



# PROJECT MANUAL

for

## Greenwood School District 50

1855 Calhoun Rd,  
Greenwood, SC 29649

### Dr. Benjamin Mays Elem. School Cooling Tower Upgrades

Submit to: Greenwood School District 50

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## **SUMMARY OF WORK**

### **Description of work:**

Provide a new cooling tower, pumps, heat exchanger, piping and controls as shown on the contract documents.

### **Demolition:**

Contractor shall provide the demolition and removal of all materials, conduits, wiring, piping and appurtenances as indicated on the drawings and as required and/or directed by Engineer. Disposal of all removed materials shall be included. The Owner shall reserve the right to retain all materials prior to removal from site.

### **Contractor Use of Premises:**

During construction the Contractor shall have use of the area indicated on the drawings for construction operations, including use of the site. The Contractor's use of the premises is limited only by the Owner's right to perform construction operations or employ separate Contractors on portions of the project.

Confine operations to areas within Contract limits. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.

Keep driveways and entrances clear at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize requirements for storage of materials.

### **Schedule of work:**

The existing facilities may be occupied during portions of construction. All disruption to services shall be scheduled in advance with the Owner prior to start of construction. Contractor shall coordinate the availability of products and equipment on the site prior to any demolition or removal of service.

### **Construction Staging Area:**

The Contractor will be assigned an area to be used for construction staging, storage of equipment on site, area for parking of temporary offices and/or supply trailers and area for parking of construction vehicles. Contractor shall provide temporary fencing with lockable gates for security.

### **SPECIAL NOTE PERTAINING TO ALL DIVISIONS OF THESE SPECIFICATIONS:**

Mechanical Design, Inc., will act as the Owner's agent during the bidding and construction phases. All references in these specifications indicating to be approved by Architect or to be performed by the Architect will be performed by Mechanical Design, Inc.

**END OF SECTION**

**SUMMARY OF WORK**

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SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: For each type of manufactured material and product, including forming and reinforcement accessories, admixtures, waterstops, joint systems, joint fillers, curing compounds, and others if requested.
- C. Design Mixes: For each concrete mix.
  - 1. Provide laboratory tests of materials and mix design tests.
  - 2. Indicate amounts of mix water, if any, to be withheld for later addition at Project site.
  - 3. Specify the location of the batch plant where the concrete will be mixed and the approximate distance from the job site.
- D. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, spacings, bent bar diagrams, arrangement, and supports of concrete reinforcement.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar to that indicated for this Project with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

- C. Source Limitations: Obtain each type of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each type of admixture from the same manufacturer.
- D. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
  - 1. ACI 301, "Specification for Structural Concrete."
  - 2. ACI 318, "Building Code Requirements for Structural Concrete."
  - 3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

## PART 2 - PRODUCTS

### 2.1 FORM-FACING MATERIALS

- A. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material.
- B. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
  - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. Structural 1, B-B, or better, mill oiled and edge sealed.
    - b. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, unless otherwise indicated.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no metal closer than 1 inch to the plane of the exposed concrete surface.

### 2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.

- C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

### 2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
  - 2. Precast concrete supports or concrete bricks may be used only for concrete members cast on earth. Reinforcement shall be wire-tied to these type supports periodically to prevent it from becoming dislodged during concrete placement.
- B. Portland Cement: ASTM C 150, Type I.
  - 1. Cement shall contain no more than 0.60% total alkalis.
- C. Fly Ash: ASTM C 618, Class C or F.
- D. Normal Weight Aggregate: ASTM C 33.
- E. Water: Potable and complying with ASTM C 94.

### 2.4 ADMIXTURES

- A. General: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. Retarding Admixture: ASTM C 494, Type B.
- E. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- F. High-Range Water-Reducing Admixture: ASTM C 494, Type F.
- G. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
- H. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

### 2.5 WATERSTOPS

- A. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch or 1/2 x 1 1/8 inch. Acceptable products include, but are not limited to:

1. Volclay Waterstop-RX, CETCO.
2. Swellstop, Greenstreak.
3. Hydro-Flex HF-302, Henry Company.

## 2.6 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

## 2.7 CURING MATERIALS

- A. Contractor shall verify that curing and sealing materials applied to floor slabs are compatible with all floor stains, coatings, tile, and other finish materials.
- B. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- C. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry. (Burleen non-staining mats).
- D. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B. Acceptable products include, but are not limited to:
  1. 1100-CLEAR, W.R. Meadows, Inc.
  2. W.B. Resin Cure, Conspec Marketing & Manufacturing Co., Inc.
  3. KUREX DR VOX, Euclid Chemical.
  4. CURE & SEAL WB, SpecChem.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

## 2.8 RELATED MATERIALS

- A. Expansion and Isolation Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber. Thickness 1/2 inch unless otherwise indicated. Acceptable products include, but are not limited to:
  1. Fibre Expansion Joint, W.R. Meadows, Inc.
- B. Vapor Barrier: See Division 7 specifications.
- C. Slab Granular Base Course: Clean crushed stone, crushed gravel, or manufactured or natural sand. Material shall be compactable. Rough or sharp materials which may puncture the vapor barrier shall not be used.
- D. Dovetail Anchor Slots: Hot-dipped galvanized sheet steel, not less than 0.0336 inch thick with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

- E. Latex Bonding Agent: ASTM C 1059, Type I or II, non-redispersible, acrylic emulsion or styrene butadiene.
- F. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- G. Epoxy Anchoring Adhesive: ASTM C 881, two-component epoxy resin, supplied in manufacturer's standard side-by-side cartridge and dispensed through a mixing nozzle supplied by the manufacturer, of class and grade to suit requirements.

## 2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109.
- B. Repair Topping: Traffic-bearing, cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

## 2.10 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
  - 1. Proportion normal weight structural concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:



1. Fly Ash: 25 percent.
- D. Maximum Slump:
  1. Concrete containing high-range water-reducing admixture or plasticizing admixture: 8 inches, after admixture is added to concrete with verified slump of 2 to 4 inches.
  2. Other concrete: 4 inches, plus or minus one inch.
- E. 28-Day Compressive Strength: As indicated. Water-cementitious materials ratio shall not exceed 0.50 for slabs-on-grade and elevated slabs.
- F. Air Content: In exterior concrete which is exposed to weather, add air-entraining admixture to result in concrete at point of placement having an air content of 5.5 percent within a tolerance of plus or minus 1.5 percent. Footings and other subterranean concrete do not require air-entrainment.
- G. Do not air entrain concrete in trowel-finished interior floors and suspended slabs except where air entrainment is required to achieve specified unit weights for lightweight concrete, or where a certain entrained air content is specified by the applicable UL fire-rated assembly. Do not allow entrapped air content in non-air-entrained concrete to exceed 3 percent.
- H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- I. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

## 2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
- B. In walls, slabs, and beams where runs of continuous bars too long to be fabricated from single bars, fabricate reinforcing so that lap splices in alternate bars are staggered.

## 2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
  1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Job site mixing is not permitted.

## PART 3 - EXECUTION

### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
  - B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
  - C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
    - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
    - 2. Class D, 1 inch for rough-formed finished surfaces which will be permanently concealed from view.
  - D. Construct forms tight enough to prevent loss or leakage of concrete mortar.
  - E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1 vertical to 1.5 horizontal.
    - 1. Install keyways, reglets, recesses, and the like, for easy removal.
    - 2. Do not use rust-stained steel form-facing material
  - F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
  - G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
  - H. Chamfer exterior corners and edges of permanently exposed concrete.
  - I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
  - J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, water, and other debris just before placing concrete.
  - K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
  - L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- 3.2 EMBEDDED ITEMS
- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, and directions furnished with items to be embedded.
    - 1. Install anchor bolts, accurately located, to elevations required.

- B. Conduits, Pipes, and Sleeves: Conduits are not permitted in elevated slabs or slabs on grade. Conduits, pipes and sleeves shall be permitted to be embedded in other concrete elements only with approval of the Structural Engineer. Embedded items must meet the following requirements:
1. Conduits, pipes and sleeves shall be made only of materials not harmful to concrete. Aluminum is not permitted.
  2. Diameter of items shall not be larger than 1/3 the thickness of the wall, footing, or beam in which they are embedded.
  3. Items shall not be spaced closer than 3 diameters on center.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained. Retaining walls and basement walls may not be backfilled until after 7 days minimum and after the concrete has achieved 100 percent of 28-day design compressive strength as verified by compression test results.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces.

### 3.4 VAPOR BARRIER INSTALLATION

- A. General: Following leveling and tamping of granular base course for slabs on grade, place vapor barrier sheeting between the bottom of the slab and the top of the granular base course. Place, protect, and repair vapor barrier according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints not less than 6 inches and seal joints and penetrations with manufacturer's recommended adhesive or pressure-sensitive tape. Vapor barrier shall be turned up at walls to top of slab and shall be sealed around pipes, conduits, and other penetrations.
  2. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all sides with seam tape.

### 3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. In walls, slabs, and beams where runs of continuous bars too long to be fabricated from single bars, install reinforcing so that lap splices in alternate bars are staggered.

- D. Before concrete is placed, accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. "Wet-sticking" of dowels, anchor bolts and reinforcing is not permitted. **Do not weld or tack weld reinforcing bars** unless indicated on the drawings or authorized by the Structural Engineer.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets so that length of overlap measured between outermost cross wires of each fabric sheet is not less than one spacing of cross wires plus 2 inches. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- G. Where blockouts are formed in slabs, unless otherwise indicated provide two #4 diagonal bars, 4'-0" long, at each corner of the blockout in the middle of the depth of the slab.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Provide construction joints at all locations where concrete placement is terminated resulting in concrete elements not being completed in a single monolithic placement. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Provide keys at construction joints using preformed galvanized steel or wood bulkhead forms, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
  - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - 5. Locate joints in continuous wall footings as required to facilitate construction.
  - 6. In areas with terrazzo or hard tile, coordinate joint locations to match joints in terrazzo or tile.
- C. Contraction (Control) Joints in Slabs on Grade: Construct contraction joints in slabs on grade to form patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab thickness unless otherwise indicated.
  - 1. Contraction joints shall be cut as soon as possible after slab finishing as may safely be done without dislodging aggregate or raveling joint edges. Joints shall be cut within 12 hours after concrete is placed.
  - 2. If joint pattern is not shown, provide contraction joints at a maximum spacing of 15 feet in each direction. Locate to conform to bay spacing where possible (at column centerlines, half bays, third bays.)
  - 3. In areas with terrazzo or hard tile, coordinate joint locations to match joints shown in terrazzo or tile.

### 3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless water has been withheld from the mix for this purpose.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
  - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
  - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When the average daily outdoor temperature is expected to fall below 40 deg F for three successive days, or when freezing temperatures may occur during the first 24 hours after concrete placement, deliver and maintain concrete temperature within the temperature range required by ACI 306.1. The average daily outdoor temperature is the average of the highest and lowest temperature during the period from midnight to midnight.
  - 2. Uniformly heat water and/or aggregates before mixing to obtain a concrete mixture temperature at point of placement within the temperature range required by ACI 306.1.
  - 3. Temperatures specified to be maintained shall be those measured at the concrete surface, whether the surface is in contact with formwork, insulation, or air.
  - 4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

5. Do not use salt or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
  6. **Do not use calcium chloride.**
- G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 95 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is included in calculation of total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- H.
- I. Blockouts in concrete walls to allow for erection of steel columns and beams shall be filled with concrete after the steel is erected and plumbed.

### 3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view, to receive a rubbed finish, or to be covered with a coating material applied directly to the concrete. This is the concrete surface imparted by selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
- 1.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### 3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: All slabs shall first receive a float finish. Machine floating shall not be used until the concrete surface will support a finisher on foot without more than a 1/4 inch indentation.
- C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, wood flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, stain, or another thin film-finish coating system.
  2. On lightweight concrete slabs containing entrained air, machine floating shall be started as late as possible and hard and prolonged troweling shall be avoided.
  3. Finish surfaces to the following tolerances, according to ASTM E 1155:
  4. Finish and measure surface so gap at any point between concrete surface and an unlevelled freestanding 10-foot-long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 1/8 inch.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and to surfaces where terrazzo, ceramic or quarry tile is to be installed by thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes, beam pockets, column pockets, and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide 3000 psi normal weight concrete fill for steel pan stair treads, landings, and associated items. Screed, tamp, and trowel-finish concrete surfaces. At stair landings, provide plain-steel welded wire fabric, of the same size used in adjacent floor slabs, located at mid-depth of the concrete fill.

### 3.11 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305R for hot-weather protection of concrete.

- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss exceeding 0.1 pounds per square foot per hour, based on chart in ACI 305R, before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period of seven days.
  - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period of seven days.
- F. Remove curing and sealing materials from floor slabs, without damaging concrete surfaces, by method recommended by curing and sealing manufacturer after the curing period in areas where floor stains, coatings, tile, and other floor finish materials are to be applied if recommended by the floor finish manufacturer.
- G. At polished concrete areas, use one of the moisture curing methods listed above. Do not use curing or sealing compounds.
- H. During grinding operations, apply a liquid hardener and densifier. Apply product in accordance with the manufacturer's recommendations. Acceptable products include, but are not limited to:
  - 1. H&C Clear Liquid Hardener & Densifier, H&C.



- I. After grinding operations are complete apply a protective finish material to provide a gloss finish and improve stain resistance. Apply product in accordance with the manufacturer's recommendations. Acceptable products include, but are not limited to:
  1. LSGuard, Prosoco.
  2. H&C Lithium Protective Finish, H&C.

### 3.12 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
  1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Do not apply to concrete that is less than seven days old.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

### 3.13 BONDING NEW CONCRETE TO EXISTING CONCRETE

- A. At locations where new concrete is placed adjacent to existing concrete, unless indicated otherwise, clean and roughen the face of the existing concrete and provide a bonding agent in accordance with the manufacturer's recommendations.

### 3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Concrete which will be exposed to view in the finished structure shall be restored to its original intended appearance or shall be removed and replaced. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension, down to solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at an inconspicuous location to verify mixture and color match

- before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness by using a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.
- 3.15 FIELD QUALITY CONTROL
- A. Special Inspections: Owner will engage a special inspector to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
  - B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., plus one set for each additional 50 cu. yd. more than the first 25 cu. yd.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for a given concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C 143; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
  3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample of air-entrained concrete.
  4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 90 deg F and above.
  5. Density: ASTM C138/C138M, fresh density of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  6. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
  7. Compressive-Strength Tests: ASTM C 39; test one laboratory-cured specimen at 7 days two at 28 days, and hold one specimen in reserve for later testing if necessary.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, Structural Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project name, date of concrete placement and testing, location of concrete batch in Work, mix identification including design compressive strength at 28 days, slump, compressive breaking strength, and type of break for both 7-and 28-day tests. Air content and concrete temperature results shall also be provided when applicable.
- E. Special inspector shall monitor the installation of post-installed concrete anchors and reinforcing. Before installation of each type anchor or reinforcing begins, the inspector shall verify that the contractor's proposed installation procedure conforms with the manufacturer's printed installation instructions (MPII). The inspector shall monitor the initial installation of each type of anchor or reinforcing to verify conformance with the (MPII) and shall monitor periodically thereafter.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive devices will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Special inspector shall make additional tests of concrete at Contractor's expense when test results indicate that slump, air entrainment, compressive strength, or other requirements have not been met, as directed by Architect. Special inspector may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect. Contractor shall fill core-drilled holes with non-shrink grout unless directed otherwise by Architect.

END OF SECTION 033000

## SECTION 051200 - STRUCTURAL STEEL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes structural steel.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 3 Section "Cast-in-Place Concrete" for installing anchor bolts in concrete.
- C. General: Submit the following in accordance with conditions of the Contract and Division 1 Specification Sections.
- D. Product Data for each type of product specified.
- E. Shop Drawings detailing fabrication of structural steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - 3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted snug-tightened, pretensioned, or slip-critical connections.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.
- G. Mill test reports certifying that structural steel complies with requirements, including chemical and physical properties.
- H. Manufacturer's certificates of compliance certifying that their products, including the following, comply with requirements.
  - 1. Weld filler materials for both shop and field welding.
  - 2. Nonshrink grout.
- I. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

#### 1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar to this Project with a record of successful in-service performance.

- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to this Project and with a record of successful in-service performance. Fabricator must meet one of the following requirements:
  - 1. A qualified fabricator who is currently certified by the AISC Quality Certification Program for Structural Steel Fabricators and is designated as AISC Certified Fabricator, Standard for Steel Building Structures.
  - 2. Fabricator must maintain detailed written fabrication, material control, and quality control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.
- C. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC's "Specification for Structural Steel Buildings."
  - 2. AISC's "Seismic Provisions for Structural Steel Buildings."
  - 3. ASTM A 6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
  - 4. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- D. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel."
  - 1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from deterioration.
  - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusted before use.
  - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures.

#### 1.5 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting templates and instructions as required for installation.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Structural Steel Shapes, Plates, and Bars: As follows:
  - 1. Wide Flange Shapes and Tees: ASTM A 992.
  - 2. Other Shapes, Plates and Bars: ASTM A 36.
  - 3. Plate Where Indicated 50 ksi: ASTM A572, Grade 50.
- B. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B or C.
- C. Steel Pipe: ASTM A 53, Type E or S, Grade B.
- D. Anchor Rods, Nuts, and Washers: As follows:
  - 1. Anchor Rods: ASTM F 1554, Grade 36.
  - 2. Nuts: ASTM A 563, heavy hex carbon steel nuts.
  - 3. Washers: ASTM F 436, Type 1, hardened carbon steel.
  - 4. Plate Washers: ASTM A 36, carbon steel plate washers in accordance with Table 14-2 of AISC's "Steel Construction Manual", Thirteenth Edition, 1/4 inch plate thickness for anchor rods up to 1 inch diameter, 3/8 inch plate thickness for anchor rods larger than 1 inch diameter.
- E. High-Strength Bolts, Nuts, and Washers: As follows:
  - 1. All bolts shall be of domestic manufacture.
  - 2. Bolts: ASTM A 325, Type 1, heavy hex steel structural bolts.
  - 3. Nuts: ASTM A 563, heavy hex carbon steel nuts.
  - 4. Washers: ASTM F 436, flat, circular carbon steel washers.
  - 5. Twist-Off Type Tension Control Bolts: ASTM F 1852, Type 325.
  - 6. Finish: Plain, uncoated.
- F. Threaded Rods: ASTM A 36.
- G. Forged Steel Hardware:
  - 1. Clevises, Turnbuckles: AISI C 1035.
  - 2. Clevis Pins: AISI C 1018 or AISI C 1035.
  - 3. Eye Bolts, Eye Nuts: ASTM A 489.
  - 4. Sleeve Nuts: AISI C 1018, Grade 2.
  - 5. Finish: Plain, Uncoated.
- H. Welding Electrodes: Comply with AWS requirements.
  - 1. Electrodes shall be E70XX.
  - 2. All electrodes for welding ASTM A 992 steel shall be low hydrogen electrodes with a maximum of 16 ml of diffusible hydrogen per 100 g of deposited weld metal.
  - 3. Electrodes for all welds in moment connections, including shear tabs and stiffener plates, shall have a minimum Charpy V-Notch toughness of 20 foot-pounds at -20 degrees F, and 40 foot-pounds at 70 degrees F.

## 2.2 PRIMER AND PAINT

- A. Primer for Steel not to Receive Topcoat: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79.

- B. Primer for Steel to Receive Topcoat: Comply with Division 09 painting Sections, or if not specified in Division 09 painting Sections, use the following:
  - 1. Interior Steel: SSPC Paint 25, Type II, zinc oxide, alkyd, linseed oil primer.
  - 2. Exterior Steel: SSPC Paint 25 BCS, Type II, zinc oxide, alkyd, linseed oil primer.
- C. Primer for Steel which Receives Intumescent Paint: Use a primer which is approved by the intumescent paint supplier.
- D. Primer color may be selected by contractor, however only one single color of primer may be incorporated in the Work.
- E. Galvanizing Repair Paint: Conform to ASTM A 780 or Military Specification MIL-P-21035A. Acceptable products include, but are not limited to:
  - 1. Galvacon GC-243 Cold Galvanizing Compound, Lanco.
  - 2. Zinga, ZingaMetall.
  - 3. Rust-Oleum Stops Rust Cold Galvanizing Spray, Rust-Oleum.
  - 4. ZRC Cold Galvanizing Compound, ZRC Worldwide.

### 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Five Star Grout; U.S. Grout Corp.
  - 2. Masterflow 713; Master Builders.
  - 3. Sonneborn SonogROUT 10K; ChemRex, Inc.
  - 4. NS Grout, Euclid Chemical Company.
  - 5. SC Multipurpose Grout, SpecChem, LLC.
  - 6. Enduro 50; Conspec.

### 2.4 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
  - 1. Camber structural steel members where indicated.
  - 2. Mark and match-mark materials for field assembly.
  - 3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
  - 4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
  - 5. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
  - 6. Welds which will be exposed to view in the completed structure shall have a neat and uniform appearance. Such welds shall be continuous, not intermittent. Plates which are exposed to view on bottoms of beams shall be straight and aligned at joints, and shall be butt welded together at joints with all welds ground smooth.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.



1. Plane thermally cut edges to be welded.
- C. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members.
1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Stairs: Hangers, brackets, posts and other supports for steel stairs shall be located so that they are concealed within walls or other areas not visible to view.
- G. Tube Members: Provide  $\frac{3}{4}$ " minimum cap plates on tube columns which support beams unless otherwise indicated. Provide  $\frac{1}{4}$ " closure plates on ends of all other tube members unless another connection is indicated. Where the tube end is exposed to view, grind closure plate smooth and flush with tube face all around, including at curved corners of tube.
1. On tube members which will be exposed to view in the completed structure, the seam on the tube shall be oriented away from view. For columns, locate seam facing towards a wall, and for beams, locate seam on upper surface of tube unless indicated otherwise.

## 2.5 SHOP CONNECTIONS

- A. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
1. Bolts: ASTM A325 high-strength bolts, unless otherwise indicated.
  2. Connection Type: Snug tightened, unless indicated as pretensioned or slip-critical.
- B. Welded Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

## 2.6 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
1. Surfaces embedded in concrete.
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Surfaces to receive sprayed-on fireproofing.
  5. Top flanges of beams to receive field welded headed shear connectors or field welded rebar.
  6. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces as follows:

1. Steel not to Receive Topcoat: SSPC-SP 1 "Solvent Cleaning", followed by SSPC-SP 2 "Hand Tool Cleaning."
  2. Interior Steel to Receive Topcoat: Comply with Division 09 painting Sections, or if not specified in Division 09 painting Sections, use SSPC-SP 1 "Solvent Cleaning", followed by SSPC-SP 2 "Hand Tool Cleaning."
  3. Exterior Steel to Receive Topcoat: SSPC-SP 6 "Commercial Blast Cleaning."
  4. Faying surfaces and surfaces adjacent to bolt heads and nuts shall be free of dirt and foreign material. Faying surfaces at slip-critical connections shall also be free of scale, except tight mill scale, and free of coatings, including inadvertent overspray.
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness complying with Division 09 painting Sections, but not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## 2.7 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A123.
- B. Galvanize shelf angles, steel lintels in exterior walls, and other items as indicated.
- C. Where tubes or pipes in exterior elements exposed to the weather have vent holes for galvanizing, the vent holes shall be closed using plug welds and then ground smooth and flush. Holes shall be closed after galvanizing and then painted with galvanizing repair paint.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before erection proceeds, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
  1. Where temporary shoring is required for composite deck construction, do not remove shoring until cast-in-place concrete has attained its 70 percent of its design compressive strength.

### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.

- B. Base Plates and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - 1. Set base plates and bearing plates for structural members on wedges, shims, or leveling nuts as required.
  - 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to grouting.
  - 3. Grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
    - a. Comply with manufacturer's instructions for proprietary grout materials.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
- E. Splice members only where indicated.
- F. Remove welded identification tags, erection bolts and clips on all steel which will be exposed to view in the completed structure; fill holes with plug welds; and grind smooth at exposed surfaces. Remove paper tags and stickers which will interfere with or show through painting.
- G. Finish sections thermally cut during erection equal to a sheared appearance.
- H. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Brick shelf angles shall be welded to the supporting structure only after concrete slabs are in place.

### 3.4 FIELD CONNECTIONS

- A. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
  - 1. Bolts: ASTM A325 high-strength bolts, unless otherwise indicated.
  - 2. Connection Type: Snug tightened, unless indicated as pretensioned or slip-critical.
  - 3. Tensioned bolts: For bolted connections indicated as pretensioned or slip-critical, use twist-off type tension control bolts.
- B. Welded Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
  - 1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
3. Welds which will be exposed to view in the completed structure shall have a neat and uniform appearance. Such welds shall be continuous, not intermittent. Plates which are exposed to view on bottoms of beams shall be straight and aligned at joints, and shall be butt welded together at joints with all welds ground smooth.
4. Shielded Metal Arc Welding (SMAW) or Flux Cored Arc Welding (FCAW) are acceptable welding processes for shop or field welding. FCAW-S (self-shielded) shall not be mixed with any other welding process in the same weld in moment connections.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform field inspections and tests and to prepare test reports.
  1. Special inspector will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Contractor shall ensure that no items which are to be tested or inspected are covered up by earth, concrete, deck or other materials before testing and inspection are complete.
- C. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- D. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- E. Periodically inspect steel frame joint details for compliance with approved construction documents.
- F. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
  1. Verify that washers are installed as required by RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
  2. Snug-Tightened Connections: Visually verify that all plies of the connected elements have been brought into firm contact.
  3. Slip-Critical Connections and Pretensioned connections indicated to have faying surfaces prepared as required for slip-critical connections: Prior to assembly, visually verify that faying surfaces of joints meet the requirements of RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- G. Provide continuous visual inspection of all multi-pass fillet welds, all single-pass fillet welds greater than 5/16", and all complete and partial penetration groove welds. Provide periodic visual inspection of single-pass fillet welds less than or equal to 5/16".

### 3.6 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
  1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils.

- B. Galvanized Surfaces: All exposed galvanized surfaces which have been damaged by shipping, handling, welding or other operations shall be repaired. Surfaces to be repaired shall be clean, dry, and free of oil, grease, welding slag or flux and corrosion products. Apply galvanizing repair paint according to the manufacturer's instructions to attain the required dry-film thickness.

END OF SECTION 051200

## SPECIAL INSPECTIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. This Section includes administration and procedural requirements for compliance with the 2015 IBC, Chapter 1 Inspections and Chapter 17 Special Inspections.
- C. South Carolina Office of School Facilities (OSF) B AINSPECTION PROGRAM MANUAL@, dated January 14, 2010 or latest edition.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Pre-construction Conference: Upon receipt of the ANotice-to-Proceed@ and prior to the start of construction, the Architect shall conduct a Pre-construction Conference. It is the responsibility of the Architect to notify the Office of School Facilities (OSF). A representative from OSF along with representatives from the testing company(ies) and the Chapter 1 and Chapter 17 inspection agencies must also be present.
- D. Related Sections include the following:
  - 1. Division 1 Section "Allowances" for testing and inspecting allowances.
  - 2. Division 1 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections. The special inspector shall continually coordinate with the construction manager for the time and requirements of required inspections.
  - 3. Divisions 2 through 26 Sections for specific test and inspection requirements.

#### 1.3 DEFINITIONS

- A. Agency Approval: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by South Carolina Office of School Facilities (OSF).
- B. Quality-Assurance Services: Activities, actions, and procedures performed before and during

execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

- C. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- D. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.
- E. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
- F. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- G. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
- H. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- I. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- J. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- K. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
- L. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

#### 1.4 CONFLICTING REQUIREMENTS

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

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.
- C. The special inspector=s reports and testing agencies results shall have precedence over reports and test results provided by the contractor.
- D. Where conflict exists between the construction documents and approved shop drawings submittal data, the construction documents shall govern unless the shop drawing/submittal data are more restrictive. All conflicts shall be brought to the attention of the architect.

### 1.5 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Recognized Agency: For the purposes of this work, only companies utilizing **certified inspectors as designated by the South Carolina Office of the State Engineer or Office of School Facilities** will be accepted for these special inspections. These Companies are listed on their web site however may not be current. Documentation of the individual=s certificates scheduled to perform inspections for this project must be submitted for review by the architect prior to award of this work.
- C. Special Inspectors shall keep and distribute records of inspections. The special inspector shall furnish inspection reports to OSF, contractor, architect and owner. Reports shall indicate that work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of OSF and to the architect prior to the completion of the phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon by the permit applicant and OSF. Prior to the start of work.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  - 1. Specification Section number and title.
  - 2. Description of test and inspection.
  - 3. Identification of applicable standards.
  - 4. Identification of test and inspection methods.
  - 5. Number of tests and inspections required.
  - 6. Time schedule or time span for tests and inspections.
  - 7. Entity responsible for performing tests and inspections.
  - 8. Requirements for obtaining samples.
  - 9. Unique characteristics of each quality-control service.
- E. Reports: Prepare and submit certified written reports that include, but are not limited to, the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.



6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.  
*Sample forms required for use by OSF are indicated in section 3.4 Testing and Inspection Log and Forms located toward the end of this specification.*

- F. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.6 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirement for specialists shall not supersede building codes and regulations governing the Work.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
  2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory

Accreditation Program.

- H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. **Contractor responsibilities include the following:**
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
    - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
  - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
  - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
  - 2. Notify Architect seven (7) days in advance of dates and times when mockups will be constructed.
  - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
  - 4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
    - a. Allow seven (7) days for initial review and each re-review of each mockup.
  - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6. Demolish and remove mockups when directed, unless otherwise indicated.
- K. **Laboratory Mockups:** Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 2 through 16.

## 1.7 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  - 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.

3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor and the Contract Sum will be adjusted by Change Order.
- B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  2. Notify testing agencies at least Forty Eight (48) hours in advance of time when Work that requires testing or inspecting will be performed.
  3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
  6. The contractor shall be responsible for costs of: Re-testing and re-inspection of materials, work and/or products that do not meet requirements of the construction documents and shop drawings/submittal data.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 1 Section "Submittal Procedures."
- D. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with the Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and

- inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within thirty (30) days of date established for commencement of the Work the Notice to Proceed.
- 1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

### 1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Shall be as listed herein.
- B. Special Tests and Inspections: Conducted by a qualified **special inspector designated by the South Carolina Office of School Facilities (OSF)** as indicated in individual Specification Sections, and as follows:
  - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  - 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
  - 4. Submitting a final report of special tests and inspections at Substantial Completion which includes a list of unresolved deficiencies.
  - 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  - 6. Retesting and re-inspecting corrected work.

### PART 2 - PRODUCTS (Not Used)

### PART 3 - EXECUTION

#### 3.1 ACCEPTABLE TESTING AGENCIES

Acceptable companies shall be as designated by the South Carolina Office of School Facilities (OSF).

#### 3.2 INSPECTIONS REQUIRED CHAPTER 1:

##### 1. IBC Chapter 1 Inspections

- 1. Chapter 1 Inspections for this project shall be provided by individuals approved by Office of School Facilities. The required Inspections for this project may include but are not limited to:

- A. **110.3.1 Footing and foundation inspection.** Footing and foundation inspections shall be made after excavation for footings are complete and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. Materials for the foundation shall be on the job, except where concrete is ready mixed in accordance with ASTM C94, the concrete need not be on the job.
- B. **110.3.2 Concrete slab and under-floor inspection.** Concrete slab and under-floor inspections shall be made after in-slab or under-floor reinforcing steel and building service equipment, conduit, piping accessories and other ancillary equipment items are in place, but before any concrete is placed or floor sheathing installed, including the
- C. **110.3.4 Frame inspection.** Framing inspections shall be made after the roof deck or sheathing, all framing, *fireblocking* and bracing are in place and pipes, chimneys and vents to be concealed are complete and the rough electrical, plumbing, heating wires, pipes and ducts are *approved*.
- D. **110.3.6 Fire- and smoke-resistant penetrations.** Protection of joints and penetrations in *fire-resistant* assemblies, *smoke barriers* and smoke partitions shall not be concealed from view until inspected and *approved*.
- E. **110.3.7 Energy efficiency inspections.** Inspections shall be made to determine compliance with Chapter 13 and shall include, but not be limited to, inspections for: envelope insulation R- and U-values, fenestration U-value, duct system R-value, and HVAC and water-heating equipment efficiency.

**3.3 SPECIAL INSPECTIONS REQUIRED CHAPTER 17: (refer to structural specs for additional information/requirements)**

A. Field Welding of Structural Steel

Special inspections are required for the welding of structural members or connections for compliance with the approved plans, shop drawings, specifications and Chapter 22 of the IBC. The special inspector shall provide a continuous inspection of, structural welding unless the requirements of the IBC are satisfied, thus allowing periodic inspections. For periodic inspection, the special inspector shall check qualifications of welders at the start of work and then make final inspection of all welds for compliance prior to completion of welding. Single pass fillet welds not exceeding 5/16 inch shall be identified on the drawing. The special inspector shall inspect the equipment, material and technique being employed and verify that the welding is performed by certified welders qualified in the procedure being used. A visual inspection of the completed work shall be made to ensure proper type, size, length and quality of the welds.

B. Concrete work

- 1. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - a. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., plus one set for each additional 50 cu. yd. more than the first 25 cu. yd.
    - 1. When frequency of testing will provide fewer than five compressive-strength tests for a given concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than

five are used.

- b. Slump: ASTM C 143; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
  - c. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample of air-entrained concrete.
  - d. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 90 deg F and above.
  - e. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
  - f. Compressive-Strength Tests: ASTM C 39; test one laboratory-cured specimen at 7 days two at 28 days, and hold one specimen in reserve for later testing if necessary.
    1. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
2. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-
  3. Test results shall be reported in writing to Architect, Structural Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project name, date of concrete placement and testing, location of concrete batch in Work, mix identification including design compressive strength at 28 days, slump, compressive breaking strength, and type of break for both 7-and 28-day tests. Air content and concrete temperature results shall also be provided when applicable.
  4. Special inspector shall monitor the installation of post-installed concrete anchors and reinforcing. Before installation of each type anchor or reinforcing begins, the inspector shall verify that the contractor's proposed installation procedure conforms with the manufacturer's printed installation instructions (MPII). The inspector shall monitor the initial installation of each type of anchor or reinforcing to verify conformance with the (MPII) and shall monitor periodically thereafter.
  5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive devices will not be used as sole basis for approval or rejection of concrete.
  6. Additional Tests: Special inspector shall make additional tests of concrete at Contractor's expense when test results indicate that slump, air entrainment, compressive strength, or other requirements have not been met, as directed by Architect. Special inspector may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect. Contractor shall fill core-drilled holes with non-shrink grout unless directed otherwise by Architect.

### 3.4 TEST AND INSPECTION LOG AND FORMS

- A. Prepare a record of tests and inspections. Include the following:
  1. Date test or inspection was conducted.

2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Architect.
  4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.
- C. Maintain all logs, inspection reports and related summary sheets as required by Office of School Facilities (OSF). Samples of the required inspection documentation forms from the OSF Inspection Program Manual (Appendix C B Chapter 1 & Appendix D B Chapter 17) are included at the end of this section for information only. The contractor, testing agency and inspectors are required to be familiar with the required forms as well as the current **AINSPECTION PROGRAM MANUAL@**. This manual along with the current OSF required inspection forms are available on line at the South Carolina Department of Education web site under Office of School Facilities.

### 3.5 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
  2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

### 3.6 TESTING AND INSPECTION

- A. Reference related specifications for the minimum level of inspections and testing. Provide additional inspections and testing as necessary to determine compliance with the construction drawings and to satisfy IBC requirements for Chapter 1 Inspections and Chapter 17 Special Inspections.

**END OF SECTION**

**SECTION 23 00 00  
MECHANICAL GENERAL**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All material and work shall comply with the National Fire Codes of the NFPA, National and local codes and the ICC International Code Council, Building, Mechanical, Plumbing and Gas Codes 2018 editions and 2009 International Energy Code. Mounting heights of devices shall be in accordance with ADA, ANSI A117.1 2017 Addition.
- 1.3 CONTRACT DOCUMENTS
  - A. Drawings for work under this Division of the specifications indicate generally the location, arrangement and intent of the systems to be installed. Although they are to some extent diagrammatic, they are to be followed as closely as possible. If due to job conditions, for coordination of other trades, or for other reasons it is found necessary to change the location of items, such changes shall be made without additional cost to the Owner and as reviewed by the Architect. Provide all offsets, fittings, etc., without extra charge.
  - B. It is not the intent of these documents to be used as installation drawings nor to include all related services or accessories to place systems in operation. Installation of equipment shall be in strict accordance with the respective manufacturer's recommended instructions. Obtain certified drawings and installation instructions before starting work. The systems shall operate safe, quietly and in the opinion of the Architect, excellent condition.
- 1.4 It is the intent of these plans and specifications to describe a complete and working HVAC system and to prescribe for the complete installation and testing of the equipment and devices specified under other sections of the specifications or on the drawings. Work under this Division of the contract includes all work necessary to make equipment and systems operational while following the details of the drawings and specifications as close as possible. When additional items are required to make systems operational, and are not specifically specified, then items shall be in accordance with the manufacturer's recommendations for the applicable conditions encountered.
- 1.5 ELECTRICAL CONNECTIONS
  - A. Temperature and equipment control wiring are included under this Division of the contract. All starters not factory-mounted shall be furnished under this Division and installed (including wiring through starters) under "Electrical" Division of the contract. Starters shall be generally furnished by the equipment manufacturer specifically for each piece of equipment. Overload heaters in all starters and in ungrounded conductors are included in this Division of the contract.
  - B. Motor starters shall be furnished by the mechanical contractor and delivered to the electrical contractor for mounting and power connections through starter to motor. The contractor shall furnish starters, or combination starter/disconnects as shown on the electrical drawings. Refer to the electrical drawings for the type required for each piece of equipment. Mounting and wiring of starters including wiring to equipment shall be provided under electrical section of the specifications.
- 1.6 SEISMIC REQUIREMENTS
  - A. All Plumbing and HVAC materials and installation shall comply with the latest ICC International Code Council Mechanical Code with the latest revisions for applicable seismic zone protection.



- B. See other sections in Division 23 for more specific specifications. Generally, the seismic requirements are covered in the sections where they apply (example: Seismic restraints for ductwork are in section 23 05 48 Mechanical, Ductwork).

#### 1.7 COMMISSIONING/FINAL CHECK-OUT (HVAC)

- A. The contractor shall provide all coordination, submittal data and shop drawing information to comply with the commissioning requirements as specified. Commissioning is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent. The commissioning process shall begin no later than the bid phase and continue through the two year warranty period.
- B. The testing and balancing contractor in conjunction with the mechanical contractor and controls contractor shall submit a statement to the Engineer that check test and start-up has been successfully completed and that all equipment, systems and controls are complete and ready for functional performance testing.
- C. The testing and balancing contractor, controls contractor and mechanical contractor shall work closely for verification of the HVAC system and all components throughout project construction. A report issued by the T&B contractor shall test the dynamic function and operation of equipment and systems executed by the Contractor. Systems are tested shall be various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after start-ups and Pre-functional Checklists are complete.

#### 1.8 COORDINATION SHOP DRAWINGS

- A. The General/Electrical/Plumbing contractor shall coordinate and assist the Mechanical contractor in preparation of detailed coordination shop drawings for all systems. Drawings shall be prepared to carefully coordinate with architectural, plumbing, sprinkler, electrical and structural drawings regarding elevation, access, serviceability and replacement of systems. Space priorities shall be coordinated and established with each trade prior to beginning work to prevent field conflicts. No extra payments for changes or modifications will be allowed any contractor where work has begun without fully coordinated shop drawings. A completed set of coordinated shop drawings shall be submitted to the Design Team for review prior to beginning any work or ordering of any associated equipment, piping, wiring, steel, fixtures, conduits, etc.
- B. Each trade contractor shall coordinate its construction operations and space requirements with those of other contractors and entities to ensure efficient and orderly installation of each trade. These parameters shall be incorporated into the shop drawings developed to identify and resolve any potential conflicts prior to project construction.
- C. Coordination meetings shall be held with the general contractor and MEP contractors at the beginning of the project and prior to start of construction in any area, to develop the coordination drawings and resolve potential installation conflicts. Coordination meetings for the purpose of producing coordinated shop drawings shall be scheduled by area(s) and held during drawing development and shall continue through project completion. Coordination shall include:
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before, during or after its own installation.

2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required for maintenance, service, and repair.
  3. Make adequate provisions to accommodate items scheduled for any installation phase including known future work.
  4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical, electrical and plumbing.
  5. Where conflicts arise during the coordination or construction phase, the construction team shall identify conflicts and present cost effective solutions to accompany RFI's to the design team for review and issuance of directive resolution measures.
- D. Shop drawings shall show the routing of all water piping, supply, return, exhaust and fresh air ductwork closely following the contract drawings and specifications. Drawings shall be detailed to miss any structural elements and work of all other trades and shall include the following as a minimum:
1. HVAC All necessary heating, ventilating, air-conditioning and specialty equipment, including air handlers, pumps, piping, air distribution ducts for supply, return, and ventilation and exhaust ducts, including control system, registers, diffusers, grills necessary to produce accurate plans, elevations, building/wall sections and schedules. All piping larger than 1.5" diameter shall be modeled.
  2. PLUMBING All necessary plumbing piping and fixture layouts, floor and area drains, and related equipment, necessary to produce accurate plans, elevations, building/wall sections, riser diagrams, and schedules. All piping larger than 1.5" diameter shall be modeled.
  3. ELECTRICAL All necessary interior electrical components (i.e., lighting, receptacles, special and general purpose power receptacles, lighting fixtures, control systems), necessary to produce accurate plans, details and schedules. Cable tray routing shall be modeled without detail of cable contents.
- E. Ductwork drawings shall show size, length of each piece, top and bottom elevations and placement of registers and grilles. Fittings shall also show throat length or radius, amount of rise or fall and amount of offset. All riser ducts shall be shown where indicated on drawings. Shaft ducts shall be detailed and fully dimensioned.
- F. Drawings shall detail exact placement of all HVAC equipment and shall define access and service area required for each piece of equipment. Pad drawings of air handling units if required shall also be included and fully detailed.

## 1.9 FIRE STOPPING AND SMOKE SEALS

The Mechanical Contractor shall be responsible for installing fire stopping and joint seals as required for the work in this section. All penetrations through fire resistive construction shall be sealed in accordance with UL drawings and Fire Stop specifications. Products used for fire stopping shall be by the same manufacturer throughout the building for all trades. Coordinate fire stopping work with the General Contractor and all other trades.

## PART 2 - PRODUCTS

### 2.1 SUBSTITUTIONS

- A. All requests for substitutions shall be submitted in writing so as to be received by the Engineer at least ten (10) calendar days prior to bid date and must be granted permission to quote before award of contract.
- B. Requests for approvals shall be submitted in the form of a letter (with one copy minimum) on letterhead of submitting firm. Letter to be addressed to the Engineer and referenced to this job.
- C. Permission to substitute items shall not be construed as authorizing any deviations from the contract documents, unless such deviations are clearly indicated in letter form. Contractor shall be responsible for verifying all dimensions with available space conditions (with provisions for proper access, maintenance, part replacement and for coordination of other trades) for proper services and construction requirements. Contractor to bear any additional costs for required changes in associated items which are directly or indirectly related to a substituted item.

## 2.2 MATERIAL AND EQUIPMENT SUBMITTALS

- A. The Engineer will review and take appropriate action on equipment submittals, product data, samples, and other submittals required by the Contract Documents. Such review shall be only for general compliance with the design and with the information given in the Contract Documents.
- B. All submittals of equipment and materials for this project shall be furnished by the manufacturer's local representative for Mechanical Design, Inc. No submittals will be received where the local representative has not originated or reviewed the submittal prior to submission. All non compliant submittals will be promptly rejected.
- C. Prior to submittal of equipment submittals to the Architect, Contractor shall review and approve equipment submittals. Equipment submittals which have not been reviewed and approved in writing by the Contractor will not be reviewed by the Engineer.
- D. The Contractor shall submit for review by the Architect detailed drawings of all equipment and all material listed in this section. All submittal data shall be bound a hardback binder. Partial submittals will not be reviewed by the Engineer. The Contractor shall furnish six (6) copies of equipment submittals.
- E. Equipment submitted for review shall be detailed, dimensioned drawings or catalog pages showing construction, size, arrangement, operating clearances, performance characteristics and capacities.
- F. It shall be the sole responsibility of the Mechanical Contractor to verify and coordinate electrical voltage supplied to all mechanical equipment prior to placing equipment order. Prior to ordering equipment, the mechanical contractor shall submit in writing a list of all mechanical equipment and voltages of each to the electrical contractor and electrical engineer for their review. The mechanical contractor shall include a copy of this letter in the equipment submittal package.
- G. Review rendered on equipment submittals shall not be considered as a guarantee of measurements of building conditions. WHERE DRAWINGS ARE REVIEWED, SAID REVIEW DOES NOT MEAN THAT DRAWINGS HAVE BEEN CHECKED IN DETAIL; SAID REVIEW DOES NOT IN ANY WAY RELIEVE THE CONTRACTOR FROM HIS RESPONSIBILITY OR NECESSITY OF FURNISHING MATERIAL OR PERFORMING WORK AS REQUIRED BY THE CONTRACT DOCUMENTS.
- H. The Contractor shall submit equipment submittals for the following materials and equipment for review by the Engineer:
  - Test and Balance
  - Mechanical Insulation (including closure system)

- Pipe and Fittings
- Water Pumps
- Water Treatment
- Heat Exchanger
- Cooling Tower
- Seismic (with calculations)
- Controls

### 2.3 FINISHES

Contractor shall furnish to Architect color chart, etc. as required for him to select finishes for any piece of equipment, grilles, diffusers, exposed ductwork and piping. Color charts shall be submitted with submittal data. All finishes shall be equivalent to baked enamel unless otherwise indicated

## PART 3 – EXECUTION

### 3.1 SITE CONDITIONS

All bidders shall visit the site and become familiar with all existing conditions before submitting a bid. No extra payments will be made for incidental work not specifically called for but which is necessary for the delivery or proper installation of equipment and functioning of the systems as specified in the bid documents. Submission of a bid will be considered as evidence that this has been done, and no extra payments will be allowed the Contractor because of extra work made necessary by his failure to do so.

3.2 Contractor shall deliver to owner a complete, fully operational system. All items to be properly lubricated and operate to their full extent upon completion of the project.

### 3.3 CONTRACT DOCUMENTS

After thorough examination of contract documents, Contractor shall bring to attention of Architect prior to bid time any discrepancies, errors or omissions in this Division.

### 3.4 CERTIFICATES AND CODES

Contractor shall deliver to Architect any certificates, permits and licenses as required to comply with all City, County and State applicable laws, ordinances, codes, rules and regulations, including any certificates required by fire department. If any of these items are requested, such items shall be furnished prior to final inspection.

### 3.5 WORKMANSHIP

All work included in this contract shall be performed by skilled people under competent supervision employing the latest and best practices of the various trades involved. All materials and equipment hereinafter specified shall be new and free from flaws and defects of any nature. Work that is not of good quality will require removal and reinstallation.

### 3.6 COORDINATION

- A. No work shall be performed, or equipment may be ordered on this project before thoroughly coordinating all space requirements for equipment, ducts, pipes, conduits, etc. with all trades concerned. Establish necessary tie-ins for each trade. No equipment shall be ordered for this project before thoroughly coordinating with all trades the type required for proper installation of equipment in roof, walls and ceiling assembly.

- B. Prior to starting installation, furnish to all trades concerned copies of reviewed shop drawings showing location of equipment, piping, ductwork, etc.
- C. Schedule periodic meetings with other trades before and during installation to avoid conflicts and assure that equipment, piping, ductwork, etc. are installed in the best manner, taking into consideration head-room, maintenance, appearance, replacement and space requirements.
- D. The responsibility for obtaining, cutting, patching, excavating, and backfilling for work under this section of the specifications is included under this section of the specifications.
- E. Contractor shall coordinate the exact size and location of all construction openings with the proper trades preparing the openings and be responsible for obtaining sizes as required. Openings for equipment shall be in accordance with the manufacturer's certified drawings. Lintels shall not be included in this section of the contract.
- F. It shall be the sole responsibility of the Mechanical Contractor to verify and coordinate electrical voltage supplied to all mechanical equipment prior to placing equipment order. Prior to ordering equipment, the mechanical contractor shall submit in writing a list of all mechanical equipment and voltages of each to the electrical contractor and electrical engineer for their review. The mechanical contractor shall include a copy of this letter in the equipment submittal package. Power wiring and mounting of starters and all control components required to install power wiring are not included in this section of the contract. Contractor shall provide adequate wiring diagrams to any trade concerned.
- G. Roof curbs as shown on the Mechanical drawings shall be furnished under this section of the specifications. Curb caps for weather proofing prior to setting of equipment shall also be furnished under this section of the specifications. The installation of roof curbs is not included in this section of the specifications.
- H. Painting of equipment, piping and ductwork for shall be included in this section of the specifications.

3.7 Contractor shall be responsible for the protection and cleanliness of equipment installed under this section of the contract.

### 3.8 INSPECTION OF CONCEALED WORK

Contractor shall notify the Engineer at least three (3) day in advance prior to covering up or concealing any work under this division of the contract. Any work covered or concealed without consent or review of the Engineer shall be exposed for examination at the Contractor's expense.

### 3.9 DAMAGES DURING CONSTRUCTION

Contractor shall be responsible for any costs of repairing any damages caused by this contractor, to the building, building contents, and site during construction and guarantee period.

### 3.10 CUTTING AND PATCHING

Provide all cutting and patching necessary to install the work specified in this section. Provide inserts, sleeves, access panels, supports, etc. Lay out work in advance and establish locations of chases, inserts, sleeves, access panels, etc.

### 3.11 EXCAVATION AND BACKFILLING

- A. Provide all excavating and backfilling for work under this Division of the contract.

- B. Install sewer and water pipes in separate trenches, graded uniformly to provide solid bearing and required fall. Dig bell holes at hubs. Remove rock for one (1) foot below pipe and replace with sand.
- C. Upon completion of tests and inspections, backfill with approved material, placed and tamped to prevent excessive settlement.

### 3.12 OWNER INSTRUCTION

- A. Contractor shall instruct the Owner's representative in complete detail as to proper operation of the overall system. Advise the Owner as to where to order common replacement items. Deliver to the Owner the equipment manufacturer agent's name, address, and telephone number for each piece of equipment.
- B. Provide two copies of a hard back three-ring file folder containing all warranties, catalog data and the manufacturer's standard operating and maintenance instructions for each item of equipment.
- C. The folder shall also contain a maintenance sheet for each piece of equipment, type written by the contractor. Each sheet shall list the maintenance functions to be performed in accordance with the manufacturer's recommendations and the frequency with which each is to be done. Provide columns on each sheet so that they may be dated by maintenance personnel when each individual function is performed. The contractor shall instruct and demonstrate each maintenance function to the Owner's representative.

### 3.13 FINAL INSPECTION

- A. Contractor shall provide all initial balancing that season conditions will allow prior to final inspection.
- B. For final inspection, all construction filters shall be replaced with new filters. All items shall be cleaned thoroughly inside and outside of all dust, dirt, plaster or other foreign material. Repainting of scratched equipment shall be completed.
- C. Contractor shall notify the Architect, Engineer and or construction manager in writing that he has complied with the above items prior to final inspection. In addition the contractor shall furnish a statement prior to OSF inspection the following items are complete:
  - All smoke detectors are installed and working properly.
  - All penetrations (pipes, conduit, ducts, etc.) in rated walls and/or floor/ceiling assemblies are properly installed using appropriate methods and materials.
  - All required seismic bracing of walls, equipment, pipes and ducts is present and properly installed.
  - All HVAC systems have been tested, balanced, and commissioned per ASHRAE 90.1. A copy of the report will be available at the inspection.
  - Listed assembly details, product data sheets, and approved submittals are available on site.
- D. A mechanic shall be present at final inspection with all tools and instruments required to completely inspect and check measurements required under "Testing and Balancing." Provide a step-ladder and keys for control instruments.
- E. Contractor shall indicate in red ink on prints all changes to underground services. Submit print along with other submittals required prior to final inspection.

### 3.14 GUARANTEE

- A. Contractor shall guarantee all equipment, ductwork, piping and any other materials specified under this Division of the contract for a period of **one (1)** year from the date of project acceptance unless otherwise indicated. Upon failure of any part(s) of the system during the guarantee period, the affected part(s) shall be repaired or replaced promptly by and at the expense of the Contractor.
- B. If any component fails during the regular **one year** period, then the replacement part(s) shall be given an additional one (1) year guarantee from the time of replacement. This shall continue until the items have given a full year of satisfactory service.

### 3.15 IDENTIFICATION

Contractor shall identify each piece of equipment (except in finished areas) and each control device with its correct set point. Items shall be identified by name and numerical sequence (RTU-1, etc.). Nameplates shall be 1/16" thick plates with 1/2" high white letters on black background. Nameplates shall be attached securely. No identification shall be done until all painting has been accomplished. Locations for servicing equipment above ceilings shall also be labeled with nameplates attached to the ceiling grid identifying equipment and access location.

### 3.16 EQUIPMENT PAINTING

Contractor shall paint all new equipment (except factory painted equipment), ductwork, piping and any other materials exposed to view. New equipment, pipes, ductwork and other exposed materials shall be completely sanded, primed and repainted where factory paint has been scratched. Paint shall be as recommended by equipment manufacturer. Pipes shall be color coded with colors selected by the Engineer. Devoe, Sherwin Williams, Pittsburg, Glidden or approved equal paints may be used.

### 3.17 RECORD DRAWINGS

- A. Contractor shall maintain on the job site one complete set of drawings for this project. All changes authorized by the Architect and/or Owner as to locations, sizes, etc. of equipment, ductwork, piping and other material shall be indicated in red ink on the drawings as work progresses.
- B. Contractor shall obtain at his expense, a set of reproducible drawings on which he shall indicate the information outlined above, prior to final inspection. The Architect will make available to the Contractor original drawings of the work to be used to make the reproducible drawings. The final, annotated, reproducible drawings shall be turned over to the Architect at the time of final inspections.

### 3.18 UTILITY INTERRUPTIONS:

- 3.19 Obtain owner's approval for water utility interruptions at least five (5) working days in advance of all scheduled interruptions. Contractor shall arrange work so that interruptions are minimized in number and duration.

### 3.20 TEMPORARY AIR CONDITIONING

- A. The Mechanical Contractor shall coordinate with the General Contractor the requirements for temporary air conditioning of the building for completion of interior finish work prior to substantial completion.

- B. The mechanical Contractor shall schedule his work to provide temporary heating and cooling utilizing the new HVAC system at the request of the General Contractor. Service, maintenance and filter service of the equipment shall be provided by the Mechanical Contractor. The Mechanical contractor shall provide temporary duct filters to maintain a clean duct system during temporary service.
- C. The use of the new HVAC system shall not decrease the equipment or installation warranty as specified herein. All equipment and installation warranties shall begin at substantial completion of work.

**END OF SECTION 23 00 00**



**SECTION 23 05 93  
TESTING ADJUSTING AND BALANCING**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer's local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non-compliant submittals will be promptly rejected.
- 1.3 Work under this section includes the testing, adjusting and balancing air and water systems in all heating, ventilating and air conditioning systems. The results of all tests, adjustments and balancing shall be submitted to the Architect for approval. The testing and balancing report shall be complete and available on site for review prior to final inspection by the Office of School Facilities (OSF).
- 1.4 Other sections of the specification are a part of this section. Refer to all other sections for a complete description of the work.
- 1.5 Testing and balancing of the HVAC system is defined as the optimization of the installed system. The equipment schedule is used for equipment selection only. Industry standards of +/-10% are considered to be benchmarks and will not be used as an absolute requirement for final acceptance of the project. Approval of the final report will be the sole responsibility of the design engineer.

**1.7 TESTING AND BALANCING AGENCY**

- A. All work shall be performed by an independent Test and Balance Agency. Testing, adjusting and balancing work shall be the firm's sole source of income. All work shall be under the direct supervision of a project manager who is qualified for testing and balancing the hydronic and air performance of heating, air conditioning, and ventilating systems.
- B. The testing and balancing contractor will test and balance the systems according to NEBB standards. The T&B contractor will provide the mechanical contractor with a written list of all project deficiencies and copy the engineer via fax. The T&B contractor will work with the engineer and contractor to insure that any and all deficiencies are adequately addressed prior to submission of the final report. The engineer will be provided with a T&B summary prior to submission of the final report. The T&B Contractor shall notify the engineer and contractor immediately of any deficiencies which impede balancing and any inability to meet the specified requirements.
- C. The design engineer may request verification of data at any time during or after the T&B process. The test, balancing and adjusting shall be performed as many times as required to prove project requirements have been met. If requested by the Engineer, tests shall be performed in his presence
- D. The Testing and Balancing firm will be certified by NEBB and have a minimum of ten years experience in testing and balancing. Acceptable firms to perform testing and balancing on this project are:

Carolina Air & Water Balancing, Inc. (803)-776-0568  
Palmetto Air and Water (864) 877-6832  
Vapor Test and Balance

## 1.8 RESPONSIBILITY OF OTHERS

- A. Mechanical Contractor- The mechanical contractor is responsible for installing the systems per the plans and specification. The mechanical contractor is also responsible coordinating work between the T&B and Control contractor. All system deficiencies will be corrected/optimized prior to the submission of the T&B report. The mechanical contractor will supply the test and balance contractor with accurate drawings, submittals, and support required to optimize the system(s).
- B. Control Contractor- The control contractor shall work closely with the T&B contractor during testing and balancing to insure proper operation of the control system. The control contractor will functionally check the controls prior to the T&B process. The T&B process will not begin until the control system has been checked and approved by the control contractor. The control contractor will furnish any software required to test and balance the system(s).

## 1.9 INSTRUMENTS

Instruments used shall be of high quality and as recommended by AABC or NEBB for the application. Instruments shall be properly calibrated and certified within the last six months.

## 1.10 ACCURACY

The balancing firm shall warrant, solely that the system will be set to the values as established by the drawings and specifications and also adjust to minimize drafts in all areas.

## 1.11 CHANGES

Any changes that are required for the final balancing results as determined by the balancing firm shall be provided under this section of the specifications. Such changes shall include, but not limited to, changing of pulleys, belts, dampers or adding dampers or access panels.

## PART 2 - PRODUCTS

### 2.1 SUBMITTALS:

- A. Prior to acceptance of the systems by the Owner, submit to the Engineer for his review, a written testing, adjusting and balancing report, in triplicate, contained in a hard-backed three ring notebook.
- B. All reports, forms and data sheets shall generally be the standards of AABC or NEBB.

## PART 3 - EXECUTION

### 3.1 BALANCING PROCEDURE:

- A. Before starting water balance, check the following items:
  - 1. Cleanliness of system water
  - 2. Cleanliness of all system strainers
  - 3. Manual air vents
  - 4. Pump and motor lubrication
  - 5. Motor overload protectors or heaters for proper size
  - 6. Proper pump rotation
- B. Measure pump capacities by venturi, orifices or flow meters if installed or by differential pressure measurements, amperage and brake horsepower method using pump manufacturer's capacity curve. Position all automatic valves, hand valves and circuit setters for full flow through coils,

tube bundles, etc. during pump adjustment. Use only calibrated test gauges for pump adjustment; the use of pressure gages installed within the system will not be permitted.

C. Coordinate the setting of controls to maintain coil water inlet design temperatures, with coil valves positioned for full flow through coil during adjustment. Balance individual water coils at full flow to maintain temperature differential specified.

D. Lock in setpoint on circuit setters correctly

### 3.2 ADJUSTING AND BALANCING

A. Adjust, balance, record and submit as previously specified, for each of the following:

1. Cooling Tower:
  - a. Water Flowrate, GPM
  - b. Water Pressure Drop, Ft. of Water
  - c. Fan RPM
  - d. Entering Air Db/Wb
  - e. Entering Water Temp
  - f. Leaving Water Temp
2. Pumps:
  - a. Final Water Flow rate, GPM
  - b. Wide Open Water Pressure Differential, Ft. of Water
  - c. No Flow Water Pressure Differential, Ft. of Water
  - d. Pump Off Pressure, Ft. of Water
  - e. Motor Amperage and Voltage
3. Heat Exchanger
  - a. Water flow rate (hot side)
  - b. Water flow rate (cold side)
  - c. Entering water temp (hot side)
  - d. Leaving water temp (hot side)
  - e. Entering water temp (cold side)
  - f. Leaving water temp (hot side)
  - g. Pressure drop (hot side)
  - h. Pressure drop (cold side)

**END OF SECTION 23 05 93**

**SECTION 23 07 00  
MECHANICAL, INSULATION**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer=s local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non-compliant submittals will be promptly rejected.

**1.3 INSULATION**

All insulation material shall have a fire hazard classification not to exceed flame spread of 25 and smoke developed rating of 50, as listed by Underwriters Laboratories and acceptable under NFPA standards. This is to apply to the complete system and to the composite insulation with jacket or facings, vapor barrier, tapes, mastic and fittings.

**PART 2 - PRODUCT**

**2.1 PIPE INSULATION**

- A. Flexible pipe insulation shall be Armaflex, or equal. Flexible pipe insulation and associated products shall meet flame and smoke rating listed in the "General" paragraph of this section of the specifications. Flexible pipe insulation adhesive shall be an air-drying contact adhesive for temperatures up to 220 degrees F, equal to Armaflex 520. Adhesive shall meet Military Specification MIL-A-24179A and Amend-2 as Type II, Class 1.
- B. Fiberglass pipe insulation shall be Owens-Corning one-piece heavy density fiberglass pipe insulation with the ASJ/SSL-II jacket.
- C. Rigid pipe insulation shall be Foamglass pipe covering.
- D. Equipment insulation shall be 1-1/2" Foamglass Block.
- E. See Section 23 00 00 Mechanical, General for pipe markers.

**PART 3 - EXECUTION**

**3.1 INSULATION FIRM**

All insulation work shall be performed by a franchised insulation firm. All insulation shall be installed in a workmanlike manner by qualified workers in the regular employ of the insulation firm.

**3.2 PIPE INSULATION**

- A. Condenser water pipes located in the mechanical room or outside exposed to weather shall be covered with 2" thick rigid pipe insulation. All seams and joints shall be sealed with rigid pipe insulation sealer. A light coat of sealer shall be applied over the entire surface of the insulation and embedded with Fab-Cloth in the sealer. This application shall be applied twice over the insulation. Surface to be smooth when complete. Insulation shall be wired on with 16 gauge Copper-Clad wire, spaced no more than 12" on center.

- B. Piping exposed to the exterior or within the mechanical room shall be protected with an aluminum jacket. It shall be applied with a 2" circumferential and 1-1/2" longitudinal lap and be secured with aluminum bands 3/8" wide, 8" on center. All elbows shall also be covered with a PVC jacket. The insulation shall be applied over electric heating tape. Mastics, etc. shall be compatible with the electric heating tape. The entire assembly shall be weather protected.
- C. Mastic shall be rubber cement, LEED approved non-flammable adhesive.

### 3.3 HEAT TRACE TAPE

- A. Provide U.L. listed self-regulating heat trace tape as manufactured by Smith-Gates or approved equal. Heat trace tape shall be Trace-4, 4 watts/foot. Pipe and valves shall be spiral wrapped. Install heat trace tape in accordance with manufacturer's recommendations.
- B. Coordinate location of electrical connections with Division 26 prior to installation of heat trace tape.

**END OF SECTION 23 07 00**

**SECTION 23 21 13  
PIPE FITTINGS AND VALVES**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer's local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non-compliant submittals will be promptly rejected.
- 1.3 Pipe and equipment locations shown are approximate. Exact location of equipment, pipes and chases to be determined prior to beginning work and coordinated with all other trades as approved by Engineer and determined in field, to avoid other pipes and maintain structural clearances. See section 23 31 13 Ductwork for coordination drawing requirements.
- 1.4 Piping to comply with best trade practice. Provide clearance between pipe and building structure so pipes can expand without damage to building structure.
- 1.5 **FIRE STOPPING AND SMOKE SEALS**
  - A. All fire-stopping on this project shall be installed by a single source contractor. All penetrations through fire resistive construction shall be sealed in accordance with Section 07-8400. Products used for fire stopping shall be by the same manufacturer throughout the building for all trades.
  - B. The Mechanical Contractor shall be responsible for coordinating fire stopping and joint seals as required for the work in this section. Coordinate fire stopping work with the General Contractor and Construction Manager for all fire-stopping work.

**PART 2 – PRODUCTS**

**2.1 PIPING**

- A. Condenser water mains 2 1/2" and larger shall be schedule 40 black steel with 150 psi black malleable fittings, weld type.
- B. Condenser water mains 2" and smaller shall be type L copper with sweat fittings.

**2.2 VALVES**

- A. See Section 23 00 00 Mechanical, General for valve tagging.
- B. Valves shall be designed for a minimum of 150 psi working pressure. The manufacturer name and the working pressure to be cast on valve body.
- C. Valves shall be manufactured by Apollo, Milwaukee, Nibco or approved equal.
- D. Gate valves shall be bronze bodied, non-rising stem. Provided extended stem for insulation thickness.
- E. Ball valves shall be two piece Class 150 designed for a minimum of 150 psi steam working pressure, 600 PSI non-shock cold water with large port, threaded or soldered type, chrome plated

ball, and blow-out proof stem. The manufacturer name and the working pressure to be cast on valve body. Provide with extended stem such that handle does not interfere with insulation.

- F. Butterfly valves shall be Class 150 designed for a minimum of 150 psi working pressure. Valves shall be lug type butterfly with cast iron body. Disc edge and liner shall be designed for low friction and tight seal. Disc shall be constructed of stainless steel ASTM A-743 gr. CF-8M. Liner shall be EPDM coated. Stem shall include a reinforcing EPDM bushing for low friction and stem-load support. Stem shall be triple sealed for low leakage with blowout-proof stem design.

### 2.3 AUTOMATIC AIR VENT

- A. Provide where shown on plans, a float actuated non-modulating high capacity air vent designed to purge free air from the system and provide positive shutoff at pressures up to 150 psig at a maximum temperature of 250 F. The design of the high capacity air vent shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vent shall be pilot operated for intermittent purging of free air at pressures up to 2 psig during normal system operation, and diaphragm operated for full capacity purging of free air at pressures between 2 and 150 psig. The high capacity air vent shall be constructed of cast iron and fitted with components of type 313 stainless steel, brass, EPDM and silicone rubber.
- B. The high capacity air vent shall be ITT Bell & Gossett Model 107 or equal by Taco, Wheatley or approved equal.

### 2.4 CIRCUIT SETTERS

- A. Provide circuit setters where shown on drawings, with provisions for connecting a portable differential pressure meter. Each valve shall be provided with a performed polyurethane insulation jacket suitable for use on heating and cooling systems. Each unit shall be B&G Number CB Circuit Setter Plus or equal by Taco, Wheatley or approved equal.
- B. Circuit setters shall be sized for proper water flow control as recommended by the valve manufacturer. The water pressure drop shall not exceed 2 psi.

### 2.5 THERMOMETERS

- A. Thermometers shall be 9" scale, adjustable angle, red reading mercury provided with clear nonbreakable front. Case material shall be nonferrous cast aluminum construction and shall be provided with a brass well.
- B. Range shall be from 0-250 F.
- C. Thermometers shall be as manufactured by Trerice, Weksler or approved equal.

### 2.6 PIPE HANGERS

- A. Provide oversized, galvanized pipe hangers over insulated piping. Install 18 gauge galvanized, shield between hanger and insulation. Ten-inch-long shield to extend 180 around the bottom of the insulated pipe.
- B. Hangers in mechanical room(s) housing pumps and all air handling unit rooms to have spring type vibration isolator of proper size to prevent transmission of noise and vibration to building. All hanger rods in mechanical rooms housing pumps and all air handling unit rooms shall be cadmium plated.

- C. Location and method of support subject to Engineer's approval. Threaded rods and supplementary steel to span structural supports to accommodate hangers is included in Division 23. Supplementary steel shall consist of galvanized angle or C-Chanel of appropriate size to support the load and span between load points. Refer to structural drawings for attachment methods to building structure.

## 2.7 FLEXIBLE PIPE CONNECTIONS

Flexible EPDM connectors shall be used on all equipment as indicated on the drawings. They shall be manufactured of multiple plies of friction nylon tire cord with an EPDM cover and liner. No steel wire or rings shall be used as internal pressure reinforcement. Straight connectors shall have two spheres with a centered molded-in external ductile iron ring to maintain the two spherical shapes. Two inch and smaller sizes may have threaded ends. Floating flanges shall have a recess to lock the bead wire in the raised EPDM flanges. Twin sphere connectors shall have a minimum rating of 250 psi at 170 degrees F. and 165 psi at 250 degrees F. Certified safety factors shall be a nominal 4 to 1 with minimum acceptable test results of 3.6 to 1. Tests shall cover burst, flange leakage, extension without control rods and flange retention at 50% of burst pressure without control rods. Flexible pipe connections Superflex MFTFU or equal by Flex-Hose Inc..

## 2.8 PIPE SLEEVES AND ESCUTCHEONS

- A. Where pipes pass through masonry construction, install sleeves sized to allow 1/2" clearance entirely around the passing pipe and insulation. Install sleeves during construction of walls, ceilings, and floors. Extend vertical sleeves a minimum of 3" above finished floor. Install sleeves in a waterproof manner. Sleeves in bearing walls and floors to be made of schedule 40 steel pipe. Sleeves in other masonry or fire rated gypsum board walls to be made of 20 gauge galvanized steel. Provide copper sleeves for copper pipes.
- B. Provide one-piece chrome plated cast brass escutcheons where pipes pass through finished walls or floors.

## 2.9 STRAINERS

- A. Strainers shall be Class 150 cast iron steel Y-type, flanged, screwed cap, SS screen with 0.033" perforations, and bottom blow-down and removable strainer cover.
- B. Strainers shall be Mueller or equal by Hoffman, Sarco, Trane, Jenkins, Grinnell, Watson McDaniel or approved equal.

## 2.10 SELF REGULATING HEATER CABLE

- A. Low Temperature - Self-Regulating Heating Cable
- B. Heating cables shall be self-regulating, capable of maintaining temperatures up to 150F and a continuous exposure to pipe temperature of 185F while de-energized.
- C. Cable must be of parallel construction so that it can be cut to length without changing its power output per unit length.
- D. The heater cable assembly shall have a monolithic heating core construction consisting of two parallel 16 AWG nickelplated copper bus conductors with a semi-conductive PTC polymer extruded over and between these parallel conductors. A polyethylene dielectric insulating jacket is extruded over the heating element core.



- E. The semi-conductive heating matrix and primary insulating jacket shall be cross-linked by irradiation.
- F. The basic cable will be covered by means of a metallic braid of tinned copper. The braid will provide a nominal coverage of eighty percent (80%) and will exhibit a resistance not exceeding 0.0.0045 ohm/ft.
- G. The cable shall be covered with a corrosion resistant overjacket of thermoplastic elastomer (for possible exposure to aqueous solutions, mild acids or bases) or fluoropolymer (for possible exposure to organic chemicals or corrosives).
- H. For longer circuit lengths and higher heat loss requirements greater than 10 W/ft @ 50F, the heating cable shall have 14 AWG nickel-plated copper bus conductors
- I. Long term stability shall be established by the service life performance test per IEEE 515 Std-2004.

### **PART 3 – EXECUTION**

- 3.1 Run pipes parallel to walls and ceilings, using a few fittings consistent with required flexibility. Pipe penetrations shall be perpendicular to walls. Wherever pipes change size, use eccentric fittings.
- 3.2 Install manual air vents where pipe drops in direction of flow. Discharge shall be elbowed down for water collection.
- 3.3 Provide a union or a flange in ferrous pipes at each piece of equipment, control valve, etc. and as required to service and maintain equipment.
- 3.4 Provide dielectric unions where pipe of dissimilar materials are connected.
- 3.5 Support pipes two inch size and under by hangers not over 8 feet apart. Support pipes over two inch size by hangers not more than 12 feet apart.
- 3.6 Support vertical pipes by clamps not over 12 feet apart. Protect copper pipes by lead sleeves between pipes and clamps.

### **3.7 PIPING TESTS**

- A. All piping installed shall be hydraulically tested as specified herein. Provide all equipment required to make the tests specified herein.
- B. Piping may be tested a section at a time in order to facilitate the construction.
- C. Fill the section of pipe to be tested with water and bring the section up to pressure with a test pump. These tests shall be conducted before any insulation is installed and any insulation installed prior to these tests shall be removed. Gauges used in the tests shall have been recently calibrated with a dead weight tester.
- D. All tests shall apply full test pressure to the piping for a minimum of 24 hours.
- E. All tests shall be conducted at the water working pressure of the pipe installed. When schedule 40 or standard weight pipe is used, the test pressure shall be 150 pounds per square inch.
- F. When the test pressure has fallen over 5% during the 24 hour test period, the point of leakage shall be found, repaired and the test repeated. This procedure shall be followed until the piping system has met requirements above.

### 3.8 CHEMICAL CLEANING OF PIPES

- A. Furnish all labor and chemicals for the cleaning of pipes.
- B. Chemically clean all Condenser water, hot water and Condenser/hot water (dual temperature) piping systems with Mitco BL-5 (or equal), using 1 gallon for each 1000 gallons of system capacity to remove dirt, oil, grease, and other foreign contaminants. Drain off 25% of system water every two hours and recharge with water and Mitco BL-5. Circulate for six (6) hours or until all contaminants are removed.
- C. After cleaning, drain and flush all systems.

### 3.9 CHEMICAL TREATMENT OF WATER PIPING SYSTEMS

The chilled and hot water systems shall be chemically treated by an automatic chemical feed system. (See specification section water treatment 23 25 00)

### 3.10 HEAT TRACE TAPE

- A. Provide heat trace tape for all water piping exposed outdoors and all piping cabinets attached to or a part of outdoor heating and cooling equipment.
- B. Install heating cables in accordance with manufacturer's instructions. Coordinate installation with pipe insulation application. Distribute and fasten cable evenly on pipe using pipe strap or tape at maximum spacing 0.5 m. Ensure that heating cables do not touch or cross each other at any point. Run only cold leads in conduit and ensure sensing bulb does not touch cable. Ground shield to building ground. Coordinate cable installation with insulation application. Loop additional cable at fittings, valves, and flanges.

### 3.11 SEISMIC RESTRAINT OF PIPING

- A. Seismically restrain all piping with cable restraints as listed below:
  - 1. Restrain all piping located in boiler rooms and mechanical rooms 1-1/4 inches nominal diameter and larger.
  - 2. Restrain all pipes 2-1/2 inches nominal diameter and larger.
- B. Piping suspended by individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be restrained.
- C. Transverse restraint shall be at 40 feet maximum except where a lesser spacing is required to limit pipe stress.
- D. Longitudinal restraints shall be at 80 feet maximum. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal restraint provided that it has a capacity equal to or greater than a longitudinal restraint. The longitudinal restraints and connections must be capable of resisting the additional force induced by expansion and contraction.
- E. For all gas piping, transverse restraint shall be at 20 feet maximum, and longitudinal restraint shall be at 40 feet maximum.

- F. Transverse restraints for one pipe section may also act as longitudinal restraints for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or tee.
- G. Branch lines may not be used to restrain main lines.

**END OF SECTION 23 21 13**

**SECTION 23 21 23  
WATER CIRCULATING PUMPS**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer's local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non compliant submittals will be promptly rejected.
- 1.3 Furnish and install base-mounted, flexible coupled, end-suction pumps with capacities as shown on plans. Pumps shall be base-mounted, single-stage, vertically split case design, capable of being serviced without disturbing piping connections.
- 1.4 Submit pump curves to shown specification compliance for each pump.
- 1.5 Pump shall be designed for complete back pull-out maintenance without disturbing piping connections.

**PART 2 - PRODUCTS**

**2.1 BASE MOUNTED PUMPS**

- A. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support. The impeller shall be cast bronze, enclosed-type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.
- B. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat of at least 98% alumina oxide content, and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.
- C. Pumps shall be rated for minimum of 175 psi working pressure. Castings shall have gauge ports at nozzles and vent and drain ports at top and bottom of casting.
- D. Pump bearing housing assembly shall have heavy-duty greaseable ball bearings, and shall be replaceable without disturbing piping connections.
- E. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area. Provide spacer couplings on all pumps.
- F. The motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for by the project requirements. Pump and motor shall be factory aligned.
- G. Each pump shall be factory tested. It shall then be thoroughly factory cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.
- H. Provide chilled water pumps with drip pan below volute.
- I. Pumps shall be Series "1510" as manufactured by ITT Bell and Gossett or equal by Taco, Armstrong or approved equal.

## 2.2 IN-LINE PUMPS

- A. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron bronze fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
- B. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
- C. The liquid cavity shall be sealed from the pump bearing by an internally-flushed mechanical seal with ceramic seal seat of at least 98% alumina oxide content, and carbon seal ring, suitable for continuous operation at 225°F.
- D. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
- E. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- F. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
- G. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- H. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
- I. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
- J. Pump manufacturer shall be ISO-9001 certified
- K. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.
- L. Pump shall be Series "e80", as manufactured by Bell and Gossett or equal by Taco, Armstrong or approved equal.

## PART 3 - EXECUTION

- 3.1 All pumps shall be installed in strict accordance with the recommendations of the manufacturer.
- 3.2 Each unit shall be checked and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to the pump for owner's reference.
- 3.3 All pumps and motor bed plates shall be installed on a inertia pad and housekeeping concrete pad. The piping shall be arranged so that no weight of the piping is resting on the pump and so that no

strain is placed on the pump. The pumps shall be placed in proper alignment and secured to the concrete pad before piping is connected. The pump installation, alignment, leveling and grouting in of the base shall be performed according to the recommendations of a qualified representative of the pump manufacturer and the manufacturer's written installation instructions.

- 3.4 After mounting of pump and piping, prior to pump start-up, each pump shall be field aligned and checked by a qualified technician.
- 3.5 Trim impellers for optimum performance per manufacturer's written instructions for final balancing.

**END OF SECTION 23 21 23**

**SECTION 23 25 00  
MECHANICAL; HVAC, WATER TREATMENT FOR HVAC SYSTEMS**

1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.

1.2 All material and work shall comply with the National Fire Codes of the NFPA, National and local codes and the ICC International Code Council Mechanical, Plumbing and Gas Codes 2015 editions.

**1.3 SUMMARY**

A. Provide complete chemical water treatment systems for the following systems:

1. Open loop cooling tower water.
2. Closed loop condenser water.

B. Provide chemicals as required to control scale, corrosion, biological fouling and biological foaming.

C. Coordinate tap and sensor locations with Drawings and the water treatment manufacturer's requirements.

D. Provide supervision of the water treatment program for a period of one year consisting of on-the-spot analysis of all systems treated and a submittal of a written report to Owner and Engineer stating current conditions and recommendations for maintaining optimal controls. This service shall be performed monthly.

**1.4 QUALITY ASSURANCE**

A. The water treatment chemical and service supplier shall be a recognized specialist, active in the field of industrial water treatment for the last ten (10) years, whose major business is in the field of water treatment. Supplier shall have regional water analysis laboratories, development facilities and service department, plus full-time service personnel located within the training area of the Project Site.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

**1.5 SUBMITTALS**

A. Product Data:

1. Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:
  - a. Pumps.
  - b. Chemical solution tanks.
  - c. Agitators.
  - d. Control equipment and devices.
  - e. Test equipment.
  - f. Chemicals.
  - g. Filters.

- h. Chemical feeders.
  - i. Bypass Chemical pot feeders.
- B. Record Documents:
- 1. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - a. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.
  - 2. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project Site.
  - 3. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Operation and Maintenance Data:
- 1. For pumps, agitators, filters, system controls, and accessories to include in Operating and Maintenance Manuals.
  - 2. Furnish manufacturer's written instructions.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Chemical Feed System Description:
- 1. Closed-Loop System: One bypass feeder on each system with isolating and drain valves with inlet piping connecting to discharge of circulating pumps, and outlet side of feeder connected to suction side of pump unless otherwise indicated.
  - 2. Introduce chemical treatment through bypass feeder when required or indicated by test..
  - 3. Open-Loop System, Condenser Water Piping: Pump sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Use agitator as required.
    - a. Intermittently feed biocide to condenser water to achieve a toxic level of the chemical to kill the organism present.
    - b. Activate chemical solution pump from water meter which is separate from the make-up water line to the cooling tower when condenser water pumps are running.
    - c. Activate chemical solution pump from the make-up contacting head water meter.
    - d. Automatically feed chemical with electronic solid-state controllers.
    - e. Deactivate solution pump and signal alarm by a liquid-level switch in each solution tank on low chemicals.
- C. Performance Requirements:
- 1. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.



2. Base chemical treatment performance requirements on the quality of water at the Project Site HVAC system equipment material and operating personnel capabilities, and the capability of personnel and guidelines of authorities having jurisdiction at the Project Site.
  - a. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics:
    - 1) Conductivity: 1200 to 2500 umhos. (nitrite raises system conductivity)
    - 2) Acceptable pH: Not less than 7.5 or greater than 8.5 10.0 (except for piping flush and clean step where the pH level is in the alkaline range of 9.5 to 10.5).
    - 3) Hardness: < 5 ppm. (when closed loops have soft water make-up water)
  - b. Condenser Water, Medium-to-Large Cooling Tower System: Maintain system essentially free of scale and total suspended solids to sustain the following water characteristics:
    - 1) Conductivity: 1500-1600 mmhos (1500 B 1650 umhos)
    - 2) Acceptable pH: Not less than 8 or greater than 9.5.

## 2.2 MANUFACTURERS

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

## 2.3 CHEMICAL FEEDING EQUIPMENT

- A. Bypass Chemical Pot Feeders: Steel or stainless steel, for introducing chemicals into the system; with funnel shutoff valve on top, air-release valve on top, drain valve on bottom, and recirculating shutoff valves on sides.
- B. Positive-Displacement Diaphragm Pump: Simplex, self-priming, rated for intended chemical with 25 percent safety factor for design pressure and temperature.
  1. Pump shall be capable of providing an adjustable flow rate.
  2. Pump shall be of thermoplastic construction.
  3. Pump motor shall be fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor.
  4. Pump shall have a built-in relief valve.
- C. Positive-Displacement Piston Pump: Metal and thermoplastic construction.
  1. Pump motor shall be fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor.
  2. Pump shall have a built-in relief valve.
- D. Chemical Solution Tanks: Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with graduated markings.
  1. Polypropylene Molded cover with recess for mounting pump, agitator, and liquid-level switch.
  2. Capacity equal to 50 gallons unless specified otherwise on the Drawings.
- E. Agitator: Direct drive, 1750 rpm, mounted on tank with angle adjustment.
  1. Agitator motor shall be fully enclosed, continuous-duty, 120-V, 60-Hz, single-phase motor.
  2. Stainless-steel clamp and motor mount, with stainless-steel shaft and propeller.
- F. Liquid-Level Switch: Polypropylene housing, Liquid-Level Switch: Polypropylene housing, integrally mounted PVC air trap, receptacles for connection to metering pump, and low-level alarm.
- G. Packaged Conductivity Controller: Solid-state circuitry, 5 percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control-function light, output to control circuit, and recorder.
- H. Cold-Water Meter: Positive-displacement type with sealed, tamperproof magnetic drive;

- impulse contact register; single-pole, double-throw, dry-contact switch.
1. Turbine type with bronze or cast-iron body rated for 125 psig.
  2. Magnetic-drive or mechanical-impulse contactor matched to signal receiver.
  3. At least six-digit totalizer.
  4. Contact switches shall be rated at 5 amps, 120-Vac.
- I. Solenoid Valves: Forged-brass body, globe pattern, and general-purpose solenoid enclosure with 120-V, continuous-duty coil.
- J. Electronic Timers: 150-second and 5-minute ranges, with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
- K. Chemical Tubing: Schedule 40 PVC with solvent-cement joints; or polypropylene tubing with heat fusion.
- L. Plastic Ball Valves: Rigid PVC or CPVC body, integral union ends, and polytetrafluoroethylene seats and seals.
- M. Plastic-Body Strainer: Rigid PVC or CPVC with cleanable stainless-steel strainer element.
- N. Condenser Water-Treatment Control Panel: Incorporate solid-state integrated circuits and digital LED displays, in NEMA 250, Type 12 enclosure with gasketed and lockable door.
1. Control dissolved solids, based on conductivity, and shall include the following:
    - a. Digital readout display.
    - b. Temperature-compensated sensor probe adaptable to sample stream manifold.
    - c. High, low, and normal conductance indicator lights. Programmable set points and alarms.
    - d. High or low conductance alarm light, trip points field adjustable; with silence switch.
    - e. Hand-off-auto switch for solenoid bleed-off valve.
    - f. Bleed-off light to indicate valve operation.
    - g. Internal adjustable hysteresis or dead band.
    - h. Network and phone line capable controller for remote monitoring/alarming.
  2. Control inhibitor feeding, based on make-up volume, and shall include the following:
    - a. Solid-state reset counter (accumulator), with selections from 1 to 15.
    - b. Solid-state timer, adjustable from 15 to 300 seconds.
    - c. Test switch.
    - d. Hand-off-auto switch for chemical pump.
    - e. Illuminated legend to indicate feed when pump is activated.
    - f. Solid-state lockout timer, adjustable from 15 to 180 minutes, with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
    - g. Electromechanical-type, panel-mounted make-up totalizer to measure amount of make-up water.
  3. Control biocide with an adjustable time programmer and shall include the following:
    - a. 24-hour timer with 14-day skip feature to permit activation any hour of the day.
    - b. Precision, solid-state, bleed-off lockout (zero to nine hours) and biocide module (zero to two and one-half hours). Pre-bleed and bleed lockout.
    - c. Solid-state alternator to enable the use of two different formulations.
    - d. 24-hour digital display of time of day.
    - e. 14-day LED display of day of week.
    - f. Fast and slow internal clock set controls.
    - g. Battery backup so clock is not disturbed by power outages.
    - h. Quartz timekeeping accuracy.
    - i. Hand-off-auto switches for biocide pumps.

- j. Biocide A and Biocide B illuminated legends to indicate pump is running.

#### 2.4 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests.
- B. Corrosion Test Coupon Assembly: Constructed of corrosion material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.
  - 1. Two-station rack for closed-loop systems.
  - 2. Four-station rack for open condenser water systems.

#### 2.5 CHEMICALS

- A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.
- B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
- C. Biocide: Chlorine release agents or microbiocides.
- D. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.
- E. Open-Loop, Condenser Water Piping Chemicals: Sequestering agent to inhibit scaling, acid to reduce alkalinity and pH, corrosion inhibitor, and biocide.

#### 2.6 CONDENSER WATER FILTRATION UNIT

- A. Description: Filtration unit, including sand filter, filter pump, strainer, and controls; factory assembled, piped, and wired; mounted to steel skid.
- B. Sand Filter: Glass-fiber-reinforced polyester tank, internal distribution piping, differential gauge panel, manual and automatic pressure relief valves, backwash valve, and backwash sight tube; graded silica sand installed according to manufacturer's written instructions.
- C. Pump: All-bronze, centrifugal filter pump with totally enclosed, fan-cooled motor; strainer mounted on pump suction; and manually reset, motor-overload switch with pilot light.
- D. Backwash Control: Automatic, with time clocks and differential pressure switches; mounted in NEMA 250, Type 4 control panel; factory wired for single, external electrical connection.

#### 2.7 WATER FILTRATION UNIT

- A. Filtration Unit: Stainless-steel housing and polypropylene filter with polypropylene core.
- B. Replaceable Filter Media: Compatible with antifreeze and water-treatment chemicals.
- C. Filter Media for Sediment Removal Service: Rated at 98 percent efficiency for 20-micrometer particulate.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

A. Water Analysis

1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 **INSTALLATION**

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer=s published recommendations.
- C. Install treatment equipment level and plumb.
- D. Add cleaning chemicals as recommended by manufacturer.
- E. Connections:
1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
  2. Install piping adjacent to equipment to allow service and maintenance.
  3. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
  4. Ground equipment.
  5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 **TESTING**

- A. Engage a factory-authorized service representative to perform Start-up service.
1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during HVAC system Start-up procedures.
- B. Test chemical feed piping as follows:
1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose Work that has been covered or concealed before it has been tested and approved.
  4. Cap and subject piping to static water pressure of [50 psig (345 kPa)] above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four (4) hours. Leaks and loss in test pressure constitute defects.
  5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
  6. Prepare test reports, including required corrective action.

C. Adjusting:

1. Sample water at one-week intervals after Start-up for a period of five (5) weeks, and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:
  - a. Silica: ASTM D 859.
  - b. Steam System: ASTM D 1066.
  - c. Acidity and Alkalinity: ASTM D 1067.
  - d. Iron: ASTM D 1068.
  - e. Water Hardness: ASTM D 1126.
2. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two (2) separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 calendar days apart. Submit written reports of water analysis.

3.4 **TRAINING**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
  1. Schedule minimum four (4) hours of training with Owner.
  2. Provide at least seven calendar days advance notice.
- C. Review manufacturer's safety data sheets for handling of chemicals.
- D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.
- E. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.

**END OF SECTION 23 25 00**

## SECTION 23 57 00

### HEAT EXCHANGER

#### PART 1 - GENERAL

- 1.1 Section 23 00 00 Mechanical, General applies to the work specified in this section of specifications.
- 1.2 The manufacturer of the Plate Heat Exchanger shall press his own plates in the United States. Plates shall not be subcontracted or purchased for resale.
- 1.3 The Plate Heat Exchanger Manufacturer shall have an established and on-going Quality Assurance and Quality Control program. Manuals of these programs shall be available for inspection at the plant.
- 1.4 APPLICABLE CODES AND STANDARDS:
  - ASME Section II - Material Specification
  - ASME Section V - Non-Destructive Testing
  - ASME Section VIII - Pressure Vessel Code
  - ASME Section IX - Welding Qualifications
  - ANSI Section B16.5 - Flanged Fittings
- 1.5 CERTIFICATION: The plate heat exchanger shall be designed, fabricated and tested in accordance with the requirements of Section VIII, Division 1 of ASME Code and shall bear a permanently affixed nameplate with the appropriate code stamp and National Board Registration Number. The plate heat exchanger shall also bear the AHRI Standard 400 certification for liquid to liquid heat transfer.
- 1.6 Plate frame heat exchanger shall be B&G model noted in the schedule on the drawings or equal by Alpha Laval, Sondex or approved equal. Verify size constraints before releasing order.

#### PART 2 - PRODUCTS

- 2.1 DESIGN:
  - A. Unit shall be single pass except when significant cost savings can be realized with a multi-pass design.
  - B. For single pass units all connections shall be located on the fixed head, frame plate, allowing the movable head, pressure plate, to slide back and plates added, removed, or replaced from the plate pack without disturbing the connections or associated piping.
  - C. The design shall allow for the removal of interior plates without the removal of the preceding plates.
  - D. The unit shall be provided with an aluminum or stainless steel OSHA splash shield.
  - E. The unit shall be ASME Code stamped.

## 2.2 FRAME

- A. The frame plate and pressure plate shall be carbon steel SA 516 grade 70.
- B. The frame and pressure plate shall be of sufficient thickness to meet the ASME design pressure. Stiffeners or support brackets are not allowed.
- C. Carbon steel frame components shall be painted with gray epoxy paint.
- D. Units with three-inch or greater connections shall be unlined or alloy lined studded ports to mate with raised face or flat faced ANSI flanges. Rubber liners are not allowed.
- E. Units with two or two and half-inch connections shall be have carbon steel female tapped NPT or male NPT connections if an alloy material is required.
- F. Units with one-inch ports shall have carbon steel or 316 stainless steel female tapped NPT or alloy material male NPT connections.
- G. Units with connections greater than 2-inch require that the thermal plates shall be supported by the carry bar, top bar. The guide bar, bottom bar, shall only help properly align the plates.
- H. The pressure plate shall be supported by a roller assembly from the carry bar for units with 2 ½ inch or greater port sizes.
- I. The carry and guide bar plate contact surfaces shall be stainless steel.
- J. The design for units with two-inch connections or smaller allow the plates be supported by the guide bar, bottom bar, and the carry bar, top bar, shall help properly align the plates. Carry and guide bars shall be steel with a zinc chromate coating.

## 2.3 TIGHTENING BOLTS

- A. Tightening bolts shall be zinc plated carbon steel SA193 B7.
- B. The tightening bolt assemblies shall include captive working nuts at the pressure plate, rear head, such that the unit can be opened and closed with one wrench from the front of the unit.

## 2.4 PLATES

- A. Plates shall be pressed in a one step stamping process.
- B. Plates shall use an integral rolled edge hanging system to provide a rigid hanger device between the plate and carry bar and guide bar. Welded on hanging brackets or stiffeners are not acceptable.
- C. The plate pack shall use a positive plate to plate alignment system to ensure proper plate to gasket seals throughout the plate pack. The positive alignment system shall either be a gasket lug which fits within a plate recess on the proceeding plate (tongue in groove) to align successive plates or an extended rolled edge hanger which nests successive plates through direct contact around the entire plate hanger. Plate designs, which only offer alignment through contact with the carry and guide bar, are unacceptable.
- D. Plates shall be permanently marked to indicate plate material and thickness.

## 2.5 GASKETS

- A. All gaskets except the gasket on the first plate shall be identical.

- B. The gaskets shall be a one-piece construction with a double gasket barrier at the port region. The area isolated by the double gasket shall be vented to the atmosphere, so that a gasket failure is detected by leakage to the exterior prior to any possible cross contamination.
- C. When available, glue-free gaskets are preferred to glued-on gaskets. Gasket attachment methods, which break during gasket removal or plate maintenance, thus destroying the gasket shall not be accepted.
- D. Selection of gasket materials shall insure compatibility with the fluids and operating temperatures.

## 2.6 SELECTION, CERTIFICATION AND TESTING

- A. The manufacturer shall provide written guarantee to the accuracy of the heat exchanger thermal design.
- B. The manufacturer shall confirm its ability to comply with AHRI Standard 400 for liquid to liquid heat exchanger.
- C. Should the Heat Exchanger not perform to the specified conditions as defined in the AHRI Standard 400 the manufacturer is responsible to replace or repair the exchanger to achieve the stated performance.

## PART 3 - EXECUTION

- 3.1 The heat exchanger shall be installed per manufacturer's printed installation instructions.
- 3.2 Bolt new heat exchanger through concrete pad to existing concrete floor in compliance with the seismic requirements of the 2015 International Building Code.
- 3.3 Pipe as shown on drawings.

**END OF SECTION 23 57 00**



**SECTION 23 65 13  
MECHANICAL COOLING TOWER**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer's local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non compliant submittals will be promptly rejected.
- 1.3 Provide as shown on the plans (1) cooling tower certified to cool condenser water per the schedule on the drawings or accepted equal. Substituted manufacturers must meet the dimensional criteria, and factory required clearances from walls and other interferences. Manufacturers' representatives shall verify physical dimensions in the field before quoting to bidders.

**PART 2 - PRODUCTS**

- 2.1 Furnish and install an induced-draft, counter flow-type, factory assembled, film fill, industrial duty, cooling tower. Unit shall consist of cells, as shown on plans. The limiting overall dimensions shall fit the layout and comply with factory recommended clearances from walls and other interferences.
- 2.2 Thermal Performance: The performance shall be as scheduled on the drawings. The thermal performance rating shall be Certified by the Cooling Technology Institute. Tower shall comply with all ASHRAE 90.1 2004 standards.
- 2.3 Performance Warranty: CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the cooling tower supplied will meet the specified performance conditions when the tower is installed as shown on the drawings. If, because of a suspected thermal performance deficiency, the Owner chooses to conduct an onsite thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI, ASME or other applicable standards during the first year of operation; and if the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to the owner to compensate for the performance deficiency.
- 2.4 Design Loading: The tower and its components shall be designed to withstand a wind load of 20 psf. The cooling tower shall be designed to withstand shipping and hoisting loads of 2g horizontal or 3g vertical. Guardrails, if specified, shall be capable of withstanding a 200 lb concentrated live load in any direction and shall be designed in accordance with OSHA guidelines.
- 2.5 Construction: Except where otherwise specified, all components of the cooling tower shall be fabricated of heavy-gauge steel, protected against corrosion by G-235 galvanizing. After passivation of the galvanized steel (8 weeks at pH 7-8, and calcium hardness and alkalinity at 100-300 ppm each), the cooling tower shall be capable of withstanding water having a pH of 6.5 to 9.0; a chloride content up to 500 ppm as NaCl (300 ppm as Cl<sup>-</sup>); a sulfate content (as SO<sub>4</sub>) up to 250 ppm; a calcium content (as CaCO<sub>3</sub>) up to 500 ppm; silica (as SiO<sub>2</sub>) up to 150 ppm; and design operating ranges up to 50F. The circulating water shall contain no oil, grease, fatty acids, or organic solvents.
- 2.6 Mechanical Equipment:
  - A. Fan(s) shall be propeller-type, incorporating heavy aluminum alloy blades and electrogalvanized hubs. Blades shall be individually adjustable and both statically and dynamically balanced. Fan(s)

shall be driven through a one-piece multi-groove, solid back V-type belt, sheaves (pulleys), and tapered roller bearings. Bearings shall be rated at an L10 life of 100,000 hours, or greater. Both motor and fan sheaves (pulleys) shall be all cast aluminum to prevent premature corrosion.

- B. Motor(s) shall be maximum horsepower scheduled on the drawings, TEFC, 1.15 service factor, variable torque, inverter duty and specially insulated for cooling tower duty. Motor nameplate power shall not be exceeded at design operation. TEAO motors are not acceptable.
- C. The complete mechanical equipment assembly for each cell shall be supported by a rigid, hot-dip galvanized steel structural support that resists misalignment between the motor and sheaves (pulleys). For belt-drive towers with motors inside the airstream, motors shall be mounted on an adjustable base that swivels outside the access door for maintenance. For belt-drive towers with motors mounted outside the airstream, a protective cover shall be mounted over the motor and sheave to protect it from the weather and prevent inadvertent contact. The mechanical equipment assembly shall be warranted against any failure caused by defects in materials and workmanship for no less than five (5) years following the date of tower shipment. This warranty shall cover the fan, speed reducer, drive shaft and couplings, and the mechanical equipment support. The electric motor shall carry a manufacturer's warranty of at least one year. The bearing assemblies and V-belts shall be warranted for 18 months.

2.7 Fill, Louvers and Drift Eliminators:

- A. Fill shall be cross-corrugated, counterflow film type, thermoformed from 15 mil thick PVC. Fill shall be assembled into packs for ease of removal and cleaning. Fill shall be supported on channel sections supported from the tower structure and have a flame spread rating less than 25. Drift eliminators shall be PVC with a minimum of three changes in air direction, and shall limit drift losses to 0.005% or less of the design water flow rate.
- B. Air inlet louvers shall be a minimum of 5 inch air travel, triple pass PVC to prevent water splashout and eliminate sunlight from entering the collection basin. For ease of service and long life of louvers, PVC louvers shall be enclosed in a removable frame that attaches to the air inlet without tools. Louvers with less than three changes in air direction are unacceptable.

2.8 Hot Water Distribution System: A pressured spray system shall distribute water evenly over the fill. The branch arms shall be corrosion resistant PVC with polypropylene spray nozzles attached to the branch arms with a rubber socket connection for ease of removal and cleaning. To ensure proper spray system operation, nozzles shall seat in branch arms without regard for direction or alignment.

2.9 Casing and Fan Guard: The casing shall be heavy gauge G-235 galvanized steel and shall be capable of withstanding the loads described above. Casing panels shall encase the fill on all four sides of the tower. The top of the fan cylinder shall be equipped with a conical, non-sagging, removable fan guard, fabricated of welded 5/16" and 7 gauge rods, and hot dip galvanized after fabrication.

2.10 Access: A large rectangular access door shall be located in the plenum on the motor side of the tower.

2.11 Cold Water Collection Basin: The collection basin shall be heavy-gauge stainless steel and shall include the number and type of suction connections required to accommodate the outflow piping system shown on the drawings. Suction connections shall be equipped with debris screens. A factory installed, float operated, mechanical make-up valve shall be included. An overflow and drain connection shall be provided in each cell of the tower. The basin floor shall slope toward the drain to allow complete flush out of debris and silt which may accumulate. Towers of more than one cell shall include steel flumes for flow and equalization between cells.

2.12 Warranty: The cooling tower shall be free from defects in materials and workmanship for a period of eighteen (18) months from the date of shipment.

- 2.13 Access: There shall be an access door allowing access to the mechanical system, drift eliminators, distribution system and fill. A ladder shall be permanently attached to the casing of the tower, rising from the base of the tower to the top of the handrail. Provide a ladder extension for connection to the foot of the ladder. This extension shall be long enough to rise from the roof level to the base of the cooling tower. The installing contractor shall be responsible for cutting the ladder to length; attaching it to the foot of the cooling tower ladder; and anchoring it at its base. A welded aluminum safety cage shall surround the ladder, extending from a point approximately 7'-0" above the foot of the ladder to the top of the handrail.
- 2.14 Motor and Fan Davit: A powder coated davit crane with hot dipped galvanized mounting base shall be field installed on the motor face of the cooling tower. The davit shall have maximum capacity of 500 lbs at a 5'-6 boom extension and 1000 lbs at a 3'-0 boom extension. The davit may be moved to other cells when each cell is modified with a mounting base to accept the davit.
- 2.15 Vibration Switch: A singlepole, double-throw vibration limit switch in a NEMA 4 housing shall be installed for each cell on the mechanical equipment support for wiring into the owner's control panel. The purpose of this switch will be to interrupt power to the motor in the event of excessive vibration. It shall be adjustable for sensitivity, and shall require manual reset.
- 2.16 Basin Heater: Provide a system of electric immersion heaters and controls for each cell of the tower to prevent freezing of water in the collection basin during periods of shutdown. The system shall consist of one or more stainless steel electric immersion heaters installed in threaded couplings provided in the side of the basin. A NEMA 4 enclosure shall house a magnetic contactor to energize heaters; a transformer to provide 24-volt control circuit power; and a solid-state circuit board for temperature and low water cut-off. A control probe shall be located in the basin to monitor water level and temperature. The system shall be capable of maintaining 40F water temperature at an ambient air temperature of 10F.
- 2.17 Fan Motor Variable Speed Drive:
- A. A complete UL listed Variable Speed Drive system in a NEMA 3R outdoor enclosure shall be provided. The VFD shall use PWM technology with IGBT switching and integrated bypass design. The VFD shall catch a fan spinning in the reverse direction without tripping. The panel shall include a main disconnect with short circuit protection and external operating handle, lockable in the off position for safety. The bypass shall include a complete magnetic bypass circuit with capability to isolate the VFD when in the bypass mode. Transfer to the bypass mode shall be automatic in the event of VFD failure or for specific trip conditions allowing safe transfer of utility voltage to the motor. Automatic bypass with an earth ground condition is not allowed. Operator controls shall be mounted on the front of the enclosure and shall consist of start and stop control, bypass/VFD selector switch, Auto/Manual selector switch, and manual speed control. An emergency bypass selector switch internal to the panel allowing the cooling tower fan motor to be run at full speed shall be furnished. To prevent heating problems in the cooling tower fan motor, the VFD system shall de-energize the motor once 25% motor speed is reached and cooling is no longer required. The VFD shall include de-icing logic with auto canceling and adjustable time. Speed in De-Ice mode shall not exceed 50% motor speed. The cooling tower manufacturer shall supply VFD start-up assistance.
- 2.18 Equalizer Flume Weir Gates: The interconnecting flume between cells shall be equipped with a removable cover plate to permit the shutdown of one cell for maintenance purposes, or to permit independent cell operation.
- 2.19 Premium Efficiency Motor: The complete mechanical equipment assembly for each cell shall be supported by a rigid, hot-dip galvanized steel structural support that resists misalignment between the motor and sheaves (pulleys). For belt-drive towers with motors inside the airstream, motors shall be

mounted on an adjustable base that swivels outside the access door for maintenance. For belt-drive towers with motors mounted outside the airstream, a protective cover shall be mounted over the motor and sheave to protect it from the weather and prevent inadvertent contact. The mechanical equipment assembly shall be warranted against any failure caused by defects in materials and workmanship for no less than five (5) years following the date of tower shipment. This warranty shall cover the fan, speed reducer, motor, drive shaft and couplings, and the mechanical equipment support. The bearing assemblies and V-belts shall be warranted for 18 months.

### **PART 3 - EXECUTION**

- 3.1 The cooling tower shall be piped so that only the distribution runouts will drain into the tower on shutdown of the condenser water pump(s). The Contractor, in conjunction with the tower manufacturer, shall verify the adjustment of the float valve for proper operation without overflow.
- 3.2 Coordinate the structural supports with the tower support. Coordinate all field control and power wiring required for a complete installation.
- 3.3 A field capacity test of the cooling tower shall be required and may be required to be performed in the presence of the Owner.
- 3.4 Balancing of condenser water system shall be accomplished at the pump balancing valve with the tower flow control valves open. The tower flow control valves shall be used to distribute water evenly to the condenser water basins and shall not be used for pump balancing.
- 3.5 Tower mounting shall provide vertical limit stops, lateral restraint, wind load resistance, and seismic per 2018 International Building Code, see section 23 00 00 Mechanical, General. All mounting hardware shall be hot dipped galvanized.

**END OF SECTION 23 65 13**

**SECTION 25 55 00 - MECHANICAL  
HVAC, AUTOMATIC TEMPERATURE CONTROL**

**PART 1 - GENERAL**

- 1.1 The provisions of the GENERAL CONDITIONS OF THE CONTRACT, the SUPPLEMENTARY CONDITIONS, and Section 23 00 00 Mechanical General of the Specifications, apply to the work under this Section to the same extent as if fully included herein.
- 1.2 All equipment and materials for this project shall be purchased from and furnished to the contractor by the manufacturer's local representative for Mechanical Design, Inc. No submittals for equipment or materials will be received where the local representative has not originated the submittal data for this project. All non-compliant submittals will be promptly rejected.
- 1.3 The Temperature Controls and Building Management System Hardware will be furnished under this contract. All controls equipment shall be Automated Logic to match the existing system. Approved contractors to bid this project are:
  - 1.4 Harris Integrated Solutions, Inc.  
304 Parnell Street  
West Columbia  
803-794-8808
- 1.5 The mechanical contractor shall coordinate closely with the control's contractor and electrical contractor in order to insure a complete and operating system.
- 1.6 **SUBMITTALS/DRAWING**
  - A. The Control System Contractor shall submit prior to installation a set of installation drawings and control strategies for review by the consultant and/or owner's representative. These drawings shall include the physical location of building control system equipment and system architecture. The complete sequence of operation of the control system shall be provided.
  - B. Upon System completion of the installation and final system adjustment, the Control Contractor shall provide a full set of as-built drawings of the installation and the control strategies.
  - C. Framed control diagrams shall be mounted on the wall inside the appropriate mechanical room.
- 1.7 **GUARANTEE:**
  - A. The entire control system shall be installed by the control system contractor and guaranteed free of defects and shall include required servicing and maintenance for one year after final acceptance.
  - B. The entire building shall be controlled by a direct digital control (DDC) system. The DDC system and all associated components shall carry a one year warranty on labor and materials from date of acceptance by the Owner. Any equipment, software or labor found to be defective during this period shall be repaired or replaced without expense to the Owner. Provide Owner operation support at no additional expense during the warranty period.
  - C. The control company shall provide for 24 months after project closeout, all programming, troubleshooting assistance required and refresher training for the Owner to operate and program the DDC control system. The control company shall make available 24 hour, 7 days per week

support to the Owner during this 24 month period. The control company shall respond to the Owner by computer interface within 60 minutes of initial contact.

- 1.8 Motor starters shall be furnished by the mechanical contractor and turned over to the electrical contractor for mounting and power connections through starter to motor. The contractor shall furnish starters, disconnects or combination starter/disconnects as shown on the electrical drawings. Refer to the electrical drawings for the type required for each piece of equipment. Mounting and wiring of starters including wiring to equipment shall be provided under electrical section of the specifications.

#### 1.9 SCOPE OF WORK

Provide new control components, devices, sensors, and programming logic for the new pumps, heat exchanger and cooling tower as required by the drawings, specifications and controls sequence. Provide interface to the existing control system including all new control points, alarms, and graphics.

### PART 2 - PRODUCTS

#### 2.1 SUBMITTALS/DRAWING

The Control Contractor shall submit prior to installation a set of installation drawings and control strategies for review by the consultant and/or owner's representative. These drawings shall include the physical location of building control system equipment and system architecture. The complete sequence of operation of the control system shall be provided. Upon completion of the installation and final system adjustment, the Control Contractor shall provide a full set of as built drawings of the installation and the control strategies. In addition, the Control Contractor shall provide as built control drawings in AutoCAD format Framed control diagrams shall be mounted on the wall inside the appropriate mechanical room.

#### 2.2 GUARANTEE:

The entire control system shall be installed by the control manufacturer and guaranteed free of defects and shall include required servicing and maintenance for a minimum of one year after final acceptance.

#### 2.3 CONTROL AND INTERLOCK WIRING:

- A. All electrical work required under this section of specifications shall comply with the latest National Electrical Code. Control system power supply shall be served by a separate breaker and fused in control center for secondary protection.
- B. All control wiring shall be run in rigid conduit below grade or, on outdoor installation. All control wiring in walls or above the ceiling (or in equipment rooms where permitted by electrical specifications) shall be run in EMT. PLENUM CABLE WILL NOT BE ACCEPTED.
- C. Control wiring shall be color coded #16 TFF of TFFN wire with 600 volt insulation. Run all wiring between terminal points without changing color. Color code of control wiring shall be as indicated on control wiring diagram. Multi conductor thermostat cable will not be acceptable.

#### 2.4 TRAINING/OWNER'S INSTRUCTION

The Control System Contractor shall provide two copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. The Control System Contractor shall instruct the Owner's designated representatives in these procedures during

the start-up and test period. These instructions are to be conducted during normal working hours.

## 2.5 TELECOMMUNICATIONS CAPABILITIES

A telecommunications interface shall be furnished as necessary to allow direct connection of the Building Management and Control System to public and private phone lines. The telecommunications interface shall have automatic answer capabilities to allow it to be accessed from a remote-control computer or terminal with modem. The interface unit shall be able to allow the person calling access to any information on the network, provided that the standard log-on security screening is met.

## 2.6 EQUIPMENT CONTROLLER

A. The equipment controller will be a complete stand alone device and will operate on default values if communications is lost with the central processor. The control action will be PID (proportional-integral-derivative). The equipment controller will also contain the resident program and data acquisition for optimum start/stop, run time logs and timed override logs. Alarm will be reported to the central processor for drift limit problems.

B. Status lights will provide confirmation of system communications, function and output status.

C. Minimum Control points will be as follows:

### 1. PUMPS

- Pump enable/disable
- Pump Status (CT or VFD output)
- Pump Speed

### 2. HEAT EXCHANGER

- Cooling Tower Water Supply Temp
- Cooling Tower Water Return Temp
- Condenser Water Supply (high temp) Temp
- Condenser Water Supply

### 3. COOLING TOWER

- Tower Enable
- Tower Fan Status (CT of VFD Output)
- Tower Fan Speed
- Cooling Tower Bypass Valve
- Make-up Water Flow meter
- Vibration cutout
- Water Level Control

## PART III - EXECUTION

### 3.1 SEQUENCE OF OPERATION

A. The control system shall enable and disable the building loop pumps. Pumps shall be enabled according to the occupied/unoccupied schedule or whenever there is a call for heating or cooling from any unit within the building.

B. The BMS shall modulate the loop pumps in order to maintain the DP/Flow setpoints.

C. Whenever the building loop return water temperature exceeds setpoint (88°F, adjustable) the

control system shall enable the cooling tower system. Whenever the water temperature is below setpoint (65°F, adjustable) the control system shall enable the hot water system. The heat exchanger bypass valve shall be enabled during all periods the cooling tower system is off.

- D. When the cooling tower system is enabled, one of the cooling tower pumps shall ramp up from 0 to 100%. On an increase in leaving condenser water temperature above setpoint (80F, Adjustable), the standby cooling tower pump shall ramp from 0 to 100%.
- E. The cooling tower fan shall remain off until the CTS leaving water temperature reaches the high limit setpoint (87°F, Adjustable). On a call for fan operation, the tower fan VFD shall ramp to the minimum fan setpoint (allowed by the tower manufacturer) and modulate to maintain a CTS leaving water temp setpoint (85°F, adjustable).
- F. Provide logic with minimum run times to prevent short cycling of fans and pumps.

### 3.2 CERTIFICATION

- A. Furnish to engineer two copies of certifications signed by authorized representative that:
  - 1. Control system has been checked-out and operates according to drawings and specifications.
  - 2. All controls are guaranteed unconditionally for two years from date of acceptance and will be serviced for this period free of charge.
  - 3. Maintenance personnel or responsible party has been instructed as to the operation of control system.

**END OF SECTION 25 55 00**



## PART 1 - GENERAL REQUIREMENTS

### 1-01 SCOPE OF WORK

WORK INCLUDED: Furnish all necessary labor, material, plant and equipment, including materials and equipment not specifically mentioned but necessary to complete the work in a neat, correct, and workmanlike manner, to include:

- 1) Feeders, panelboard breakers, and distribution equipment.
- 2) Complete branch circuit wiring system for receptacles, equipment, and outlets.
- 3) Line voltage connections to equipment furnished under other Sections of these specifications, including disconnects, where indicated.
- 4) Seismic for Electrical Systems, see Section 260529.
- 5) Vibration and Seismic Controls for Electrical Systems, see Section 260548.

SPECIAL NOTE: The provisions of the Instructions to Bidders, General Conditions, Supplementary General Conditions and all applicable requirements of Division 1 shall govern the work under this Division the same as if incorporated herein.

### 1-02 EQUIPMENT WIRING

Furnish and install power circuits to and line voltage connections to all equipment furnished and installed by other trades, including disconnects, where indicated. Disconnect switches to be furnished, installed, and wired under Division 26 unless noted otherwise in the Design Documents.

Furnish and install receptacles for equipment furnished with cord and plug, such as electric water coolers, kitchen equipment with cord and plug, computer and data processing equipment, portable welders, shop equipment, and other equipment indicated on the drawings.

CONTROL WIRING: Raceways, wiring, and control devices (thermostats, pressure switches, program clocks, etc) for low voltage HVAC control systems and other mechanical and plumbing systems shall be furnished and installed under Division 23, unless otherwise indicated on the drawings or specified in this Division.

ROOFTOP HVAC UNITS: Power circuits for rooftop HVAC units shall rise thru the inside of the HVAC unit curb into the bottom of the unit and out to the disconnect switch mounted on the unit. The Electrical Contractor shall coordinate this work closely with the Mechanical Contractor in the field to avoid conflicts with ductwork.

MOTOR STARTERS / VFDs: All Motor Starters and Variable Frequency Drives (VFDs) for HVAC-related equipment that are not factory-mounted and prewired shall be furnished by the Mechanical Contractor, installed and power wired by the Electrical Contractor unless noted otherwise on the Design Documents. Refer to Mechanical Drawings for locations and quantities of Motor Starters and VFDs.

VOLTAGE: The Electrical Contractor shall supply power to equipment at the voltage indicated on the electrical drawings. The Electrical Contractor and the other applicable trades will be held responsible for coordinating the equipment voltages, the control equipment wiring, and the location and type of disconnect required to comply with the equipment manufacturer's requirements, the National Electric Code, and applicable local building codes. IF EQUIPMENT IS SUPPLIED AT A VOLTAGE OTHER THAN THAT PROVIDED, THE GENERAL CONTRACTOR AND SUBCONTRACTORS WILL BE HELD RESPONSIBLE FOR MAKING ANY NECESSARY ADJUSTMENTS TO CORRECT THE CONFLICT, AT NO COST TO THE OWNER, TO THE SATISFACTION OF THE ELECTRICAL ENGINEER.

1-03 EXISTING CONDITIONS

The Contractor will be held responsible for having visited the site and having familiarized himself with the existing conditions prior to submitting his bid.

1-04 COORDINATION

**OTHER TRADES:** All work under this Section shall be coordinated with other trades to ensure proper location of outlets and equipment connections, and to minimize conflicts with structural members, duct work, piping, etc. Conflicts between equipment and/or material locations shall be corrected as directed by the Architect-Engineer at no additional cost to the Owner.

**UTILITIES:** The service locations, arrangement and metering for electrical and telephone service entrances shall be coordinated in detail with those utilities. All provisions necessary for these services shall be provided in the Electrical Contractor's bid, unless otherwise indicated.

1-05 CODES AND PERMITS

Installation and materials shall be in accordance with the applicable versions of the National Electrical Code, the International Building Code, and all local codes. Apply and pay for all permits and fees required for this construction.

1-06 DRAWINGS

The drawings and specifications shall be considered as complementary, one to the other, so that materials and labor indicated, called for, or implied by either shall be furnished and installed as if required by both. Where a disagreement exists between the plans and specifications, the item or arrangements of better quality, greater quantity, or higher cost shall be included in the base bid. Any discrepancies between the drawings, specifications, and field conditions shall be resolved with the Engineer prior to commencing work. All agreements shall be verified in writing.

**RECORD DRAWINGS:** The Contractor shall maintain one set of clean blueprints for "RECORD" drawings. All changes, revisions, or modifications to the project shall be recorded daily on these drawings with **redline pencil**. Upon completion of the project, these redline drawings shall be turned over to the Engineer for preparation of final Record Drawings. All changes, revisions, or modifications on the redline drawings provided to the Engineer shall be noted in red or shall be highlighted in yellow. **Failure to comply with the above criteria may result in rejection of the Record Drawings by the Architect-Engineer.**

1-07 MAINTENANCE AND OPERATING MANUALS

The Contractor shall furnish the Owner two (2) complete maintenance and operating manuals for each piece of equipment and material furnished under this project. These manuals shall be bound in hard cover binders with tabs for each section item or piece of equipment. The manuals shall be furnished to the Engineer prior to the final observation, and final acceptance shall not be given until the Owner's maintenance personnel are instructed in maintenance and operation of all systems.

1-08 GUARANTEE

All materials and labor furnished under this Section of the specifications shall be guaranteed by the Contractor to be free from defects for a period of one year from the date of acceptance. The Contractor shall repair or replace any deficiencies reported in the guarantee period promptly after notification, without any additional compensation from the Owner. LED lamps are included in this warranty. Incandescent, fluorescent, & HID lamps are excluded from this warranty, except that all lamps shall be operational on the date of acceptance.

1-09 MATERIALS

UL LISTING: All materials shall be listed by Underwriter's Laboratories, or an approved equal testing laboratory, and shall bear the "UL" Label, where applicable.

SUBSTITUTIONS: Specific reference in the specifications to any article, device, product, material, fixture, form or type of construction, etc., by name, make or catalog number, with or without the words "or equal" shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition and the Contractor in such cases may, at his option, use any article, device, product, material, fixture, form or type of construction, which in the judgment of the Architect-Engineer, expressed in writing prior to bidding as specified below, is equal to that herein named.

Requests to substitute materials or equipment considered by the Contractor as equal to those specified shall be submitted for review to the Architect-Engineer ten (10) days before bids are taken. Requests shall be accompanied by samples, descriptive literature, and engineering information, as necessary to fully identify and appraise the product. No increase in the contract sum will be considered when requests are not accepted. If the item is found to be equal, the Architect-Engineer will issue an Addendum making it a part of the Contract Documents prior to bidding.

1-10 SUBMITTALS

**Electrical shop drawings shall be submitted in one complete package containing all items required by this specification and all other Division 26-28 specifications. Partial shop drawing submittals may be rejected by the Architect-Engineer.**

**Refer to Section 260510 - Electrical Submittals for additional information.**

PART 2 - MATERIALS

2-01 GENERAL REQUIREMENTS

COORDINATION: Coordinate arrangement, mounting, and support of electrical equipment to allow maximum possible headroom (unless specific mounting heights that reduce headroom are indicated), to provide for ease of disconnecting the equipment with minimum interference to other installations, to allow right of way for piping and conduit installed at required slope, and so connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

2-02 GROUNDING

INSULATED CONDUCTORS: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

BARE COPPER CONDUCTORS:

- 1) Solid Conductors: ASTM B3.
- 2) Stranded Conductors: ASTM B8.
- 3) Tinned Conductors: ASTM B33.
- 4) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
- 5) Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
- 6) Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- 7) Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

GROUNDING BUS: Predrilled Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

BOLTED CONNECTORS FOR CONDUCTORS AND PIPES: Copper or copper alloy, bolted pressure-type, with at least two bolts.

WELDED CONNECTORS: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

GROUND RODS: Copper-clad steel; 3/4 inch by 10 feet in diameter. Use Cadweld type "GT" or equivalent ground rod connectors as indicated on drawings.

## 2-03 RACEWAYS AND FITTINGS

GALVANIZED RIGID CONDUIT (GRC): UL 6 and ANSI C80.1 with full weight screwed fittings. Bushings shall be malleable iron. Bushings 1 1/4" and larger shall have insulated throat and grounding lug.

INTERMEDIATE GRADE METALLIC CONDUIT (IMC): UL 1242 and ANSI C80.6, galvanized, with full weight screwed fittings. Bushings shall be as specified above.

ELECTRICAL METALLIC TUBING (EMT): UL 797 and ANSI C80.3 with steel compression or set-screw type fittings. Die-cast fittings are not acceptable. Fittings 1 1/4" and larger shall have nylon insulated throat. Indented or drive-on fittings are not acceptable. Conduit used for Fire Alarm System wiring shall be red, similar to Allied Fire Alarm EMT.

FLEXIBLE STEEL CONDUIT (GREENFIELD): UL 1. Fittings shall be steel.

LIQUIDTIGHT FLEXIBLE STEEL CONDUIT (SEALTITE): UL 360. Fittings shall be steel compression type.

PLASTIC CONDUIT (PVC): Schedule 40 polyvinylchloride. NEMA Standard TC-2 and TC-3 and UL Standards. Conduit, solvent, and fittings shall all be supplied by the same manufacturer. PVC is not permitted above grade.

SURFACE METAL RACEWAY (INDOOR): Wiremold V700 ivory surface metal raceway, or acceptable equivalent. Straps, boxes, elbows, etc. shall all be supplied by the same manufacturer. Total cross-sectional area shall be a minimum of 0.25 square inches.

## 2-04 WIRE AND CABLE

UL STANDARDS: UL 44 and UL 83.

CONDUCTOR (COPPER): Copper, soft drawn, per ASTM B3 and comply with NEMA WC 70. Sizes No. 12 and 10 shall be solid conductor. Sizes No. 8 and larger shall have Class B concentric stranding per ASTM B8. Stranded conductors may not be used on No. 12 and No. 10 circuits.

CONDUCTOR (ALUMINUM) (WHERE SPECIFIED ONLY): Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less, complying with ASTM B 800 and ASTM B 801.

INSULATION: 600 Volt, 90°C rated, comply with NEMA WC 70. Type THHN-THWN-MTW, unless noted otherwise.

**SPLICING MATERIALS:**

- No. 10 and smaller: Acceptable wire nuts or insulated crimped splice caps.  
No. 8 and larger: Bronze or copper split bolts, or tinned compression connectors.  
(Polaris insulated splice blocks may not be used on this project).

Insulation shall be Scotch No. 23 rubber tape and Scotch No. 33 plastic tape, or approved equivalent method.

Power feeders shall not be spliced.

TYPE MC CABLE: Metal-clad cable, Type MC, rated 600 V or less, UL 1569, RoHS compliant, as manufactured by AFC, Encore Wire, or acceptable equivalent. Refer to paragraph 3-04 for restrictions on use of Type MC Cable.

**2-05 BOXES AND WIREWAYS**

OUTLET BOXES: Galvanized sheet steel per UL 514. "Through-wall" boxes SHALL NOT BE USED. Back-to-back mounting of boxes is not permitted. All outlet boxes 4"x4" or smaller located on opposite sides of a rated wall shall have a minimum of 24" horizontal spacing or shall be protected with listed putty pads. All outlet boxes larger than 4"x4" (communications outlets, etc.) located in rated walls shall be protected with listed putty pads.

Box sizes shall be as follows:

- 1) Wall Receptacle Outlets: 4" square by 2 1/8" deep with plaster ring as required.
- 2) Wall Computer, Communications and TV Outlets (up to 1" conduit): 4" square by 2 1/8" deep with one gang plaster ring. Provide box with 1" conduit knockouts.
- 3) Wall Computer, Communications and TV Outlets (1 1/4" conduit): 4 11/16" square by 2 1/8" deep with one gang plaster ring. Provide box with 1 1/4" conduit knockouts.
- 4) Ceiling outlets: 4" square or octagonal by 1 1/2" or 2 1/8" deep with stud or ears where required for fixture support.
- 5) Indoor Surface Mounted Outlets: Wiremold V5744S-2 surface metal box unless noted otherwise on the drawings (steel boxes and EMT conduit may be used in equipment rooms, janitor's closets, storage rooms).
- 6) Exposed Outlets: Malleable iron or heavy duty cast aluminum with threaded hubs, Type FS, FD, or GS. Manufactured by Crouse Hinds, Appleton, Killark, or approved equal. Die cast boxes are not acceptable.

SUPPORT FOR RECESSED BOXES IN MASONRY WALLS: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

SUPPORT FOR RECESSED BOXES IN STUD WALLS: Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose. Box brackets reliant on support legs pressed against back of opposing wall are not acceptable.

WIREWAYS, PULL BOXES AND JUNCTION BOXES: UL 50. NEMA 250, Type 12 unless otherwise indicated. Code gage galvanized sheet steel, aluminum, or steel primed and painted after fabrication. Manufactured by Square D, Austin Berryhill, Hoffman Engineering, B-Line Systems, or approved equal. Wireways shall have hinged covers.

HANDHOLES: Polymer Concrete unless otherwise indicated, see details on drawings. As manufactured by Hubbell (Quazite), Armorcast, CDR Systems, or acceptable equivalent.

## 2-06 WIRING DEVICES

**MANUFACTURERS:** All wiring devices shall be Hubbell Extra Heavy-Duty Specification Grade Series or equivalent of Arrow Hart Premium Industrial Spec Grade, Pass and Seymour Industrial Extra Heavy-Duty Spec Grade, or Leviton Industrial Spec Grade, unless specifically noted otherwise. If devices not meeting the specifications are supplied, they shall be removed, discarded, and new devices meeting the specification shall be furnished & installed by the Electrical Contractor at no cost to the Owner or the Engineer.

**RECEPTACLES:** 20A, 125V, 3 wire grounding, NEMA 5-20R, side and back wired, with impact resistant nylon face and standard color as selected by Architect.

- "TR" denotes Tamper-Resistant receptacle. Tamper Resistant receptacles shall be listed Tamper-Resistant receptacles per NEC Article 406.11, typical for receptacles in Dwelling Units, Kindergartens, and Childcare Areas.
- "CR" denotes indoor Corrosion Resistant receptacle. Indoor Corrosion Resistant receptacles shall be listed Weather/Corrosion Resistant receptacles per NEC Article 406.8.
- "WP" denotes weatherproof receptacle. Weatherproof receptacles shall be listed Weather/Corrosion Resistant receptacles per NEC Article 406.8 and shall include an Extra-Duty rated "In-Use" style wet location cover with shallow lockable cover.

- 1) Duplex Receptacle: Hubbell HBL-5362 or P&S 5362A
- 2) Duplex Receptacle, Tamper Resistant (NEC 406.11): Hubbell HBL-5362-TR, P&S TR5362.
- 3) Duplex Receptacle, Corrosion Resistant (NEC 406.8): Hubbell HBL-5362-WR, P&S CR6300.
- 4) Single Receptacle: Hubbell HBL-5361-X
- 5) Isolated Ground Duplex Receptacle: Hubbell IG-5362-X

**GFCI RECEPTACLES:** Feed Thru type, 20A, 125V, NEMA 5-20R, standard color as selected by Architect. All GFCI Receptacles shall be self-testing and shall be listed Tamper Resistant (NEC 406.11) and Weather Resistant (NEC 406.8).

- 1) GFCI Duplex Receptacle: Hubbell GFR-5362-SG-X, P&S 2097TR
- 2) Faceless GFCI: Hubbell GFSTBF20-X

**SWITCHES:** 20A, 120/277V, side and back wired, ivory color. Single pole, double pole, three way, or four way, as indicated on the drawings. Standard color as selected by Architect.

- 1) Single Pole Switch: Hubbell HBL-1221-X, P&S PS20AC1-X
- 2) Double Pole Switch: Hubbell HBL-1222-X, P&S PS20AC2-X
- 3) Three Way Switch: Hubbell HBL-1223-X, P&S PS20AC3-X
- 4) Four Way Switch: Hubbell HBL-1224-X, P&S PS20AC4-X

**SPECIAL RECEPTACLES:** Specification grade, rating as specified on the drawings.

**COVER PLATES:** Provide plates to suit the devices.

- 1) Finished interior walls: Jumbo Stainless Steel.
  - Receptacles noted on drawings as dedicated for computers shall include a factory engraved jumbo stainless steel coverplate labeled "COMPUTER". See Electrical Symbols and Power Plans on drawings to identify dedicated computer receptacle.
- 2) Exposed outlets: Galvanized steel.
- 3) Wet and damp locations: Weatherproof Extra-Duty rated "In Use" type with shallow lockable cover, Legrand WIUCED Series or equivalent. Provide plate kits to suite devices.

2-07 SAFETY SWITCHES AND FUSES

SWITCHES: NEMA Standard HD, heavy-duty type, 3 pole, 480 or 240 volt, as indicated, with Class R fuse clips. Manufactured by Square D, General Electric, Siemens, or Eaton.

FUSES: Time delay type, UL Class RK5. Bussman Fusetrons, or approved equal of Chase-Shawmut or General Electric.

NAMEPLATE: Provide engraved nameplate for each safety switch identifying load served, voltage, and fed-from identification. Example:

**AHU-1, 480-3-60  
FED FROM HA-15**

2-08 PANELBOARDS

STANDARDS: UL 67 and NEMA PB-1.

MANUFACTURERS: Square D, General Electric, Siemens, or Eaton.

CONSTRUCTION: Code gage cabinet with clamping trim cover and locking doors, keyed alike. Cabinets shall be minimum 20" wide with hinged trim (door-in-door). Busses shall be for bolt-in breakers with full sized neutral bus. Provide ground bus in each panelboard. Provide separate insulated ground bus where indicated on the drawings (Isolated Ground panelboards).

ENCLOSURE: Flush or surface mounted, NEMA 1, NEMA 3R, or NEMA 4X as indicated on drawings.

- 1) Front: Surface-mounted fronts, match box dimensions; Flush-mounted fronts, overlap box.
- 2) Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover. Provide typewritten circuit directory for each panel identifying load served and room location. Identify spares in pencil.
- 3) Panels and Trim Finishes: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two (2) coat, baked-on finish consisting of prime coat and thermosetting topcoat.
- 4) Hinged Trim (Door-In-Door).

CIRCUIT BREAKERS: Molded case bolt in type. Breakers shall be rated for the specified panelboard interrupting capacity rating in RMS symmetrical amperes. Two and three pole breakers shall have common internal trip. Branch mounted main breakers are not permitted unless specifically noted on the drawings.

CIRCUIT NUMBERING: Circuit numbering and breaker layout to match Contract Documents. Where circuit numbering is not permanently engraved, the manufacturer's plastic numbering strips shall be used. Paper numbers are not acceptable and may not be used.

**BREAKER COORDINATION: Manufacturer shall provide coordination between feeder breakers and upstream devices. These coordination settings shall be made in the field by a manufacturer's field technician and documented. A letter confirming the setting and providing the setting information shall be provided prior to energization of the switchboard.**

NAMEPLATE: Provide engraved nameplate for each panel identifying panel name, voltage, phase, and fed-from identification. Example:

**PANEL HA  
480/277V, 3PH  
FED FROM MSB-2**

## 2-09 CABLE MANAGEMENT

FIRE RATED WALL PENETRATIONS: Where cable trays and/or signal cables penetrate rated walls the Electrical Contractor shall furnish and install a UL Listed rated assembly, Specified Technology, Inc. (STI) EZ-Path Triple Cable Pathway System, or equivalent system by Legrand, Cooper, Metacaulk, 3M, or Hilti. See details on drawings.

## 2-10 NAMEPLATES AND WARNING SIGNS

NAMEPLATE: Provide engraved 3-ply laminated plastic nameplates for each panelboard, safety switch, transformer, enclosed circuit breaker, contactor, control panels. Attach to equipment cover using metal screws, rivets, or industrial epoxy cement. Manufacturer's sticky-back adhesive is not acceptable. Use 1/4" white letters on black field for normal power items. Use 1/4" white letters on red field for emergency power items (generator).

METAL-BACKED, BUTYRATE WARNING SIGNS: Weather-resistant, nonfading, preprinted, celluloseacetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

## 2-11 TELEPHONE AND COMPUTER SYSTEMS

Telephone and computer conduits, outlet boxes, cable tray, equipment mounting boards, grounding, and convenience outlets shall be provided as indicated on the drawings.

WIRING: Provide telephone and computer conduit with pull wires as indicated on the drawings.

## PART 3 - EXECUTION

### 3-01 GENERAL REQUIREMENTS

WORKMANSHIP: All work shall be installed in a neat and orderly manner. Devices, cabinets, covers, fixtures, exposed raceways, etc., shall be aligned parallel or perpendicular to the building walls, ceiling, and floor. Wiring in panelboards and cabinets shall be neatly looped and laced, and not wadded. The Owner reserves the right to require repair or replacement of defective workmanship and material without additional compensation to the Contractor.

SUPPORTS: Conduits, boxes, cabinets, enclosures, etc., shall be securely supported by structural members or structural walls at intervals required by the NEC or as recommended by the manufacturer. Plaster, gypsum board, acoustical tile, and other ceiling and wall finish materials shall not be used for support.

CUTTING, PATCHING, AND PAINTING: The Electrical Contractor shall perform all boring, drilling, and cutting of walls, ceilings, and floors as required to install and support his raceways and equipment. Provide rough patching to seal penetrations through walls, ceilings, and floors. Finish patching and painting will be performed by the General Contractor.

FIRE WALL PENETRATIONS: Penetrations through fire rated walls and floors shall be sealed to maintain the integrity of the fire rating. Raceways through penetrations shall be in metal raceways.



Penetration openings shall be sealed after the installation of the raceway with UL-49 listed fire retardant material. Through penetrations of conduits and cables of fire resistance rated walls must comply with Section 714.3.1 of the IBC. Through penetrations of fire resistance ceiling assemblies must comply with section 714.4.1.1 of the IBC.

Where cable trays and/or signal cables penetrate rated walls the Electrical Contractor shall furnish and install a UL Listed rated assembly, Specified Technology, Inc. (STI) EZ-Path Triple Cable Pathway System, or equivalent system by Legrand, Cooper, Metacaulk, 3M, or Hilti. See details on drawings.

**ROOF PENETRATIONS:** Do not penetrate roof or flashing unless permitted, in writing, by the Architect-Engineer.

**TRENCHING AND BACKFILL:** The Electrical Contractor shall perform all excavation, trenching, and backfilling necessary to install his work. Trenches shall be run after final grades are established, and shall be run at 24 inches minimum depth from finished grades. Contact all underground utilities (electric, telephone, cable TV, gas, water, sewer) and establish locations of underground utilities prior to digging. Damages to underground utilities will be repaired by the Owner of the line, and the Contractor responsible for such damage will pay all costs of repairs. After completion of backfilling operations, restore the disturbed areas to their original condition by leveling, raking, seeding and mulching.

### 3-02    GROUNDING

**CODE:** Entire system shall be grounded and bonded in accordance with the requirements of Article 250 of the National Electrical Code. Comply with UL 467 for grounding and bonding materials and equipment. Comply with IEEE C2 grounding requirements.

**GROUNDING CONDUCTORS:** Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

**GROUND RODS:** Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

**GROUNDING BUS:** Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

**FEEDERS AND BRANCH CIRCUITS:** Each feeder raceway shall be bonded to every cabinet, pull box, etc., to which it is connected by grounding bushings and bonding jumpers sized per NEC Table 250.122. Each branch circuit raceway must be connected to every cabinet, pull box, outlet box, etc., with double locknuts. Separate grounding conductors shall be installed on all feeders and on all receptacle and equipment branch circuits, whether indicated on the drawings or not. Size per NEC 250.122.

**RECEPTACLES AND FIXTURES:** Bond grounding terminal of each receptacle and fluorescent fixture to its outlet box with No. 12 green ground wire. Self-grounding receptacles are not acceptable as a substitute for this requirement.

### 3-03    RACEWAYS

**WIRING:** All wiring shall be installed in raceways, unless noted. Raceways shall be run concealed, unless noted.

UNDERGROUND FEEDER CONDUIT, COMMUNICATIONS CONDUIT, AND DUCT BANKS:

- 1) Use GRC or PVC schedule 40 for underground conduit and duct bank installations.
- 2) Where required concrete encasement shall be either 2000 psi or 3000 psi.
- 3) Red colored concrete encasement, where required, shall use a red pigment integrally mixed into the concrete. Dry shake or broadcast coloring agents are not to be used.
- 4) For concrete encased conduits use manufactured PVC spacers and mounts for support and spacing of the conduits. Do not use concrete blocks, pipes, or other means to support and space conduits that are to receive concrete encasement.
- 5) A metallic backed marking tape shall be installed 12" above all underground feeder conduits, service entrance communications conduit, and duct banks.

FEEDERS:

- 1) Feeders shall be run in GRC or IMC where run exposed.
- 2) Feeders shall be run in GRC, IMC, or EMT where run concealed in walls or ceilings
- 3) Feeders shall be run in GRC or Schedule 40 PVC encased in concrete with 2-inches minimum concrete encasement on all sides where run underground (Schedule 40 PVC is not required to be encased in conduit where run under the concrete floor slab).
- 4) Where PVC is used, elbows for turn-outs and risers shall be GRC.
- 5) PVC is not permitted above grade.
- 6) Metal conduits installed in contact with earth shall be painted with 2 coats Rustoleum paint or other acceptable preservative.

BRANCH CIRCUITS:

- 1) Branch circuits shall be run concealed where practical.
- 2) Branch circuits run concealed in walls or ceilings shall be run in EMT, GRC, or IMC.
- 3) Branch circuits run exposed to weather (wet or damp location) on exterior walls, canopies, ceilings, or on roofs shall be run in GRC or IMC with screwed fittings.
- 4) Branch circuits run exposed in dry, finished spaces shall be run in Wiremold surface metal raceway.
- 5) Branch circuits run exposed in interior damp locations, unfinished spaces (attics), and unoccupied spaces (storage room, equipment rooms, janitor's closet) may be run in EMT in lieu of Wiremold.
- 6) Branch circuits run underground shall be run in GRC, IMC, or Schedule 40 PVC plastic conduit.
- 7) All interior conduit homeruns to panelboards shall be run overhead in EMT, GRC, or IMC unless noted otherwise on the drawings. EXCEPTION: Homeruns for receptacle circuits may be run underground in GRC, IMC, or Schedule 40 PVC plastic conduit.
- 8) Underground conduits shall be run 24" minimum below grade.
- 9) Metal conduits installed in contact with earth shall be painted with 2 coats Rustoleum paint or other acceptable preservative.
- 10) Where plastic conduits are indicated, transition from plastic to GRC or IMC below grade or slab and rise with GRC or IMC. PVC is not permitted above grade. EXCEPTIONS: 1) Plastic conduit may enter floor mounted switchboards, motor control centers, or other floor mounted enclosures. 2) Plastic conduit risers are acceptable where run concealed from underfloor conduit to receptacle or switch boxes in masonry walls.
- 11) Branch circuit wiring for receptacle circuits may be run under floor in PVC. Transition from PVC to metal conduit as noted above.

Final connections to motors, motor driven equipment, transformers, and vibrating equipment shall be made thru flexible conduit, 36" maximum length. "Sealtite" flexible metal conduit shall be installed outdoors, in equipment rooms, and in wet locations.

PULL WIRES: Raceways for wiring by others or for future shall contain a No. 14 galvanized steel pull wire or equivalent plastic cord with 200 lb. tensile strength.

**INSTALLATION:** Ream raceways, butt ends into couplings, 3 quarter bends per run maximum, plug raceways until wiring is pulled in place. Exposed conduits shall be run parallel and perpendicular to walls, floor, and ceiling. Multiple conduit runs shall be racked using Unistrut or Kindorf channels and pipe clamps. Install conduits in concrete slabs between the top and bottom layers of reinforcing steel. Maximum size of conduits in slabs is 1 inch. Crossing of conduits in slabs shall be avoided, if possible.

**PULL BOXES:** Maximum length between pull points shall be 200 ft. for pulls with two 90 degree bends, and 100 ft for pulls with three 90 degree bends. Furnish and install pullboxes, junction boxes, handholes, or conduit bodies where bends or pulling lengths exceed these specifications.

**EXPANSION JOINTS:** Furnish and install expansion joints where conduit crosses building expansion joints and for straight runs exceeding 100 ft. in length.

**PLASTIC CONDUIT:** Do not damage conduit while making field bends and offsets, cutting and joining conduit. Use GRC elbows where length between pulls exceeds 100 ft. Clean conduit prior to applying solvent. Ensure that conduit extends fully into coupling or fitting when making joints.

**MINIMUM SIZE:** Home runs to panelboards shall be 3/4" minimum, otherwise raceways shall be 1/2" minimum, except that flexible conduit shall be 3/8" minimum.

**FIRESTOPPING:** Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

**TEST AND INSPECTIONS:** After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

**3-04 WIRE AND CABLE**

**MINIMUM SIZE:** No. 12 for power circuits, No. 16 for control circuits, unless noted. Where home run exceeds 75 ft. length on 120 volt circuits, use No. 10 minimum. Aluminum conductors may be used for feeders 400A and larger. All other conductors to be copper.

**COLOR CODE:** No. 12 and No. 10 shall have color-coded insulation. No. 8 and larger shall be marked at all terminals and joints with color-coded tape. Color code as follows:

<u>Voltage</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>	<u>Neutral</u>	<u>Grounding</u>
208/120	Black	Red	Blue	White	Green
480/277	Brown	Orange	Yellow	Gray	Green

**INSTALLATION:** Ensure that raceway system is complete and that conductors will be free from moisture or physical damage prior to installing conductors. Install all conductors at the same time. Do not exceed cable manufacturer's recommended pulling tension for conductors. Where required, lubricate cables with Ideal Yellow 77, Burndy Slikon, or other acceptable cable lubricant. Do not use lubricants that are not acceptable to the Architect-Engineer.

**SPLICING:** Splices on Sizes No. 10 and smaller shall be made with wire nuts. Splices on Sizes No. 8 and larger shall be made with split bolt connectors, compression connectors, or solderless lugs. Splices shall be insulated with two or more layers of Scotch 23 rubber tape covered with two or more layers of Scotch 33 plastic tape, or acceptable equivalent method.

**CONNECTIONS:** Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Absent published values, use those specified in IL 486A and UL 486B.

**MULTIWIRE BRANCH CIRCUITS:** Shared or common neutrals are not permitted on this project for multiwire branch circuits. The Contractor shall pull a separate neutral for all 120V & 277V circuits.

**TYPE MC CABLE:** Type MC Cable may be used for light fixture whips. Per NEC, MC Cable light fixture whips 6' or less are not required to be independently supported (Type MC Cable fittings permitted as means of cable support). MC Cable light fixture whips longer than 6' must be independently supported. Type MC Cable may not be used elsewhere on this project except as permitted below for Type MC-PCS Cable.

### 3-05 BOXES

**WALL OUTLETS:** Flush mounted, unless noted. Boxes shall be securely mounted to wall studs or be grouted in masonry. Boxes shall have single or multi-gang plaster rings, as required. "Through-wall" boxes **SHALL NOT BE USED**. Back-to-back mounting of boxes is not permitted. Boxes on opposite sides of a rated wall shall have a minimum of 24" horizontal spacing or shall be protected with listed putty pads. Locate boxes so that cover or plate will not span different building finishes.

**RECESSED BOXES IN MASONRY WALLS:** Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.

**RECESSED BOXES IN STUD WALLS:** Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

**CEILING OUTLETS:** Flush mounted or concealed above ceiling. Boxes for fixture support shall have studs or ears as required and shall be securely supported by adjustable bar hangers or steel angle.

**JUNCTION BOXES, PULL BOXES, AND WIREWAYS:** Shall be sized and installed as indicated on the drawings or where required by NEC for pulling or splicing wiring. All junction boxes and pull boxes shall be accessible. Junction boxes and pull boxes shall not be located above inaccessible ceilings.

**LOCATIONS:** Verify heights and arrangement prior to setting boxes. The Owner reserves the right to move any outlet by as much as 10 ft. from its indicated location at no additional cost, provided the Contractor is notified prior to roughing in.

### 3-06 WIRING DEVICES

**INSTALLATION:** Devices shall be installed as indicated on the drawings and wired in accordance with the manufacturer's instructions. Install conductors at each outlet with at least 6-inches of slack.

**MASKING:** Devices shall be masked to prevent painting of faces and handles during construction. Do not install cover plates until clean-up has been completed.

**COVER PLATES:** Cover plates shall be installed on all wiring devices, telephone and computer outlets, junction boxes, and outlet connections.

3-07 SAFETY SWITCHES

LOCATION: Mount switches where shown on drawings and within sight of equipment served. Mount in a readily accessible location unless noted. Verify fuse sizes with equipment manufacturer's requirements.

3-08 PANELBOARDS

INSTALLATION: Mount panelboards so that the center grip of the operating handle of the highest circuit breaker in the panelboard is not more than 6'-7" (2.0 meters) above the floor when in its highest position per the requirements of NEC 240.24(A). Bottom of panelboard to be a minimum of 12" above the floor except where a lower height is required to comply with NEC 240.24(A). Connect circuits as indicated on the drawings, observing correct color code and numbering. Mark all wires in panelboard with circuit number.

DIRECTORY: Provide typewritten circuit directory for each panel identifying load served and room location. Identify spares in pencil. Panelboard schedules must comply with NEC 408.4, including listing room description and room number for each load. Turn all spare breakers off.

ARC-FLASH HAZARD WARNING LABELS: Provide warning labels for all panels, switchboards, switchgear, and industrial control panels per the requirements of NEC 110.16. Labels to read,

**DANGER ARC FLASH & SHOCK HAZARD  
APPROPRIATE PERSONAL PROTECTION  
EQUIPMENT REQUIRED**

3-09 CABLE MANAGEMENT

SUPPORT: Fasten cable tray supports to building structure and install seismic restraints.

3-10 NAMEPLATES AND WARNING SIGNS

INSTALLATION: Verify identity of each item before installing identification products. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

3-11 TELEPHONE AND COMPUTER SYSTEMS

REQUIREMENTS: Verify telephone and computer equipment space requirements and outlet locations with Owner prior to roughing in. Telephone and computer service conduits, equipment mounting boards, grounding, and convenience outlets shall be provided as indicated on the drawings.

WIRING: Provide telephone and computer conduit with pull wires as indicated on the drawings. Minimum size conduit is 3/4".

3-12 COMPLETION OF WORK

TESTS AND FINAL REVIEW: Upon completion of work, the entire system shall be completely operational and tested to conform with these specifications and drawings, and shall be reviewed by the Architect-Engineer. All defects in workmanship and material shall be immediately corrected without additional compensation to the Contractor.

The final review of the electrical installation by the Engineer cannot be provided until the following items have been submitted to the Engineer for review:

- 1) Letter from the Electrical Contractor on company letterhead indicating that the installation is complete and ready for a final review.

**Failure to submit the above documentation prior to requesting the Engineer's Final Review of the project may result in delays in providing the final review. The Engineer assumes no liability for delays in the project resulting from failure to provide the proper documentation.**

The system will not be considered complete until Record Documents are provided and training of facility personnel on the system operation is complete. This facet of the services to be provided by the Contractor is deemed very important to the satisfactory completion of the contract and the installation cannot be deemed complete until these services have been provided in accordance with the Contract Documents.

CLEAN UP: Upon completion of all installations and prior to final acceptance by the Owner, remove all debris from the site. Clean and touch up paint on fixture lenses and trims, cabinets, enclosures, cover plates, etc.

END OF SECTION 260500

## PART 1 - GENERAL REQUIREMENTS

### 1-01 SUMMARY

Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

### 1-02 ELECTRICAL SUBMITTALS

Electrical shop drawings shall be submitted in one complete package containing all items required by this specification and all other Division 26-28 specifications. Partial shop drawing submittals may be rejected by the Architect-Engineer.

Exceptions: Fire Alarm System CAD drawings, Lighting Control System CAD drawings, and Allowanced Light Fixtures may be submitted separately if additional time is needed to prepare these shop drawings. Submit written request to Architect/Engineer for extension with a timeline schedule indicating submittal date for items to be submitted separately.

### 1-03 ELECTRICAL SUBMITTAL FORMAT

FILE TYPE: Electrical submittals to be submitted digitally and shall be searchable pdf documents divided into categories as indicated below.

SUBMITTAL TRANSMITTAL LETTER: The submittal package shall include a single transmittal letter saved as a separate pdf file indicating the following:

- The project name and address
- The date of submission
- The Electrical Contractor name and address
- The General Contractor name and address
- The Construction Manager name and address (if applicable)
- A list of each submittals category (use categories listed below)
- Any applicable remarks and/or comments
- Signature of transmitter

SUBMITTAL CATEGORY COVER SHEET: The digital submittal shall be divided into submittal categories as indicated below. **Each submittal category shall be saved as a separate pdf file with a cover sheet indicating the following:**

- The project name
- The submittal category (category names to match those listed below where applicable)
- The date of submission
- The Electrical Contractor name and address
- The name and address of the firm or entity that prepared the submittal.
- Any applicable remarks and/or comments

Submittals not meeting the above criteria may be rejected.

Refer to the sample Category Cover Sheet at the end of this specification section.

ELECTRICAL SUBMITTAL CATEGORIES: Within 45 days after award of contract and before any materials are delivered to the site, submit a digital set of Electrical Submittals in pdf format to the Architect-Engineer on each of the following categories/materials:

- 1) Section 260500, 2-03: Raceways and Fittings.
- 2) Section 260500, 2-04: Wire and Cable.

- 3) Section 260500, 2-05: Boxes and Wireways.
- 4) Section 260500, 2-06: Wiring Devices.
- 5) Section 260500, 2-07, 2-08: Switchgear (Disconnect Switches, Panelboard Breakers).
- 6) Section 260500, 2-09: Cable Management (Fire Wall Penetration Assembly).
- 7) Section 260500, 2-10: Nameplates and Warning Signs.
- 8) Section 260529: Seismic for Electrical Systems (Including Engineer's calculations where required).
- 9) Section 260548: Vibration and Seismic Controls for Electrical Systems.

OPTIONAL FEATURES: Clearly identify options requiring selection by Architect/Engineer.

RESUBMITTALS: Make resubmittals in same format as initial submittal. Note date and content of previous submittal. Note date and content of revision in label or title block and clearly indicate extent of revision.

DISTRIBUTION: Furnish copies of final reviewed submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms where applicable.

USE FOR CONSTRUCTION: Retain complete copies of submittals on Project site (either a digital copy or a hard copy is acceptable provided it is readily accessible). Use only final action submittals that are marked as such from the Engineer's action stamp.

#### 1-04 ELECTRICAL SUBMITTAL SCHEDULE

SCHEDULE: Within 45 days after award of contract and before any materials are delivered to the site, submit a digital set of Electrical Submittals in pdf format to the Architect-Engineer. If additional time is needed, submit a written request to Architect/Engineer for extension with a timeline schedule indicating revised submittal date.

No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

No extension of the Contract Time will be authorized because of failure to transmit submittals in the proper format.

#### 1-05 ELECTRICAL SUBMITTAL REJECTION

**Failure to comply with the above criteria may result in rejection of the submittal by the Architect-Engineer. Refer to Division 1 for additional Submittal requirements.**

#### PART 2 - NOT APPLICABLE

#### PART 3 - EXECUTION

##### 3-01 CONTRACTOR'S ACTIONS

GENERAL: The primary purpose of submitting electrical shop drawings is to demonstrate the way by which the Contractor proposes to comply with the design concept expressed in the Contract Documents for the portions of work that require submittals.

CONTRACTOR REVIEW: Prior to submittal to the Engineer, the Contractor shall review shop drawings for compliance with the Contract Documents.

No electrical equipment or materials shall be ordered or installed by the Contractor prior to receipt of properly reviewed shop drawings. The Contractor may not perform any portion of the work for



which the Contract Documents require submittal and review of shop drawings prior to receipt of properly reviewed shop drawings.

**Failure to comply with the above criteria may require the removal by the Contractor of any equipment or materials installed prior to receipt of properly reviewed electrical shop drawings, at no cost to the Owner or the Architect/Engineer.**

3-02 ENGINEER'S ACTIONS

GENERAL: Engineer will not review submittals that do not bear Contractor's approval/acceptance stamp and will return them without action.

ELECTRICAL SUBMITTALS: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate actions required.

INCOMPLETE OR PARTIAL SUBMITTALS: Incomplete or partial submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 260510

**ELECTRICAL SUBMITTAL CATEGORY COVER SHEET**

PROJECT NAME: Sample Project Middle School

SUBMITTAL CATEGORY: Section 260500, 2-05 & 2-06 - Lighting Fixtures (Including Lamps and Ballasts)

DATE OF SUBMISSION: May 01, 2017

ELECTRICAL CONTRACTOR: ABCD Electrical Contractor, 123 Main Street, Anywhere, SC 29999

SUBMITTAL PREPARER: WXYZ Lighting, Inc. 456 Elm Street Somewhere, SC 21111

REMARKS/COMMENTS: Color selections needed for types C1 and W4 fixtures.

## PART 1 - GENERAL REQUIREMENTS

### 1-01 SUMMARY

#### SECTION INCLUDES:

- 1) Hangers and supports for electrical equipment and systems.
- 2) Construction requirements for concrete bases.

### 1-02 PERFORMANCE REQUIREMENTS

- 1) Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- 2) Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- 3) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- 4) Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

### 1-03 SUBMITTALS

- 1) Product Data: For steel slotted support systems.
- 2) Shop Drawings: Shop Drawings shall be signed and sealed by a qualified professional engineer and shall show fabrication and installation details and include calculations for the following:
  - a. Trapeze hangers. Include Product Data for components.
  - b. Steel slotted channel systems. Include Product Data for components.
  - c. Equipment supports.
- 3) Welding Certificates.

### 1-04 QUALITY ASSURANCE

- 1) Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- 2) Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2-01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- 1) Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Allied Tube & Conduit.
    - ii. Cooper B-Line, Inc.; a division of Cooper Industries.
    - iii. ERICO International Corporation.

- iv. GS Metals Corp.
  - v. Thomas & Betts Corporation.
  - vi. Unistrut; Tyco International, Ltd.
  - vii. Wesanco, Inc.
  - c. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - d. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - e. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - f. Channel Dimensions: Selected for applicable load criteria.
- 2) Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- 3) Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- 4) Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- 5) Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- 6) Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
- a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - i. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - ii. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - Hilti Inc.
      - ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - MKT Fastening, LLC.
      - Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  - b. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - i. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - ii. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - Cooper B-Line, Inc.; a division of Cooper Industries.
      - Empire Tool and Manufacturing Co., Inc.
      - Hilti Inc.
      - ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - MKT Fastening, LLC.
  - c. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - d. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - e. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - f. Toggle Bolts: All-steel springhead type.
  - g. Hanger Rods: Threaded steel.

## 2-02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- 1) Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- 2) Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3-01 APPLICATION

- 1) Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- 2) Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- 3) Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - a. Secure raceways and cables to these supports with two-bolt conduit clamps.
- 4) Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3-02 SUPPORT INSTALLATION

- 1) Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- 2) Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- 3) Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- 4) Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - a. To Wood: Fasten with lag screws or through bolts.
  - b. To New Concrete: Bolt to concrete inserts.
  - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - d. To Existing Concrete: Expansion anchor fasteners.
  - e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts; beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69; or spring-tension clamps.
  - g. To Light Steel: Sheet metal screws.
  - h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

- 5) Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3-03    INSTALLATION OF FABRICATED METAL SUPPORTS

- 1) Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- 2) Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- 3) Field Welding: Comply with AWS D1.1/D1.1M.

3-04    CONCRETE BASES

- 1) Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- 2) Use 3000-psi, 28-day compressive-strength concrete.
- 3) Anchor equipment to concrete base.
  - a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - b. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3-05    PAINTING

- 1) Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- 2) Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- 3) Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

## PART 1 - GENERAL REQUIREMENTS

### 1-01 SUMMARY

#### SECTION INCLUDES:

- 1) Isolation pads.
- 2) Spring isolators.
- 3) Restrained spring isolators.
- 4) Channel support systems.
- 5) Restraint cables.
- 6) Hanger rod stiffeners.
- 7) Anchorage bushings and washers.

### 1-02 PERFORMANCE REQUIREMENTS

- 1) Seismic-Restraint Loading:
  - a. Site Class as Defined in the IBC: D.
  - b. Assigned Seismic Use Group or Building Category as Defined in the IBC.
    - i. Component Importance Factor: 1.25.
    - ii. Component Response Modification Factor: Refer to Architectural and Structural Drawings and Specifications.
    - iii. Component Amplification Factor and Design Spectral Response Acceleration: Refer to Architectural and Structural Drawings and Specifications.
- 2) Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- 3) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- 4) Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

### 1-03 ACTION SUBMITTALS

- 1) Product Data: For the following:
  - a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    - i. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
    - ii. Annotate to indicate application of each product submitted and compliance with requirements.
  - c. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- 2) Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - a. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

- i. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
- b. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
- c. Field-fabricated supports.
- d. Seismic-Restraint Details:
  - i. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - ii. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.

#### 1-04 INFORMATIONAL SUBMITTALS

- 1) Welding certificates.
- 2) Field quality-control test reports.

#### 1-05 QUALITY ASSURANCE

- 1) Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- 2) Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- 3) Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- 4) Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2-01 VIBRATION ISOLATORS

- 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. Amber/Booth Company, Inc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control.
  - f. Mason Industries.
  - g. Vibration Eliminator Co., Inc.
  - h. Vibration Isolation.
  - i. Vibration Mountings & Controls, Inc.
- 2) Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
- 3) Spring Isolators: Freestanding, laterally stable, open-spring isolators.



- a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - e. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
  - f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- 4) Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
- a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - b. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
  - c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2-02 SEISMIC-RESTRAINT DEVICES

- 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Amber/Booth Company, Inc.
  - b. California Dynamics Corporation.
  - c. Cooper B-Line, Inc.; a division of Cooper Industries.
  - d. Hilti Inc.
  - e. Loos & Co.; Seismic Earthquake Division.
  - f. Mason Industries.
  - g. TOLCO Incorporated; a brand of NIBCO INC.
  - h. Unistrut; Tyco International, Ltd.
- 2) General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.
- 3) Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- 4) Restraint Cables: ASTM A 603 galvanized-steel or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- 5) Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections of reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- 6) Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

- 7) Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- 8) Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- 9) Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- 10) Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

### PART 3 - EXECUTION

#### 3-01 APPLICATIONS

- 1) Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or other agency acceptable to authorities having jurisdiction.
- 2) Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- 3) Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

#### 3-02 SEISMIC-RESTRAINT DEVICE INSTALLATION

- 1) Equipment and Hanger Restraints:
  - a. Install restrained isolators on electrical equipment.
  - b. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - c. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- 2) Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- 3) Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- 4) Drilled-in Anchors:
  - a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

- c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
- d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- e. Set anchors to manufacturer's recommended torque, using a torque wrench.
- f. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3-03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- 1) Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

### 3-04 FIELD QUALITY CONTROL

- 1) Tests and Inspections:
  - a. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - b. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - c. Test to 90 percent of rated proof load of device.
  - d. Measure isolator restraint clearance.
  - e. Measure isolator deflection.
  - f. Verify snubber minimum clearances.
  - g. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- 2) Remove and replace malfunctioning units and retest as specified above.
- 3) Prepare test and inspection reports.

### 3-05 ADJUSTING

- 1) Adjust isolators after isolated equipment is at operating weight.
- 2) Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- 3) Adjust active height of spring isolators.
- 4) Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548