

## **SECTION 220400 PLUMBING**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION:**

- A. Work Included: Provide plumbing where shown on the Drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
  - 1. Domestic hot and cold water piping system.
  - 2. Drain, waste, and vent systems.
  - 3. Gas piping system.
  - 4. Plumbing fixtures and trim as shown on the Drawings.
- B. Related Work: Documents affecting Work of this Section include, but are not necessarily limited to: General Conditions, Supplementary, and Sections in Division 1 of these Specifications.
- C. Drawings: The mechanical drawings show the general arrangement of piping, equipment, and appurtenances and shall be followed as closely as actual building construction, site conditions, and the work of other trades will permit. The mechanical work shall conform to the requirements shown on all of the drawings. General and structural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly.

#### **1.2 QUALITY ASSURANCE:**

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.
- B. Codes and Regulations:
  - 1. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies having jurisdiction, all applicable laws, codes, and ordinances including those of the state, county and city.
  - 2. The Work shall also comply with all applicable requirements of the National Fire Protection Association, International Building, Plumbing and Mechanical Codes, and all locally accepted amendments to these codes.
  - 3. In the event of conflict between or among specified requirements and pertinent regulations, the more stringent requirement will govern.
  - 4. Non-compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local

ordinances, industry standards, and utility company regulations, he shall bear all costs arising in correcting the deficiencies.

- C. Install all utility connections to water, sewer, and gas per requirements of Governing Agencies. Pay all fees and permits for inspection and certification for the execution of this Work.
  - 1. Temporary Utility Service: All required utility services such as gas, water, storm and sanitary shall be obtained and paid for by the contractor under the section of the specifications for which they are required. The general contractor shall be responsible for utilities used during construction.
- D. Certificate of Final Inspection: Under each applicable section of the specifications, the contractor shall, upon completion of the work under that section, furnish a certificate of final inspection from the department having jurisdiction.

### **1.3 EXAMINATION OF SITE:**

- A. Visit the site, inspect the existing Conditions and check the Drawings and Specifications so as to be fully informed of the requirements for completion of the Work.
- B. Lack of such information shall not justify a request for extra compensation to the contract price.

### **1.4 MATERIAL AND EQUIPMENT:**

- A. All materials and equipment shall be new, those of the same type shall be by the same Manufacturer, and shall be of the best quality and design and free from defects.
- B. A Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.
- C. Manufacturer's name and model numbers used herein and on the Drawings establish type and quality required. Equal products may be considered if submitted in writing to the Engineer/Architect for approval 10 days prior to bid date. The Contractor shall be responsible for assuring the items and equipment substituted for those shown on the Drawings will physically fit in the space allocated.
- D. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection until installed. All items subject to moisture damage (such as controls) shall be stored in dry, conditioned spaces.

- E. Protection: Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury. Damage or defects developing before acceptance of the work shall be made good at the contractor's expense.
- F. Dimensions: It shall be the responsibility of the contractor to insure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install sizes and shapes of equipment so that the final installation shall suit the true intent and meanings of the drawings and specifications.
- G. Manufacturer's Directions: Shall be followed completely in delivery, storage, protection and installation of all equipment and materials. The contractor shall promptly give notice in writing of any conflict between any requirement of the Contract Documents and the manufacturer's directions and shall obtain written instructions before proceeding with the work. Should the contractor perform any work that does not comply with the manufacturer's directions or such written instructions, he shall bear all costs arising in correcting the deficiencies.

#### **1.5 SUBMITTALS:**

- A. Comply with pertinent provisions of Division 1.
- B. Product Data: After the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Materials list of items proposed to be provided under this Section.
  - 2. Manufacturer's Specifications, catalog cuts, and other data needed to prove compliance with the specified requirements.
  - 3. Shop Drawings and other data as required to indicate method of installing and attaching equipment, except where such details are fully shown on the Drawings.
  - 4. All sheets of the submittal shall have the job name stamped or permanently written neatly on them and shall be assembled in an indexed brochure. The descriptive material shall be arranged in the brochure in the same order as found in the specifications. Each brochure shall be submitted in a hardback, 3-ring binder. The leading sheet of the descriptive material for each item shall be full size, of heavy paper, with a numbered outside tab, and an index sheet showing the location in the brochure.
  - 5. Manufacturer's regular catalog sheets will not be acceptable under these requirements unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction, they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submittal item with its respective specified item. Special features shall be listed on a separate typewritten sheet.
  - 6. Brochures shall contain a certification by the Contractor that the equipment or materials are suitable for conditions shown and specified; that the equipment or

materials are believed to be in conformity with the plans and specifications, except as may be specifically described; be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required action.

7. Finding "APPROVED" or "APPROVED AS NOTED" shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called, in writing, to the proposed deviations at the time of transmittal of the brochures and such deviations have been found acceptable, nor shall it eliminate the responsibility for freedom from errors of any sort in the data submitted. Discovery of such deviations at or after installation shall be cause for immediate replacement at no additional cost to the Owner.
  8. No material or equipment so governed shall be ordered until found acceptable by the Architect/Engineer/Owner.
- C. Sterilization Certificate: Upon completion of water line sterilization, deliver to the Architect two copies of an acceptable "Certificate of Performance" for that activity.
- D. Record Drawings:
1. Comply with pertinent provisions of Division 1.
    - a. Record Drawings- The contractor shall furnish to the owner CAD record drawings consisting of three (3) sets of 11" x 17" prints (To be bound in O&M Manuals), one (1) full size set of prints and one (1) disk, showing the piping and ductwork for the HVAC and plumbing systems. Piping sizes, rerouting, etc., for both under floor and above ceiling piping shall be shown. Also, provide a blue-line of the site plan, clearly marked, to indicate any and all changes in sanitary sewer, storm sewer, domestic cold water and natural gas piping to the building. In addition to these drawings, a complete set of approved ductwork shop drawings and temperature control shop drawings shall be included in this set of drawings.
      - 1) CAD Record drawings shall incorporate all change and field orders. (No separate or supplemental drawings).
      - 2) All equipment schedules to be revised to reflect installed manufacturer model numbers and capabilities.
  2. Include a copy of the Record Drawings in each copy of the operation and maintenance manual as described below. (Original document shall be reproducible paper.)
- E. Manuals: Upon completion of the Work of this Section, deliver to the Architect two copies of an operation and maintenance manual compiled in accordance with the provisions of Division 1 of these Specifications. Include within each manual:
1. Copy of the approved record documents for this portion of the Work.
  2. Copies of all warranties and guarantees.
  3. Description of equipment control and seasonal operation, including schedule of required maintenance.

**1.6 INSPECTION:**

- A. Make written notice to the Architect adequately in advance of each of the following stages of construction:
  - 1. In the underground Condition prior to placing concrete floor slab, when all associated Work is in place.
  - 2. When all rough-in is complete, but not covered.
  - 3. At completion of the Work of this Section.
- B. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.

**1.7 PRODUCT HANDLING:**

- A. Comply with pertinent provisions of Division 1.

**1.8 CLEANING, TESTING AND PLACING IN SERVICE:**

- A. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- B. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- C. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.

**1.9 ADJUSTMENT AND INSTRUCTION:**

- A. Energize all systems, equipment and fixtures and check for proper operation.
- B. The Contractor's service personnel shall instruct the Owner's Representative in the proper operation of all systems.

**1.10 GUARANTEE:**

- A. The Contractor guarantees all Work against any defects due to faulty workmanship or material and that all raceways, ducts, and piping are free from foreign material, obstructions, holes, or breaks of any nature.

- B. Upon written notice from the Architect or Owner, the Contractor shall promptly remedy without cost to the Owner any defects occurring within a period of one (1) year from the date of final acceptance.

**1.11 WARRANTY:**

- A. The Contractor shall properly execute in the Owner's name all Manufacturer's standard warranty certificates applying to equipment installed on the project and shall deliver said certificates to the Architect at completion of the job. All warranty cards shall also be properly executed and delivered to the supplier or Manufacturer's records. Standard warranties for equipment shall not be less than one (1) year.

**PART 2 - PRODUCTS**

**2.1 PIPE SCHEDULE:**

- A. Drain, Waste, and Vent System:
  - 1. For sanitary Work below the floor and outside underground:
    - a. Provide service weight cast iron pipe and fittings or Schedule 40 PVC or ABS DWV pipe if allowed by local codes.
    - b. Soil lines 5'-0" or more away from the structures may be Schedule 40 PVC.
  - 2. Above ground:
    - a. Provide service weight cast iron pipe and fittings with No-Hub joints. Schedule 40 PVC or ABS DWV pipe may be used in lieu of cast iron if allowed by local codes. All above ground rain water piping shall be cast iron and insulated.
- B. Water System (domestic piping):
  - 1. Above ground, provide Type "L" copper with sweated connections.
  - 2. Below grade, provide Type "K" copper with sil-fossed connections. Schedule 40 PVC may be used for water service, if allowed by local codes.
- C. Gas Piping:
  - 1. Underground piping equal to Republic X-Tru-Coat plastic coated black steel pipe with protective wrap over joints.
    - a. Piping 2" and smaller: Threaded fittings.
    - b. Piping 2-1/2" and larger: Welding fittings.
  - 2. Above ground piping shall be black steel.
  - 3. Gas service piping up to the building shall be continuous plastic pipe meeting ASTM D2513 and D2517.

## **2.2 MATERIALS:**

- A. Cast Iron Soil Pipe and Fittings:
  - 1. Provide service weight cast iron conforming to ASTM A74 and CISPI 301, or provide hubless type per above standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.
- B. Galvanized:
  - 1. Provide standard weight complying with ASTM A53 and A120 for above ground piping. (Galvanized not allowed underground or under slab floors.)
- C. Copper Pipe:
  - 1. Provide copper pipe conforming to ASTM B42 and B302. (Type "M" copper not allowed underground or under slab floors.)
- D. Copper Tube:
  - 1. Provide copper tube conforming to ASTM B75, B88, and B251. (Type "M" copper not allowed underground or under slab.)
- E. Polyvinyl Chloride Pipe:
  - 1. Provide PVC pipe conforming to ASTM D2665 for waste, vent, and drainage pipe above and underground within 5'-0" of the building.
  - 2. Provide PVC pipe conforming to ASTM D2265 for building sewer pipe.
  - 3. Provide PVC pipe conforming to ASTM D1785 for water service pipe.
- F. Black Steel Pipe:
  - 1. Provide black steel pipe conforming to ASTM A53 and A120.
- G. Fittings:
  - 1. 2" and smaller provide standard cast iron threaded fittings.
  - 2. 2-1/2" and larger provide standard Butt Welding fittings.
- H. Unions:
  - 1. For copper lines, provide copper unions.
  - 2. For connections in iron pipe lines:
    - a. 2" and smaller provide ground joint brass-to-iron fittings.
    - b. 2-1/2" and larger provide standard cast iron with flanged ends and gaskets.
- I. Lead:
  - 1. Provide new pig lead complying with ASTM B29.

## **2.3 VALVES:**

- A. All valves of the same type shall be by the same Manufacturer.

- B. Gate Valves: Provide solid wedge disc, rising stem, 200# WOG; non-rising stem valves may be used only where there is insufficient clearance. Sweat joint valves shall be used on all copper pipes.
  - 1. 2" and smaller, rising stem: Provide Hammond #IB-640, bronze, screwed, B-62 bronze body and stem, malleable iron handwheel.
  - 2. 2" and smaller, non-rising stem: Provide Hammond IB-645, bronze, screwed, B-62 bronze body and stem, malleable iron handwheel.
  - 3. 2-1/2" and larger: Provide Hammond #IR-1140, IBBM, flanged, non-rising stem.
- C. Globe Valves: Provide replaceable composition disc suitable for 200°F water.
  - 1. 2" and smaller: Provide Hammond #IB-413T, bronze, screwed, malleable iron hand wheel.
  - 2. 2-1/2" and larger: Provide Hammond #IR-116, iron body, flanged, 200# WOG.
- D. Ball Valves: Provide large port ball of chrome plated, bronze or stainless steel construction, screwed ends, quarter turn operation, lever or C-handle operator. Valve shall be rated for 150 psi steam, 600 psi WOG. Valve shall have blow out proof stem and adjustable packing nut.
  - 1. 2" and smaller: Hammond #8501 Series or approved equal.
- E. Gas Cocks:
  - 1. 2" and smaller: Provide bronze, screwed, lubricated square head valve equal to Resun #R-1430.
  - 2. 2-1/2" and larger: Provide Nordstrom #142 or #143.
- F. Check Valves:
  - 1. 2" and smaller: Provide Hammond #IB-940, bronze, screwed, Y-pattern, 200# WOG, swing check type.
  - 2. 2-1/2" and larger: Provide Hammond #IR-1124, IBBM, flanged, 200# WOG.
- G. Plumbing Fixture Service Valves:
  - 1. 1/2" angle valve with wheel handle stop, 1/2" I.P.S. female inlet, 3/8" tube compression fitting outlet, 3/8" chrome plated flexible riser and chrome plated escutcheon plate. Chicago Faucet #1015 or equal.

## **2.4 FLASHING:**

- A. Where pipes of this Section pass through the roof, flash with Semco, #1100-4 seamless 4 lb. flashing, with steel reinforced "Vari-Pitch" boot and cast iron counterflashing sleeve or equal method approved by the Architect.

## **2.5 PIPE HANGERS:**

- A. Water Piping:
  - 1. Provide Fee and Mason #212 split ring hangers with supporting rods.



2. Copper plated hangers or hangers with dielectric isolators to be installed for copper pipe.
- B. Soil and Waste Piping:
  1. Provide Fee and Mason #212 adjustable ring hangers with supporting rods.
  2. Use Fee and Mason #241 riser clamps at each floor and as required.
- C. Gas Piping:
  1. Provide Fee and Mason #241 split ring hangers with supporting rods.

## **2.6 CLEANOUTS:**

- A. Exterior:
  1. Provide Wade W-6030-Z, or Smith #4253 with XH cast iron top in concrete areas.
- B. Floors:
  1. Provide Wade W-6030-1 or Smith #4023 with round nickle bronze top in finished room floors.
  2. Provide Wade W-6030-Z or Smith #4223 with round cast iron top in unfinished room floors.
  3. Provide "flush-with-floor" type cleanouts, with adjustable watertight covers and integral anchoring flange with clamping collar where waterproofing membrane is used.
- C. Finished Walls:
  1. Provide Wade W-8460-R6 or Smith #4532 with round chrome plate or stainless steel access plate and screw.
- D. Provide cleanout plugs of extra heavy bronze.

## **2.7 ACCESS BOXES:**

- A. Walls:
  1. Provide Wade W-8480-ST or Smith #4730 with polished chrome plate face in tile walls.
  2. Provide Wade W-8490-AKL, Smith #4760-AKL or #4765-AKL with bonderized prime-coated steel face and with Allen locks in walls of other finished rooms.
- B. Ceilings:
  1. Provide Acorn DW Series bonderized prime-coated steel face with Allen lock.

## **2.8 TRAPS:**

- A. For lavatories and sinks, except service sinks, provide chrome plated cast brass traps with brass nuts. Provide deep seal traps where required and/or shown on the Drawings.

- B. For handicap lavatories, provide off-set tailpiece ahead of P-trap.

## **2.9 WATER HAMMER ARRESTORS:**

- A. Provide Smith #5000 series or Precision Plumbing Products, Inc. stainless steel.

## **2.10 INSULATION:**

- A. Insulate hot water, cold water, and condensate piping with ½" thick glass fiber preformed pipe insulation with factory applied all purpose glass fiber reinforced flame retardant kraft paper and aluminum foil self sealing lap.
- B. Elbows and fittings to be insulated with factory preformed PVC jacketed insulation material to match thickness of pipe insulation.
- C. Valve bodies shall be insulated with Armstrong Armaflex type "FR" or equal insulation with vapor barrier. Factory preformed insulation enclosures may be substituted for field applied insulation.
- D. Insulated waste traps receiving cooling coil condensate and piping for a minimum of 10 feet after trap with ½ inch Armstrong Armaflex type "FR" or equal insulation with vapor barrier.
- E. Where shown on the Drawings or required by governmental agencies having jurisdiction, at lavatories for handicapped persons provide TRUEBRO Inc. Handi Lav-Guard model #102W and #105W white finish insulation on hot water supply, cold water supply, tailpiece, and trap.

## **2.11 FIXTURES AND EQUIPMENT:**

- A. Provide plumbing fixture, trim, (exposed trim to be chrome plated) and equipment as shown on the "Plumbing Fixture Schedule" in the Drawings. China fixture shall be of the best grade vitreous ware without pit holes and blemishes. The Architect reserves the right to reject any pieces which, in his opinion, are faulty.
  - 1. For the purpose of identification only one Manufacturer's model numbers are used throughout the schedule shown on the Drawings.
  - 2. Approved Manufacturers: American Standard, Crane, Kohler, or Eljer.
- B. Non-Freeze Hose Bibbs (FPHB):
  - 1. Provide ¾" non-freeze type of cast bronze construction with lock shield cap and loose key operator to suit wall size.
  - 2. Hose bibb to have integral backflow preventer, pressure relief valve and vacuum breaker.
  - 3. Approved equal by Wade (W-8620), Zurn or Woodford.

- C. Cover Plates (Escutcheons):

1. Provide chrome plated brass equal to Beaton Corbin Company style 2-BC for copper tube and 13-BC for standard pipe.
- D. Floor Drains:
  1. Provide floor drains where indicated on the Drawings complete with deep seal P-trap as listed below for various floor conditions:
    - a. Linoleum or asphalt tile floor - Wade W-1100-STD-1 with nickle bronze raised lip strainer.
    - b. Quarry tile or Terrazzo floor - Wade W-1100-G-1 with nickle bronze square strainer.
    - c. General - Wade W-1100 with type B nickle bronze strainer:
      - 1) 2" drain to have 5" strainer;
      - 2) 3" drain to have 6" strainer;
      - 3) 4" drain to have 8" strainer.
    - d. Heavy duty - Wade W-1200-13-5 with 12" diameter secured coated iron grate.
    - e. Manufacturers - Zurn, Wade, or J.R. Smith.

**2.12 INSULATION:**

- A. Insulate hot water, cold water, rain leader, condensate, and refrigerant suction lines with 1/2" thick IMCOA Polyolefin Insulation or Armstrong Armaflex type "FR" with vapor barrier.
- B. Also see requirements specified for "Handicap Fixture Insulation."

**2.13 SLEEVES:**

- A. Where pipes pass through concrete, masonry, or stud walls, or pass through ceilings, provide 20-gauge galvanized sheet metal sleeve large enough to allow for free movement of the pipes with expansion.

**2.14 WATER HEATER (GAS FIRED):**

- A. Provide domestic gas fired water heater sized as noted on the Drawings or of approved equal by A.O. Smith, Rheem/Ruud, National, State or approved equal.
- B. Water heater features to include glass lining bonded to heavy steel tank; magnesium anode, factory insulation, cold rolled steel jacket with baked enamel finish, thermostat, 100% safety shut-off, gas pressure regulator, flue collector, draft hood, and 3 year commercial warranty.
- C. Provide watts N40XL pressure/temperature relief valve with AGA label.

**2.15 CIRCULATING PUMP (HOT WATER RECIRCULATION):**

- A. General: Circulating pump shall be of the in-the-line booster type, horizontal mounting, of the capacity listed on the Drawings.
- B. Features: Bronze body construction, mechanical seal, brass impeller, steel shaft with thrust collar supported by two horizontal sleeve bearings (oil lubricated), drip-proof-sleeve bearing non-overloading motor mounted on rubber isolators.

**2.16 OTHER MATERIALS:**

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

**PART 3 - EXECUTION**

**3.1 SURFACE CONDITIONS:**

- A. Examine the areas and Conditions under which Work of this Section will be performed. Correct Conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory Conditions are corrected.

**3.2 PLUMBING SYSTEM LAYOUT:**

- A. Lay out the plumbing system in careful coordination with the Drawings, determining proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.
- B. Follow the general layout shown on the Drawings in all cases except where other Work may interfere.
- C. Lay out pipes to fall within partition, wall, or roof cavities, and do not require furring other than as shown on the Drawings. Do not install domestic water lines in exterior walls without proper considerations of required insulation and routing.
- D. Slots, Chases, Openings, and Recesses: Through floors, walls, ceilings, and roofs as specified in new structure will be provided by the various trades in their respective materials, but the trade requiring them shall see that they are properly located and shall do any cutting and patching caused by the neglect to do so. No cuts shall be made into any structural element, beam or column, without written approval. Opening in existing structures will be provided by the trade requiring same.
- E. Locations: Of pipes, ducts, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The

contractor shall determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
2. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The contractor shall furnish and install all traps and sanitary vents, etc., as required to effect these offsets, transitions and changes in direction.

### **3.3 TRENCHING AND BACKFILLING:**

- A. Perform trenching and backfilling associated with the Work of this Section in strict accordance with the provisions of Division 2 of these Specifications.
- B. Cut bottom of trenches to grade. Make trenches 12" wider than the greatest dimension of the pipe.
- C. Bedding and Backfilling:
  1. Install piping promptly after trenching. Keep trenches open as short a time as practicable.
  2. Under the building, install pipes on a 6" bed of damp sand. Backfill to bottom of slab with damp sand.
  3. Outside the building, install underground piping on a 6" bed of damp sand. Backfill to within 12" of finish grade with damp sand. Backfill remainder with native soil.
  4. Do not backfill until installation has been approved and Project Record Documents have been properly annotated.
  5. Provide bare copper trace wire 6 inches above all buried plastic pipe.
  6. Provide continuous plastic banner labeled CAUTION-GAS PIPING 12 inches above all buried gas piping.

### **3.4 INSTALLATION OF PIPING AND EQUIPMENT, GENERAL:**

- A. General:
  1. Proceed as rapidly as the building construction will permit. Install piping parallel and perpendicular to building walls and partitions.
  2. Thoroughly clean items before installation. Cap pipe openings to exclude dirt until fixtures are installed and final connections have been made.
  3. Cut pipe accurately, and work into place without springing or forcing, properly clearing windows, doors, and other openings. Excessive cutting or other weakening of the building will not be permitted.

4. Show no tool marks or threads on the exposed plated, polished, or enameled connections from fixtures. Tape all finished surfaces to prevent damage during construction.
5. Make changes in directions with fittings; make changes in main size with eccentric reducing fittings. Unless otherwise noted, install water supply and return piping with straight side of eccentric fittings at top of the pipe.
6. Run horizontal sanitary piping at a uniform grade of 1/4" per ft., unless otherwise noted. Branch connections and changes in direction to be made with 45 degree "Y" fittings or long sweep ell.
7. Run horizontal water piping with an adequate pitch upward in direction of flow to allow complete drainage.
8. Install vent connections on all fixtures, traps, and equipment connected to the soil and waste system and extend not less than 3'-6" above floor before turning horizontal. Extend vent through roof minimum 1'-0" above roof or adjacent wall within 18" of roof penetration.
9. Provide sufficient swing joint, ball joints, expansion loops, and devices necessary for a flexible piping system, whether or not shown on the Drawings. Make branch connections with offsets to provide for pipe movement.
10. Support piping independently at pumps, and similar locations, so that weight of pipe will not be supported by the equipment.
11. Pipe drain lines from drip pans, air vents, relief valves and similar locations, to spill over an open sight drain, floor drain, or other acceptable discharge point, and terminate with a plain end, unthreaded pipe 2" above the drain.
12. Securely bolt all equipment, isolators, hangers, and similar items in place.
13. Support each item independently from other pipes. Do not use wire for hanging or strapping pipes.
14. Provide complete dielectric isolators between ferrous and non-ferrous metals.
15. Provide union and shut-off valves suitably located to facilitate maintenance and removal of equipment and apparatus.
16. Provide shut-off gas valve and union at each piece of gas fired equipment and service penetration through exterior wall and roof.
17. Valves, strainers, check valves, and fittings shall be full size of the line they serve unless noted otherwise.
18. Make change in pipe size noted on the plans after last fitting of larger pipe. When supply pipes are larger than equipment tapings, reduce size immediately prior to entry.

B. Equipment Access:

1. Install piping, equipment, and accessories to permit access for maintenance. Reroute pipe and/or relocate items as necessary to provide such access, and without additional cost to the Owner.
2. Provide access doors where valves, motors, or equipment requiring access for maintenance are located in walls or chases or above ceilings. Coordinate location of access doors with other trades as required.

### 3.5 PIPE JOINTS:

- A. Copper Tubing:
  - 1. Cut square, remove burrs, and clean inside of female fitting to a bright finish.
    - a. Apply solder flux with brush to tubing.
    - b. Remove internal parts of solder-end valves prior to soldering.
  - 2. Provide dielectric unions at points of connection of copper tubing to ferrous piping and equipment.
  - 3. For joining copper tubing, use:
    - a. Water piping 3" and smaller : 95-5 solder.
    - b. Water piping larger than 3" : "Sil-fos" brazing.
    - c. Underground : "Sil-fos" brazing.
- B. Screwed Piping:
  - 1. Deburr cuts.
    - a. Do not ream exceeded internal diameter of the pipe.
    - b. Thread to requirements of ANSI B2.1.
  - 2. Use teflon tape on male thread prior to joining other services.
  - 3. Use litharge and glycerin on joint prior to cleaning for air and oil piping.
- C. Plastic Piping:
  - 1. Mechanical joints shall be made with an Elastomeric thread seal on male thread. Joint shall be clean and free of dirt and made in accordance with Manufacturer's instructions. (DWV piping to conform to ASTM D3212.)
  - 2. Solvent Cementing:
    - a. Clean joint surfaces free of dirt and moisture.
    - b. Prime joint with colored primer past extend of joint.
    - c. Apply cement to all joint surfaces and make joint while cement is still wet.
    - d. Use Solvent Cement for particular pipe material and make joint in accordance with Manufacturer's instructions.
  - 3. Threaded joints shall be made in using lubricant or tape approved for pipe material applied to male thread. Threads of joints shall conform to ANSI B2.1 and shall be clean of dirt immediately prior to making joint.
- D. Welded Piping:
  - 1. Welded pipe to be joined in accordance with American Welding Society Code using butt-welded single V beveled 45 degrees to within 1/16" of inside wall. Use welding fittings for changes of direction and intersection of lines.
- E. Leaky Joints:
  - 1. Remake with new material.
  - 2. Remove leaking section and/or fitting as directed.
  - 3. Do not use thread cement or sealant to tighten joint.

### 3.6 PIPE SUPPORTS:

- A. Support suspended piping with clevis or trapeze hangers and rods.
- B. Space hangers and support for horizontal steel pipes according to the following schedule:

<u>Pipe Size</u>		<u>Maximum Spacing on Centers</u>
1-1/4" and smaller	:	8'-0"
1-1/2" to 3"	:	10'-0"
4" to 5"	:	14'-0"

- C. Space hangers and supports for horizontal copper tubing according to the following schedule:

<u>Tube Size</u>		<u>Maximum Spacing on Centers</u>
1" and smaller	:	6'-0"
1-1/2"	:	7'-0"
2"	:	8'-0"
2-1/2"	:	9'-0"
3" and larger	:	10'-0"

- D. Space hangers and supports for horizontal cast iron soil pipe 5'-0" on center.
- E. Space hangers and supports for horizontal PVC and ABS plastic pipe 4'-0" on center.
- F. Provide sway bracing on hangers longer than 18".
- G. Support vertical piping with riser clamps secured to the piping and resting on the building structure. Provide at each floor unless otherwise noted.
- H. Provide insulation continuous through hangers and rollers. Protect insulation by galvanized steel shields.
- I. Arrange pipe supports to prevent excessive deflection, and to avoid excessive bending stress.
- J. Support piping from inserts or anchors in concrete slabs. Provide the inserts under this Section and arrange for the placing under Section 03300 of these Specifications. Use expansions inserts only where approved by the Architect.
- K. Hubless Piping:
1. Provide hangers on the piping at each side of, and within 6" of, hubless pipe coupling so the coupling will bear no weight.
  2. Do not provide hangers on couplings.
  3. Provide hangers adequate to maintain alignment and to prevent sagging of the pipe.
  4. Make adequate provisions to prevent shearing and twisting of the pipe and the joint.



**3.7 SLEEVES AND OPENINGS:**

- A. Provide sleeves for each pipe passing through walls, partitions, floors, roofs, and ceilings.
  - 1. Set pipe sleeves in place before concrete is poured.
  - 2. For uninsulated pipe, provide sleeves two pipe sizes larger than the pipe passing through, or provide a minimum of 1/2" clearance between inside and outside of the pipe.
  - 3. For insulated pipe, provide sleeves of adequate size to accommodate the full thickness of pipe covering, with clearance of packing and caulking.
- B. Caulk the space between sleeve and pipe or pipe covering, using a noncombustible, permanently plastic, waterproof, non-staining compound which leaves a smooth finished appearance, or pack with noncombustible cotton, rope, or fiberglass to within 1/2" of both wall faces, and provide the waterproof compound described above.
- C. Finish and Escutcheons:
  - 1. Smooth any rough edges around sleeves with plaster or spackling compound.
  - 2. Provide 1" wide chrome or nickle plated escutcheons in all pipes exposed to view where passing through walls, floors, partitions, ceilings, and similar locations.
    - a. Size the escutcheons to fit pipe and covering.
    - b. Hold escutcheons in place with set screw.

**3.8 CLEANOUTS:**

- A. Accessible cleanouts shall be installed in all horizontal waste lines at no greater than 100 ft. intervals and at the base of all vertical stacks.
- B. Secure the Architect's approval of locations for cleanouts in finished areas prior to installation.
- C. Provide cleanouts of same nominal size as the pipes they serve; except where cleanouts are required in pipes 4" and larger, provide 4" cleanouts.
- D. Make cleanouts accessible. After pressure tests are made and approved, thoroughly graphite the cleanout threads.

**3.9 VALVES:**

- A. Provide valves in water, air, and gas systems. Locate and arrange so as to give complete regulation of apparatus, equipment, and fixtures.
- B. Provide valves in at least the following locations:
  - 1. In branches and/or headers of water piping serving a group of fixtures.
  - 2. On both sides of apparatus and equipment.

3. For shutoff of risers and branch mains.
  4. For flushing and sterilizing the system.
  5. Where shown on the Drawings.
- C. Locate valves for easy accessibility and maintenance.

### **3.10 WATER HAMMER ARRESTORS:**

- A. Provide water hammer arrestors on hot water lines and cold water lines.
1. Install in upright position at all quick closing valves, solenoids, isolated plumbing fixtures, and supply headers at plumbing fixture groups.
  2. Locate and size as specified or as shown on the Drawings and, where not shown, locate in accordance with Plumbing and Drainage Institute Standard WH-201.
  3. Install water hammer arrestors behind access panels.
- B. Where fixtures are not protected by water hammer arrestors, provide air compression chambers equal to twelve (12) pipe diameters, 18" minimum on all water supply connections.

### **3.11 BACKFLOW PREVENTION:**

- A. Protect plumbing fixtures, faucets with hose connections, yard hydrants, lawn irrigation, and other equipment having plumbing connection, against possible back-siphonage.

### **3.12 PLUMBING FIXTURE INSTALLATION:**

- A. Installation:
1. Set fixtures level and in proper alignment with respect to walls and floors, and with fixtures equally spaced.
  2. Provide supplies in proper alignment with fixtures and with each other.
  3. Provide flush valves in alignment with the fixture, without vertical or horizontal offsets.
  4. Install all fixture supports before wall finish is applied.
- B. Grout wall and floor mounted fixtures watertight where the fixtures are in contact with walls and floors.
- C. Caulk deck-mounted trim at the time of assembly, including fixture and casework mountings. Caulk self-rimming sinks installed in casework.
- D. All fixtures shall be cleaned before setting and the installation shall be left ready for use.

**3.13 WATER HEATER:**

- A. Installation:
  - 1. Set tank level with proper clearances and arranged for easy access to pilot, adjustment of controls, and shut-off valves.
  - 2. Provide shut-off valves and dielectric unions on both hot water and cold water lines.
  - 3. Gas service piping to heater to include installation of dirt leg, union, and shut-off valve.
  - 4. Provide relief line from pressure and temperature relief valve to nearest floor drain, or approved receptor.
  - 5. Install all auxiliary equipment such as thermometers, gauges, circulating pumps, temperature control valves, etc., as noted on the Drawings.

**3.14 DISINFECTION OF WATER SYSTEMS:**

- A. Sterilize domestic hot and cold water systems to meet Health Department requirements.
  - 1. Prior to treatment, flush the system of all dirt and foreign matter.
  - 2. Fill system with water treated with 50 ppm of chlorine. Leave treated water in the systems for 24 hours.
  - 3. Open all valves and faucets several times during flushing and treatment filling to insure full circulation.
  - 4. Test the chlorine content at the end of treatment period and if chlorine content is greater than 10 ppm, flush the system. If chlorine content is found to be less than 10 ppm, repeat the sterilization process. Take samples from several points in the system.
  - 5. After sterilization, flush the system with clean water until the chlorine is less than 0.1 ppm.
- B. After final flushing, obtain Health Department Certificate of Approval on samples of water taken from the systems. (Use a testing agency approved by the Health Department.) Test shall show negative for coli-aerosene organisms.
- C. If analysis results are not satisfactory, repeat the disinfection procedures and retest until specified standards are achieved.

**3.15 INSTALLATION OF PUMPS:**

- A. General: Install pumps where shown, in accordance with Manufacturer's written instructions and recognized industry practices to ensure that pumps comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.
- B. In-line Pumps: Pumps shall be supported from structure with all-thread rod, angle iron and isolators or on wall bracket with isolators. Pump is not to be supported by piping. Provide isolation and balance valves and check valve.

- C. Field Quality Control:
  - 1. Field Test: Upon completion of pump installation, and after motor has been energized from normal power source, bleed air from pump casing and test pump to demonstrate compliance with requirements. When possible, field-correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.
  - 2. After the pumps are in operation, the contractor shall check the seals at 30-, 60-, and 90-day intervals and replace any that are defective.
- D. Electrical Connections:
  - 1. Grounding: Provide positive electrical pump and motor grounding in accordance with applicable requirements of the NEC.

### **3.16 OTHER TESTING AND ADJUSTING:**

- A. Provide personnel and equipment, and arrange for and pay the costs of, all required tests and inspections required by governmental agencies having jurisdiction.
- B. Test the following systems at the pressures listed:
  - 1. Gas piping: Test under 30 psi air pressure.
  - 2. Domestic water: Test under 130 psi hydrostatic pressure.
  - 3. Soil and waste:
    - a. Above ground test with 12 ft. water head;
    - b. Underground test with 8 ft. water head.
- C. Where tests show materials or workmanship to be deficient, replace or repair as necessary, and repeat the tests until the specified standards are achieved.
- D. Adjust the piping systems to optimum standards of operation.

END OF SECTION

**SECTION 230600 HEATING, VENTILATING, AND AIR CONDITIONING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Work Included: Provide heating, ventilating, and air conditioning systems where shown on the Drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
  - 1. Rooftop packaged air-cooled, gas/electric conditioning systems, complete with direct-expansion cooling section, burner gas valve and heat exchanger, dampers, damper operators, mounting frame, operating and safety controls, blowers, motors, compressors, condensers, filters, and related items.
  - 2. Split system direct expansion heat pump heating and cooling system with controls, safety controls, blowers, motors, electric strip heaters, compressors, coils, filters, and related items.
  - 3. Air conditioning supply and return ductwork system with grilles, diffusers, registers, dampers, sheet metal hardware, and related items.
  - 4. Exhaust systems including, motors, ductwork, grilles, registers, controls and related items.
  - 5. Temperature control system.
  - 6. Air systems balance for air quantities shown on the plans.
  - 7. Acoustical and thermal insulation of ducts, piping, and equipment.
- B. Related Work: Documents affecting Work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of this Specification.
- C. Drawings: The mechanical drawings show the general arrangement of all piping, equipment, and appurtenances and shall be followed as closely as actual building construction, site conditions, and the work of other trades will permit. The mechanical work shall conform to the requirements shown on all of the drawings. General and structural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly.

**1.2 QUALITY ASSURANCE:**

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.
- B. Codes and Regulations:

1. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies having jurisdiction, all applicable laws, codes, ordinances including those of the state, county and city.
  2. The Work shall also comply with all applicable requirements of the National Fire Protection Association, International Building, Plumbing and Mechanical codes, and all locally accepted amendments to these codes.
  3. In the event of conflict between or among specified requirements and pertinent regulations, the more stringent requirement will govern.
  4. Pay all fees, taxes, licenses and permits for inspection and certification for the execution of this Work.
  5. Non-compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, and utility company regulations, he shall bear all costs arising in correcting the deficiencies.
- C. Certificate of Final Inspection: Under each applicable section of the specifications, the contractor shall, upon completion of the work under that section, furnish a certificate of final inspection from the department having jurisdiction.

### **1.3 EXAMINATION OF SITE:**

- A. Visit the site, inspect the existing Conditions and check the Drawings and Specifications so as to be fully informed of the requirements for completion of the Work.
- B. Lack of such information shall not justify a request for extra compensation to the contract price.

### **1.4 MATERIAL AND EQUIPMENT:**

- A. All materials and equipment shall be new, of the same type and Manufacturer, and shall be of the best quality and design and free from defects.
- B. A Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.
- C. Manufacturer's name and model number used herein and on the Drawings establish type and quality required. Equal products may be considered if submitted in writing to the Engineer/Architect for approval 10 days prior to bid date. The Contractor shall be responsible for assuring the items and equipment substituted for those shown on the Drawings will physically fit in the space allocated.
- D. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection until installed. All items subject to moisture damage (such as controls) shall be stored in dry, conditioned spaces.

- E. Protection: Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury. Damage or defects developing before acceptance of the work shall be made good at the contractor's expense.
- F. Dimensions: It shall be the responsibility of the contractor to insure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install sizes and shapes of equipment so that the final installation shall suit the true intent and meanings of the drawings and specifications.
- G. Manufacturer's Directions: Shall be followed completely in delivery, storage, protection and installation of all equipment and materials. The contractor shall promptly give notice in writing of any conflict between any requirement of the Contract Documents and the manufacturer's directions and shall obtain written instructions before proceeding with the work. Should the contractor perform any work that does not comply with the manufacturer's directions or such written instructions, he shall bear all costs arising in correcting the deficiencies.

## **1.5 SUBMITTALS:**

- A. Comply with pertinent provisions of Division 1.
- B. Product Data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Materials list of items proposed to be provided under this Section.
  - 2. Manufacturer's Specifications, catalog cuts, and other data needed to prove compliance with the specified requirements.
  - 3. Shop Drawings and other data as required to indicate method of installing and attaching equipment, except where such details are fully shown on the Drawings.
  - 4. All sheets of the submittal shall have the job name stamped or permanently written neatly on them and shall be assembled in an indexed brochure. The descriptive material shall be arranged in the brochure in the same order as found in the specifications. Each brochure shall be submitted in a hardback, 3-ring binder. The leading sheet of the descriptive material for each item shall be full size, of heavy paper, with a numbered outside tab, and an index sheet showing the location in the brochure.
  - 5. Manufacturer's regular catalog sheets will not be acceptable under these requirements unless they indicate completely all of the specification requirements. Where drawings cover several sizes or types of construction, they shall clearly indicate the size or type of construction to be used on the project. In cases where several sizes of the same type of equipment are required to be furnished, the submittal shall include a schedule identifying each piece of equipment, complete with all capacity information needed to compare every submittal item with its respective specified item. Special features shall be listed on a separate typewritten sheet.
  - 6. Brochures shall contain a certification by the Contractor that the equipment or materials are suitable for conditions shown and specified; that the equipment or

materials are believed to be in conformity with the plans and specifications, except as may be specifically described; be signed by the Contractor. Brochures received not in conformity with these requirements will be returned for required action.

7. Finding "APPROVED EQUAL" or "NO EXCEPTION TAKEN" shall not eliminate responsibility for compliance with the plans and specifications, unless specific attention has been called, in writing, to the proposed deviations at the time of transmittal of the brochures and such deviations have been found acceptable, nor shall it eliminate the responsibility for freedom from errors of any sort in the data submitted. Discovery of such deviations at or after installation shall be cause for immediate replacement at no additional cost to the Owner.
8. No material or equipment so governed shall be ordered until found acceptable by the Architect/Engineer/Owner.

C. Record Drawings:

1. Comply with pertinent provisions of Division 1.
  - a. Record Drawings- The contractor shall furnish to the owner CAD record drawings consisting of three (3) sets of 11" x 17" prints (To be bound in O&M Manuals), one (1) full size set of prints and one (1) disk, showing the piping and ductwork for the HVAC and plumbing systems. Piping sizes, rerouting, etc., for both under floor and above ceiling piping shall be shown. Also, provide a blue-line of the site plan, clearly marked, to indicate any and all changes in sanitary sewer, storm sewer, domestic cold water and natural gas piping to the building. In addition to these drawings, a complete set of approved ductwork shop drawings and temperature control shop drawings shall be included in this set of drawings.
    - 1) CAD Record drawings shall incorporate all change and field orders. (No separate or supplemental drawings).
    - 2) All equipment schedules to be revised to reflect installed manufacturer model numbers and capabilities.
2. Include a copy of the Record Drawings in each copy of the operation and maintenance manual described below. (Original document shall be reproducible paper.)

D. Manuals: Upon completion of this portion of the Work, and as a Condition of its acceptance, deliver to the Architect two copies of an operation and maintenance manual compiled in accordance with the provisions of Division 1 of these Specifications. Include within each manual:

1. Copy of the approved record documents for this portion of the Work.
2. Copies of all warranties and guarantees.
3. Description of HVAC equipment control and seasonal operation, including schedule of required maintenance.

**1.6 PRODUCT HANDLING:**

- A. Comply with pertinent provisions of Division 1.



**1.7 INSPECTION:**

- A. Make written notice to the Architect adequately in advance of each of the following stages of construction:
  - 1. In the underground condition prior to placing concrete floor slab, when all associated Work is in place.
  - 2. When all rough-in is complete, but not covered.
  - 3. At completion of the Work of this Section.
- B. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.

**1.8 CLEANING, TESTING AND PLACING IN SERVICE:**

- A. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- B. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- C. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.

**1.9 ADJUSTMENT AND INSTRUCTION:**

- A. Energize all systems, equipment and fixtures and check for proper operation.
- B. HVAC system shall be placed in operation and balanced to provide air and water flow as indicated on the Drawings.
- C. The Contractor's service personnel shall instruct the Owner's Representative in the proper operation of all systems.

**1.10 GUARANTEE:**

- A. The Contractor guarantees all work against any defects due to faulty workmanship or material and that all raceways, ducts and piping are free from foreign material, obstructions, holes or breaks of any nature.

- B. Upon written notice from the Architect or Owner, the Contractor shall promptly remedy without cost to the Owner any defects occurring within a period of one (1) year from the date of final acceptance.

**1.11 WARRANTY:**

- A. The Contractor shall properly execute in the Owner's name all Manufacturer's standard warranty certificates applying to equipment installed on the project and shall deliver said certificates to the Architect at completion of the job. All warranty cards shall also be properly executed and delivered to the supplier or Manufacturer's representative for Manufacturer's records. Standard warranties for equipment shall not be less than one (1) year.

**PART 2 - PRODUCTS**

**2.1 SHEET METAL DUCTWORK:**

- A. For interior heating, ventilating, and air conditioning systems, provide best grade, prime, open hearth, galvanized sheet metal ducts fabricated and installed to pertinent ASHRAE and SMACNA standards, or to the requirements of governmental agencies having jurisdiction, whichever requirement is more stringent.
- B. Round ductwork to be constructed of best grade prime, open hearth galvanized steel with spiral seams. For systems with less than .75" W.G. pressure, round duct with longitudinal snap lock seams and beaded sleeve transverse joints may be installed.

**2.2 FLEXIBLE DUCT:**

- A. Provide factory fabricated insulated low pressure flexible duct with the following attributes as manufactured by Thermaflex, Wire Mold, Metaflex, or Flexmaster.
  - 1. Helix wire flexible core.
  - 2. 2" fiberglass blanket insulation of 3/4 lb. density with continuous sealed vapor barrier jacket.
  - 3. Accessories shall include strap clamps, spin-in duct taps, air scoops and dampers as required.
  - 4. Composite assembly, including insulation and vapor barrier, shall meet all requirements of UL 181, including flame spread of 25 or less and smoke developed rating of 50 or less as set forth in NFPA Bulletin 90-A, and bearing UL label as a Class 1 air duct.

**2.3 DUCTWORK FABRICATION:**

- A. All interior ductwork and fittings shall be fabricated in accordance with recommendations as outlined in current ASHRAE and SMACNA Standards.

- B. Gauges and reinforcing in accordance with current SMACNA Standards for greatest dimensions of duct or housing.
- C. Lap metal ducts in direction of air flow. Hammer down edges and slip joints to leave smooth duct interior.
- D. Cross break all rectangular ducts 18" and larger. Omit cross breaking if two gauge heavier metal is used in duct construction.
- E. Transverse Joints: Ductwork up to 24", use s-drive, pocket, or bar slip. Ductwork 25" to 40", use joints forming outside ribs. Other joint connections of equivalent mechanical strength and air tightness may be used if approved by the Engineer.
- F. Construct elbows with radius of not less than 1-1/2 times width of duct on center line or square elbows with air foil turning vanes. Round duct elbows shall be of the smooth radius type. For round duct systems with less than .75" W.G. pressure, jointed elbows may be installed.
- G. Branch ducts shall be tied to main trunk duct through radius take-off and splitter damper, or 45 degree branch and curved blade extractor. Round branch duct tappings to be of the conical or spin-in type with air scoop and volume damper for supply air on 12" round and smaller. Flanged or bellmouth taps used for larger ducts as noted on the Drawings.
- H. Transitions shall be constructed per SMACNA Standards and shall not exceed 20 degrees for diverging air flows or 30 degrees for contracting air flows.
- I. Plenums shall be fabricated in accordance to duct gauges and shall be reinforced per SMACNA standards.

#### **2.4 DUCT HANGERS AND SUPPORTS:**

- A. Hangers shall be galvanized steel band iron or angle iron and galvanized threaded rod. Wall supports shall be galvanized steel band iron or fabricated angle bracket.

#### **2.5 DUCT INSULATION:**

- A. General:
  - 1. Provide materials complying with NFPA Bulletin 90-A, as determined by UL method NFPA 225-ASTM E84, and complying with the governing code, with flame spread rating less than 25 and smoke developed rating less than 50.
  - 2. Where vapor barriers are used, provide intact and continuous throughout with all joints sealed.
  - 3. Manufacturer of duct liners shall print density and thickness on face of duct liner.
  - 4. Acceptable Manufacturers:

- a. Owens/Corning Fiberglass
  - b. Johns-Manville
  - c. Certainteed
  - d. Armstrong
- B. Ductliner (Interior Rectangular Duct): Insulate internal supply, return and exhaust ducts with 1" glass fiber with a minimum density of 1.5 pounds per cubic foot. Liner to be coated to prevent fiber erosion at air velocities up to 4000 f.p.m.
- C. Ductwrap (Interior Round Duct and Rectangular Duct): Insulate externally all round and rectangular ducts and fresh air ducts with 2" thick, 1 pound density, fiberglass ductwrap with factory applied reinforced aluminum foil vapor barrier.
- D. Sound Attenuation Ductliner (Interior Rectangular Duct): Insulate internal supply and return ducts with 2" glass fiber with a minimum density of 3 pounds per cubic foot. Liner to be coated to prevent fiber erosion at air velocities up to 4000 f.p.m. Attenuation duct liner installed for a minimum of the first two duct sections from the unit or as noted on the drawings.
- E. Exterior Duct Liner: All ductwork exposed to weather to be internally insulated with 2" glass fiber with a minimum density of 3.0 pounds per cubic foot. Liner to be coated to prevent fiber erosion at air velocities up to 4000 f.p.m.
- F. Fire Resistive Duct Wrap: Insulate kitchen exhaust duct with 1-1/2 inch thick FireMaster duct wrap non-asbestos, high temperature, inorganic, ceramic filled totally encapsulated in foil/scrim having a service temperature range up to 2300 deg. F. for zero clearance to combustible construction and to provide a two hour fireresistive duct enclosure. Insulation shall meet UL 723, UL1978, UL 1479, ASME E119, ASME E814, ASME E136, and BOCA Evaluation Services , Inc. report No. 92-3. Tape joints with manufacturer's approved material to maintain integrity of fire stopping performance.

## **2.6 DUCTWORK ACCESSORIES:**

- A. Acceptable Manufacturers:
- 1. Air Balance, Inc.
  - 2. Ruskin
  - 3. Carnes
  - 4. Young
  - 5. Krueger
  - 6. Prefco
  - 7. Nailor Industries
- B. Access Doors: Access doors shall be installed for inspection, service, and maintenance of balance dampers, fire dampers, filters, etc. Doors shall be 12" x 12" for handhole and 24" x 24" for manhole where required. Access doors shall have gasket seals, insulated core and shall be secured air tight.

- C. Flexible Connections: Duct connections to fans and where noted elsewhere on plans shall be sound isolation of fire resistant, water proof, and mildew-resistant canvas. Connections shall not be less than 4" long, shall have suitable metal collar frame on each end, and shall be made with at least 1" slack material.
- D. Opposed Blade Dampers:
  - 1. Construct of galvanized steel blades a maximum width of 6" set in 18-gauge galvanized steel frame with blade stops. Damper blades to be equipped with rigid linkage bar and pivoted using noncorrosive bearings of oilite or nylon. Provide with minimum of 2 inch stand-off handle.
  - 2. Single or parallel multiple blade dampers shall be of the same quality of construction, but shall not be used unless noted on the Drawings.
  - 3. Damper blades shall be interlocking.
  - 4. Where low leakage dampers are noted, blades shall be airfoil, insulated type with edge seals. Damper shall also include edge and jamb seals to limit air leakage.

## **2.7 AIR OUTLETS:**

- A. Provide and install grilles, registers, and diffusers as scheduled on the Drawings with accessories as noted.
- B. Acceptable Manufacturers:
  - 1. Metalaire
  - 2. Titus
  - 3. Tuttle & Bailey
  - 4. Barber Colman
  - 5. Krueger
  - 6. Nailor Industries
- C. Flanged frame grilles, registers, and diffusers to have gasket seals.
- D. Provide insulated plenums, adaptor boxes or square to round transitions for connection to flexible duct runouts where required.

## **2.8 ROOF HOODS:**

- A. Provide and install all aluminum roof hoods with bird screens as sized and noted on the Drawings. Backdraft dampers and other accessories to be furnished and installed as noted on the Drawings.
- B. Acceptable Manufacturers:
  - 1. Penn
  - 2. Greenheck
  - 3. Cook
  - 4. Carnes

5. Or as provided by fan Manufacturer when installed in conjunction with exhaust or supply fan systems.

## **2.9 VIBRATION ISOLATION:**

- A. Vibration isolation shall be of the type and deflection for the duty indicated on the Drawings. The vibration isolator supplier shall confirm equipment weights and revolutions (Frequency) with actual products approved and installed by Division 15 Contractor.
- B. All vibration isolators and bases shall be treated for resistance to corrosion.
- C. Size type and deflection of isolators shall conform to recommendations set forth in ASHRAE standards.
- D. Approved Manufacturers:
  1. Amber Booth
  2. Mason Industries, Inc.
  3. Consolidated Kinetic Corporation

## **2.10 FANS:**

- A. Exhaust fans shall be of the type and capacity as scheduled on the Drawings. All fans bear seal of ratings certified by A.M.C.A. Fans shall be furnished and installed with accessories, special coatings, special materials and construction, and controls as noted on the Drawings.
- B. Approved Manufacturers:
  1. Penn
  2. Greenheck
  3. Cook
  4. Carnes
  5. Twin City

## **2.11 SPLIT SYSTEM FAN COILS and CONDENSING UNITS:**

- A. Provide cooling only split system fan coil air-handling unit as scheduled, evaporator/condenser coil in fan unit, air cooled outdoor condensing unit, of the capacities and voltage as scheduled on the Drawings.
- B. Fan coil outdoor condensing unit shall be of the same Manufacturer and matched for the capacities scheduled on the Drawings. Performance ratings shall comply with those scheduled for the outdoor and coil entering air design data listed on the Drawings.
- C. Fan Coil Features:

1. Cabinet: Constructed of cold-rolled steel finished with baked enamel and fully insulated; duct connection flanges; filter frame and access door; and removable access panels for servicing.
  2. Fan: Direct drive, multi-speed blower, dynamically and statically balanced; fan motor overload protection; resilient mounting. Indoor unit powered from the outdoor unit.
  3. DX Coil: Copper tube and mechanically bonded aluminum fins; refrigerant metering device; refrigerant line fittings; condensate drain pan with pump for condensate piping.
- D. Condenser Features: Both refrigerant lines from the outdoor unit shall be insulated. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection. The outdoor unit shall be capable of operating in the cooling mode down to 23 degrees F ambient temperature, without additional low ambient controls. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Unit casing shall be fabricated of galvanized steel, bonderized and finished. Each outdoor unit shall be furnished with one direct drive, variable speed propeller type fan. All fan motors shall have permanently lubricated bearings and be completely variable speed. Outdoor unit shall use R410A refrigerant. Coil shall be nonferrous constructions with lanced or corrugated plate fins on copper tubing. The coil shall be protected with a metal guard. Each unit shall have one inverter driven scroll hermetic compressor. The compressor shall be equipped with an internal thermal overload.
- E. Controllers: The thermostat shall be wall mounted equal to PAR-21MAA and perform all functions necessary for operation of multiple fan coil units.
- F. Acceptable Manufacturers:
1. Lennox, no exceptions

## **2.12 REFRIGERANT PIPING:**

- A. Precharged and factory insulated refrigerant lines shall be installed for distances less than 50 feet and direct, unconcealed pipe routing. Refrigerant piping shall be type "L" copper, refrigerant grade with wrought copper fittings and insulated per Section 15400, item 2.12.
- B. Pipe sizes shown on the Drawings are for estimating purposes only. Equipment Manufacturer shall verify size of refrigerant piping for system installation.
- C. Refrigerant system shall include liquid filter dryer, strainer, charging valves, relief valves, check valves, sight glass, solenoid valves, and thermostatic expansion valves.

## **2.13 ROOF TOP UNITS (GAS HEAT AND ELECTRIC DX COOLING):**

- A. Provide package air cooled, electric DX cooling, single zone, gas fired heating unit with capacities and voltage as scheduled on the Drawings.
- B. Unit Features: Insulated galvanized steel cabinet with baked enamel finish, aluminized steel with heat exchanger with end shot burners, redundant gas valve, intermittent pilot ignition, A.G.A. approved for outdoor application, evaporator and condenser coils with aluminum plate fins mechanically bonded to seamless copper tubes, hermetic compressors with motor overload protection, crankcase heater and vibration isolators, centrifugal forward curve indoor fan with motor and drive, condensing propeller fans with direct drive motor, low temperature operation to 0° F, short cycling protection, freezestat.
- C. Provide factory installed pressure relief damper and enthalpy controlled economizer damper section on units as noted in the Roof Top Unit Schedule.
- D. Approved Manufacturers:
  - 1. Lennox, no substitutions

2.14 DOAS Unit:

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas furnace to be installed outside the building.
  - 1. CABINET
    - a. Cabinet: double-wall galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Cabinet shall be fully weatherized for outside installation.
    - b. Access Panels: Piano hinged with cam-lock fasteners for furnace and fan motor assemblies on both sides of unit.
    - c. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II, applied on complete unit.
    - d. Thickness: 2 inches with R13.
    - e. Insulation Adhesive: Comply with ASTM C 916, Type I.
    - f. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.
    - g. Finish: Heat-resistant, baked enamel.
    - h. Roof Curb: Full-perimeter curb of sheet metal, minimum 24 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
    - i. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
  - 2. SUPPLY-AIR FAN
    - a. Fan Type: Direct drive centrifugal, rated according to AMCA 204-96: statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball



- bearings, or pillow-block bearings rated for L50 or 200,000 hours with external grease fittings.
- b. Motor: Open dripproof, single-speed motor.
- c. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
- d. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric or spring isolators.
- 3. OUTDOOR-AIR INTAKE
  - a. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen complying with ASHRAE 62.1-2004, and finish to match cabinet; and sized to supply maximum 100 percent outdoor air.
- 4. AIR FILTERS
  - a. Comply with NFPA 90A.
  - b. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, washable metal mesh air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1. Mixed air filters shall be MERV-13.
  - c. Media: Interlaced glass or polyester fibers.
  - d. Frame: Galvanized steel.
- 5. DAMPERS
  - a. Outdoor-AirDamper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. of damper area, at differential pressure of 2-inch wg.
  - b. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.
- 6. Refrigeration System
  - a. Unit shall utilize a variable speed inverter duty scroll compressor. Refrigerant shall be factory charged with R410A refrigerant.
  - b. Compressor and blower assembly shall be mounted on rubber vibration isolators.
  - c. Unit shall have a crankcase heater.

## **2.15 TEMPERATURE CONTROL:**

- A. Contractor shall coordinate with TPS assigned controls contractor for a complete and operational control system based on TPS criteria.
- B. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect/Engineer.

## **PART 3 - EXECUTION**

**3.1 SURFACE CONDITIONS:**

- A. Examine the areas and Conditions under which Work of this Section will be performed. Correct Conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory Conditions are corrected.

**3.2 COORDINATION:**

- A. Coordinate as required with other trades to assure proper and adequate provision in the Work of those trades for interface with the Work of this Section.
- B. Slots, Chases, Openings, and Recesses: Through walls, ceilings, and roofs as specified in new structure will be provided by the various trades in their respective materials, but the trade requiring them shall see that they are properly located and shall do any cutting and patching caused by the neglect to do so. No cuts shall be made into any structural element, beam or column, without written approval. Opening in existing structures will be provided by the trade requiring same.
- C. Locations: Of pipes, ducts, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The contractor shall determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.
  - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
  - 2. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The contractor shall furnish and install all traps and sanitary vents, etc., as required to effect these offsets, transitions and changes in direction.

**3.3 PREPARATION:**

- A. Flashing:
  - 1. Where items of this Section penetrate the roof, outer walls or waterproofing of any kind, provide under this Section all base flashing and counterflashing required at such penetration.
  - 2. Provide on each pipe passing through the roof a 4 lb. seamless lead flashing and counterflashing assembly. Penetrations through sheet metal roofs shall be installed per roofing Manufacturer's recommendations.

**3.4 EQUIPMENT INTERFACE:**

- A. Provide all required shutoff valves, unions, and final connections of piping to the Work of this Section.

- B. For electrically operated equipment, verify the electrical characteristics actually available for the Work of this Section and provide equipment meeting those characteristics.

### **3.5 DUCTWORK INSTALLATION:**

- A. Rigidly support all interior ductwork using angle iron and galvanized threaded rods or galvanized strap hangers spaced to carry the load but not less than 5'-0" on centers and secured to the building structure in a method approved by the Architect. All hangers shall be installed truly vertical. Ductwork shall be hung level except where Architectural or structural Conditions dictate otherwise.
- B. Flexible ductwork shall not exceed 8'-0" runout total length from tapping to diffuser connection. Make smooth radius bends and secure duct at each end using a method of mechanical fastening with air tight seal. Support duct from resting on ceiling using strap hangers.
- C. Clean duct system of dirt and debris prior to operating any fan connected to the duct system. Cap all floor outlets and open ductwork during construction until final connections are made.
- D. Duct sizes shown on the Drawings are internal clear dimensions. The Contractor shall adjust for thickness of duct liner required.

### **3.6 DUCT HANGER AND SUPPORT INSTALLATION:**

- A. Duct hangers and supports to be secured to the building structure via a method approved by the Architect.
- B. Hanger Minimum Sizes:
  - 1. Up to 30" wide: 1" x 16 ga. at 5 feet spacing.
  - 2. 31" to 48" wide: 1-1/2" x 16 ga. at 5 feet spacing.
- C. Horizontal Duct on Wall Supports Minimum Sizes:
  - 1. Up to 18" wide: 1-1/2" x 16 ga. galvanized steel strap or 1" x 1" x 1/8" angles at 8 feet spacing.
  - 2. 19" to 40" wide: 1-1/2" x 1-1/2" x 1/8" angles at 4 feet spacing.

### **3.7 INSULATION:**

- A. Duct liner shall be adhered to interior sides of ductwork with minimum 50% coverage of fire retardant adhesive. Coat all exposed edges with adhesive. Use mechanical fasteners, (12-gauge impale anchor tabs or equal) maximum 16" on centers. Cut off excess fastener length and cover with brush coat of mastic. Liner shall be cut to fit and be without gaps at all joints. Just before sections of ductwork are hung, coat end butt joints of duct liner with adhesive and hang immediately.

- B. Ductwrap shall be firmly secured to ductwork with adhesive applied in 6" widths on 16" centers. Securely fasten insulation in place with 16-gauge annealed tie wire spirals wound 16" on center for straight duct runs and half hitched around duct on 4" centers for elbows and fittings OR tape longitudinal seams on straight duct runs with 2" tape. Butt insulation and seal joints and breaks with 2" tape or foil adhered to vapor barrier. Do not stretch or compress insulation excessively during application.
- C. Duct liner to be installed as noted and indicated on the drawings. All other duct installations to be externally insulated with ductwrap.
- D. All supply air, return and outside air ductwork and plenums shall be insulated. Exhaust air shall be insulated from point of intake to location of backdraft damper.

**3.8 DUCTWORK ACCESSORIES:**

- A. Install items in accordance with Manufacturer's instructions and accepted methods.

**3.9 AIR OUTLETS:**

- A. Install all grilles, registers, and diffusers and their accessories in accordance with Manufacturer's instructions and accepted methods.
- B. Paint interior of all ductwork visible behind air outlets matt black.
- C. Review requirements of outlet sizes, finish, mounting, and air patterns prior to installation. Coordinate location of outlets and make necessary adjustments to conform with Architectural features, symmetry, and light locations. Refer to grille, register and diffuser list for additional requirements.

**3.10 ROOF HOODS:**

- A. Set roof hoods on factory or field built curbs and connect to ductwork as shown on the Drawings. Flash, caulk, and seal weather tight per Manufacturer's instructions and Architectural details.

**3.11 VIBRATION ISOLATION:**

- A. Install vibration isolators in accordance with Manufacturer's instructions.

**3.12 FANS:**

- A. Install fans in accordance with Manufacturer's instructions and accepted methods.

- B. Set roof mounted fans on factory or field-built curbs and connect to ductwork as shown on the Drawings. Fans manufactured for sloped roofs to be flashed into roofing per Manufacturer's instructions. Flash, counterflash, caulk, and seal water tight per Manufacturer's instructions and Architectural details.
- C. Vibration isolation shall be included in all fan mounting methods as required in the "Vibration Isolation" Section of these Specifications above and as detailed on the Drawings.

**3.13 SPLIT SYSTEM HEAT PUMP:**

- A. Install in accordance with code requirements and Manufacturer's instruction, adhering to required clearances for operation and servicing. Division 23 Contractor to complete ductwork, refrigerant piping, mounting and condensate connections for a fully functional system. Division 26 Contractor to rough-in and make final connections of required electrical and control wiring.
- B. Refrigerant system to be tested and fully charged and complete for a fully functional system.

**3.14 REFRIGERANT PIPING:**

- A. Install refrigerant piping parallel and perpendicular to building structure. Route piping as directly between equipment as possible, using only the minimum number of bends required. Support and hang piping as described in Section 220400, Item 2.05 A and 3.06 C. Joints and fittings to be sweat with SIL-FOS or equivalent silver bearing solder.
- B. Test refrigerant system with Nitrogen at 300 psi.

**3.15 ROOF TOP UNITS:**

- A. Install in accordance with code requirements and Manufacturer's instructions adhering to required clearances for operation and servicing. Division 23 Contractor to complete ductwork, gas piping, and condensate connections for a fully functional system. Division 26 Contractor to rough-in and make final connections of required electrical and control wiring.
- B. Set roof mounted unit on factory curb or rails as noted on the Drawings. Flash, counterflash, caulk and seal weather tight per Manufacturer's instructions and Architectural details.
- C. Vibration isolation shall be included as specified above and detailed on the Drawings.

**3.16 TEMPERATURE CONTROL:**

- A. Division 26 Contractor shall furnish and install all control wiring. Coordinate and verify control requirements with unit Manufacturer and description of control shown on the Drawings. Locate thermostats as shown on the Drawings.

### **3.17 SEQUENCE OF OPERATION:**

A. PACKAGED ROOF TOP UNIT CONTROL SEQUENCES

1. Room thermostat with fan on/auto switch, heat/cool/auto/off switch, heating and cooling set points.
2. Local selection of fan operation and temperature active during occupied periods only. Unit operational control shall be through manufacturer provided, factory installed self contained control module.
3. Heat-Auto-Cool selection shall be capable at the face of the thermostat. Selection of fan on-auto shall be capable at the face of the thermostat. Thermostat operation shall be capable of being overridden by the building management system.
4. Smoke Detector shall shut unit "off", close outside air damper, and initiate alarm signal to building fire alarm system.
5. Fan Control: System starts fan to cycle during a call for heating or cooling.
6. Smoke Control: Smoke detector, located in return air, signals alarm, stops fan when products of combustion are detected in airstream. Provide fire-stat for furnaces with cfm capabilities less than 2000 cfm.
7. Upon a call for cooling, the unit shall initiate operation of the unit fan, condensing fans, and refrigerant compressor(s) to provide cooling. The unit controller shall sequence the unit operation and safeties.
8. Upon a call for heating, the unit shall initiate operation of the gas fired heater and unit fan to provide heating. The unit controller shall sequence the unit operation and safeties.
9. Outside Air Control:
10. When fan is running, open outside-air dampers to minimum position. Damper spring returns to closed position when fan is "off".

B. DOAS UNIT SEQUENCE

- C. Make-up Air Unit is initiated to energized from the kitchen hood control panel. Make-up air unit is interlocked to operate when kitchen hood exhaust fan is "ON". When kitchen hood exhaust fan is "off", make-up air unit shall be "off".

1. Make-up air unit fan is initiated and outside air intake damper driven open when unit is energized.
2. Supply air temperature is controlled through duct mounted adjustable temperature sensor to maintain supply air temperature through modulation of the furnace section gas valve.
3. Outdoor air intake temperature sensor shall lockout unit gas furnace operation when entering outside air is above sensor setpoint temperature. (Setpoint to be adjustable)
4. Upon shut down of kitchen hood, make-up air unit returns to "OFF", furnace section de-energizes, outside air damper closes.

**D. VENTILATION SEQUENCES**

1. Exhaust Fans: Refer to fan schedule on the drawings for description of fan controls.
  - a. Main toilet fans to be operated through the building management system scheduled control. Verify hours of occupancy with the Owner to establish schedule of operation.
  - b. Individual janitor closet and single toilet exhaust fans shall be individually operated as described in the fan schedule and will not be controlled through the BMS control system.
2. Kitchen Hoods Exhaust Fans:
  - a. Kitchen hood exhaust fans shall be controlled through the kitchen hood control panel to initiate when kitchen hood operation is initiated.
  - b. Kitchen hoods with associated DOAS units shall interlock with make-up air unit controls to initiate operation of make-up air unit when hood exhaust fan is started and shut down make-up air operation when hood exhaust fan is shut-off.

**3.18 TESTING AND ADJUSTING:**

- A. Test and adjust each piece of equipment and each system as required to assure proper air balance and operation.
  1. Test and regulate ventilation and air conditioning systems to conform to the air volumes shown on the design Drawings.
  2. Make tests and adjustments in apparatus and ducts for securing the proper volume and face distribution of air for each grille and ceiling outlet.
  3. Where required, provide pulleys for fans at no additional cost to the Owner, and set to drive the fan at the speed to give the indicated volume.
  4. For each system, take the following data in tabulated form:
    - a. Air volumes at all supply, return, and exhaust outlets
    - b. Total cfm supplied
    - c. Total cfm returned
    - d. Total outdoor air cfm supplied
    - e. Total cfm exhausted
- B. Submit two sets of test and balance reports to the Architect for approval.
- C. Eliminate noise and vibration, and assure proper function of all controls, maintenance of temperature, and operation in accordance with the approved design.

**3.19 INSTRUCTIONS:**

- A. Upon completion of this portion of the Work, and prior to its acceptance by the Owner, provide a qualified representative and fully instruct the Owner's maintenance personnel in the proper operation and maintenance of items provided under this Section.
- B. Demonstrate the contents of the approved operation and maintenance manual required in the "Submittals" Section of these Specifications.

**END OF SECTION**





T U L S A

PUBLIC SCHOOLS

***260400***  
***Electrical Systems***

## SECTION 260400 - ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION:

- A. Work Included: Provide Design, Engineering and Construction Documents incorporating the Owner's Guidelines and Specifications defined herein, with proper installation of materials, assemblies and equipment including, but not limited to:
  - 1. Basic Materials and Methods.
  - 2. Control-Voltage Electrical Power Cables
  - 3. Low-Voltage Electrical Power Conductors and Cables.
  - 4. Grounding and Bonding.
  - 5. Hangers and Supports.
  - 6. Raceways and Boxes.
  - 7. Sleeve-Seal Systems for Electrical Raceways
  - 8. Lighting Control Devices.
  - 9. Panelboards.
  - 10. Wiring Devices.
  - 11. Fuses.
  - 12. Enclosed Switches and Circuit Breakers.
  - 13. Enclosed Controllers.
  - 14. Interior and Exterior Lighting.
  - 15. Other items and services required to complete the systems.
- B. Drawings:
  - 1. These Design Guidelines and Specifications are accompanied by floor plans of the building showing the general location of the work. Exact locations shall be subject to the approval of the Owner who reserves the right to make any reasonable changes in locations indicated, prior to rough-in, without cost to the Owner. While the general run of feeders, branches, and conduits are indicated on the Drawings, it is not intended that the exact routing of circuits or locations of conduits be determined by Conceptual Drawings. Detailed arrangements of all Work shall be subject to the Owner's approval.
- C. Related Work:
  - 1. Documents affecting Work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- D. Temporary Power:
  - 1. Arrange, provide and pay for the costs of installing temporary power to the site in accordance with the requirements of Division 1.

## 1.2 QUALITY ASSURANCE:

- A. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.
- B. Codes and Ordinances:
  - 1. The installation shall comply with requirements of all applicable laws, codes and ordinances including those of the state, county and city.
  - 2. NFPA 70 - 2014.
  - 3. NFPA 72 – 2015 (including FM Directives)
  - 4. NFPA 101 – 2014.
  - 5. Where these Drawings, Design Guidelines and Specifications show more stringent requirements than required codes, the more stringent shall prevail.
  - 6. The Work shall comply with current standards of the serving utility companies.
- C. Permits, Fees and Licenses:
  - 1. The Contractor shall obtain and pay for all permits, fees and licenses, for Work required under these Specifications.
- D. Utility Company Fees:
  - 1. Coordination of existing utilities and easements including fees associated with the project shall be included in the Work.
- E. Without additional cost to the Owner, provide such other labor and materials as are required to complete the Work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.

## 1.3 EXAMINATION OF SITE:

- A. Visit the site, inspect the existing conditions and check the Drawings and Specifications to be fully informed of the requirements for completion of the Work.
- B. Lack of such examination shall not justify a request for extra compensation to the Contract price.

## 1.4 MATERIAL AND EQUIPMENT:

## 1.5 SUBMITTALS:

- A. SHOP DRAWINGS AND SUBMITTAL DATA
  - 1. Process shop drawings and submittal data to ensure that the proposed materials, equipment and devices conform to the requirements of the Contract Documents, and that there are no omissions or duplications. Provide layouts, fabrication information and data for systems, materials, equipment and devices proposed for the project.

- a. Shop drawings shall be drawn on a scale not less than ¼ inch equals 1 foot showing actual dimensions. Shop drawings shall include, but not be limited to:
    - 1) Switchboards
    - 2) Distribution Panelboards
2. Submittal data (manufacturer's catalog data) shall include Manufacturer's Specifications, product literature and other data needed to demonstrate compliance with the specified requirements, but not be limited to the following:
  - a. Equipment: Switchboards, Panelboards, Transformers, Disconnect Switches, Enclosed Controller, Circuit Breakers, Fuses, etc.
  - b. Materials: conduit, conductors, connectors, supports, etc.
  - c. Lighting Fixtures and Lamps.
  - d. Wiring Devices.
  - e. Lighting Control Devices – Sensors, Dimming, etc.
  - f. Low-Voltage Data outlet devices and Cabling systems.
  - g. Low-Voltage Clock and Intercom System – (Existing).
  - h. Security and Camera Systems – (Existing)
  - i. Addressable Fire Alarm System – (Existing).
3. Manufacturer's recommended installation procedure which, when approved by the Owner, will become the basis for accepting or rejecting actual installation procedures used on the work.
4. The submittal data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.
5. Do not submit detailed quantitative listings of materials, equipment and devices. It is the Contractor's responsibility to provide proper sizes and quantities to conform to Contract Documents.
6. Assemble submittals on related items procured from a single manufacturer in brochures or other suitable package form, rather than submitting a multiplicity of loose sheets.
7. The Contractor shall submit shop drawings whenever equipment proposed varies in physical size and arrangement from that indicated thus causing rearrangement of equipment space, where tight spaces require extreme coordination between this work and other work, where called for elsewhere in these Specifications and where specifically requested by the Owner. Shop drawings shall be prepared at a scale of not less than ¼ inch equals 1 foot.

#### B. SUBSTITUTIONS

1. Where a single manufacturer is mentioned by trade name or manufacturer's name, it has been done to establish a standard rather than to discriminate against an equal product made by another manufacturer.
2. Where multiple manufacturers are listed in the Owner's drawings and/or specification, none other than those manufacturers will be accepted.
3. Substitute manufacturers will be considered prior to bid only. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each subparagraph noted with the comment, "compliance", "deviation" or "alternate". In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

4. By noting the term "compliance" or "C", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
  5. By noting the term "deviation" or "D", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
  6. It shall be understood that space allocations have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not. If any item of equipment or device is offered in substitution which differs substantially in dimension or configuration from that indicated on the Drawings or specifications, provide as part of the submittal ¼ inch equals 1-foot scaled drawings showing that the substitute can be installed in the space available without interfering with other portions of the work or with access for operations and maintenance in the completed project.
  7. Where substitute equipment or devices requiring different arrangement or connections from that indicated is accepted by the Owner, install the equipment or devices to operate properly and in harmony with the intent of the Contract Documents, making all incidental changes in piping, ductwork or wiring resulting from the equipment or device selection without any additional cost to the Owner. The Contractor shall pay all additional costs incurred by other portions of the work in connection with the substituted equipment or device.
  8. The Owner reserves the right to call for samples of any item of material, equipment or device offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.
  9. When any request for a substitution of material, equipment or device is submitted and rejected, the item named in the Contract Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.
- C. Samples:
1. When requested by the Owner, promptly provide samples of items scheduled to be exposed in the final structure.
  2. When specifically, so requested by the Contractor and approved by the Owner, approved samples will be returned to the Contractor for installation on the Work.
- D. Record Drawings:
1. Comply with pertinent provisions of Division 1.
  2. Include a copy of the Record Drawings in each copy of the operation and maintenance manual described below.
- E. Manual:
1. Upon completion of this portion of the Work, and as a Condition of its acceptance, deliver the operation and maintenance manual to the Owner complied in accordance with the provisions of Division 1 of these specifications. Include within each manual.
    - a. Copy of the approved Record Documents for this portion of the Work.
    - b. Copy of each circuit directories.
    - c. Copy of each warranty and guaranty.

1.6 GUARANTEE:

- A. The Contractor guarantees all Work against any defects due to faulty workmanship or material and that all raceways, ducts and piping are free from foreign material, obstructions, holes or breaks of any nature.
- B. Upon written notice from the Owner or Owner, the Contractor shall promptly remedy without cost to the Owner any defects occurring within a period of one (1) year from the date of final acceptance.

1.7 WARRANTY:

- A. The Contractor shall properly execute in the Owner's name all Manufacturers' standard warranty certificates applying to equipment installed on the project and shall deliver said certificates to the Owner at completion of the job. All warranty cards shall also be properly executed and delivered to the supplier or Manufacturer's representative for Manufacturer's records. Standard warranties for equipment shall be not less than one (1) year.

PART 2 - PRODUCTS

2.1 BASIC ELECTRICAL MATERIALS AND METHODS:

- A. Provide only materials that are new and of the type and quality specified. Where Underwriter's Laboratories, Inc. have established standards for such materials, provide only materials bearing the UL label.
- B. Materials and equipment shall be new, of the same type and manufacturer, of the best quality and design, free from defects and meet the requirements of UL and NFPA where standards are established for those items and assemblies.
- C. Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.
- D. Manufacturer's name and model number used herein and, on the Drawings, establish type and quality required. Equal products may be considered if submitted in writing to the Owner's Representative for approval 10 (ten) days prior to bid date. The Contractor shall be responsible for assuring the items and equipment substituted for those shown on the Drawings will physically fit in the space allocated.
- E. Fire stopping material shall be 3M Fire Seal Caulking, or approved substitution.
- F. Terminals and enclosures shall be marked for 75° C operation or conductor size shall be increased as required at no cost to the Owner.
- G. Steel Pipe Wall Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends. Comply with NECA 1.

- H. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work and roof manufacturer's requirements.
- I. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.
- J. Provide sleeves and chases where conduits pass through rated floors and walls, fire stopped in accordance with UL Listed assembly.
- K. When boring, cutting or drilling structural wood or wall members, drill only in locations as approved by the Owner.
- L. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- M. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- N. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.
- O. Service voltage and color codes for 480Y/277V: Phase A - Brown, Phase B - Orange, Phase C - Yellow, Neutral - White, and Ground - Green.
- P. Service voltage and color codes for 208/120V: Phase A - Black, Phase B - Red, Phase C - Blue, Neutral - White, and Ground - Green.

## 2.2 CONTROL-VOLTAGE ELECTRICAL POWER CABLES

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits, Classes 1, 2, and 3 control cables.
- B. Related Requirements:
  - 1. Section 270528 "Pathways for Communications Systems" for cabling used for voice and data circuits.
- C. Performance Requirements:
  - 1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- D. RS-485 Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  2. Fluorinated ethylene propylene insulation.
  3. Unshielded.
  4. Fluorinated ethylene propylene jacket.
  5. Flame Resistance: Comply with NFPA 262.
- E. Low-Voltage Plenum-Rated, Paired Control Cable: NFPA 70, Type CMP.
1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with NFPA 262.
- F. Control-Circuit Conductors
1. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
  2. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
  3. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
  4. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
    - a. Smoke control signaling and control circuits.
    - b. Life Safety control systems listed in NFPA 72.
- G. Cable will be considered defective if it does not pass tests and inspections.

## 2.3 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

- A. Related Requirements:
1. Section 260400 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
  2. Section 270400 "Communications Horizontal Cabling" for cabling used for voice and data circuits.
- B. Copper Building Wire: Flexible, insulated and uninsulated, drawn copper current-carrying conductor complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors with an overall insulation layer or jacket, or both, rated 600 V or less.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Southwire Company or comparable product by one of the following:
1. Alpha Wire Company.



2. Cerro Wire LLC.
  3. Encore Wire Corporation.
  4. General Cable Technologies Corporation.
  5. Southwire Company.
- D. Service Entrance Conductors:
1. For line voltages, provide 600 V THHN insulated copper wire with UL Label, listing, and color coded for voltage.
- E. Conductors:
1. For line voltages, provide 600 V insulated copper wire and cable, with UL Label, listing, and color coded for voltage.
  2. Use type THHN/THWN color coded for voltage at interior, type THHN/THWN-2 for exterior.
  3. For wire No. 10 and smaller, provide solid wire: for wire larger than No. 10, provide stranded wire.
  4. Conductors No. 8 and larger, provide insulating bushings or insulating sleeves.
  5. Use only copper wires and cables.
- F. No. 12 AWG THHN conductors and larger for all branch circuits, protected by 20-amp circuit breakers. Where so indicated on the Drawings, by actual load, or by the N.E.C., use larger wires to limit voltage drops:
1. Increase wire sizes to next largest AWG size for:
    - a. 120-volt circuits exceeding 150 feet in circuit length.
    - b. 208-volt circuits exceeding 200 feet in circuit length.
  2. Wire and conduit sizes shall be increased for the above conditions whether shown on the Drawings or not.
- G. Use identified (white) neutrals and colored-coded phase wires for all branch circuit wiring.
- H. Make splices electrically and mechanically secure with pressure-type. Push-in connectors shall not be allowed.
1. For wires size 10 AWG and smaller, provide NSI twist-on connectors.
  2. For wires size 8 AWG and larger, provide NSI Polaris insulated connectors.
- I. Tape all joints with rubber tape 1-1/2 times the thickness of the conductor insulation, then cover with the friction tape or the vinyl-plastic electrical tape specified above.
- 2.4 GROUNDING AND BONDING ELECTRICAL SYSTEMS:
- A. Submittals:
1. Product Data: For each type of product.
  2. Product Schedule: Indicate type, use, location, and termination locations.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Burndy; Part of Hubbell Electrical Systems.

2. ERICO International Corporation.
  3. TE Connectivity Ltd.
  4. ILSCO.
  5. O-Z/Gedney; a brand of Emerson Industrial Automation.
- C. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- D. Bare Copper Conductors:
1. Stranded Conductors: ASTM B 8.
  2. Tinned Conductors: ASTM B 33.
  3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- E. Grounding Bus: Pre drilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, 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.
- F. Connectors: Listed and labeled by an NRTL as complying with NFPA 70, acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 467.
1. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
  2. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  3. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
  4. Cable-to-Cable Connectors: Compression type, copper or electroplated tinned copper, C and H shaped.
  5. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
  6. Conduit Hubs: Mechanical type, terminal with threaded hub.
  7. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
  8. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
  9. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
  10. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.
  11. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
  12. Water Pipe Clamps: Tin-plated aluminum or Silicon Bronze. Mechanical type, two pieces with zinc-plated bolts.

## 2.5 HANGERS AND SUPPORTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Material: Pre-galvanized steel.
  - 2. Channel Width: 1-5/8 inches.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. B-line, an Eaton business.
    - b. Empire Tool and Manufacturing Co., Inc.
    - c. Hilti, Inc.
    - d. MKT Fastening, LLC.
  - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Toggle Bolts: All-steel springhead type.
  - 5. Hanger Rods: Threaded steel.
- F. Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- G. 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. Wire-ties and zip-ties shall not be an acceptable means of support to structure(s).
- H. 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 in diameter.
- I. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

- J. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  6. To Light Steel: Sheet metal screws.
  7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- K. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- L. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

## 2.6 RACEWAYS AND BOXES

- A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
- B. Raceways and Fittings:
1. Steel Electrical Intermediate Metal Conduit (IMC) - UL 1242 and UL Category Control Number DYBY: Exterior - Zinc coated; Interior - Zinc with organic top coated. Fittings: Steel, compression coupling.
  2. Steel Electrical Metal Tubing (EMT) and Elbows: UL 797 and UL Category Control Number FJMX: Exterior - Zinc coated; Interior - Zinc with organic top coated. Fittings: Steel, compression coupling.
  3. Aluminum Electrical Metal Tubing (EMT) and Elbows: UL 797A and UL Category Control Number FJMX: Exterior - Zinc coated; Interior - Zinc with organic top coated. Fittings: Steel, compression coupling.
  4. Flexible Metal Conduit (FMC): Steel. UL 1 and UL Category Control Number DXUZ. Fitting: UL 514B and UL Category Control Number ILNR.
  5. Liquidtight Flexible Metal Conduit (LFMC): Steel. UL 360 and UL Category Control Number DXHR. UL 514B and UL Category Control Number DXAS.
  6. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings: UL 651 and UL Category Control Number DZYR. For use with maximum 90 deg C wire.
  7. Minimum raceway size: 3/4" raceway for power circuits and 1" raceways for low-voltage communication cable raceways.

- C. Surface mounted raceways: Wiremold or Owner approved equal, steel 500 or 700 Series with matching surface mount box and mounting accessories. Color as directed by Owner. EMT conduit is not an allowable method for surface raceways. Submit to Owner prior to installation.
- D. Surface mounted raceways on existing walls: 3/4" EMT maximum. Provide 1/2" EMT raceways for thermostat, HVAC sensors and control circuits anchored to wall system by approved method.
- E. Boxes, Enclosures and Cabinets:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crouse-Hinds, an Eaton business.
    - b. Hubbell Incorporated.
    - c. RACO; Hubbell.
    - d. Thomas & Betts Corporation; A Member of the ABB Group.
    - e. Wiremold / Legrand.
  - 2. General Requirements for Boxes, Enclosures, and Cabinets: Comply with NFPA 70 for intended location and use. UL 514A and UL CCN QCIT.
  - 3. Wireways and Auxiliary Gutters:
    - a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Manufacturer's standard enamel finish.
    - b. Wireway Covers: Hinged, Screw-cover and Flanged-gasketed as indicated in drawings.
  - 4. Metallic Outlet, Device Boxes, Rings, Covers and Conduit Bodies:
    - a. Description: 4" square outlet box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
    - b. Material: Sheet steel and Cast metal.
    - c. Sheet Metal Depth: 2-1/8" deep minimum to accommodate 1" knockout.
    - d. Cast-Metal Depth: 2.4 inch deep.
    - e. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing 50 lb.
    - f. Paddle Fan and Large Luminaire Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.
    - g. Conduit Bodies: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point.
  - 5. Metallic Floor Boxes and Floor Box Covers: RFB4 series with (4) independent compartments, stamped steel, and shallow steel for concrete 2 7/16" depths accepting 3/4" and 1" conduit.
    - a. Coverplates shall be scrub-proof with carpet in-lay and easy open handle. Activate all compartments with specified and approved wiring devices.
  - 6. Nonmetallic Outlet, Conduit Bodies and Device Boxes: UL 514C and UL CCN QCMZ.
- F. Termination Boxes: UL 1773 and UL Category Control Number XCKT.

1. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
  2. Listed and labeled for installation on line or load side of service equipment.
- G. Cabinets, Cutout Boxes, Junction Boxes and Pull Boxes: UL 50 and 50E.
1. Sheet Metal Cabinets:
    - a. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung. UL Category Control Number CYIV.
  2. Sheet Metal Cutout Boxes:
    - a. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
  3. Sheet Metal, Cast-Metal, and Polymeric Junction and Pull Boxes:
    - a. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable. UL Category Control Number BGUZ.
- H. Cover Plates for Devices Boxes: UL 514D and UL Category Control Numbers QCIT and QCMZ.
1. Wallplate-Securing Screws: Metal with head color to match wallplate finish.
  2. Cover Plates for Device Boxes:
    - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
    - b. Metallic Wallplate Material: 0.032-inch-thick Type 302/304 non-magnetic stainless steel with brushed finish. Coordinate with Owner.
    - c. Nonmetallic Wallplate Material: 0.060 inch thick high-impact thermoplastic (nylon) with smooth finish and color matching wiring device.
    - d. Color: As indicated on architectural drawings or selected by Owner/Architect.
  3. Hoods for Outlet Boxes:
    - a. Reference Standards:
      - 1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
      - 2) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
    - b. Mounts to box using fasteners different from wiring device.
  4. provide galvanized code-gauge sheet steel units with screwed-on covers, of size and shape required to accommodate wires without crowding, and to suit the location. Mark with permanent ink circuit designations on cover plate. If box is to be painted provide permanent ink marking on inside of box cover.
  5. For exterior pull boxes, provide fiberglass quazite box with sealed lid identified "ELECTRICAL" at size required to accommodate wires at 40% fill.
  6. Provide sleeves and chases where conduits pass through floors and walls, fire-stopped in accordance with NEC Article 300.21.
  7. For switches and receptacles, provide standard ganged switch boxes with plastic or stainless-steel covers as required by Architect; except for exposed Work, provide pressed steel boxes with galvanized or cadmium plated steel covers.
    - a. For telephone/communication outlets, provide 4" square boxes with single device cover. Route conduit to accessible ceiling cavity with end bushings and nylon pullstring.

- I. Junction boxes may not be installed back-to-back in walls and partitions. Consult with Owner for proper separation of boxes (typically, 12" in non-rated walls, 24" in rated walls).
- J. Securely and rigidly support boxes to super structure throughout the Work.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armorcast Products Company.
    - b. NewBasis.
    - c. Oldcastle Enclosure Solutions.
    - d. Quazite: Hubbell Power Systems, Inc.
  - 2. Standard: Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: Molded lettering, "ELECTRIC."
- C. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

## 2.8 SLEEVE-SEAL SYSTEMS FOR ELECTRICAL RACEWAYS

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
- b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

D. SLEEVE-SEAL SYSTEMS

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Advance Products & Systems, Inc.
  - b. CALPICO, Inc.
  - c. Metraflex Company (The).
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

E. SLEEVE-SEAL FITTINGS

1. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - 1) HOLDRITE.
    - 2) Presealed Systems.

F. GROUT

1. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000-psi, 28-day compressive strength.

G. SILICONE SEALANTS

1. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. A Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.9 LIGHTING CONTROL DEVICES:

A. Occupancy Sensors and Presence Detection:

1. Ceiling mounted in Classrooms: STEINEL: 64470 IR QUATTRO HD COM2-24.
2. Ceiling mounted in Corridors: STEINEL: 64560 US HALLWAY COM2-24.
3. Ceiling mounted in Restrooms: STEINEL: 64700 DT QUATTRO COM1-24.



4. Manufacturer part numbers change and must be verified prior to work.
- B. Wall Dimmers/Occupancy/Vacancy Sensors:
  1. LEVITON: DS710-10Z, Locations may vary, final by Owner.
- C. Photocells: Integral with egress exterior fixtures.
- D. Provide and install time clocks for automatic operation of lighting and equipment loads in accordance with the Time Clock Schedule shown on the Drawings, and as follows:
  1. Equipment Control:
    - a. Tork W-220-L, SPST, reserve power, 40 AMP contacts, NEMA 1 surface mounted enclosure.
    - b. Lighting Control:
      - 1) Tork 7200ZL, DPST, reserve power, 40 AMP contacts, astronomic dial, NEMA 1 surface mounted enclosure.
    - c. Photocell:
      - 1) Tork 2101, SPST, 2000 Watt rating, 120 Volt.

#### PANELBOARDS:

- A. Panelboards and Retrofit Panelboards: Comply with NEMA PB 1 and NFPA 70.
- B. Eaton - Cutler-Hammer Type "Pow-R-Line" or approved equal. Commercial Grade.
- C. Retrofit panelboards shall be Cutler-Hammer Pow-R-Line or equal. Commercial.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets as indicated in drawings.
  1. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R:
  3. Wash-Down Areas: NEMA 250, Type 4X S.S.
  4. Kitchen Areas: NEMA 250, Type 1 with seal for Stainless Steel front cover.
  5. Cabinets, flush or surface mounted as indicated. Top and/or Bottom Entry.
  6. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  7. Gutters: Same gage and finish of panel enclosure; integral with body.
  8. Directory Card: Inside panelboard door, mounted in metal frame with transparent cover.
  9. Doors shall be as required, accurately fitted with catch-lock and two (2) keys. All front keys alike.
- F. Panel boards shall be rated for the voltage, 3 phase, 4 wire, solid neutral, UL 489 and rated 250 or 600 volts.
- G. Incoming Mains Location: Convertible between top and bottom and terminate in cable lugs or main circuit breaker.

- H. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Phase, Neutral and Ground Bus shall be hard drawn copper of 98 percent conductivity.
  - 2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
  - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device where indicated on drawings.
  - 5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device where indicated on drawings.
- I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
- K. Surge Suppression: Comply with UL 1449 SPD for the following Types indicated on drawings and specified in "Surge Protection for Electrical Power Circuits":
  - 1. Type 1 for service equipment where the device is ahead of the service disconnect. Factory installed as an integral part of panelboard in segregated compartment.
  - 2. Type 2 for panelboards on the load side of the service disconnect. Provide SPD mounted in rated enclosure, exterior of panelboard.
- L. DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES (OCPDs):
- M. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  - 4. GFCI Circuit Breakers: Single- thru three-pole configurations with Class A ground-fault protection (6-mA trip).
  - 5. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

- e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in “on” or “off” position.
  - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in “on” or “off” position.
- N. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- O. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder. Provide name and phone number of installing company.
- P. Provision for Future Devices: Equipment with mounting brackets, bus connections, and necessary appurtenances for the OCPD ampere ratings indicated for future installation of devices.
- Q. Tandem and mini-circuit breakers shall NOT be used. Multipole breakers shall have common trip.
- 2.11 WIRING DEVICES:
- A. UL Listed and labeled as defined in NFPA 70.
- B. Color of wiring devices shall match existing facility devices or per Owner's requirements. Color of isolated ground receptacles to be orange. Coordinate with Architect/Owner for final color of all devices.
- C. Duplex Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- D. Industrial Heavy Duty, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement SD, and FS W-C-596.
- E. Twist-Locking Receptacles: Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration Heavy-duty, NEMA 5-20R, and UL 498.
- F. GFCI Receptacles: 125 V, 20 A, straight blade, 20 A feed-through type. Comply with NEMA WD 1, Heavy-duty NEMA 5-20R, UL CCN KCXX, UL 498, UL 943 Class A, and FS W-C-596.
- 1. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
  - 2. Self-testing technology with indicators including disconnecting power if damaged.
  - 3. Receptacles shall be side wired feed-thru, Hubbell No. GFST20 or equal.
- G. Tamper-Resistant Duplex Straight-Blade Receptacle: 125 V, 20 A: Comply with NFPA 70, Heavy-duty NEMA 5-20R, UL CCN RTRT and UL 498, and FS W-C-596.

- H. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment: 125 V, 20 A: Comply with NFPA 70, Heavy-duty NEMA 5-20R, UL CCN RTRT and UL 498, and FS W-C-596.
- I. Duplex Straight-Blade Receptacle with Type 3 Surge Protective Device: 125 V, 20 A: Comply with color BLUE per NEMA WD 1, heavy-duty. Configuration NEMA 5-20R, UL 498, and FS W-C-596.
- J. Toggle Switches: Comply with NEMA WD 1, UL 20, and FS W-S-896. Commercial-industrial type, 20 amp, 120/277 V AC, from the following:
  - 1. Single Pole:
    - a. Cooper; AH1221.
    - b. Hubbell; HBL1221.
    - c. Leviton; 1221-2.
    - d. Pass & Seymour; CSB20AC1.
  - 2. Two Pole:
    - a. Cooper; AH1222.
    - b. Hubbell; HBL1222.
    - c. Leviton; 1222-2.
    - d. Pass & Seymour; CSB20AC2.
  - 3. Three Way:
    - a. Cooper; AH1223.
    - b. Hubbell; HBL1223.
    - c. Leviton; 1223-2.
    - d. Pass & Seymour; CSB20AC3.
  - 4. Four Way:
    - a. Cooper; AH1224.
    - b. Hubbell; HBL1224.
    - c. Leviton; 1224-2.
    - d. Pass & Seymour; CSB20AC4.
- K. Cover plates for flush mounted receptacles and switches:
  - 1. Mechanical, utility, kitchen and Exterior: provide 0.040" stainless steel cover plates in all areas and all devices.
  - 2. Office and classroom areas: Provide 0.040" stainless steel cover plates. Plastic cover plates matching the wiring devices specified for millwork.
  - 3. Where wiring devices are grouped, set in gangs with one cover plate.
  - 4. Where wiring devices are noted to be weatherproof, provide cast cover, gasketed & hinged, while-in-use rated and lockable cover.
  - 5. Use jumbo size plates, 302 stainless steel for outlets installed in masonry walls or as specified by Owner and existing facility standard installation.
- L. Manual motor starter: Square D "Class 2510" for 120V, 1ph motors.

## 2.12 FUSES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Bussmann, an Eaton business.

2. Edison; a brand of Bussmann by Eaton.
3. Littelfuse, Inc

**B. CARTRIDGE FUSES**

1. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - a. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  - b. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  - c. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting, time delay.
  - d. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NEMA FU 1 for cartridge fuses.
4. Comply with NFPA 70.
5. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**2.13 ENCLOSED SWITCHES AND CIRCUIT BREAKERS:**

- A. Provide safety and fused switches, horsepower rated, quick-make and quick-break design, externally operated with provision for padlocking in "OFF" position, fusible or non-fusible as shown on the Drawings. Cartridge to accommodate Class R fuses.
- B. Provide enclosures clearly marked for maximum voltage, current, and horsepower rating, and:
  1. Indoor: General Duty, NEMA Type 1
  2. Outdoor: Heavy Duty, NEMA Type 3R, Rain-tight
  3. Kitchen Wash-down areas: Heavy Duty, NEMA Type 4x
- C. For switches having dual ratings (higher rating when used with dual-element fuses), provide ratings indicated on a metal plate riveted or otherwise, or permanently fastened to the enclosure.
- D. For switches serving equipment with multiple motors, switches shall be fused as indicated on the equipment nameplate.

**2.14 ENCLOSED CONTROLLERS:**

- A. General: Provide Cutler-Hammer or equal, of the sizes and types needed for the operations shown on the Drawings, specified herein, and otherwise required for the facility and with the following attributes:
  1. Comply with pertinent requirements of NEMA and NEC.
  2. Include required accessory items.
  3. Lockable handle to "OFF" position for combination starters.
  4. Horsepower rated, with interchangeable thermal overloads and with double-break contacts capable of interrupting 10 times the rated motor current.
  5. Normally reset without entering the starter enclosure.

6. Equipped with overloads in each ungrounded leg.
  7. Equipped with integral phase loss protection.
  8. In finished areas where conduit is concealed, switches shall be flush mounted.
- B. Manual Starters:
1. For both single-phase and three-phase starters, provide units that open all ungrounded conductors simultaneously.
  2. For single-phase starters, provide units of tumbler switch type that clearly indicate ON, OFF, and TRIPPED positions. Switches shall have built-in thermal overload protection for reach ungrounded conductor. Switches shall be Square D class 2510 or equal.
  3. For three-phase starters, provide pushbutton operated units with START-STOP-RESET button on the enclosure cover. Provide handle guards for padlocking in the "OFF" position.
- C. Magnetic Starters:
1. Provide units with operating coils designed to operate on line voltage or any other auxiliary voltage shown on the Drawings.
  2. For starters with line voltage operating coils, provide built-in under-voltage release.
  3. Provide units with the accessories and auxiliary contacts needed for automatic or remote operation as shown on the Drawings.
- D. Combination Starters:
1. Provide units complying with requirements for magnetic starters and, in addition, with a fused switch on the same enclosure.
  2. Provide circuit protection to comply with NEC requirements for the motor being operated.
- E. Lock-out/Tag-out Requirements: Per Owners requirements.

## 2.15 SURGE PROTECTION FOR ELECTRICAL POWER CIRCUITS

- A. General SPD Requirements:
1. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with NFPA 70.
  3. Comply with UL 1449.
  4. MCOV of the SPD shall be the nominal system voltage.
- B. SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR
1. Type 1 for service equipment where the device is ahead of the service disconnect.
  2. Integral disconnect switch.
  3. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  4. Indicator light display for protection status.
  5. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure

of any surge diversion module or on opening of any current-limiting device.  
Coordinate with building power monitoring and control system.

6. Surge counter.

C. PANELBOARD SUPPRESSORS

1. Type 2 for panelboards on the load side of the service disconnect.
2. Include LED indicator lights for power and protection status.
3. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

A. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

B. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

C. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 208Y/120 V.
3. Line to Line: 1000 V for 208Y/120 V.

D. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

E. SCCR: Equal or exceed 200 kA.

F. Inominal Rating: 20 kA.

G. ENCLOSURES

1. Indoor Enclosures: NEMA 250, Type 1.
2. Outdoor Enclosures: NEMA 250, Type 3R.

2.16 INTERIOR AND EXTERIOR LIGHTING FIXTURES:

A. LED TROFFER - MANUFACTURERS

1. Pre-Approved Manufacturers Listed: Products of firms regularly engaged in the manufacture of recessed LED lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. The manufacturer of the lighting fixtures shall comply with the provisions of the appropriate code and standards. All fixtures shall be pretested before shipping.

Provisions for a single fixture shipped to the project site shall become property of the Owner to test and evaluate the construction meets or exceeds the original fixture approved by the Owner and listed in the fixture schedule.

2. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.
3. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State, and local codes and regulations.
4. UL or CSA US Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL 8750 or others as they may be applicable. A listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.
5. Luminaire Flat Panel Edge Lit shall be DLC Premium Certified (Design Lights Consortium).
6. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
7. Base Bid Manufacturers: Are listed on fixture schedule and specification. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards and photometric distribution set by the specified product.
8. Alternate Manufacturers: Identification by means of manufacturers names and catalog numbers is to establish basic features, quality and performance standards. Any substitutions must meet or exceed these standards. The three listed manufacturers are pre-approved Owner's standard fixtures and substitution request may not be allowed prior to bid.

**B. LED LUMINAIRE SOURCE REQUIREMENTS**

1. LED's shall be manufactured by, Nichia, Cree, Samsung or Osram.
2. Lumen Output – minimum initial lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-90-degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.
3. Type 2x4: 40 Watt, Efficacy (lm/W) >123 @ 5000K for ceilings up to 10'-0".
4. Type 2x4: 48 Watt, Efficacy (lm/W) >124 @ 5000K for ceilings 10'-1" to 12'-0".
5. Type 2x2: 30 Watt, Efficacy (lm/W) >121 @ 5000K for ceilings up to 10'-0".
6. Type 2x2: 40 Watt, Efficacy (lm/W) >119 @ 5000K for ceilings 10'-1" to 12'-0".
7. 4-Ft Strip: 45 Watt, Efficacy (lm/W) >128 @ 5000K.
8. Recessed Fixtures: Comply with NEMA LE 4.
9. Retain CRI and CCT in first subparagraph below for projects that require the same CRI and CCT values across all product types. If different product types require different CRI or CCT values, remove CRI and CCT values from this article and insert under each product type used in the Project. Note that each product type may have a different minimum CRI or CCT requirement.
10. Rated lamp life of 50,000 hours. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours.
11. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.



12. LED Boards shall be suitable for field maintenance or replacement with plug-in connectors at power supply/drive.
13. Light Color/Quality:
14. Correlated Color temperature (CCT) range as per specification, luminaire sources and 5000K shall be correlated to chromaticity as defined by the absolute (X, Y) coordinates on the 2- D CIE chromaticity chart.
15. The color rendition index (CRI) shall be 82 or greater.
16. Chromaticity shift over 6,000 hours shall be <0.007 change in delta-u'v' average as demonstrated data set in IESNA LM-80-08 report.
17. Lumen Maintenance Factor: >0.84 at 25°C, 50,000 hours and reported in TM-21 L70 Lifetime >60,000 hours.
18. Binning: Per ANSI, 3-step MacAdam ellipse with abilities to produce uniform color across copious quantities of fixtures.

C. LED LUMINAIRE POWER SUPPLY AND DRIVE REQUIREMENTS

1. Driver: Instant start. 120 – 277 Volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 85% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
2. Flat Panel Edge-lit LED: The electronics/power supply enclosure shall be external to the SSL luminaire and be accessible per UL requirements.
3. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output with a smooth shut off function. Dimming shall be controlled by a 0-10V signal. Signal wires shall be 22 AWG solid copper minimum.
4. Compatible with Leviton dimming device(s): DS710-10Z or equal.
5. Electrical Characteristics:
6. Power Factor: >0.93.
7. Input Power: 120-277V, 50/60 Hz.
8. Total Harmonic Distortion (THD): <20%.
9. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.
10. Material Usage: Drivers shall be (ROHS)-compliant.
11. Warranty: Five (5) years.

D. LED FLAT PANEL CONSTRUCTION

1. Frame: LED strips mounted on edges enclosed in solid extruded aluminum frame, painted after formed with UV-stabilized acrylic optical lens with a full aluminum back. Construction seals conditioned air from the plenum or non-conditioned air. Housing shall be designed rigid to eliminate warping or bending for level installation. Frame corners conformed for seamless appearance.
2. Optical Lens/Diffusers:
3. Retain "Acrylic" Subparagraph below if acrylic options in "Diffusers and Globes" Paragraph above are retained.
4. Acrylic: One hundred percent virgin UV-stabilized acrylic (PMMA) optical panel, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

5. Retain "Glass" Subparagraph below if glass options in "Diffusers and Globes" Paragraph above are retained.
6. Retain "Lens Thickness" Subparagraph below for all diffuser and globe types.
7. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
8. Each luminaire shall be designed to operate at an average operating temperature - 4°F to 104°F.
9. Humidity: 20% – 85% RH, Lighting Facts.
10. Luminaire housing to have no visible welding, screws, springs, hooks, rivets, bare LED's or plastic supports in viewing angles at floor to ceiling placement.
11. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply and circuit board for the luminaire shall be fundamental to the unit.
12. Driver disconnect shall be provided where required to comply with codes.
13. Finish: Polyester white powder coat painted with 92% high-reflective paint after fabrication.
14. Integral Grid Clips required on recessed mounted luminaires along with integral tie wire mounting points. Compatible with standard 15/16" and 9/16" T-Bar ceilings.
15. Luminaire to have air removal capability where specified.
16. Any questions shall be directed to Randy Ramsey in the Bond office of TPS. Office: 918-746-6131 or E-mail: ramsera@tulsaschools.org
17. NOTE: As new technologies become available this specification will be changed. Do not assume you have the latest spec, ask for the most recent revised specification from Tulsa Public Schools bond office.

E. RECESSED LED DOWNLIGHTS

1. An approved manufacturer same as LED troffers or equal. 4000K minimum.
2. Housing finish to be white unless otherwise specified
3. Must be able to accept an actual lensed R-30 LED, with Edison medium base.

F. LED HIGH-BAY

1. Housing: Low copper, corrosion resistant, die cast aluminum.
2. Optics/Lens: High transmittance opaque glass lens sealed (IP66) with silicone gasket. Narrow, medium and wide distribution types. Optically opaque plastic lens factory installed to diffuse source intensity.
3. LED Source: High power LED source, with performance of 135 lumens per Watt.
4. LED source color: 3000K-5000K, CRI >80.
5. LED Drivers: UL/CSA recognized component to meet UL8750 & EN61347.
6. Light beam spread: 120° wide beam.
7. Finish: High-gloss black powder coated heat-radiative coating, anti-corrosion, anti-UV paint.
8. Mounting: Beam clamp, ceiling, hook and stem mount availability.
9. Input Power: 120-277V, 50/60 Hz.
10. Total Harmonic Distortion (THD): <20%.
11. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 10% of rated lumen output with a smooth shut off function. Dimming shall be controlled by a 0-10V signal. Signal wires shall be 22 AWG solid copper minimum. Compatible with Leviton dimming device(s): DS710-10Z or equal.

12. Operating Temperature: -30°C to +55°C ambient.
13. Material Usage: Drivers shall be (ROHS)-compliant.
14. Warranty: Five (5) years.

G. EXIT SIGNS:

1. Comply with LM80 and with authorities having jurisdiction for sign colors and lettering size, and with be LED illuminated
2. Internally Lighted Signs: As follows:
3. Lamps for AC Operations: Light-emitting diodes, 50,000 hours minimum rated lamp life
4. Self-Powered Exit Signs (Battery Type)” Integral automatic charger in a self-contained power pack.
5. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty
6. Charger: Fully automatic, solid-state type with sealed transfer relay.
7. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.

H. EMERGENCY LIGHTING UNITS:

1. Self-contained units Comply with UL 924/LM 80. Units include the following features:
  - a. Battery: Sealed, maintenance-free nickel - cadmium type with minimum 10-year nominal life and special warranty.
  - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - c. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level when normal voltage is restored, relay disconnects lamps and batter is automatically recharged and floated on charger.

I. EMERGENCY LED POWER SUPPLY UNIT:

1. Self-contained, modular, battery-inverter unit factory mounted within fixture body-comply with UL 924/LM 80.
2. Test Switch and light-emitting diode indicate light: Visible and accessible without opening fixture or entering ceiling space.
3. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum 10-year nominal life.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamp, and battery is automatically recharged and floated on charger.
6. Do not support from sub-purlins of panelized roof systems.

## PART 3 - EXECUTION

### 3.1 ELECTRICAL SITE COORDINATION AND PREPARATION

- A. Examine the areas and the Conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of this work. Do not proceed until unsatisfactory conditions are corrected.
- B. Coordinate with local utility company temporary and permanent power requirements for the project. Provide a request for all utilities to be located and marked at project site prior to the start of Work. Prepare site easements for saw-cutting, trenching and backfill. Coordinate power outages with Owner and utility company 10-days prior to outage.
- C. Coordination with Division Trades:
  - 1. Coordinate as necessary with other trades to assure proper and adequate provision in this Work of those trades for interface with the Work of this Section.
  - 2. Coordinate the installation of electrical items with the schedule for Work of other trades to prevent unnecessary delays in the total Work.
  - 3. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, provide required supports and wiring to clear the encroachment.
  - 4. Provide 110-volt temperature control, control transformers in enclosures and interlock wiring. Coordinate all requirements with mechanical contractor prior to rough-in and installation.
  - 5. Provide weatherproof ground-fault receptacles within 25'-0" of devices and equipment to be readily-accessible for maintenance.
- D. Coordinate arrangement, mounting and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. Provide for ease of disconnecting the equipment with minimum interference to other equipment installations.
  - 3. Allow right-of-way for piping and conduit installed at required slope.
  - 4. Connecting raceways, cables, wireways, cable trays and busways to be clear of obstructions and allow working clearances of other equipment.
- E. Where outlets are not specifically located on the Drawings, locate as determined in the field by the Architect. Where outlets are installed without such specific direction, relocate as directed by the Architect and at no additional cost to the Owner.
- F. The Electrical Drawings are diagrammatic but are required to be followed as closely as actual construction and Work of other trades will permit. Where deviations are required to conform with actual construction and the Work of other trades, make such deviations without additional cost to the Owner.

### 3.2 INSTALLATION OF CONTROL-VOLTAGE ELECTRICAL POWER CABLES

- A. Comply with requirements in Section 260400 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
  - 2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
  - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
  - 2. Secure conduits to backboard if entering the room from overhead.
  - 3. Extend conduits 3 inches above finished floor.
  - 4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards and BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems".
  - 2. Cables may not be spliced.
  - 3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  - 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 6. Support: Do not allow cables to lay on removable ceiling tiles.
  - 7. Secure: Fasten securely in place with hardware specifically designed and installed to not damage cables.
- F. Installation of Control-Circuit Conductors:
  - 1. Install wiring in raceways. Comply with requirements specified in Section 260400 "Raceways and Boxes for Electrical Systems."
- G. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
  3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.
- H. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
  2. Install cabling after the flooring system has been installed in raised floor areas.
  3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.
- I. Minimum Control-Circuit Conductor Sizes:
1. Class 1 remote-control and signal circuits; No 14 AWG.
  2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
  3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.
- J. Identification: Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

### 3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

- A. Conductor Material Applications:
1. Feeders: Copper for feeders smaller than No. 250 MCM; copper or aluminum for feeders No. 250 MCM and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Adjust raceway sizes accordingly where use of aluminum material is allowed.
  2. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
  3. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- B. Conductor Insulation and Multiconductor Cable Applications and Wiring Methods:
1. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
  2. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
  3. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
  4. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
  5. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
  6. Branch Circuits Concealed in Millwork and Wall Partitions: Metal-clad cable, Type MC.
  7. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- C. Installation of Conductors and Cables:
1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

2. Complete raceway installation between conductor and cable termination points according to Section 260400 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
  3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
  4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
  5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
  6. Support cables according to Section 260400 "Hangers and Supports for Electrical Systems."
- D. Connections:
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
  2. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- E. Identification: Identify and color-code conductors and cables according to NFPA 70. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.
- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- G. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260400 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- H. Other Requirements:
1. Conductors No. 4 and larger, provide insulating bushings or insulating sleeves.
  2. Provide barriers in boxes where different voltages and conductor insulation exist.
  3. Install control wiring for equipment or as required by other Division Trade Work.
  4. Tape all joints with rubber tape 1-1/2 times the thickness of the conductor insulation, then cover with a minimum of two half-lapped layers of Scotch Brand No. 33 vinyl-plastic electrical tape.
  5. Provide expansion fittings in conduits which are non-continuous and exposed to the weather.
- I. Wire Sizes:
1. Increase wire sizes and raceway to next largest AWG size for: (Size shown of 60% load, increase as required for larger loading)
    - a. 120 volt circuits exceeding 150 feet in circuit length.
    - b. 208 volt circuits exceeding 250 feet in circuit length.
  2. Wire sizes shall be increased for the above conditions whether indicated on the Drawings.

- J. Use identified (white) neutrals and colored-coded phase wires for all branch circuit wiring.
  - 1. Make splices electrically and mechanically secure with pressure-type ILSCO Snapblock connectors, or LSI lugs to make splices electrically and mechanically secure. Soldering is not permitted for grounding equipment.
    - a. For wires size 6 AWG and smaller, provide "Scotch-lock" connectors.
  - 2. For wires size 4 AWG and larger, provide Burndy "Versitaps" and heavy-duty connectors, or T&B "lock-tite" connectors.

### 3.4 INSTALLATION OF GROUNDING SYSTEMS

- A. Coordinate existing conditions and wiring configurations to assure proper grounding systems are installed per NEC Art. 250. Where existing system grounding means are not known or clearly identifiable, contact Owner to provide as-built documents prior to start of Work.
- B. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- C. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.
- F. Grounding at The Service: Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
- G. Comply with IEEE C2 grounding requirements.
- H. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2



inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

- I. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- J. Equipment Grounding: Install insulated equipment grounding conductors with all feeders and branch circuits.
- K. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- L. 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.
- M. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- N. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- O. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- P. Perform tests and inspections as listed in "Testing and Inspections".

- Q. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
  5. Substations and Pad-Mounted Equipment: 5 ohms.
  6. Manhole Grounds: 10 ohms.
- R. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

### 3.5 HANGERS AND SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70 utilizing listed beam clamps and supports. Tie-wires shall not be an acceptable method of securing raceways.
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. 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.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- F. 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 .
- G. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.

5. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  7. To Light Steel: Sheet metal screws.
  8. 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.
- H. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- I. Concrete Bases:
1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
  2. Use 3000-psi , 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements as specified by equipment manufacturer.
  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.

### 3.6 RACEWAYS AND BOXES INSTALLATION

- A. Selection of Raceways: Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
1. Exposed and Subject to Physical Damage: RMC.
  2. Exposed and Not Subject to Physical Damage: IMC.
  3. Concealed Aboveground: EMT.
  4. Direct Buried: PVC-40.
  5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- C. Indoors:
1. Hazardous Classified Locations: RMC.
  2. Exposed and Subject to Physical Damage: IMC.
  3. Exposed and Not Subject to Physical Damage: EMT.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Damp or Wet Locations: IMC.
  6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC.
- D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. RMC and IMC: Provide threaded type fittings unless otherwise indicated.
- E. Installation of Raceways:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
  2. Comply with requirements in Section 260400 "Hangers and Supports for Electrical Systems" for hangers and supports.
  3. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
  4. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4" and insulated throat metal bushings on 1-1/2" and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
  5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  6. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
  7. Support conduit within 12" of enclosures to which attached.
  8. MC Cable or FMC is allowed in limited uses: Lighting whips, interior partition walls, and millwork. MC Cable is NOT allowed for homerun branch circuits.
  9. Adjust raceway sizes required for derating and ambient temperatures.
  10. Provide necessary sleeves and chases where conduits pass through floors and walls, and provide other necessary openings and spaces, arranging to prevent unnecessary cutting.
  11. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
    - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    - b. Where an underground service raceway enters a building or structure.
    - c. Conduit extending from interior to exterior of building.
  12. Do not install conduits within 2" of the bottom side of a metal deck roof.
  13. Keep raceways at least 6" away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  14. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength.
  15. Do not install aluminum raceways or fittings in contact with concrete or earth.
- F. Underground conduit installations where open trenching occurs and accessible to public, shall require barriers and warning tape per OSHA guidelines.

- G. Where conduit or wiring is exposed, run parallel to, or at right angles with, lines of the building.
  - 1. Make bends with standard conduit elbows or conduit bent to not less than the same radius.
  - 2. Make bends free from dents and flattening.
  - 3. Where outlets and devices are installed exposed on masonry walls, contractor shall route conduit up to highest point on wall to junction box serving the device vertically.
- H. Where conduits pierce the roof, provide 24-gauge galvanized iron roof jacks and flashing collar brazed onto the conduits and covering the top of the roof jacks. Any brazing shall occur prior to installation of conductors.
- I. When boring, cutting or drilling structural wood or wall members, drill only in locations as approved by the Architect.
- J. Installation of Boxes and Enclosures:
  - 1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
  - 2. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
  - 3. 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 box and cover plate or supported equipment and box, whether installed indoors or outdoors.
  - 4. Locate boxes so that cover or plate will not span different building finishes.
  - 5. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
  - 6. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
  - 7. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
  - 8. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.

### 3.7 SLEEVE-SEAL SYTEM INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work and as specified by roofing manufacturer.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.
- H. Sleeve-Seal-System Installation
1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
  2. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- I. Sleeve-Seal-Fitting Installation
1. Install sleeve-seal fittings in new walls and slabs as they are constructed.
  2. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
  3. Secure nailing flanges to concrete forms.
  4. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.8 PANELBOARD INSTALLATION

- A. Comply with NECA 1.

- B. Install panelboards and accessories according to NECA 407.
- C. Mount top of trim 90 inches above finished floor where top-most operating handle is not higher than 79 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box.
- E. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Provide breakers with ground-fault protection of equipment for listed areas:
  - 1. Kitchens.
  - 2. Garages.
  - 3. Bathrooms and Locker Rooms.
  - 4. Exterior equipment not supplied with integral ground-fault protection.
  - 5. Mechanical and Janitorial closets for equipment not supplied with integral ground-fault protection.
  - 6. Locations where equipment is located within 6'-0" of water source or listed wet locations.
- H. Make grounding connections and bond neutral for service entrance and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- I. Install filler plates in unused spaces.
- J. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or floor below slab not on grade.
- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- L. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with OSHA and NFPA 70E.
- M. Panelboard Nameplates: Label each switchboard compartment with a nameplate.
- N. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate.
- O. Test and Inspections: Section 260400 "Testing and Inspections."
  - 1. Panelboards will be considered defective if they do not pass tests and inspections.

### 3.9 INSTALLATION OF WIRING DEVICES

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.

### 3.10 INSTALLATION OF FUSES

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install labels complying with requirements for identification specified in "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

### 3.11 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS
  - 1. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
    - a. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.



- f. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 with cover attached by Type 316 stainless steel bolts.
  - B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
    - 1. Notify Owner no fewer than ten days in advance of proposed interruption of electric service.
    - 2. Indicate method of providing temporary electric service.
    - 3. Do not proceed with interruption of electric service without Owner or Construction Manager's written permission.
    - 4. Comply with NFPA 70E.
  - C. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
  - D. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
  - E. Install fuses in fusible devices.
  - F. Comply with NFPA 70 and NECA 1.
  - G. IDENTIFICATION
    - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.
  - H. Test and Inspections: Section 260400 "Testing and Inspections."
    - 1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
  - I. Prepare test and inspection reports.
    - 1. Test procedures used.
    - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
    - 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- 3.12 INSTALLATION OF ENCLOSED CONTROLLERS
- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with "Hangers and Supports for Electrical Systems."

- B. Floor-Mounted Controllers: Section 260400 "Installation of Power Equipment."
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Comply with NECA 1.
- G. Identification
  - 1. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in "Identification for Electrical Systems."
    - a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    - b. Label each enclosure with engraved nameplate.
    - c. Label each enclosure-mounted control and pilot device.
- H. Control Wiring Installation
  - 1. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in "Control-Voltage Electrical Power Cables."
  - 2. Bundle, train, and support wiring in enclosures.
  - 3. Connect selector switches and other automatic-control selection devices where applicable.
    - a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
    - b. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.
- I. Test and Inspections: Section 260400 "Testing and Inspections."
- J. Adjusting:
  - 1. Set field-adjustable switches and overload-relay pickup and trip ranges.
  - 2. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer of Record before increasing settings.

### 3.13 INSTALLATION OF INTERIOR LIGHTING

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports: Sized and rated for luminaire weight.
- E. Flush-Mounted Luminaire Support: Secured to outlet box.
- F. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
  - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
  - 1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
  - 2. Ceiling mount with pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
  - 3. Ceiling mount with hook mount.
- H. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
  - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:
  - 1. Secure to any required outlet box.
  - 2. Secure luminaire using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
- J. Comply with requirements in Section 260400 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- K. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260400 "Identification for Electrical Systems."
- L. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
  3. Photometric Requirements:
    - a. The performance shall be adjusted (depreciated) by using the LED manufacturer's data or the data from the IESNA Standard TM-21 test report, whichever one results in a higher level of lumen depreciation.
    - b. The initial minimum illuminance level is achieved in 100% of the area of the specified lighting pattern.
    - c. The measurements shall be calibrated to standard photopic calibrations.
    - d. Luminaire shall be tested per IESNA LM 79-08.
- M. Luminaire will be considered defective if it does not pass operation tests and inspections.
- N. Prepare test and inspection reports.
- 3.14 INSTALLATION OF SURGE PROTECTION FOR ELECTRICAL POWER CIRCUITS
- A. Comply with NECA 1.
  - B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
  - C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - D. Use crimped connectors and splices only. Wire nuts are unacceptable.
  - E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.
  - F. Test and Inspections: Section 260400 "Testing and Inspections."
  - G. Prepare test and inspection reports.
  - H. Train Owner's maintenance personnel to operate and maintain SPDs.
- 3.15 INSTALLATION OF POWER EQUIPMENT
- A. FLOOR-MOUNTED EQUIPMENT CONCRETE PAD: Install switchboards, transformers and enclosed controllers on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
    1. Install conduits entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after equipment is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from enclosures and components.
- C. Provide power and control wiring for HVAC, switchboards, panelboards, motor starters and safety switches as shown on the Drawings.
- D. Connections to miscellaneous building equipment:
1. Wire to, and connect to, all items of building equipment not specifically described but to which line-voltage electrical power is required.
  2. Coordinate as necessary with other trades and suppliers to verify types, numbers and locations of equipment.
  3. Make final connections to all kitchen equipment per manufacturer's instructions.
  4. Mark each pull-box/junction box with a permanent ink marker the panel designation and circuit number contained.
- E. Mounting Heights:
1. Install light switch at 48 inches to center of device above finished floor. Unless otherwise noted.
  2. Install convenience receptacle at 18 inches to center of device above finished floor. Unless otherwise noted.
  3. Install convenience receptacle at 4 inches to center of device, above back splash of counter top. Unless otherwise noted.
  4. Install telephone jack rough in at 18 inches to center of device above finished floor. Unless otherwise noted.
  5. Install telephone jack for side-reach wall telephone, to position top of telephone at 54 inches to center of device, above finished floor. Unless otherwise noted.

### 3.16 MATERIAL AND EQUIPMENT

- A. All materials and equipment shall be new, of the same type and manufacture, and shall be of the best quality and design and free from defects.
- B. A Manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating Manufacturer's name, address and catalog number.

### 3.17 MISCELLANEOUS ITEMS

- A. The Contractor shall provide all miscellaneous items that would normally be required for proper installation of all electrical systems specified herein.
- B. Completed wiring systems shall be free from short circuits. After completion, this Division 26 shall perform tests for insulation resistance in accordance with the requirements of the National Electrical Code.
- C. Complete temperature control wiring rough-in is the responsibility of this Division 26. Coordinate with Division 23 to provide all locations for rough-in box and conduit requirements. Temperature control wiring shall be installed in conduit as specified by Division 23. Final terminations shall be by Division 23 unless system is 110 volts or greater.
- D. Provide all disconnects and safety switches for mechanical and plumbing equipment. Where safety switches serve equipment with multiple motors, switches shall be fused according to the nameplate of the equipment, or the breaker serving the equipment shall be "HACR" type.

### 3.18 CUTTING AND PATCHING

- A. The Electrical Contractor shall be responsible for cutting all floors, walls, partitions, ceilings or other construction required for proper installation of his Work. No cutting shall be done without prior approval of the Architect and all cutting shall be performed as directed by the Architect. Compacting of soil shall be provided in accordance to Division 2 Work. Concrete and Asphalt Work shall be provided in accordance to Division 2 Work.
- B. The Electrical Contractor shall provide and install fire-safing material in penetrations through fire rated walls, floors, and ceilings in accordance with local codes.

### 3.19 CLEANING AND PLACING IN SERVICE

- A. Immediately prior to final inspection, the Contractor shall make a final cleanup of dirt and refuse resulting from his Work and shall assist in keeping the premises clean at all times.
- B. Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this Contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original Condition.
- C. Mechanism of all equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required to produce the intended performance.

### 3.20 ADJUSTMENT AND INSTRUCTION

- A. Energize all systems, equipment, and fixtures and check for proper operation. Check electrical feeders for proper phasing and balance loads between phases.
- B. Position adjustable light fixtures to meet approval of Architect.

### 3.21 TESTING AND INSPECTION:

- A. Provide personnel and equipment, make required tests, and secure approvals from the Owner and governmental agencies having jurisdiction.
- B. Make written notice to the Owner adequately in advance of each of the following stages of construction:
  - 1. Underground electrical system installation is complete, but not covered.
  - 2. Rough-in installation of electrical systems are complete, but not covered.
  - 3. At final completion of the Work of this Section 260400.
- C. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.
- D. Provide personnel and equipment to perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each distribution bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the enclosure and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Values shall not deviate more than 50 percent of lowest value tested.
    - c. Test ground-fault protection for service equipment per NFPA 70.
    - d. Use suitable test instrument to measure resistance to ground system. Test in accordance with test instrument manufacturer's specified fall-of potential method.
  - 2. Tests and Inspections:
    - a. Perform each visual, accessible bolted electrical connection, mechanical inspection and electrical test for component type stated in NETA Acceptance Testing Specification including Tables. Certify compliance with test parameters.
    - b. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - c. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
    - d. Prior to energizing motors, verify voltages are within plus or minus 10 percent of nameplate rated voltages at motor.
    - e. Test each connected motor for proper phase rotation.

- E. In the Owner's Presence:
    - 1. Test all parts of the electrical system and prove that all such items provided under this Section function electrically in the required manner.
    - 2. Measure voltages between phases and between phase wires and neutrals, and report these voltages to the Owner.
    - 3. Immediately submit to the Owner a report of maximum and minimum voltages, and a copy of the recording volt-meter chart.
  - F. Adjust and set all time clocks in accordance with Owner's instructions.
  - G. When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost to the Owner.
- 3.22 PROJECT COMPLETION:
- A. Upon completion of the Work of this Section, thoroughly clean all exposed portions of the electrical installation, removing all traces of soil, labels, grease, oil, and other foreign material, and using only the type cleaner recommended by the Manufacturer of the item being cleaned.
  - B. Thoroughly indoctrinate the Owner's operation and maintenance personnel in the contents of the operations and maintenance manual required to be submitted under Article 1.05 of this Section of these Specifications.

END OF SECTION 260400



## SECTION 260450 - ELECTRICAL DEMOLITION

### 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.
- B. Section 024100 – Minor Demolition for Remodeling.
- C. Refer to drawings outlining the scope of work and general conditions and requirements in addition to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Demolition and removal of selected portions of the building electrical distribution system as well as portions of the building telecommunications and data systems, fire alarm systems and security systems. In addition, associated controls, electrical wiring, specialty system interfaces, and other building infrastructure is affected by this work.
  - 2. Patching and repairs to adjacent surfaces and adjoining spaces not specifically included in the demo drawings but affected by the removal of systems and or sub-systems related to or served by systems serving affected areas.
  - 3. Contractor shall provide Temporary Electrical Service and lighting for all trades during course of demolition and construction.
  - 4. Maintain existing fire alarm system in service to include Fire Alarm pull station at all exit egress stairwells and corridors and magnetic door releases for separation of smoke compartments. All smoke detection will be covered during daytime working hours and uncovered by completion of work shift.
  - 5. This section does not include the demolition of asbestos or other hazardous materials identified during the process of demolition of the building and building systems. The Contractor shall notify the Architect and Owner when suspicious materials are identified which might be hazardous and request the Owner to test the identified materials and remove materials if found to be hazardous before the Contractor continues with demolition of the building.

#### 1.3 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- D. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

#### 1.4 MATERIALS OWNERSHIP

- A. **The Owner has exclusive rights to all salvage and shall be asked prior to removal of any salvage item.** Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.
  - 1. **The Owner's representative shall identify in addition to those items noted on the drawings, any other equipment or materials which he has interest in retaining or salvaging.**
  - 2. **The Contractor shall review and coordinate with the Owner to identify materials to be salvaged and the location that salvaged materials are to be moved for Owner's storage.**

#### 1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, for information only, unless otherwise indicated.
- B. Inventory of items to be removed and salvaged.
- C. Inventory of items to be removed by Owner.
- D. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.
- E. Record drawings at Project closeout according to Division 1 Section "Contract Closeout."
  - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

#### 1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed selective demolition Work similar to that indicated for this Project.

- B. Regulatory Requirements: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

## 1.7 PROJECT CONDITIONS

- A. Owner will occupy portions of the building immediately adjacent to selective demolition area. Conduct selective demolition so that Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations. Provide temporary electrical services to adjacent areas that might be affected per Owner's directive.
- B. Owner assumes no responsibility for actual condition of buildings to be selectively demolished.
  - 1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - 2. Asbestos will be selectively removed by Owner before start of Work.
- C. Storage or sale of removed items or materials on-site will not be permitted.

## 1.8 SCHEDULING

- A. Arrange selective demolition schedule so as not to interfere with Owner's on-site operations.

## 1.9 WARRANTY

- A. Existing Special Warranty: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in Section 01700.
- B. Include required temporary equipment to maintain existing electrical power to facility with complete coordination with the Owner's representative for time of work and outages scheduled without disruption to daily operations.
- C. Include required temporary materials and equipment to maintain existing fire protection system within area of remodel and construction. Notify Owner and coordinate with Owner's safety personnel times during the work when areas of the existing building are not fully protected by the building fire protection system. A fire watch shall be provided during all hours of building occupancy (24 hours per day, 7 days per week) whenever fire protection system is not fully operational within area of demolition and remodel.

- D. Include required temporary materials and equipment to maintain active portions of the building infrastructure systems that must stay in operation during demolition and remodel work to serve adjacent spaces. All temporary work shall be suitable for continued operation even if the proposed remodel work is not completed.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of demolition.
- B. Coordinate with owner to determine which security system devices such as; cameras, key pads, etc to remove for reuse in remodel phase of contract.
- C. Verify that abandoned wiring and equipment serve only abandoned facilities and remove all abandoned wiring from the floor.
- D. Demolition Drawings are based on casual non-destructive field observation. Report discrepancies to Owner before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.
- F. Verify that building systems serving the area of demolition have been disconnected, terminated, and capped to prevent damage to the building or harm to personnel.
- G. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- H. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Architect.
- I. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
- J. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

### 3.2 BUILDING INFRASTRUCTURE SYSTEMS

- A. Maintain existing building infrastructure systems indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Do not interrupt existing building systems serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions, as acceptable to Owner and to governing authorities.

2. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.
- B. Building Systems Requirements: Locate, identify, disconnect, and seal or cap off indicated building infrastructure systems services serving building to be selectively demolished.
  1. Owner will arrange to shut off indicated building systems when requested by Contractor.
  2. Where building systems are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.
  3. Remove existing branch systems noted to be demolished back to the active main remaining in service. Cap, valve, or plug and seal, or terminate the remaining portion of pipe or conduit after bypassing.

### 3.3 PREPARATION

- A. Disconnect all electrical systems in walls, floors, and ceilings scheduled for removal. Verify that removal of systems will not impact adjacent areas that are to remain in use.
- B. Maintain existing fire alarm system in operation until new system components and devices have been installed and approved by local authorities having jurisdiction.
- C. Maintain existing systems serving areas adjacent to area of demolition so as to not affect Owner operations.
- D. In the event that it becomes necessary to interrupt electrical systems serving areas adjacent to demolition area, contractor shall notify owner not less than 72 hours prior to shutdown.
- E. Provide temporary services during interruptions to existing utilities or building infrastructure, as acceptable to Owner and to governing authorities.
- F. Contractor shall inform Owner prior to bid of required upgrading of existing fire alarm system to accept new work and provide line item bid for work.

### 3.4 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Provide temporary lighting and GFI protected power, during demolition and remodel phases of contract. Utilize existing to be relocated normal power, panelboard feeders for temporary power panels.
- B. Verify that removal of branch circuit conductor feeders will not disrupt services in adjacent spaces prior to taking offline for removal. Coordinate any required shutdown with Owner a minimum of 72 hours in advance of shutdown and do not proceed without written acknowledgement from owner. Provide temporary services during shutdown per Owner's direction.
- C. Ensure complete removal of all abandoned conduit and conductors in area of demolition. Remove abandoned conduit, except abandoned conduit above all ceiling finishes within the demo area. Cut conduit flush with walls and floors indicated to remain, and patch surfaces.

- D. Remove abandoned wiring to junction box in ceiling and terminate in areas of partial demolition. Tag and identify all circuits that are abandoned in panels that are to remain that are in adjacent areas not specifically covered in these documents or scheduled for demolition. Provide new temporary panel schedule for affected electrical panels indicating all spare circuits.
- E. Identify and tag all circuits that are fed from or to adjacent floors or spaces, indicating from where they are fed or where they feed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Remove completely all abandoned Lighting in all areas of demolition. Identify capacity of existing system feeders and all spare circuits in panels that are to remain.
- H. Identify on record drawings the locations of existing panelboard feeders, locations of panelboards in adjacent areas that serve demolition area, and circuits and or locations served by equipment in the demolition area.
- I. Provide written report to the Owner, Architect, and Engineer of Record detailing all above required identification requirements.

### 3.5 DEMOLITION AND EXTENSION OF EXISTING FIRE ALARM, AND SECURITY SYTEMS

- A. Do not interrupt existing building fire alarm system serving areas adjacent to demolition area without Owners written approval. Maintain existing fire alarm system devices in service and on floors where work is being done to include maintaining fire alarm manual pull stations at all exit egress stairwells and corridors. Coordinate any interruptions in service with Owner and Authorities Having Jurisdiction a minimum of 72 hours in advance of required shutdown. All smoke detection will be covered during daytime working hours and uncovered by completion of work shift.
- B. Verify that removal of branch circuit conductor feeders will not disrupt services in adjacent spaces prior to taking offline for removal.
- C. Identify on record drawings all locations of existing fire alarm distribution points, control panels, annuciators, and devices to remain in operation throughout construction.
- D. Identify on record drawings the location of all security cameras removed and there model #'s and note what type of cabling is used to interconnect camera system.
- E. Provide written report to the Owner, Architect, and Engineer of Record detailing all above required identification requirements.

3.6 DEMOLITION AND EXTENSION OF EXISTING TELECOMMUNICATION  
DISTRIBUTION SYSTEMS

- A. Schedule removal of existing MDF closet low-voltage systems with TPS Representative Tim Youngblood prior to Work. Removal shall be done prior to the HVAC systems being turned "OFF". Removal of the existing systems shall be provided by the contractor. Equipment shall be de-commissioned per TPS Standards, removed from service, packaged and returned to Owner in working order.
- B. Identify and tag all telecommunications feeders feeding this floor for future use in remodel phase of contract. Identify capacity and number of circuits available for use in remodel phase of contract.
- C. Identify all telecommunication feeders that pass-through demolition area that may or may not require relocation during remodel phase of contract. Identify type and style of distribution cable for coordination during remodel phase of project.
- D. Identify all telecommunication lines that emanate from areas to be demolished that provide communication to other adjoining floors or spaces.
- E. Remove to junction box in ceiling and terminate all abandoned Data, and Telephone, wiring in all areas of demolition.
- F. Identify on record drawings all locations of existing telecommunications lines that have been terminated but remain active and those that pass through, stop at, or start in areas of demolition. Identify where Fiber Optic Cable distribution systems pass through areas of demolition and where distribution points are located for future reuse during remodel phase of contract.
- G. Provide written report to the Owner, Architect, and Engineer of Record detailing all above required identification requirements.

END OF SECTION 260450

## SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal Conduits and Fittings.
  - 2. J-Hooks and D-Rings.
- B. Related Requirements:
  - 1. Section 260400 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
    - a. Metal Conduits and Fittings.
    - b. Nonmetallic Conduits and Fittings.
    - c. Metal Wireways and Auxiliary Gutters.
    - d. Surface Pathways.
    - e. Boxes, Enclosures, And Cabinets.
    - f. Handholes And Boxes for Exterior Underground Wiring.
    - g. Underground Raceways.
  - 2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.



## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of pathway groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.

### 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

### 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.

- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Screw-cover type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

## 2.4 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Owner/Architect.

## 2.5 HOOKS

- A. Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. MonoSystems, Inc.
  - 2. Panduit Corp.
  - 3. Wiremold/ Legrand.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-C.
- E. Galvanized steel.
- F. J, D or U shape.

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  - 2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  4. Damp or Wet Locations: IMC.
  5. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
  6. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1-inch trade size. Optical-fiber cables is 1-1/2 inch .
- D. Raceway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only were indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F .

### 3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- H. Support conduit within 12 inches of enclosures to which attached.
- I. Pathways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  - 5. Change from ENT to GRC or IMC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- Q. Surface Pathways:
  - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
  - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid, and flexible, as follows:
1. 1-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet .
  2. 1-1/2-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet .
  3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- T. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F , and that has straight-run length that exceeds 25 feet . Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet .
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Installation of Boxes and Enclosures:

1. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
2. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
3. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
4. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
5. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
6. Set metal floor boxes level and flush with finished floor surface.
7. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

X. J -Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet on-center.
5. Provide a hook at each change in direction.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

## 271500 COMMUNICATIONS HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. UTP cabling.
  - a. Cable connecting hardware, patch panels, and cross-connects.
  - b. Racks and Cabinets.
2. Telecommunications outlet/connectors.
3. Cabling system identification products.

##### B. Related Requirements:

1. Section 271500 "Premise Cabling Specifications" for copper data cabling associated with Tulsa Public Schools system panels and devices, provided by Owner.

##### C. Premise Wiring System: TIA/EIA T568-A/B compliant infrastructure for voice and data communications. System shall be a complete and operable including:

1. CAT 6 cabling and terminations.
2. CAT 6 Patch Panels for termination of network cables.
3. Conduit and surface mounted raceway systems, boxes, coverplates and connector housings for outlet locations.
4. Bridle rings and or D-rings, J-Hooks to support communication cabling to IDF closet.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

##### A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

##### B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

#### 1.3 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

##### B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Wiring diagrams to show typical wiring schematics, including the following:
  - a. Cross-connects.



- b. Patch panels.
  - c. Patch cords.
- 3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI with current Uniprise Certification on staff. Change of the Project Lead shall not be acceptable without prior approval from Owner.
  - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

### PART 2 - PRODUCTS

#### 2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

## 2.3 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

## 2.4 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Uniprise International.
2. Hubbell Premise Wiring.
3. Leviton Manufacturing Co., Inc.

## 2.5 UTP CABLE

- A. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket for data and white for voice.
  1. Comply with ICEA S-90-661 for mechanical properties.
  2. Comply with TIA/EIA-568-B.1 for performance specifications.
  3. Comply with TIA/EIA-568-B.2, Category 6.
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
    - b. Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.
    - c. Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.

## 2.6 UTP CABLE HARDWARE

- A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
  - 1. CS-Uniprise: 6540+Blue CPK.
- B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
  - 1. Number of Jacks per Field: Provide quantity in IDF or MDF equal to the number of patch panel ports and workstations equal to the number of jacks. One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- D. Data Jack Panels: Each IDF\MDF will require a modular blank jack panel either 24 or 48 port based upon quantity of cables terminated. Terminate all Category 6 cabling on Uniprise Cat 6 compliant jack panels. Provide enough connection points for all Cat 6 active ports plus 20% open for spares. With each jack panel and associated switch location, provide a wire management panel with dimensions sufficient for the number of connections being supported.
  - 1. Commscope: UNJ600-BL CAT 6 Blue.
  - 2. Commscope: M20000-24-1U, 24-P modular blank jack panel.
  - 3. Commscope: M20000-48-2U, 48-P modular blank jack panel.
- E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- F. Patch Cables: Uniprise - Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.
  - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
    - a. Commscope: UNC6-BL-3F - Cat 6 3ft blue patch cable (only in wall racks).
    - b. Commscope: UNC6-BL-5F - Cat 6 5ft blue patch cable.
    - c. Commscope: UNC6-BL-7F - Cat 6 7ft blue patch cable.
- G. MDF/ IDF Relay Racks - Data racks that are to contain minimal components as follows:
  - 1. Standard two post aluminum relay rack frame to accept standard 19" wide equipment – Black with matte (satin) finish.
    - a. #55053-703 (Chatsworth) -- Black Rack with matte finish.
    - b. #30091-703 (Chatsworth) -- Black vertical wire management.
    - c. #12853-701 (Chatsworth) -- Black rack mount AC power strip 38".
  - 2. 120V power from dedicated circuit for IDF rack mounted power strips.
  - 3. Surge protective AC power strips as required.
  - 4. Uniprise CAT 6 jumper cables for all active ports and length of work area cords, based on TIA/EIA-568-B.1.

## 2.7 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Description: The contractor will be responsible for providing all plates for communications boxes for interconnection to voice and data systems. The contractor will also be responsible for providing blank inserts for every communications face plate having available unused ports. Provide sample color to the owner for approval prior to purchase. Coordinate these plates and connectors with the existing components and match those components.
- B. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- C. Flush-mount Workstation Outlets: Multi-port-connector assemblies mounted in single gang Uniprise flush mount faceplate.
  - 1. Plastic Faceplate: White High-impact plastic:
    - a. #M12L-262 ---- White two port faceplate.
    - b. #M13L-262 ---- White three port faceplate.
    - c. #M14L-262 ---- White four port faceplate.
    - d. #M16L-262 ---- White six port faceplate.
  - 2. For use with blue snap-in jacks accommodating any combination of UTP work area cords. Provide blanks as necessary to fill unused positions of the outlet.
  - 3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.
- D. Surface-mount Workstation Outlets: Provide junction boxes and faceplates for surface mounted raceway. Install (2) anchors per box and every three feet along raceway.
  - 1. Junction Box: JBX3510WH-A.
  - 2. Raceway: LD5WH8-A up to 3 CAT 6 cables. LD10WH8-A for 4 or more CAT 6 cables.

## 2.8 GROUNDING

- A. Comply with requirements in Section 260400 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

## 2.9 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260400 "Identification for Electrical Systems."

## 2.10 SOURCE QUALITY CONTROL

- A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.

- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 WIRING METHODS

- A. Install cables in pathways and basket trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method such as J-Hooks may be used. Conceal pathways and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

### 3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Cable runs, not to exceed a maximum footage of 295' each, including a 10' maintenance loop.
4. A white label with the IDF-Panel and port number will be placed on station end of the cable.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
- 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260400 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.

- D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- F. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
  - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
  - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
  - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  - 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
  - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.



4. UTP Performance Tests:

- a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

- 1) Wire map.
- 2) Length (physical vs. electrical, and length requirements).
- 3) Insertion loss.
- 4) Near-end crosstalk (NEXT) loss.
- 5) Power sum near-end crosstalk (PSNEXT) loss.
- 6) Equal-level far-end crosstalk (ELFEXT).
- 7) Power sum equal-level far-end crosstalk (PSELFEXT).
- 8) Return loss.
- 9) Propagation delay.
- 10) Delay skew.

5. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

- a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
- b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 271500

## SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. UTP cabling.
  - 2. RS-232 cabling.
  - 3. RS-485 cabling.
  - 4. Low-voltage control cabling.
  - 5. Control-circuit conductors.
  - 6. Fire alarm wire and cable.
  - 7. Identification products.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

## 1.7 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
  - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP cable and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: **25** or less.
  - 2. Smoke-Developed Index: **50** or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 UTP CABLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. ADC.
  - 2. AMP Netconnect; a brand of Tyco Electronics Corporation.
  - 3. Belden Inc.
  - 4. Berk-Tek; a Nexans company.
  - 5. CommScope, Inc.
  - 6. Mohawk; a division of Belden Networking, Inc.
  - 7. 3M; Communication Markets Division.
- B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties.
  - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
  - 3. Comply with TIA/EIA-568-B.2, Category 6.
  - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG.

- b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- c. Communications, Riser Rated: Type CMR, complying with UL 1666.
- d. Communications, Limited Purpose: Type CMX.

## 2.3 UTP CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. ADC.
  - 2. American Technology Systems Industries, Inc.
  - 3. AMP Netconnect; a brand of Tyco Electronics Corporation.
  - 4. Belden Inc.
  - 5. Dynacom Inc.
  - 6. Hubbell Incorporated; Hubbell Premise Wiring.
  - 7. Leviton Commercial Networks Division.
  - 8. Panduit Corp.
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

## 2.4 RS-232 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Plastic insulation.
  - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  - 4. Plastic jacket.
  - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  - 6. Flame Resistance: Comply with NFPA 262.

## 2.5 RS-485 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  - 2. Fluorinated ethylene propylene insulation.
  - 3. Unshielded.
  - 4. Fluorinated ethylene propylene jacket.
  - 5. Flame Resistance: NFPA 262, Flame Test.

## 2.6 LOW-VOLTAGE CONTROL CABLE

### A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

## 2.7 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

## 2.8 FIRE ALARM WIRE AND CABLE

### A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire.

### B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

### C. Signaling Line Circuits: Twisted, shielded pair, No. 18 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

### D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Line-Voltage Circuits: No. 12 AWG, minimum.

2. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

## 2.9 IDENTIFICATION PRODUCTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  1. Brady Worldwide, Inc.
  2. HellermannTyton North America.
  3. Kroy LLC.
  4. Panduit Corp.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 260400 "Identification for Electrical Systems."

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 260400 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

### 3.2 WIRING METHOD

- A. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- B. Wiring within Enclosures:
  1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  2. Install lacing bars and distribution spools.
  3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
  4. Install conductors parallel with or at right angles to sides and back of enclosure.
  5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
  6. Mark each terminal according to system's wiring diagrams.
  7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
  - 1. Comply with TIA/EIA-568-B.2.
  - 2. Install 110-style IDC termination hardware unless otherwise indicated.
  - 3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
- E. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.4 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Section 260400 "Raceways and Boxes for Electrical Systems."
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
  1. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
  2. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.



- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### 3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 260400 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits, No. 14 AWG.
  - 2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
  - 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### 3.6 CONNECTIONS

- A. Comply with requirements in Section 271500 "Access Control" for connecting, terminating, and identifying wires and cables.
- B. Comply with requirements in Owner Guidelines - "Video Surveillance" for connecting, terminating, and identifying wires and cables.
- C. Comply with requirements in Section 283111 "Zoned (DC Loop) Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

### 3.7 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.8 GROUNDING

- A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Section 260400 "Grounding and Bonding for Electrical Systems."

### 3.9 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260400 "Identification for Electrical Systems."

### 3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

END OF SECTION 280513

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

#### SECTION ONE: GENERAL

##### 1.1 Scope

This specification document provides the requirements for the installation, programming and configuration of a complete Honeywell Farenhyt Series IFP-300ECS digital protocol analog addressable fire alarm system with integrated Emergency Communication System capabilities (ECS). This system shall include, but not be limited to, system cabinet, power supply, voice command module, microphone, built in Signaling Line Circuit (SLC), 160 character LCD annunciator, four programmable notification circuits, built in dual line, IP and optional cellular digital communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational life safety system.

##### 1.2 Work Included

###### 1.2.1 General Requirements

The contractor shall furnish and install a complete 24 VDC, electrically supervised, analog addressable fire alarm system with emergency communication as specified herein and indicated on the drawings. The system shall include but not be limited to all control panels, audio amplifiers, power supplies, initiating devices, audible and visual notification appliances, alarm devices, and all accessories required to provide a complete operating fire alarm, carbon monoxide alarm and emergency communication system.

###### 1.2.2 Listings

All fire alarm system equipment shall be listed for it's intended purpose and be compatibility listed to assure the integrity of the complete system.

##### 1.3 Standards

The fire alarm equipment and installation shall comply with the current provisions of the following standards and shall be listed for it's intended purpose and be compatibility listed to insure integrity of the complete system.

###### 1.3.1 National Electric Code, Article 760

###### 1.3.2 National Fire Protection Association Standards:

NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm and Signaling Code
NFPA 101	Life Safety Code
NFPA 720	Standard for the Installation of CO Detection

###### 1.3.3 Local and State Building Codes

BOCA, National Building Code, Mechanical Code, Fire Prevention Code

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

#### 1.3.4 Local Authorities Having Jurisdiction

#### 1.3.5 Underwriters Laboratories Inc.

All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose, listed as power limited by Underwriters Laboratories, Inc., for the following standards as applicable:

UL 864 UOJZ	Control units for Fire Protective Signaling Systems
	Local Signaling Unit
	Central Station Signaling Protected Premises Unit
	Remote Signaling Protected Premises Unit.
	Water Deluge Releasing Unit
UL 2572	Mass Notification Standard
UL 2075	CO Detectors Connected to FACP
UL 268	Smoke Detectors for Fire Protective Signaling systems
UL 268A	Smoke Detectors for duct applications
UL 217	Smoke Detectors for Single Stations
UL 521	Heat Detectors for Fire Protective Signaling systems
UL 228	Door Holders for Fire Protective Signaling systems
UL 464	Audible Signaling appliances
UL 1638	Visual Signaling appliances
UL 38	Manually Activated Signaling Boxes
UL 346	Waterflow indicators for Fire Protective Signaling systems
UL 1481	Power Supplies for Fire Protective Signaling systems.
UL1711	Amplifiers for Fire Protection Signaling Systems

#### 1.3.6 Americans with Disabilities Act (ADA)

All visual Notification appliances and manual pull stations shall comply with the requirements of the Americans with Disabilities Act.

### 1.4 General Requirements

#### 1.4.1 Manufacturers/Distributors Services

1.4.1.1 The following supervision shall be provided by a factory trained service technician from the distributor of the fire alarm equipment. The technician shall be trained and shall have a minimum of two (2) years of service experience in the fire alarm industry. The technicians name shall appear on equipment submittals and a copy of his manufactures trained shall be sent to the project engineer. The technician shall be responsible for the following items:

- a. A pre installation visit to the job site to review equipment submittals and to verify the method by which the system is to be wired.

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

- b. During the installation the certified technician shall be on site or make periodic visits to verify installation and wiring of the system. He shall also supervise the completion of conduit rough, wires pulled into conduit and wiring rough, and ready for trim.
- c. Upon completion of wiring, final checkout and certification of the system shall be made under the supervision of this technician.
- d. At the time of the formal checkout, technician shall give operational instructions to the owner and or his representative on the system.

#### 1.4.2 Submittals

The contractor shall submit three (3) complete sets of documentation within thirty (30) calendar days after award of the purchase order. Indicated in the document will be the type, size, rating, style, catalog number, manufacturer's names, photos, and /or catalog data sheets for all items proposed to meet these specifications. The proposed equipment shall be subject to the approval of the Architect/Engineer and no equipment shall be ordered or installed on the premises without that approval.

NOTE: DOCUMENTATION - Submittal of shop drawings shall contain at least three (3) copies of original manufacturer specification and installation instruction sheets. Subsequent information may be copies. All equipment and devices on the shop drawings to be furnished under this contract shall be clearly marked in the specification sheets.

Supplier qualifications shall be submitted indicating years in business, service policies, warranty definitions, NICET certification, and completion of factory training program and a list of similar installations.

Contractor qualifications shall be supplied indicating years in business and prior experience with installations that include the type of equipment that is to be supplied.

The contractor shall provide hourly service rates, performed by a factory trained technician for this installed life safety system with the submittal. Proof of training and authorization shall be included with the submittal. These hourly service rates shall be guaranteed for a 1-year period.

#### 1.4.2 Contract Close-out Submittals

Deliver two (2) copies of the following to the owner's representative within Thirty (30) days of system acceptance. The closeout submittals shall include:

- 1- Installation and Programming manuals for the installed life safety system.
- 2- Point to point diagrams of the entire life safety system as installed. This shall include all connected smoke detectors and addressable field modules.
- 3- All drawings must reflect device address as verified in the presence of the engineer and/or end user.

## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

#### **1.4.3 Warranty**

Unless otherwise specified, all materials, installation and workmanship shall have a warranty for a three (3) year period. A copy of the manufacturer warranty shall be provided with the close out documentation.

#### **1.4.4 Products**

This life safety system specification must be conformed to in its entirety to ensure that the installed and programmed life safety system will accommodate all of the requirements and operations required by the building owner. Any specified item or operational feature not specifically addressed prior to the bid date will be required to be met without exception.

Submission of product purported to be equal to those specified herein will be considered as possible substitutes only when all of the following requirements have been met:

- 1- Any deviation from the equipment, operations, methods, design or other criteria specified herein must be submitted in detail to the specifying architect or engineer a minimum of ten (10) working days prior to the scheduled submission of bids. Each deviation from the operation detailed in these specifications must be documented in detail, including page number and section number, which list the system function for which the substitution is being proposed.
- 2- A complete list of such substituted products with three (3) copies of working drawings thereof shall be submitted to the approved Architect and/or Consulting Engineer not less than ten (10) working days prior to the scheduled submission of bids.
- 3- The contractor or substitute bidder shall functionally demonstrate that the proposed substitute products are in fact equal in quality and performance to those specified herein.

#### **1.4.5 General Equipment and Materials Requirements**

All equipment furnished for this project shall be new and unused. All components shall be designed for uninterrupted duty. All equipment, materials, accessories, devices and other facilities covered by this specification or noted on the contract drawings and installation specification shall be best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this specification is provided by different manufacturers, then that equipment shall be "Listed" as to its compatibility by Underwriters Laboratories (UL), if such compatibility is required by UL standards.

#### **1.4.6 Satisfying the Entire Intent of these Specifications**

It is the contractor's responsibility to meet the entire intent of these specifications. Deviations from the specified items shall be at the risk of the contractor until the date of final acceptance by the architect, engineer and owner's representative. All costs for

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

removal, relocation, or replacement of a substituted item shall be at the risk of the electrical contractor.

## SECTION TWO: SPECIFICATIONS

### 2.1 General

#### 2.1.1 Control Panel with Emergency Communication System

The fire alarm control panel (FACP) shall be the Honeywell Farenhyt Series IFP-300ECS analog addressable fire alarm control panel and emergency communication system. The audio amplifiers shall be the Honeywell Farenhyt Series ECS-DUAL50W voice evacuation units. The FACP must have a 6 amp power supply and be capable of expansion to a minimum of 102 total amps via bus connected expander modules that supervise low battery, loss of AC and loss of communication.

The system must contain at least one (1) Honeywell Farenhyt Series ECS-50W, ECS-125W, ECS-INT50W or ECS-DUAL-50W amplifier and shall be expandable from 50 to 1000 watts utilizing up to 7 additional amplifiers. The ECS-50W and ECS-125W amplifiers shall be capable of adding a 4 zone splitter (ECS-CE4) to distribute the audio information to different locations in the installation. The system shall have the capability of controlling up to 40 notification zones. The amplifiers must contain the capability of being remotely located through a four-wire SBUS communications circuit and a two-wire VBUS voice circuit. The system shall have the capability of adding up to 7 ECS-LOCs local operating consoles.

The voice evacuation system must have the capability of downloading fifteen (15) 60 second messages and utilize DSP technology for higher audio intelligibility.

The voice evacuation system shall be capable of operating at 25vrms or 70.7vrms (ECS-50W, ECS-INT50W and ECS-DUAL50W only) and must be field selectable at the amplifier level. Systems that require additional modules for voltage conversion shall not be accepted.

The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting up to 300 analog addressable points. This shall be accomplished via signaling line circuits (SLC) capable of supporting a minimum of 159 detectors and 159 module devices each. The main panel will contain one SLC circuit with the option of utilizing a 6815 expander module. The communication protocol on the SLC loop must be digital.

The FACP must support a minimum of four programmable notification circuits. The panel must have a built in 160 character LCD annunciator with the capability of having an additional supervised remote annunciators connected in the field.

The FACP must have a built in UL approved IP and digital communicator with the option of adding a cellular module for communications. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.



## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.

The FACP must compensate for the accumulation of contaminants that affect detector sensitivity. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core programming software on site or over the telephone.

The main communication bus (SBUS RS485) shall be capable of class A or class B configuration with a total SBUS length of 6,000 feet.

The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system.

The FACP must have the ability to upgrade the firmware revision from a laptop where the FACP is installed.

Panels that do not have these capabilities will not be accepted.

#### **2.1.2 System Wiring**

The Signaling Line Circuit (SLC) and Data Communication Bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and also comply with article 760 of the NEC.

#### **2.1.3 Signaling Line Circuits**

Each SLC shall be capable of a wiring distance of 5,000 feet from the panel or SLC driver module (6815) and be capable of supporting 318 devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC within 10 seconds. The auxiliary 6815 SLC loop module must be capable of being located up to 6,000 feet from the FACP on a SBUS, which is separate from the SLC. The SLC shall be capable of functioning in a class A or class B configuration.

#### **2.1.4 SLC Loop Devices**

Devices supported must include analog photoelectric, analog heat detectors, addressable input modules, relay output modules, addressable notification modules or wireless gateway. Each SLC loop shall support up to 159 detectors and 159 modules.

#### **2.1.5 Analog Detector Functions**

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:

- Automatic compliance with NFPA 72 standards for detector sensitivity testing
- Drift compensation to assure detector is operating correctly
- Maintenance alert when a detector nears the trouble condition
- Trouble alert when a detector is out of tolerance

#### 2.1.6 Sensitivity Function

The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

#### 2.1.7 Programmable Notification Circuits

The FACP shall support four programmable notification circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits can be configured as four Class B outputs, two Class B and one Class A outputs or two Class A outputs.

#### 2.1.75 Addressable Notification Module

The contractor shall furnish and install where indicated on the plans, addressable notification modules, Honeywell Farenhyt Series Model IDP-CONTROL or SK-CONTROL. The modules shall be U.L. listed compatible with Honeywell Farenhyt Series IFP-300ECS fire alarm control panel. The notification module must provide one class A (Style Z) or class B (Style Y) notification output with one auxiliary power input. The notification module must be suitable for mounting in a standard 4 square electrical box and must include a plastic cover plate. The notification module must provide an LED that is visible from the outside of the cover plate. The notification module must be fully programmable for such applications as required by the installation. The IDP-CONTROL or SK-CONTROL shall reside on the SLC loop and can be placed up to 5,000 feet from the control or 6815 SLC loop module.

#### 2.1.8 Annunciator

The main control must have a built in annunciator with a 160-character LCD display and feature LED's for Alarm, Supervisory, Trouble, Silenced and Power. When in the normal condition the LCD shall display time and date based on a 200 year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms. The annunciators must have twenty levels of user codes that will allow the limitation of operating system programming to authorized individuals.

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

#### 2.1.9 Remote Annunciators

The fire system shall be capable of supporting remote annunciators. LCD Remote annunciator, Model RA-2000, shall have the same control and display layout so that they match identically the built in annunciator. Remote annunciators shall be available in two colors, red and light gray. Remote annunciators shall have the same functionality and operation as the built-in annunciator. All annunciators must have 160-character LCD displays and must feature five LED's for Alarm, Supervisory, Trouble, Silenced, and Power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.

The annunciator must be able to silence and reset alarms. The annunciator must have twenty levels of user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6,000 feet from the main control panel on unshielded, non-twisted cable.

#### 2.1.10 I/O Module

The fire system shall be able to support I/O modules (SK5880) that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs, including ECS inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches. The system shall also support up to 40 LED drivers that reside on the two-wire SLC loop. These driver boards shall contain 80 LED outputs that are powered by an external power source.

#### 2.1.11 Serial/Parallel Interface

The fire system shall be capable of supporting up to two serial/parallel interfaces (SK5824) that are capable of driving standard computer style printers. The interface shall be programmable for the serial and parallel ports and allow printing of events as they occur.

#### 2.1.12 Distributed Power Modules

The contractor shall supply power modules, Models RPS-1000 and 5496, compatible with the IFP-300ECS fire alarm control panel. The RPS-1000 power module must have 6 amps of output power, six Flexput™ circuits rated at 3amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six Flexput™ circuits shall be capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in class A or B configurations to support dry contact or compatible two wire smoke detectors.

The RPS-1000 shall be capable of being connected via an RS-485 system bus (SBUS) at a maximum distance of 6,000 feet from the main control panel. The RPS-1000 shall contain an additional RS-485 bus that is completely compatible with all IFP-300ECS add

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

on modules; including 6815 SLC expanders, RA-2000-SK5865-SK5880 annunciators, 5824 serial/parallel module and addressable devices. The RPS-1000 will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6,000 feet from the power module.

The 5496 power module must have 6 amps of output power and four circuits rated at 3 amps each. The four circuits can be programmed as notification outputs or auxiliary power outputs of door holder, constant and resettable types.

#### 2.1.13 Digital Communicator

The digital/IP communicator must be an integral part of the control panel and be capable of reporting all zones or points of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, event history and detector sensitivity compliance information to a PC on site or at a remote location.

The communicator shall transmit the information by one or more of the following means of communication – internet, cellular or standard telephone lines. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use external modems for remote programming and diagnostics shall be accepted.

#### 2.1.14 Dry Contacts

The FACP will have three form “C” dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, sprinkler supervisory, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and battery) will cause a trouble condition. In the event that the microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

#### 2.1.15 Ground Fault Detection

A ground fault detection circuit shall be used to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground faults will not interfere with normal operation, such as alarm, or other trouble conditions.

#### 2.1.16 Overcurrent Protection

All low voltage circuits will be protected by microprocessor controlled power limiting or have a self restoring polyswitches for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

#### 2.1.17 Test Functions

A “Lamp Test” mode shall be a standard feature of the fire alarm control panel and shall test all LED’s and the LCD display on the main panel and remote annunciators.

A “Walk Test” mode shall be a standard feature of the fire alarm control panel. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for 6 to 180 seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual points return to normal.

A “Fire Drill” mode shall allow the manual testing of the fire alarm system notification circuits. The fire drill shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.

A “Bypass Mode” shall allow for any point or NAC circuit to be bypassed without effecting the operation of the total fire system.

#### 2.1.18 Remote Input Capabilities

The control panel shall have provisions for supervised switch inputs for the purpose of alarm reset and alarm and trouble silence.

#### 2.1.19 Notification Appliance Mapping Structure

All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 999 output groups. Each of these groups shall have the ability to be triggered by any of the panels 999 zones, panel wide events, or site wide events. Additionally each zone, panel, or site will individually control the cadence pattern of each of the groups that it is mapped to so that devices can indicate a variety of conditions. The zone, panel, or site shall be capable of issuing a different cadence pattern for each of the groups under its control. The mapping structure must also allow a group to be designated to “ignore cadence” for use with strobes and other continuous input devices. Zones shall have ten different output categories; Detector Alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual Pull, Zone Auxiliary 1 and Zone Auxiliary 2, CO Alarm and CO Supervisory.

Each of the categories shall have the ability to control output groups with a cadence pattern. The patterns are; March code, ANSI 3.41, Single Stroke Bell Temporal, California Code, Zone 1 Coded, Zone 2 Coded, Zone 3 Coded, Zone 4 Coded, Zone 5 Coded, Zone 6 Coded, Zone 7 Coded, Zone 8 Coded, Custom Output Pattern 1, Custom Output Pattern 2, Custom Output Pattern 3, Custom Output Pattern 4, Constant, System Sensor Synchronization, Wheelock Synchronization, Gentex Synchronization, Amseco Synchronization, and Faraday Synchronization. This mapping/cadence pattern shall be supported by all system power supplies. 15 recordable one minute messages are available that can be mapped to eight ECS buttons. ECS messages can have priority over fire alarm outputs.

## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

#### **2.1.20 On-board Programmer**

The FACP shall have an on board programmer which will allow for all system functions and options, except for mapping, to be programmed via the on board annunciator keypad. Any panel that does not have this capability will not be accepted.

#### **2.1.21 Downloading Software**

The fire alarm control panel must support up/downloading of system programming from a PC. The FACP must also be able to download the detector sensitivity test results and a 1,000 event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same communication method as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

#### **2.1.22 English Language Descriptions**

The FACP shall provide the ability to have a text description of each system device, input zone and output group on the system. The use of individual lights to provide descriptions will not be acceptable.

### **2.2 SYSTEM OPERATION**

#### **2.2.1 Alarm**

When a device indicates any alarm condition the control panel must respond within 10 seconds. All programmed audio and visual devices will activate at this time. The Alarm or Supervisory LED on the annunciator(s) should light and the LCD should prompt the user as to the number of current events. The alarm information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

When the alarmed device is restored to normal, the control panel shall be required to be manually reset to clear the alarm condition, except that the alarms may be silenced as programmed.

An alarm shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur (subsequent alarm feature). When alarms are silenced the silenced LED on the control panel, and on any remote annunciators shall remain lit, until the alarmed device is returned to normal.

#### **2.2.2 Troubles**

When a device indicates a trouble condition, the control panel System Trouble LED should light and the LCD should prompt the user as to the number of current events. The trouble information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

When the device in trouble is restored to normal, the control panel shall be automatically reset. The trouble restore information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators. A trouble shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur.

#### **2.2.3 Supervision Methods**

Each SLC loop shall be electrically supervised for opens and ground faults in the circuit wiring, and shall be so arranged that a fault condition on any loop will not cause an alarm to sound. Additionally, every addressable device connected to the SLC will be supervised and individually identified if in a fault condition. The occurrence of any fault will light a Trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

## **SECTION THREE: SYSTEM COMPONENTS**

### **3.0 CONTROL UNIT**

#### **3.1 System Cabinet**

##### **3.1.1 Mounting**

The system cabinets shall be red and can be either surface or flush mounted.

##### **3.1.2 Audible System Trouble Sounder**

An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.

#### **3.2 Power Supply and Charger**

The entire system shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 6 Amps. The FACP must have a battery charging circuit capable of complying with the following requirements:

Sixty (60) hours of battery standby with five (5) minutes of alarm signaling at the end of this sixty (60) hour period (as required per NFPA 72 remote station signaling requirements) using rechargeable batteries with automatic charger to maintain standby gel-cell batteries in a fully charged condition.

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

OR

Twenty-four (24) hours of battery standby with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period (as required per NFPA 72 central station signaling requirements) using rechargeable batteries with automatic charger to maintain gel-cell batteries in a fully charged condition.

The power supply shall comply with U.L. Standard 864 for power limiting.

The FACP will indicate a trouble condition if there is a loss of AC power or if the batteries are missing or of insufficient capacity to support proper system operation in the event of AC failure. A "Battery Test" will be performed automatically every minute to check the integrity of the batteries. The test must disconnect the batteries from the charging circuit and place a load on the battery to verify the battery condition.

In the event that it is necessary to provide additional power one or more of the Model RPS-1000 or 5496 distributed power modules shall be used to accomplish this purpose.

#### 3.2.1 Connections and Circuits

Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Fire Alarm Code NFPA 72, National Electrical Code (NEC) NFPA 70, and the local authority having jurisdiction (AHJ). The circuit and connections shall be mechanically protected.

A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked "FIRE ALARM CIRCUIT CONTROL".

## SECTION FOUR: ACCESSORY COMPONENTS

### 4.1 The FACP shall support the following devices on the RS-485 data bus:

ECS-NVCM	Network Voice Control Module
ECS-SW24	Additional 24 Zone Switch Module
ECS-50W	50 Watt Amplifier
ECS-125W	125 Watt Amplifier
ECS-DUAL50W	50/100 Watt Dual Channel Amplifier with 50 Watt Backup
ECS-CE4	4 Zone Splitter
ECS-LOC	Local Operator Console (15 max.)
6815	Signaling Line Circuit Expander (SLC) Module
5824	Printer Interface Module
RA-2000	LCD Remote Annunciator
5865-3	LED Remote Annunciator
5865-4	LED Remote Annunciator with reset and silence switches
5880	LED I/O module
RPS-1000	Intelligent Distributed Power Module
5496	Intelligent Distributed Power Module



## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

- 4.2 **The FACP shall support the operation of 159 detectors and 159 addressable modules per SLC loop without regard to device type.**

The following devices shall be supported:

IDP-PHOTO	Addressable Photoelectric Smoke detector
IDP-PHOTO-T	Addressable Photoelectric Smoke detector with Thermal
IDP-PHOTOR	Addressable Photoelectric Smoke detector with Relay
IDP-FIRE-CO	Addressable Combination Photoelectric and CO Detector
IDP-HEAT	Addressable Heat Sensor
IDP-HEAT-ROR	Addressable Heat with Rate of Rise
IDP-HEAT-HT	Addressable Heat High temp 190°
IDP-ACCLIMATE	Addressable Multi Criteria Smoke detector with thermal
IDP-6AB	6" detector base
DNR	Addressable Duct Detector Housing
IDP-RELAY	Addressable Relay Module
IDP-RELAY-6	Addressable Multi Relay Module
IDP-RELAYMON-2	Addressable Relay/Input Module
IDP-MONITOR	Addressable Input Module (Class A or B)
IDP-MINIMON	Mini Input Module
IDP-MONITOR-2	Addressable Dual Input Module
IDP-MONITOR-10	Addressable Multi Input Module (10)
IDP-CONTROL	Addressable Notification Module
IDP-CONTORL-6	Addressable Notification Multi Module (6)
IDP-ZONE	Two Wire Smoke Detector Module
IDP-ZONE-6	6 Multi Smoke Detector Module
IDP-ISO	Isolation Module
IDP-BEAM	Addressable Beam Detector
IDP-BEAM-T	Addressable Beam Detector with Test feature
B224BI	Addressable Isolator base
B224RB	Detector Relay Base
B200S	Intelligent Detector Sounder Base
B200S-LF	Intelligent Detector Low Frequency Sounder Base
RTS151KEY	Remote Test Switch for Photoelectric Duct Detector
RTS151	Remote Test Switch for Photoelectric Duct Detector
IDP-Pull-SA	Addressable Single Action Pull Station
IDP-Pull-DA	Addressable Dual Action Pull Station
ISO-6	6 Multi Isolation Module

OR

SK-PHOTO	Addressable Photoelectric Smoke detector
SK-PHOTO-T	Addressable Photoelectric Smoke detector with Thermal
SK -PHOTOR	Addressable Photoelectric Smoke detector with Relay
SK -FIRE-CO	Addressable Combination Photoelectric and CO Detector
SK -HEAT	Addressable Heat Sensor
SK -HEAT-ROR	Addressable Heat with Rate of Rise
SK -HEAT-HT	Addressable Heat High temp 190°
SK -ACCLIMATE	Addressable Multi Criteria Smoke detector with thermal

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

SK -6AB	6" detector base
SK-DUCT	Addressable Duct Detector Housing
SK -RELAY	Addressable Relay Module
SK -RELAY-6	Addressable Multi Relay Module
SK -RELAYMON-2	Addressable Relay/Input Module
SK -MONITOR	Addressable Input Module (Class A or B)
SK -MINIMON	Mini Input Module
SK -MONITOR-2	Addressable Dual Input Module
SK -MON-10	Addressable Multi Input Module (10)
SK-CONTROL	Addressable Notification Module
SK -CONTORL-6	Addressable Notification Multi Module (6)
SK -ZONE	Two Wire Smoke Detector Module
SK -ZONE-6	6 Multi Smoke Detector Module
SK -ISO	Isolation Module
SK -BEAM	Addressable Beam Detector
SK -BEAM-T	Addressable Beam Detector with Test feature
B224BI	Addressable Isolator base
B224RB	Detector Relay Base
B200S	Intelligent Detector Sounder Base
B200S-LF	Intelligent Detector Low Frequency Sounder Base
RTS151KEY	Remote Test Switch for Photoelectric Duct Detector
RTS151	Remote Test Switch for Photoelectric Duct Detector
SK -Pull-SA	Addressable Single Action Pull Station
SK -Pull-DA	Addressable Dual Action Pull Station

The FACP shall support these other Honeywell devices via addressable input, addressable notification, or addressable output modules.

PS-DALOB	Dual Action Manual Pull Outdoor Listed
PS-DAH	Dual Action Manual Pull Hex Key reset
PS-SATK	Single Action Manual Pull Station – Key Reset
PS-DATK	Dual action Manual Pull Station – Key Reset
PS-DASP	Dual action Manual Pull Station “Spanish”- Key reset
SB-I/O	Surface mount back box for outdoor use.

#### 4.3 Furnish and install, where shown on the drawings, the following devices

##### 4.3.1 Manual Fire Alarm Stations

Manual fire alarm stations shall be non-coded, break glass, single or double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed of die cast metal or polycarbonate with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single-gang box, and shall be installed within the limits defined by the Americans with Disabilities

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

Act (ADA) dependent on manual station accessibility or per local requirements. Manual stations shall be addressable models IDP-PULL-DA / IDP-PULL-SA or SK-PULL-DA / SK-PULL-SA or installed in conjunction with an addressable input module, IDP-MONITOR / IDP-MINIMON or SK-MONITOR / SK-MINIMON. Manual stations shall be Honeywell Underwriters Laboratories listed.

#### 4.3.2 Remote Power Supplies

The remote power supplies for notification appliances shall be the Model RPS-1000 or 5496. The Model RPS-1000 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-300ECS. It will support 6 amps of 24 volt DC power with 6 Flexput™ circuits, rated at 3 amps each. Two additional 6815 SLC loop expanders shall be capable of be install in the cabinet. The power supply will also regenerate the SBUS for an additional 6000 feet of SBUS capability.

The Silent Knight 5496 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-300ECS. It will support 6 amps of 24 volt DC power with 4 notification circuits, rated at 3 amps each.

The remote power supply model 5499 or 5495 may also be used on the system. These power supplies are activated by a notification circuit or an IDP-Control module and support 6 or 9 amps of 24VDC power, with 4 notification circuits, rated at 3 amps each.

#### 4.4 Notification Devices

The visible and audible/visible signal shall be System Sensor series signal devices and be listed by Underwriters Laboratories Inc. per UL 1971 and/or 1638 and UL 464. The notification appliance (combination audible/visible units only) shall produce a peak sound output of 90dba or greater as measured in an anechoic chamber. The signaling appliance shall also have the capability to silence the audible signal while leaving the visible signal energized with the use of a single pair of wires. Additionally, the user shall be able to select either continuous or temporal tone output with the temporal signal having the ability to be synchronized. The visible signaling appliance shall maintain a minimum flash rate of 1Hz or greater regardless of power input voltage. The appliance shall also be capable of meeting the candela requirements of the blueprints presented by the engineer and ADA. The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with terminals with barriers for input/output wiring and be able to mount to a single gang or double gang box or double workbox with the use of an adapter plate. The unit shall have an input voltage range of 20-30 volts with either direct current or full wave rectified power.

#### 4.5 Smoke Detectors

Smoke detectors shall be Honeywell Farenhyt Series Model IDP-PHOTO or SK-PHOTO, analog/addressable photoelectric smoke detectors. The combination detector head and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300ECS fire alarm control panel. The base shall permit direct interchange with Honeywell's IDP-ACCLIMATE / IDP-HEAT detectors or SK-ACCLIMATE / SK-HEAT detectors. The base shall be the

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

appropriate twist lock base B210LP. The smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment. The vandal security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits. Detectors shall have completely closed back to restrict entry of dust and air turbulence and have a 30 mesh insect screen. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

#### 4.6 Heat Detectors

Furnish and install analog/addressable heat detectors, Honeywell model IDP-HEAT or SK-HEAT. The combination heat detector and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300ECS fire alarm control panel. The base shall permit direct interchange with the Honeywell Farenhyt Series IDP-PHOTO / IDP-ACCLIMATE or SK-PHOTO / SK-ACCLIMATE detectors. The base shall be appropriate twist lock base B210LP. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

#### 4.7 Duct Detectors

Duct Detector shall be Honeywell Farenhyt Series Model DNR Duct Detector Housing. A separate IDP-PHOTO / IDP-PHOTOR or SK-PHOTO / SK-PHOTOR is required. The duct detector housing shall be capable of housing the IDP-RELAY or SK-RELAY module for optional output devices.

#### 4.8 Wireless Device Fire Alarm Panel Connectivity

Wireless devices used as components of a fire alarm system shall be capable of connection to the IFP-300ECS via a Signaling Line Circuit (SLC) via a gateway. The gateway shall provide the link to one mesh network of wireless devices. Multiple gateways can be supported on the same IFP-300ECS, limited to (4) wireless mesh networks in the same radio space. All sensing functions supported for wired devices shall be supported by comparable wireless devices. Additionally, the panel shall allow wired devices to be identified with unique type codes which allow the system to display wireless trouble indications such as low battery, jamming, and tamper.

##### 4.8.1 Wireless Reliability

Wireless communication for the wireless system shall incorporate an advanced mesh technology which incorporates UL 864 Class A approved supervised, redundant communication. All devices in the mesh network shall be capable of acting as repeaters

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

for other devices in the same network. The wireless system shall also have a suite of tools that can be installed on a portable PC and used to assist in qualifying the site, installing the system, and verifying the proper operation of the system.

#### 4.8.2 Wireless Approvals

The wireless system shall be approved or listed by the following agencies, as appropriate for each device:

UL  
FM  
CSFM  
FCC

#### 4.8.3 Addressable Wireless Devices

The system shall be capable of supporting addressable wireless detectors, monitor modules, and relay modules with similar appearance and capabilities as wired addressable devices.

Wireless devices shall utilize a gateway device to communicate with the fire alarm control panel, so that the wireless devices report to the panel using the established SLC protocol.

Wireless devices shall be capable of co-existing on the same panel with wired devices, and shall be capable of participating in software zone programming.

Device addressing for wireless device shall be consistent with wired devices, and shall use decade, decimal address switches.

Wireless devices (except the gateway) shall operate on batteries recommended by the manufacturer, and shall be UL tested and listed for 2 years of operation on one set of batteries.

The gateway shall be connected to the panel SLC loop and shall be capable of being powered by the SLC loop as well. Alternately, the gateway shall be capable of connection to the SLC loop only for communication with the FACP, and power may be supplied via a separate 24VDC input.

Wireless devices shall be connected to a compatible fire alarm system, and shall be supported by the system as wireless devices. Trouble conditions that are unique to wireless devices shall be reported to the FACP built-in annunciator and all connected remote annunciators.

Wireless devices shall use a UL approved Class A mesh communication protocol to provide redundant supervised wireless communication links.

A wireless mesh shall be comprised of one gateway and from one to forty-eight wireless devices.

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

Multiple wireless gateway systems may be connected to a single FACP.

The system shall allow for up to four wireless gateway systems in the same radio space.

Device status indicators (LEDs) on wireless devices shall not be required to match indications of wired devices, in particular for active indications where a steady on LED would reduce the battery life of the device.

Wireless detectors shall have dedicated bases with a magnetic tamper mechanism that initiates a trouble when the device is removed from the base. The tamper trouble condition shall latch at the panel until the detector is restored to the normal installed position and the trouble has been reset.

Wireless monitor modules shall have a dedicated cover that requires unfastening two screws to remove. The cover shall have a built-in magnet, and removal of the cover shall initiate a trouble condition at the panel. The tamper trouble condition shall latch at the panel until the monitor module is restored to the normal installed position and the trouble has been reset.

Wireless monitor modules shall be capable of being mounted in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. The optional surface mount Lexan enclosure shall be used for this purpose, except where installation of the wireless monitor module in a metal box has been tested and adequate performance for the application using the metal box has been confirmed.

Available Wireless devices shall include:

- WIDP-PHOTO Wireless Photoelectric Smoke Detector
- WIDP-ACCLIMATE Wireless Multi-Criteria Photoelectric Smoke Detector
- WIDP-HEAT-ROR Wireless Heat Rate of Rise Detector
- WIDP-HEAT Wireless Fixed Heat Detector
- WIDP-MONITOR Wireless Monitor Module
- WIDP-RELAY Wireless Relay Module
- WIDP-WGI Wireless Gateway Module
- B210W 6" Wireless Base

OR

- WSK-PHOTO Wireless Photoelectric Smoke Detector
- WSK-PHOTO-T Wireless Photoelectric Smoke w/Fixed Heat Detector
- WSK-HEAT-ROR Wireless Heat Rate of Rise Detector
- WSK-HEAT Wireless Fixed Heat Detector
- WSK-MONITOR Wireless Monitor Module
- WSK-RELAY Wireless Relay Module
- WSK-WGI Wireless Gateway Module
- B210W 6" Wireless Base

Unprogrammed wireless devices shall be capable of being used to perform a site survey to assist in determining the viability of a site for a wireless application. Tests shall include point to point connectivity, and a background RF Scan.

## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

A program that supports qualification of potential wireless applications, configuration and installation, and diagnostics shall be available. This program shall be installed on a Windows® PC, and shall be capable of communicating with wireless devices by use of a USB adapter that plugs into the computer.

## **SECTION FIVE: WIRING**

### **5.1 Installer's Responsibilities**

The installer shall coordinate the installation of the fire alarm equipment. All conductors and wiring shall be installed according to the manufacturer's recommendations.

It shall be the installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

### **5.2 Installation of System Components**

System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, the requirements of the fire department and other applicable authorities having jurisdiction (AHJ).

All wire used on the fire alarm system shall be U.L. Listed as fire alarm protection signaling circuit cable per National Electrical Code, Articles 760.

## **SECTION SIX: WARRANTY AND FINAL TEST**

### **6.1 General**

The contractor shall warrant all equipment and wiring free from inherent mechanical and electrical defects for one year (365 days) from the date of final acceptance.

### **6.2 Final Test**

Before the installation shall be considered completed and acceptable by the awarding authority, a test of the system shall be performed as follows:

- The contractor's job foreman, a representative of the owner, and the fire department shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel.
- At least one half of all tests shall be performed on battery standby power.
- Where application of heat would destroy any detector, it may be manually activated.

## **SECTION 283111**

### **DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

- The communication loops and the indicating appliance circuits shall be opened in at least two (2) locations per circuit to check for the presence of correct supervision circuitry.

When the testing has been completed to the satisfaction of both the contractor's job foreman and owner, a notarized letter cosigned by each attesting to the satisfactory completion of said testing shall be forwarded to the owner and the fire department.

The contractor shall leave the fire alarm system in proper working order, and, without additional expense to the owner, shall replace any defective materials or equipment provided by him under this contract within one year (365 days) from the date of final acceptance by the awarding authority.

Prior to final test the fire department must be notified in accordance with local requirements.

#### **6.3 As Built Drawings, Testing, and Maintenance Instructions**

##### **6.3.1 As Built Drawings**

A complete set of reproducible "as-built" drawings showing installed wiring, color coding, and wire tag notations for exact locations of all installed equipment, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.

##### **6.3.2 Operating and Instruction Manuals**

Operating and instruction manuals shall be submitted prior to testing of the system. Three (3) complete sets of operating and instruction manuals shall be delivered to the owner upon completion. User operating instructions shall be provided prominently displayed on a separate sheet located next to the control unit in accordance with U.L. Standard 864.