. Visually verify proper grounding connections at the service entrance equipment.
2. Visually verify proper connections to the grounding electrode system.
3. Visually verify proper grounding connections of separately derived systems.
4. Visually verify proper grounding connections at emergency generators.
5. Visually verify proper grounding connections at distribution panels and branch circuit panels.

B. Testing:

1. Perform ground impedance measurements using the fall-of-potential method described in IEEE Standard 81. Instrumentation utilized shall be specifically designed for ground testing.
2. The testing shall be performed before the electrical distribution system is energized, and shall be made in normally dry conditions not less than 48 hours after rainfall, and without moistening the ground.
3. The impedance-to-ground of the main grounding electrode system shall be 5 ohms or less.
4. Where tests show an impedance to ground of more than 5 ohms, take action to decrease this value to 5 ohms by driving and interconnecting additional ground rods, installing ground plates, or installing chemical electrodes.

END OF SECTION 16170

SECTION 16195 – ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SCOPE

A. Provide and install electrical identification for electrical conductors and equipment.

1.3 QUALITY ASSURANCE

A. Comply with National Electrical Code (NEC).

B. Comply with UL Standard 969.

C. Comply with ANSI C2.

D. Comply with NEMA WC-1 and WC-2.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. W. H. Brady
2. Ideal Industries, Inc.
3. Seton Nameplate Co.
4. Panduit Corp.

2.2 EQUIPMENT NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates:

1. Melamine plastic laminate, minimum 1/16” thick for signs up to 20 sq. inches, and 1/8” thick for larger sizes.
2. White letters on black face for equipment connected to normal power system.
3. White letters on red face for equipment connected to emergency power system.
4. Attach with self-tapping stainless-steel screws, except contact-type permanent adhesive can be used where screws can not or should not penetrate the surface.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coded Plastic Tape: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.

B. Identification Bands: Provide manufacturer's standard vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters to show circuit identification.

2.4 UNDERGROUND LINE WARNING TAPE

A. Permanent, bright colored, continuous printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indication type of underground line.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install electrical identification products in accordance with the manufacturer's written instructions, and requirements of NEC and OSHA.

B. For items attached with adhesive, degrease and clean the surface as recommended by the manufacturer.

C. Where items attach to surfaces that require painting, attach after completion of painting.

D. Install signs at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Identification on Boxes:

1. Boxes for fire alarm circuits shall be painted red.
2. Every box containing circuit wiring shall have the circuit numbers marked on the outside cover of the junction box. Use indelible marker with wide tip. Markings for normal circuits shall be black, and shall be red for emergency circuits.

3.2 CONDUCTOR IDENTIFICATION

A. Apply conductor identification on each conductor in each box, enclosure, cabinet and panel.

B. Refer to Section 16120 for color-coding of conductors.

3.3 MARKING EXTERIOR UNDERGROUND LINES

A. During trench backfilling for power, control, signal, and communication lines, install continuous underground plastic line marker located directly above the line at 12 to 16 inches below finished grade.

3.4 EQUIPMENT IDENTIFICATION

A. Install engraved, plastic laminate sign on each unit of electrical equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems unless the units contain their own self-explanatory identification.

B. Unless otherwise indicated, provide a single line of text with ½" high lettering on 1-1/2" high sign (2" high where 2 lines are required).

C. Text shall match the notations used on the drawings for identification.

3.5 IDENTIFICATION OF PANELBOARDS, SWITCHBOARDS, AND SWITCHGEAR

A. Install engraved plastic laminate sign containing 3 lines of text. The top line shall be the panel name. The centerline shall indicate the panel voltage, and the bottom line shall indicate the source of supply.

B. Signs for equipment fed from the normal system shall have white letters on black background, and equipment fed from the emergency system shall have white letters on red background.

C. An example of the required identifications is:

Panel 4HA
277/480
Fed From Panel 4DP

END OF SECTION 16195

SECTION 16441 – SAFETY SWITCHES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Complete drawings showing dimensions.
2. Conduit entry/exit locations.
3. Voltage rating, continuous current rating, and short-circuit rating.
4. Cable terminal size.
5. Fuse rating and type.

1.3 SCOPE

A. Provide, install, and connect all safety switches shown on the drawings or required by codes.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   UL 50 Enclosures for electrical Equipment
   UL 98 Enclosed and Dead-Front Switches
3. National Electrical Manufacturers Association (NEMA)
   No. 250 Enclosures for Electrical Equipment

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Square D
2. Cutler Hammer
3. General Electric

2.2 HEAVY DUTY SWITCHES

A. Requirements: Provide and install safety switches as shown on the drawings or as required by NEC. Where code requires the installation of safety switches that are not shown on the drawings, provide and install the required switches.

B. All switches shall be heavy-duty type.

C. Switches shall be fusible or non-fusible as noted on the drawings or as required by codes.

D. Provide switches with the voltage and current ratings as shown on the drawings.

E. Where safety switches serve as motor or motor starter disconnects, provide horsepower rated switches with auxiliary contacts to disconnect all power and control circuits.

F. Construction:

1. Switch blades and jaws shall be plated copper.
2. Switches shall have a handle that is easily padlockable in the OFF position.
3. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position.
4. Switch assembly and operating handle shall be an integral part of the enclosure base.
5. Switches rated 100A to 600A shall have reinforced fuse clips.
6. Switch blades shall be readily visible in the OFF position.
7. Switch operating mechanism shall be non-teasible, positive quick-make / quick-break type.
8. Fusible switches shall be suitable for service entrance equipment.
9. Switches shall have line terminal shields.
10. Switches shall have CU/AL mechanical lugs.

G. Enclosures:

1. Where installed indoors, all enclosures shall be NEMA I, general purpose type unless otherwise noted.
2. Where installed outdoors, all enclosures shall be NEMA 3R, raintight type unless otherwise noted.
3. Where noted on the drawings, provide the following enclosures:

    a. NEMA 4 – watertight (304 stainless steel).
    b. NEMA 12 – dust tight/oil tight.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install safety switches in accordance with manufacturers written instructions and NEC requirements.

B. Install adjacent disconnects at the same height.

C. Install disconnects to maintain the required NEC clearances and working space.

3.2 IDENTIFICATION

A. Identify and color-code conductors in safety switches as specified under WIRES AND CABLES Section.

B. Install engraved plastic sign on each safety switch as specified in ELECTRICAL IDENTIFICATION Section.

C. The sign shall contain 3 lines of text. The top line shall identify the load served. The center line shall indicate the voltage. The third line shall indicate the source of supply.

D. An example of the required identification is:

AHU #2
480 V
Fed From Panel PP

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. Visually inspect each switch for proper grounding connections as specified under GROUNDING AND BONDING Section.
2. Visually verify proper color-coding of conductors in safety switches as specified under WIRES AND CABLES Section.
3. Verify fusible switches contain proper type and size of fuses.

B. Testing:

1. Test cable mechanical connections to the manufacturers recommended values with calibrated torque wrench.
2. Operate each switch ON and OFF four times to verify proper operation.
3. Energize circuit and verify proper operation.

END OF SECTION 16441

SECTION 16470 – PANELBOARDS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Complete drawings showing dimensions.
2. Conduit entry/exit locations.
3. Voltage rating, continuous current rating, and short-circuit rating.
4. Cable terminal sizes.
5. Catalog product sheets.
6. Nameplate Identification.

1.3 SCOPE

A. Provide, install, and connect all electrical panelboards shown on the drawings and specified herein. Panels shall be complete assemblies including enclosures, bussing, overcurrent protective devices, and trim.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   UL 50 Cabinets and Boxes
   UL 67 Panelboards
   UL 489 Molded Case Breakers / Enclosures
3. National Electrical Manufacturers Association (NEMA)
   PB-1 Panelboards
   No. 250 Enclosures for Electrical Equipment
   AB-1 Molded Case Circuit Breakers

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Square D
2. Cutler Hammer
3. General Electric

2.2 PANELBOARD REQUIREMENTS

A. All panelboards shall be listed by Underwriters Laboratories.

B. The building main panel shall be listed as suitable for “Service Entrance Equipment”.

C. Panels shall be arranged for flush mounting, surface mounting, or free-standing as indicated on the drawings.

D. Panels shall have the voltage ratings, continuous current ratings, and interrupting ratings as scheduled on the drawings.

E. All panelboard accessories and features scheduled or specified on the drawings shall be provided.

F. Where a circuit protective device is scheduled as a “spare”, provide the device complete for operation. Where the device is scheduled as a “space” or “space only”, provide proper space and all necessary connectors for future installation of the size of device scheduled. Where the device is scheduled to serve a “future” load, provide the device complete for operation.

G. All circuit breakers shall be quick make, quick break, trip-free, thermal magnetic indicating type unless otherwise noted.

H. Branch circuit breakers shall be fully interchangeable without disturbing adjacent units.

I. Connect all overcurrent protective devices with sequence phasing.

J. Provide each panelboard with a neatly typewritten directory of circuits mounted in a plastic covered cardholder on the inside of the panelboard door.

K. Install laminated plastic nameplate for each panel as specified under ELECTRICAL IDENTIFICATION Section.

2.3 CONSTRUCTION

A. Cabinets:

1. Rigidly constructed of galvanized sheet steel per UL 50 Standards. Corners shall be overlapped or welded with the edges turned over to receive trim.
2. Where two-section panels are required, both sections shall be same height, and have fully rated bussing in separate cabinets connected by conduit nipples.

B. Trim:

1. Fabricated from sheet steel meeting the requirements of UL 50 Standards. Trim shall have medium gray enamel finish suitable to serve as the final finish, or suitable to receive field painting.
2. Trim door shall have rounded corners and edges free from burrs.

3. Surface trims shall be the same height and width as box. Flush trims shall overlap the box ¾" on all sides.
4. Furnish each door with substantial flush, cylinder tumbler lock and catch. Doors more than 48" high shall have auxiliary fasteners. Provide each lock with 2 keys. All locks shall be keyed alike.
5. Unless noted otherwise, interior mounted panels shall have type 1 fronts (one piece with hinged door). Where door-in-door construction is specified, it shall consist of a hinged door within a piano-hinged cover secured with trim clamps.
6. Exterior mounted panels shall be type 3R in accordance with UL 50 requirements. All doors shall be gasketed and be equipped with a tumbler type vault lock and two additional trunk type latches.

C. Bussing:

1. All bussing shall be plated copper sized in accordance with UL Standards to limit temperature rise on any current-carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
2. Main lugs and main breakers shall be UL approved for copper conductors sized to accommodate the conductors to be terminated. Provide oversized lugs to terminate conductors that are increased in size due to voltage drop or temperature requirements.
3. A bolted ground bus shall be included in all panels. Where scheduled, an isolated ground bus shall also be included.
4. A full size (100%) neutral bar shall be furnished for panels shown with neutral. Neutrals shall have suitable lugs for each outgoing feeder requiring neutral connection. Where scheduled, provide 200% rated neutrals with lugs for oversized neutral conductors.

2.4 DISTRIBUTION PANELS – CIRCUIT BREAKER TYPE

A. Distribution panels with bolt-on devices contained therein shall have fully rated interrupting ratings to interrupt fault current values indicated on the drawings. Breakers shall be molded case type.

B. Molded case circuit breakers shall provide overcurrent and short circuit protection with inverse time and instantaneous tripping characteristics. Also provide ground fault protection where scheduled.

C. Circuit breakers shall operate by toggle-type handle and shall be quick make, quick-break switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.

2.5 DISTRIBUTION PANELS – FUSIBLE SWITCH TYPE

A. Distribution panels shall have fusible switches for fuses in the ratings shown on the drawings.

B. Fusible switches shall be quick-make, quick-break design. Units 30 thru 600 amperes shall be rated not less than 200 kAIC with rejection-type fuse clips for Class R fuses. Units 800 and 1200 amperes shall be rated for 200 kAIC with Class L fuse provisions.

C. Fuses shall be field installed.

2.6 LIGHTING AND APPLIANCE PANELS

A. Bolt-in type, heavy duty, quick-make, quick-break, single- and multi-pole molded case circuit breakers with toggle handles that indicate when unit has tripped.

B. Circuit breakers shall be thermal magnetic type with common handle for all multiple pole breakers.

C. Breakers shall be UL listed as type SWD for lighting circuits.

D. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights and fire alarm panels.

E. Breakers shall be fully rated to interrupt the fault current values scheduled on the drawings.

F. Provide breaker accessories as scheduled on the drawings.

G. Where a lighting and appliance panelboard contains more than 42 branch overcurrent devices, the assembly shall consist of two or more separate boxes with each box containing not more than 42 branch overcurrent devices.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturers written instructions, NEMA PB1.1 and NEC standards.

B. Panelboard enclosures shall be securely fastened to the structure with a minimum of four bolts or screws.

C. Clean dirt and foreign paint from exterior and interior of all panels.

D. Do not splice conductors in panels.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. A single conductor shall terminate in each lug on a circuit breaker. Do not terminate multiple conductors under a single lug.

G. During installation carefully balance the electrical loads between the various phases. This may require connecting loads to circuits different from the circuit numbers indicated on the drawings.

3.2 IDENTIFICATION

A. Identify and color-code conductors in panelboards as specified under WIRES AND CABLES Section.

B. Install panelboard nameplate identification as specified under ELECTRICAL IDENTIFICATION Section.

C. Provide individual circuit identification for each circuit with a type-written directory of circuits mounted in a holder on the inside of the panel door. The directory shall identify the type or name of the load served along with the room names and numbers. The room names and numbers shall be the final names and numbers assigned to the space and not those used on the drawings.

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. Visually inspect each panel for proper grounding connections as specified under GROUNDING AND BONDING Section.
2. Visually inspect breakers and switches for broken parts and loose terminals.
3. Visually verify proper color-coding of conductors as specified under WIRES AND CABLES Section.
4. Visually verify panelboard trim fits properly with no gaps between the trim and panel enclosure.

B. Testing:

1. Test cable mechanical connections to the manufacturers recommended values with calibrated torque wrench.
2. Operate each breaker ON and OFF to verify proper operation.
3. Energize circuits and demonstrate proper operation.
4. When the facility is under normal use, amperage measurements shall be taken on each phase conductor in each panel feeder, and any unbalances shall be corrected to a point that no conductor load shall be more than 5% high or low (maximum unbalance of 10%).

END OF SECTION 16470

SECTION 16477 - FUSES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Catalog data for each type fuse.
2. Time-current curves for fuses
3. Current limiting characteristics and let-thru current curves.

1.3 SCOPE

A. Provide and install all fuses necessary for leaving the installation complete and in working order.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   UL 198B Class H Fuses
   UL 198C Current-Limiting Fuses
   UL 198D Class K Fuses
   UL 198E Class R Fuses
3. National Electrical Manufacturers Association (NEMA)
   FU-1 Low voltage cartridge fuses

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. Bussmann
2. Littlefuse

2.2 GENERAL REQUIREMENTS

A. Provide fuses of types, classes, and current ratings as required by NEC. Voltage ratings shall be suitable for the systems to which the fuses are applied.

B. Fuses shall be UL listed and labeled.

2.3 FUSES

A. Class L: Fuses larger than 600 amperes shall be Class L, current-limiting, time delay type, with minimum interrupting rating of 200,000 amperes RMS symmetrical.

B. Class RK1: 600 amperes and below, current-limiting, time delay type, minimum interrupting rating of 200,000 amperes RMS symmetrical.

2.4 SPARE FUSE CABINET

A. Wall mounted, fabricated from minimum 18-gauge sheet steel with full length, recessed, piano-hinge door with lock keyed the same as panelboard locks.

B. Provide interior shelves for the orderly storage of spare fuses specified for this project.

C. Finish shall be gray baked enamel.

D. The exterior of the door shall have the letters “SPARE FUSES” stenciled on the door, or by engraved nameplate.

PART 3 – EXECUTION

3.1 APPLICATION

A. Unless otherwise noted, fuses larger than 600 amperes shall be Class L current-limiting, time delay type. Fuses 600 amperes and below shall be Class RK1, current-limiting time delay type.

3.2 INSTALLATION

A. Install fuses in each fusible device after installation is complete and prior to energizing equipment.

B. Where the spacing of fuse clips in equipment is greater than required by the proper size of fuse, use suitable fuse reducers to fit the fuses.

C. Install Spare Fuse Cabinet in each electrical room identified on the drawings. Where not identified, install a Spare Fuse Cabinet in the main electrical room containing the service entrance equipment.

D. Place a fuse identification label showing type and size of the required fuses inside the door of each enclosure requiring fuses.

END OF SECTION 16477

SECTION 16510 – LIGHTING

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all lighting products.

B. Submit complete photometric data for each fixture.

1.3 SCOPE

A. This Section pertains to all labor, material, equipment and services necessary for and incidental to the complete interior and exterior lighting system as shown on the drawings and specified herein.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
   - No. 101 Life Safety Code
2. National Electrical Manufacturers Association (NEMA)
   - LE 4 Recessed Luminaires, Ceiling Compatibility
3. Underwriters Laboratories (UL)
   - UL 924 Emergency Lighting and Power Equipment
   - UL 1449 Surge Protection Devices
   - UL 1571 Incandescent Lighting Fixtures
   - UL 8750 Light Emitting Diode (LED) Equipment for Use in Lighting Products
4. Illuminating Engineering Society (IES)
   - LM-79 Electrical and Photometric Measurements of Solid-State Lighting Products
   - LM-80 Measuring Lumen Maintenance of LED Light Sources
   - TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by the following companies are acceptable:

1. Ballasts:

a. Advance
b. Lutron
c. General Electric
d. Valmont

2. Lamps:

a. Osram/Sylvania
b. General Electric
c. Philips

2.2 LUMINAIRES

A. Provide and install a lighting fixture on each lighting outlet shown. Furnish fixtures in accordance with the designations scheduled on the drawings. Should any designation be omitted on the drawings, furnish fixtures of the same type as used in rooms of similar usage. All features scheduled for fixtures shall be provided, even if the catalog number given in the schedule lacks the required numerals, prefixes of suffixes corresponding to the feature called for.

2.3 LED FIXTURES

A. Fixtures shall bear UL label.

B. General Requirements:

1. Drivers shall be Electronic type.
2. Total Harmonic Distortion Rating: 20% or less
3. Power Factor: 90% minimum.
4. Sound Rating: A
5. Surge Protection: Surge protection devices (SPD) to be provided with each luminaire.
6. RF Interference: Labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15.

2.4 LAMPS

A. LEDs:

1. Color Temperature: 4000 K
2. CRI: 80 or higher.
3. Lumen output as scheduled on the drawings.
4. LEDs of the same fixture type shall be supplied from the same batch during manufacturing.

PART 3 – EXECUTION

1.1 INSTALLATION

A. Installation of Interior Fixtures: Outlet box locations shown for fluorescent fixtures are diagrammatic. Locate boxes to coincide with stem hangers where such occur. Fixtures shall be level, square with the general construction and securely attached.

B. Lay-in Type Fixtures: Refer to the ceiling installer's layout for exact location. Center the fixtures in ceiling grids. Wire the fixtures using concealed outlet boxes accessible through ceiling panels. Install conductors in flexible metallic conduit from box to fixture.

C. Fixtures in Plaster Ceilings: Provide a suitable plaster ring or frame for each fixture recessed in a plaster ceiling.

D. Surface Mounted Fixtures: Fixtures shall be installed flush with the ceilings. Where fixtures are mounted to an exposed grid ceiling, the fixtures may be clipped to the ceiling grid provided the attachment holds the fixture flush, level, and secure. Where they cannot be centered on a grid, install a structural member to span two tees and attach the fixture to the structural members.

E. Where fixtures are installed in a continuous row, the row shall be straight and plumb. Lens shall be aligned in all planes and no part of the lamp shall be visible.

END OF SECTION 16510