

SECTION 15010
BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Basic Mechanical Requirements specifically applicable to Division 15 Sections, in addition to Division 1 – General Requirements.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.03 WORK

- A. New Work: Scope of work includes furnishing and installing new ductwork and return air and transfer air registers. Providing new water closet flush valves, new urinals and lavatories.

1.04 SUBMITTALS

- A. Refer to Division 1 for submittal requirements. The following paragraphs supplement the requirements of Division 1.
- B. Submit shop drawings and product data as requested by other Division 15 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 1.
- C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 1. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.
- D. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.
- E. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 1.

- F. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.

1.05 SUBSTITUTIONS

- A. Any and all proposed substitutions must be approved by the Engineer during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 1.

1.06 COORDINATION

- A. Coordinate with all other trades as required throughout the project.

1.07 REGULATORY REQUIREMENTS

- A. Building Codes: Conform to Massachusetts State Building Code, CMR 780.
- B. Mechanical: Conform to Massachusetts State Building Code, CMR 780. Conform to the BOCA National Mechanical Code as referenced in CMR 780.
- C. Plumbing: Conform to the Massachusetts Fuel Gas and Plumbing Code, 248 CMR.
- D. Obtain permits and request inspections from authority having jurisdiction.

1.08 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on the Drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

1.09 RECORD DOCUMENTS

- A. Refer to Division 1 for record document requirements. The following paragraphs supplement the requirements of Division 1.

1.10 PRODUCTS

- A. When two or more items of same material or equipment are required (pumps, valves, fixtures etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flange types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- B. Provide products which are compatible within systems and other connected items.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

- C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.12 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of equipment and devices requiring access with all trades. Allow ample space for removal of all parts that require replacement or servicing.

1.13 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

1.14 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- E. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- F. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.

1.15 CLEANING

- A. Refer to Division 1 for general requirements for final cleaning.

1.16 ASBESTOS REMOVAL

- A. Asbestos removal is not a part of this project. Should this Contractor or any of its Subcontractors encounter any suspect asbestos containing material or products during the performance of its work, stop work immediately and so inform the General Contractor, the Owner, and the Engineer so that testing and proper action may be taken.

1.17 WARRANTIES

- A. Refer to Division 1 for warranty requirements. The following paragraphs supplement the requirements of Division 1.
- B. Compile and assemble all warranties for equipment specified in Division 15 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.

- C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.18 GUARANTEE

- A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 15410
PLUMBING PIPING

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Pipe and pipe fittings.
- B. Plumbing valves.
- C. Sanitary sewer piping system.
- D. Domestic water piping system.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with the latest edition of 248 CMR, as adopted and amended by the Massachusetts Plumbing Board.

1.04 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.

1.05 SUBMITTALS

- A. Submit product data under provisions of Section 15010.
- B. Include data on pipe materials, pipe fittings, valves, and accessories.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 15010.
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

PART 2 – PRODUCTS

2.01 SANITARY SEWER, ABOVE GRADE CONCEALED

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.

2. Joints: Hub-and-spigot CISPI HSN compression type with ASTM C564, neoprene gasket system.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron.
 2. Joints: Neoprene gasket system and stainless steel clamp-and-shield assemblies.
- 2.02 SANITARY VENT PIPING, CONCEALED
- A. Cast Iron Pipe: ASTM A74 Service weight.
1. Fittings: Cast iron.
 2. Joints: ASTM C564, neoprene gasket system.
- B. Copper Tubing: ASTM B306, DWV.
1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
 2. Joints: ASTM B32, lead-free (less than 0.2%) solder.
- C. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron.
 2. Joints: Neoprene gasket system and stainless steel clamp-and-shield assemblies.
- 2.03 WATER PIPING, ABOVE GRADE CONCEALED
- A. Copper Tubing: ASTM B88, Type L, hard drawn.
1. Fittings: ASTM B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
 2. Joints: ASTM B32, lead-free (less than 0.2%) solder.
 3. Fittings: Roll grooved copper, 300 psi rated, UL listed.
 4. Joints: Ductile iron grooved couplings with flush seal gasket, 300 psi rated, UL listed.
- 2.04 FLANGES, UNIONS, AND COUPLINGS
- A. Pipe Size 2 Inches and Under:
1. Ferrous pipe: 150 psig malleable iron threaded unions.
 2. Copper tube and pipe: 150 psig bronze unions with soldered joints.
- B. Pipe Size Over 2 Inches:
1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16-inch thick preformed neoprene gaskets.

2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16-inch thick preformed neoprene gaskets.
 - C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- 2.05 STOP VALVES
- A. Brass stop valves suitable for bubble-tight water service shutoff, chrome plated in finished areas. Key-operated in all public building areas, lever handle operated in all building service areas.
- 2.06 BALL VALVES
- A. Manufacturers:
 1. Apollo
 2. Milwaukee
 3. Stockham
 4. Watts
 - B. Up to and including 3 Inches: Bronze two-piece body, 600 psi WOG/125 psi WSP, steel plated ball, teflon seats and stuffing box ring, lever handle, and soldered or threaded ends to suit piping which valve will be installed in.
 - C. Valves shall have stem extensions suitable to allow for insulation of the valve body to the thickness of adjoining pipe without interfering with valve wheel operations.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever joining dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- I. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Section 09900.
- J. Install valves with stems upright or horizontal, not inverted.

3.03 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install ball valves for throttling, bypass, or manual flow control services.
- D. Install stop valves at each plumbing fixture water connection.
- E. Install other valve types and piping specialties as indicated on the Drawings.

3.04 ERECTION TOLERANCES

- A. Establish invert elevations, slopes for sanitary drainage to comply with the current edition of the 248 CMR Massachusetts Fuel Gas and Plumbing Code. Slopes for storm drainage to be 1/8 inch per foot minimum. Maintain gradients (unless otherwise indicated on the Drawings).

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, pressure tested, flushed and clean.
- B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 ppm.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.06 TESTING

- A. All other plumbing shall be tested in accordance with the 248 CMR Massachusetts Fuel Gas And Plumbing Code and the City of Springfield's requirements.

END OF SECTION

SECTION 15440
PLUMBING FIXTURES

PART 1 – GENERAL

1.01 WORK INCLUDED

A. General fixtures and fixture trim:

1. Water closets
2. Urinals
3. Lavatories

B. Flush valves.

C. Fixture carriers.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 Specification sections, apply to work of this Section.

B. All related Specification sections shall be used in conjunction with this Section.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 15010.

B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 15010.

B. Include fixture trim exploded view and replacement parts lists.

PART 2 – PRODUCTS

2.01 PLUMBING FIXTURES, TRIM, AND ACCESSORIES

A. Plumbing fixtures, trim and accessories are scheduled on the Drawings. Acceptable manufacturers for each type of fixture, trim and accessories are indicated in this section.

B. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers listed will be acceptable ONLY if their products are similar in quality, size, capacity, operating efficiency, function, adaptability to space requirements, etc. It shall be the Contractor's responsibility to demonstrate to the satisfaction of the Architect that the equipment,

as manufactured by other than the first name manufacturer, shall meet all requirements as to quality, size, capacity, function, adaptability to space requirements, etc.

2.02 ACCEPTABLE MANUFACTURERS - GENERAL FIXTURES AND FIXTURE TRIM

- A. Toto
- B. American Standard
- C. Kohler
- D. Eljer
- E. Elkay
- F. Moen
- G. Chicago Faucet

2.03 ACCEPTABLE MANUFACTURERS - FLUSH VALVES

- A. Sloan
- B. Zurn
- C. Toto

2.04 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS

- A. Toto
- B. Olsonite
- C. Kohler

2.05 ACCEPTABLE MANUFACTURERS - FIXTURE CARRIERS

- A. Zurn
- B. Jay R. Smith
- C. Josam

2.06 FIXTURE SCHEDULE

- A. All fixtures and accessories are scheduled on the Drawings.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.02 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with stop valves, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with floor-mounted wall carriers and bolts unless otherwise specified.
- E. Seal fixtures to wall and floor surfaces with acrylic sealant color to match fixture. Sealant shall be as specified in Section 07900.
- F. Mount fixtures to the heights scheduled on the Drawings and in accordance with the current handicapped accessible codes where applicable.

3.03 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion clean plumbing fixtures and equipment.
- C. Solidly attach water closets and urinals to carriers.

3.04 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with schedule on drawing of minimum sizes for particular fixtures.

END OF SECTION

SECTION 15890
DUCTWORK

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. HVAC ductwork

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES

- A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.
 1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 2. SMACNA - HVAC Duct Construction Standards.
 3. SMACNA - HVAC Duct Leakage Test Manual.

1.04 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

1.05 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 15010.
- B. Indicate duct fittings, types, and particulars such as gauges, sizes, welds, and configuration prior to start of work.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Steel Ducts: Fabricate with ASTM A653 Coating Designation "G60" zinc-coated (galvanized) steel sheet, of lock-forming quality. Steel sheet zinc coating shall be minimum of 0.60 oz. per sq.ft. total both sides, per Triple-Spot Test. Steel sheet shall be in accordance with ASTM A568 and/or ASTM A924. Testing shall be per ASTM A90.
- C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Sealant:

1. United McGill - United Duct Sealer (Water Base) or acceptable substitute.
 - a. Water-based duct sealant contains no solvents or asbestos and has no harmful fumes. It is nonflammable (wet or dry) and fire retardant. The antimicrobial and antibacterial agents contained in this sealant remain effective after it has cured.
 - b. Color: Gray.
 - c. Composition: Vinyl copolymer.
 - d. Solids Content: 69%.
 - e. Viscosity: 65,000 cps.
 - f. Weight per Gallon: 11.3 pounds.
 - g. UL Classified: Flame spread smoke developed at 0.020 inches thick.
 - h. Application temperature: +40 deg. F to +110 deg. F.
 - i. Operational Temperature: -25 deg. F to +200 deg. F.
 - j. Performance: Successfully tested to meet SMACNA leakage requirements; tests conducted from -40 inches wg to +40 inches wg.
 - k. Durability: Will exceed 500 hours under accelerated-aging (oxygen bomb) test conditions without degradation (ASTM D572); tested for 500 hours in QUV accelerated-exterior-aging apparatus with no degradation (ASTM C732).
 - l. Curing Time: 48 hours minimum.
 - m. Recommended Storage Temperature: +75 deg. F.

- E. Hanger Rods: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.02 HVAC DUCTWORK

- A. Fabricate, install, and support in accordance with SMACNA HVAC Duct Construction Standards and other referenced standards, except if more stringent requirements are specified or indicated on the Drawings. For each ductwork system provide duct material, gauges, and reinforcing, for external static pressures indicated on the drawing schedules. All ductwork on the project shall have a minimum basis of compliance of 2" W.G. pressure class.
- B. Ductwork shall be sealed in accordance with Seal Class A as defined in the SMACNA HVAC Duct Construction Standards.
- C. Size round ducts installed in place of rectangular ducts in accordance with SMACNA table of equivalent rectangular and round ducts. No variation of duct configuration or sizes is permitted except by written permission from the Architect.

D. Fittings:

1. Construct all elbows, offsets, "tees," bends, turns, etc., with full radius inside (throat) and full radius outside (heel) duct wall. Inside and outside radii shall correspond to a fitting centerline radius of 1-1/2 times the width of the duct.
 2. In instances where a fitting centerline radius of 1-1/2 times the width of the duct cannot be installed, a fitting centerline radius equal to the width of the duct (1 times duct width), may be permitted. Fittings with a centerline radius less than the width of the duct (<1 times duct width) shall not be permitted.
 3. Radius fittings with a centerline radius less than 1-1/2 times the width of the duct shall be provided with full length splitter vanes, spaced per SMACNA design standards. Splitter vanes shall be fully welded in place. The Engineer's approval of the splitter vane design is required prior to fabrication.
 4. In instances where short radius fittings cannot be installed, rectangular mitered fittings may be permitted, provided single thickness turning vanes are installed. Turning vanes shall be continuously welded into supporting tracks. Turning vane supporting tracks shall be secured in fittings with sheet-metal screws or rivets for ducts with pressure classifications less than 2" W.G. For ducts with pressure classifications of 2" W.G. or greater, turning vane supporting tracks shall be welded into the fittings. Turning vanes shall be installed such that the leading and trailing edges of the vanes are plumb and parallel to the airstream for all fittings.
 5. Fittings with radius outside (heel) and square inside (throat) duct wall shall not be accepted. Mitered fittings without turning vanes shall not be accepted.
- E. Branch takeoffs shall be 45-degree lateral wye, conical tee, or bellmouth type, or square-to-round dovetail type. Other takeoff types shall not be used except by written permission from the Architect.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. For duct pressure classification less than 2" W.G., divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees. For duct pressure classifications over 2" W.G., divergence upstream of equipment shall not exceed 15 degrees; convergence downstream shall not exceed 45 degrees.
- G. Do not use ductwork easements without written permission from the Architect.
- H. Use crimp joints with or without bead for joining round duct sizes 8-inch and smaller with crimp in direction of air flow.
- I. Longitudinal lock seams shall be double-locked and flattened to make tight joints.
- J. Make transverse joints, field connections, collar attachments, and flexible connection to ducts and equipment with sheetmetal screws or bolts and nuts. Do not use rivets and staples.
- K. Transverse joints shall be slip joint construction, except as described below.
- L. Except for duct 16-gauge and heavier, and duct 23-gauge or lighter, transverse joints in galvanized sheetmetal ductwork may be made with prefabricated galvanized gasketed frame and angle duct joint system by Ductmate, TDF, or TDC. Angles shall be at least 20-gauge. Secure angles to duct with screws or spot welds spaced as recommended by the joint manufacturer for the particular duct pressure class.

- M. Use double nuts and lock washers on threaded rod supports.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Provide openings in ductwork where required to accommodate thermometers and controllers. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- B. Ductwork shall be sealed in accordance with Seal Class A as defined in the SMACNA HVAC Duct Construction Standards.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent or minimize construction dust from entering ductwork system.
- E. Ductwork Application Schedule:

AIR SYSTEM	MATERIAL
Supply and Return	Galvanized Steel

3.02 ADJUSTING AND CLEANING

- A. Where necessary, clean duct system and force air at high velocity through duct to remove any accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- B. Where necessary, clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- C. The Architect reserves the right to require full cleaning of all interior ductwork surfaces as part of this contract. It is imperative that construction dust entering the ductwork system be prevented or minimized at all times.

END OF SECTION

SECTION 15910
DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Volume control dampers.
- B. Fire dampers.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.03 REFERENCES

- A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.
 - 1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 - 2. SMACNA - HVAC Duct Construction Standards.

1.04 REGULATORY REQUIREMENTS

- A. Comply with NFPA 90A and SMACNA standards.

1.05 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 15010.
- B. Submit manufacturer's installation instructions for fire dampers.

PART 2 – PRODUCTS

2.01 VOLUME CONTROL DAMPERS.

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 12 inches high and 48 inches wide.
- C. For duct sizes over 12 inches high or 48 inches wide, fabricate multi-blade dampers of opposed blade pattern. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

- E. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- F. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.02 ACCEPTABLE MANUFACTURERS - FIRE DAMPERS

- A. Greenheck
- B. Arrow
- C. Ruskin
- D. Air Balance/American Warming

2.03 FIRE DAMPERS

- A. Provide vertical UL labeled fire dampers where indicated on the drawings. Assembly shall consist of formed steel blades with 100 percent interlocking joints to form a continuous steel curtain when closed. Damper shall meet NFPA 90A requirements.
- B. Provide 16-gauge galvanized steel duct sleeves for dampers in ducts with maximum height dimension of 24 inches and maximum width dimension of 36 inches, and 14-gauge galvanized duct sleeve for larger duct sizes. Depth of sleeve shall be sufficient to install perimeter angles attached to the sleeve on both sides of the wall as required by UL-555.
- C. Fire dampers shall be designed and constructed so that the blade stack in the open damper position is completely outside the air stream.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Provide volume control dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
- C. Provide duct test holes where required for testing and balancing purposes.

END OF SECTION

SECTION 15936
AIR OUTLETS AND INLETS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Registers.
- B. Grilles.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.03 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.04 SUBMITTALS

- A. Submit product data under provisions of Section 15010.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. Where Architect is to make color selection, submit color charts indicating available colors.
- E. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - DIFFUSERS, REGISTERS, AND GRILLES

- A. Match existing manufacturer in project area.
- B. Tuttle & Bailey
- C. Metalaire
- D. Titus
- E. Krueger
- F. Price

2.02 REGISTERS, AND GRILLES

- A. Provide diffusers, registers, and grilles of the types and sizes as indicated on the drawings and as specified herein. Tuttle & Bailey, Price, Metalaire, Nailor, Titus, and Kreuger are acceptable manufacturers provided that they can provide diffusers of the same types, materials, sizes, and performance (including noise levels) which the design has been based on.
- B. Where indicated for registers, neck size opposed-blade dampers shall be provided.
- C. Provide transitions where round duct ductwork is to be connected to square or rectangular necks, and where square or rectangular ductwork is to be connected to square or rectangular necks of different sizes.
- D. Provide registers, and grilles specifically intended for the type of ceiling, wall or floor in which they are to be installed.
- E. All ceiling-mounted registers and grilles shall be of the overall size indicated on the Drawings.
- F. All ceiling-mounted registers and grilles shall have baked enamel finish of color to be selected by the Architect.
- G. All wall-mounted registers and grilles shall have baked enamel finish of color to be selected by the Architect.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install registers and grilles to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to grilles and registers, regardless of whether dampers are specified as part of the grille or register assembly.

END OF SECTION

SECTION 16000
ELECTRICAL TRADE CONTRACT REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. The Electrical Work includes the Work specified in the following Sections:
 - 1. All Division 1 Sections.
 - 2. All Division 16 Sections.
- B. Electrical Work is shown on E-Series drawings.
 - 1. The Electrical Subcontractor shall also refer to the Drawings showing work of other trades for proper coordination.

1.02 FILED SUB-BID REQUIREMENTS

- A. Submit sub-bids in accordance with the provisions of Massachusetts General Laws, Chapter 149, Sections 44A-44J, and in accordance with the INSTRUCTIONS TO BIDDERS. The time and place of submission of sub-bids is set forth in the Instructions to Bidders.
- B. Submit each sub-bid for the work of this Section on the form furnished by the Awarding Authority.
- C. With each sub-bid, submit a bid deposit in the form of a bid bond, or a certified check on, or a treasurer's or cashier's check issued by, a responsible bank or trust company, payable to the Awarding Authority, in the amount of five percent (5%) of the bid amount. A bid bond shall be (a) in a form satisfactory to the Awarding Authority, (b) with a surety company qualified to do business in the Commonwealth of Massachusetts and satisfactory to the Awarding Authority, and (c) conditioned upon the faithful performance by the principal of the agreements contained in the bid.
- D. For the following class or classes of work, list on the bid form the names of persons, firms and corporations furnishing to the sub-bidder labor or labor and materials for the class or classes or part thereof, the name of such class of work or part thereof, and the bid price for such class of work or part thereof:

Class of Work	Section(s)	Paragraph References
1. None	N/A	N/A

- E. The Trade Contractor selected to perform this work will be required to furnish a performance bond and a payment bond, each in the amount of one hundred percent (100%) of the Trade Contract price.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Basic electrical requirements specifically applicable to Division 16 sections, in addition to Division 1 - General Requirements.
- B. Furnish all labor, materials, services, supplies, tools, equipment, apparatus, transportation, facilities and incidentals required and perform all operations necessary to accomplish and complete installation of the electrical power, lighting, motor control systems, and electrical accessories as shown on the Contract Drawings, specified herein or as reasonably may be implied as being incidental to this work, and as required for complete electrical systems.
- C. The performance of the work under Division 16 shall be in accordance with the regulations and rulings of all authorities having jurisdiction over the work.
- D. The scope of work involves and includes but is not limited to the following:
 - 1. Power and control wiring for equipment by mechanical and other systems.
 - 2. Grounding.
 - 3. Lighting systems.
 - 4. Fire alarm system additions and modifications.
 - 5. Electrical systems removal/demolition.

1.02 RELATED DOCUMENTS

- A. This Specification is partially of the abbreviated or "streamlined" type and includes incomplete sentences. Omitted words or phrases shall be supplied in inference in the same manner as they are when a "note" occurs on the Drawings. Words "shall be" will be supplied by inference where colon (:) is used within sentences or phrases.
- B. Drawings and general provisions of the Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- C. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- D. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It

remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

- E. All related Specification Sections shall be used in conjunction with this Section.

1.03 DEFINITIONS

- A. Definitions pertaining to Division 16:

1. Provide: Furnish, install and connect.
2. Furnish: Supply materials only.
3. Indicated: On Contract Drawings.
4. Concealed: Hidden from sight at completion of work.
5. Trade: General Contractor, HVAC, plumbing, etc.
6. Contractor: The person, firm or corporation performing the work called for in this Electrical Specification, whether they be prime or sub.
7. Whenever the word "Engineer" appears, it shall be construed as meaning the Owner's representative.

1.04 SUBMITTALS

- A. Refer to Division 1 for submittal requirements. The following paragraphs supplement the requirements of Division 1.
- B. Submit shop drawings and product data as requested by other Division 16 sections. All submittals to follow requirements of General Conditions, modifications to General Conditions, and Division 1.
- C. The Contractor will be held responsible for checking and verifying all field measurements, and shall submit promptly, as to cause no delay in any work, shop drawings and schedules required for the work. The Contractor shall check and approve all submittals before forwarding to the Architect. All submittals shall be transmitted to the Architect using the submittal transmittal form contained in Division 1. The Architect will forward submittals to the Engineer. The Engineer will check and review the submittals with reasonable promptness, but only for conformance with design concept of the project and for compliance with information given in Contract Documents. The Contractor shall make any corrections required by the Engineer. The Engineer's review of submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications, unless he has, in writing, called the Engineer's attention to such deviations at the time of submission and has secured the Engineer's written approval. Additionally, the Engineer's review of submittals shall not relieve the Contractor from responsibility for any errors or omissions contained in the submittals.
- D. Submittals shall be clear and concise. The submittals shall clearly indicate the product name, applicable Specification Section, proposed location and all features and ratings. The intended product shall be differentiated from others with a model number or highlighting.

- E. When necessary, shop and setting drawings shall be based upon actual measurements taken at the site and upon other job conditions. Show any variations and revisions to Drawings or Specifications that are necessary for proper installation.
- F. Submit copies of manufacturer's shop drawings showing illustrated cuts of item to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, installation instructions, wiring diagrams and controls and all pertinent information. Submit the quantity of copies indicated in Division 1.
- G. The Contractor shall note that where more than one manufacturer's name is listed for the various major items of equipment and materials specified herein, the plans and specifications have been developed on the basis of equipment as manufactured by the first manufacturer name. Other manufacturers names are included to indicate the equipment manufactured by them may be considered acceptable for this project, provided that the equipment meets all requirements as to quality, size, adaptability to space requirements, etc. It shall be the Contractor's responsibility to assure that the equipment, as manufactured by other than the first name manufacturer, shall meet all requirements as to equipment ratings, quality, size, capacity, function, adaptability to space requirements, etc. The Engineer's review of shop drawings for equipment as manufactured by other than the first named manufacturer shall in no way relieve the Contractor of this responsibility.

1.05 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 for operation and maintenance manual requirements. The following paragraphs supplement the requirements of Division 1.
- B. The Contractor shall provide the following information in a bound manual:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 2. Manufacturer's printed operating procedures to include start-up, routine and normal operating instructions; regulation, control, and emergency instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and schedules.
- C. Two (2) copies of operations and maintenance data shall be submitted to the Architect for review: one (1) copy shall be returned to the Contractor (with any instructions for changes). After implementing any changes, five (5) copies of instructions covering all equipment shall be furnished to the Architect who will forward two (2) copies to the Owner for his information and use.
- D. Append to the manual, the name, address and telephone number of the Contractors and Subcontractors and for electrical items, provide the name, address and telephone number of companies servicing installed equipment on a 24-hour basis.
- E. After submission and approval of the operating and maintenance data, the Contractor shall furnish competent Operation Engineer(s) at such time or times as directed by the Architect to meet with the Owner or his representative, to fully explain instructions and to demonstrate and fully familiarize the Owner or his representative with all of the equipment and all phases of its operation and maintenance. The amount of time devoted to instructions shall be reasonable and consistent with the size of the installation and the complexity therefore. Instructions shall be

adequate to the extent that the Owner's personnel may proceed with normal operations in a safe and efficient manner.

1.06 FINAL SUBMITTALS

A. As a requisite for final acceptance, the following are required:

1. Project Record Documents:

- a. During progress of the Work, maintain an accurate record of the installation of the electrical system, locating each concealed conduit precisely by dimension. This shall include, but not be limited to: conduit below ground level and in or below building slab. All service, sub-service and main riser conduits for both power and communication systems. All spare conduits stubbed in concealed spaces and the locations of all electrical equipment essential for system operation (such as end of line resistors, etc.).
- b. Upon completion of the electrical installation, transfer all record data to prints of the original Drawings. Where required by Division 1, provide project record documents in AutoCAD file format.

2. Manual: Upon completion of the electrical installation, and as a condition of its acceptance, deliver to the Owner and the Engineer operation manuals compiled in accordance with the provisions of Division 1 and paragraph 1.05 of this Specification Section; include one copy of as-built Project Record Drawings in each copy of the manual. Provide quantity of manuals as required in Division 1.

3. Certificates:

- a. Two (2) copies of the City Building Inspector's Certificate of Approval showing acceptability of work done under this Contract. Deliver to the Owner with a copy to the Engineer.
- b. Two (2) copies of any other Certificates of Approval. Deliver to the Owner with a copy to the Engineer.

4. At completion of construction, the Contractor shall furnish the Owner with one (1) unused copy of all reviewed shop drawings, manufacturer's diagrams, installation instructions, literature, etc., that were used in execution of the work.

5. Warranties: Provide all indicated warranties in accordance with Division 1.

1.07 SUBSTITUTIONS

A. Any and all proposed substitutions must be approved by the Architect during the bid phase and must be indicated on the form of proposal. For specific substitution requirements, refer to Division 1.

1.08 COORDINATION

A. Coordinate scheduling, proposed routing, and critical dimensions with all other trades prior to roughing and equipment installation.

- B. It shall be the responsibility of the Contractor to verify dimensions and elevations shown or scaled on Drawings by actual field measurements after building construction has progressed to the point where such measurements may be taken.
- C. Advise Owner in writing regarding those critical dimensions which must be held by other Trades as they perform their work.
- D. Assume full responsibility for accuracy of all work under this Division and make corrections as required.
- E. It shall be this Division's responsibility to coordinate with all other Trades and separate equipment contracts regarding mechanical equipment layouts, space requirements, mounting details, "roughing-in" dimensions, and for items substituted for those specified herein to avoid conflict.
- F. Layouts of feeders and wiring shown on Drawings are diagrammatic, and shall be constructed as such, intended to show scope of work and general arrangement, unless otherwise noted.
- G. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment.
- H. Where job conditions require reasonable changes in indicated locations or arrangements prior to roughing, make such changes without extra cost to the Owner.
- I. Any Work installed contrary to or without approval of the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed the Contractor for making these changes.
- J. Provide all power wiring to equipment furnished by this and other Trades (heating, ventilation, plumbing, general construction, etc.) unless otherwise indicated or specified.
- K. Control wiring by Division 16 shall include, but not be limited to that wiring between starters, controllers, interlocks and motors not included as a manufacturer packaged unit, wired by factory installers or wired by Temperature Control Trade.
 - 1. Where only portions of control packages are prewired, Division 16 shall provide balance of power and control wiring, and as indicated on control diagrams.
- L. Division 16 shall provide all required circuit breakers in addition to those indicated on panelboard schedule for equipment provided by other divisions.
- M. Where locations are dimensioned on the Drawings, they may be changed only with the written approval of the Owner or his representative. If interferences are found between the electrical work and that of other Trades, Owner shall decide which must be relocated.
- N. Contractor shall study and compare all Contract Drawings, Specifications, and other instructions and shall at once report to the Engineer any error, inconsistency or omission which he may discover.
- O. Where a conflict occurs between this Specification and other Contract Documents, the more stringent requirements shall govern.
- P. Contractor shall have a competent foreman in charge of work with authority to receive verbal and written instructions from Owner. Contractor shall inform Owner of foreman's name and title.

- Q. The Drawings are diagrammatic and functional only, and are not intended to show exact layouts, number of fittings, or other installation details. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.
- R. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be verified during construction so that they shall coordinate with all other work and equipment. The Contractor shall obtain in the field all information relevant to the placing of electrical work and, in case of any interference with other work, shall proceed as directed by the Engineer and shall furnish all labor and materials necessary to complete the Work in an approved manner.
- S. The ratings of motors and other electrically operated devices, together with the size shown for their branch circuit conductors and conduits, are approximate only, and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment. Equipment sizes may vary from sizes indicated on the Drawings and must be verified with actual equipment to be furnished and coordinated with all other equipment and material sizes. If equipment or material sizes need to change due to this coordination, such changes shall be made with prior Engineer approval and at no cost to the Owner.

1.09 QUALITY ASSURANCE

A. Qualifications of Installers:

- 1. For the actual fabrication, installation, and testing of the Work of this Division, use only thoroughly trained and experienced personnel who are completely familiar with the codes and requirements for this Work and with the installation recommendations of the manufacturers of the specified items.

B. Workmanship:

- 1. Complete electrical installation shall be made in a neat and workmanlike manner and to the full satisfaction and approval of the Owner and Engineer.
- 2. Work not meeting Owner's standard for adequate workmanship shall be removed and replaced at once, at no additional Contract cost to the Owner.
- 3. Remove and replace all work rejected by Owner as defective, non-operational or not in conformance with intent of this Contract.

1.10 REGULATORY REQUIREMENTS

A. Perform the work and provide material under this Division in strict accordance with applicable provisions of all governing codes, rules, laws and ordinances as amended and in effect on date of issue for bids, specifically including but without being limited to:

- 1. American National Standards Institute (ANSI).
- 2. American Society for Testing Materials (ASTM).
- 3. Americans with Disabilities Act (ADA).
- 4. Association of Edison Illuminating Companies (AEIC).
- 5. Canadian Standards Association (CSA)

6. Edison Electric Institute (EEI).
 7. Environmental Protection Agency (EPA)
 8. Factory Mutual (FM)
 9. Federal Communications Commission (FCC)
 10. Federal Information Processing Standards Publication 94 (FIPS Pub 94)
 11. Institute of Electrical and Electronics Engineers (IEEE).
 12. Insulated Cable Engineers Association (ICEA).
 13. International Building Code (IBC)
 14. International Electrotechnical Commission (IEC)
 15. International Energy Conservation Code (IEEC)
 16. International Organization for Standardization (ISO 9001)
 17. Local ordinances, regulations and electric codes.
 18. Occupational Safety and Health Act (OSHA).
 19. National Electrical Code (NEC).
 20. National Electrical Safety Code (NESC).
 21. National Electrical Manufacturers' Association (NEMA).
 22. National Fire Protection Association (NFPA).
 23. Requirements for Underwriters' Laboratories, Incorporated for all items installed for which UL standards have been established.
 24. Pertinent requirements of the local utility companies.
- B. In each case, codes are minimum requirements.
- C. It shall be understood that all codes and standards mentioned shall be those in force at the time the Contract is signed. If any code is changed during the construction period, these Specifications may be changed by change order.
- D. Each item of equipment and material shall conform to requirements of these applicable publications which make them most suitable for environmental conditions where they shall be installed.
- E. Items which are within scope of items tested by Underwriter's Laboratories, Inc., or other suitable nationally recognized independent testing laboratories shall have their conformance with these applicable publications evidenced by attachment of authorized seal, label, or stamp of those testing laboratories.
- F. The Contractor shall cooperate with and assist Owner in securing from the authority enforcing the codes any "special permission" or interpretation needed to complete work.
- G. The work required by the Drawings and the Specifications shall comply with applicable codes. Conflicting provisions of the Contract Documents to the contrary notwithstanding, it shall be the sole responsibility of the Contractor as part of the base Contract to execute the work so as to obtain the approval of the Local Authority at completion of the work.

- H. On preparing his bid, the Contractor shall carefully check the Drawings and Specifications for compliance with applicable codes and other legal requirements. He shall inform the Engineer in writing of any non-conformance before he submits his bid.

1.11 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on the Drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect before proceeding.

1.12 PRODUCTS

- A. In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays and other items is essential. All similar items shall be of the same manufacturer, type, model and dimensions or, in the case of special systems which are a composite of a number of manufacturers' products, shall be supplied and/or serviced from an organization with one source of responsibility.
- B. Provide products which are compatible within systems and other connected items.
- C. For ease of maintenance and parts replacement, to the maximum extent possible, use equipment of a single manufacturer.
- D. The Engineer reserves the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to the maximum extent possible.
- E. All equipment and fixtures shall be of the capacity and type shown on the Drawings and specified herein and shall be as manufactured by one of the manufacturers designated or shall be an equal approved in advance by the Engineer.
- F. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.
- G. Install all equipment and fixtures in complete accordance with the manufacturer's recommendations and all pertinent codes and regulations.
- H. Materials and equipment shall be listed by Underwriters Laboratories unless it can be demonstrated that no UL standards exist for a specific items or class of equipment.

1.13 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated electrical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly packaged and protected to prevent damage during shipment, storage, and handling.

- B. Use all means necessary to protect electrical system materials during and after installation and to protect the installed work and materials of all trades until testing and final acceptance.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- D. Provide approved protection of all work and property against damage, injury, loss, etc., until testing and final acceptance. Follow manufacturer's recommendations for protection of equipment and materials during storage and construction; protect equipment outlets, pipe and conduit openings with temporary plugs or caps.
- E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
- F. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.
- G. The Contractor shall be responsible for the work of other trades that may be damaged or disturbed in the course of his work and he shall restore the damaged work to the condition existing prior to damage without additional cost to the Owner.

1.15 ELECTRICAL INSTALLATION

- A. Coordinate electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. Where mounting heights are not detailed or dimensioned, install electrical conduits and services to provide the maximum headroom possible.
- E. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- F. Coordinate the installation of electrical materials, light fixtures, and equipment in ceilings with suspension system, mechanical equipment, and other piping installations.
- G. Note that special efforts have been made to layout mechanical and electrical systems exposed to view in order to achieve a certain aesthetic quality. The Contractor is responsible to layout and install all systems, especially those exposed to view, in a neat, orderly, and workmanlike manner in order to provide a high quality installation, and to maintain the desired aesthetic quality, as appropriate.

1.16 CUTTING AND PATCHING

- A. Unnecessary cutting and patching shall be avoided through proper planning of work, provision of pipe and duct sleeves and cooperation with other Contractors. Each Contractor shall be responsible for all cutting, patching and restoration of his own work at no expense to the Owner and to the satisfaction and approval of the Owner.

- B. In no case shall structural members be cut or notched without approval of the Engineer.
- C. All patching shall be done only by mechanics who are skilled in this line of work to produce a neat finished job acceptable to the Owner in all respects.
- D. Repair and/or replace the work of Trades damaged as a result of work performed under this Division, at no additional cost to the Owner.

1.17 SURFACE CONDITIONS

- A. Inspection:
 - 1. Prior to all work of this Division, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 2. Verify that the electrical installation may be made in complete accordance with all pertinent codes and regulations and the original design.
- B. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Engineer.
 - 2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

1.18 CLEANING

- A. Thoroughly inspect all equipment and any items dented, scratched or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish.
 - 1. All items so repaired and refinished shall be brought to the attention of the Engineer for inspection and approval.
- B. Upon completion of all installation, lamping, and testing, thoroughly inspect all exposed portions of the electrical installation and completely remove all exposed labels, soil, markings and foreign material.

1.19 VISIT TO SITE

- A. As there may be various conditions at the site which do not show on the accompanying Drawings, or which are at variance with the conditions indicated on the Drawings, it is important that each Bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

1.20 EXISTING SERVICES

- A. Active: When encountered in work, protect, brace, support existing active drains, gas, electric, water, other services where required for proper execution of work. If existing active services are encountered that require relocation, make request in writing for determination. Do not prevent or disturb operation of active services that are to remain. Repair broken service at no cost to the Owner. Record any existing services encountered on Contractor's job site drawing sets.

- B. Inactive Services: When encountered in work, remove cap or plug inactive services. Notify Owner; protect or remove these services as directed. Record on "as-built" drawings.
- C. Interruption of Services: Where work makes temporary shutdowns of services unavoidable, shutdown at night or at such terms as approved by Owner, which will cause least interference with established operating routine. Arrange to work continuously, including overtime, if required, to assure that services will be shutdown only during time actually required to make necessary connections to existing work.

1.21 MECHANICAL SYSTEMS COORDINATION

- A. Furnish and install, as indicated on the electrical drawings all disconnect switches, motor overload protective devices, contactors, magnetic starters, complete with required pushbuttons, selector switches, and pilots.
- B. Provide all power wiring as indicated on the electrical drawings.

1.22 OVERCURRENT PROTECTION COORDINATION

- A. New overcurrent protective devices shall be coordinated with the existing system. It shall be the responsibility of the Contractor to provide a coordination study to ensure proper circuit opening sequence and equipment protection. Applicable ANSI and IEEE standards shall be followed. Contractor shall obtain necessary time current curves for existing equipment to perform the study. Provide to the Engineer prior to equipment approval, in one bound submittal in accordance with Division 1, the following:
 - 1. Type written description of the coordination study and parameters used.
 - 2. Time current curves for all overcurrent protective devices involved (existing and new).
 - 3. One-line diagram indicating overcurrent protective devices location in circuit, type and settings, if needed.
 - 4. Letter by Contractor stating that coordination study has been performed, who performed the study and that equipment is properly coordinated.
- B. The Engineer reserves the right to review the submittal for conformance with this Contract. Engineer approval is needed prior to equipment purchase. Conform to Division 1 for submittal requirements.

1.23 WARRANTIES

- A. Refer to Division 1 for warranty requirements. The following paragraphs supplement the requirements of Division 1.
- B. Compile and assemble all warranties for equipment specified in Division 16 into vinyl-covered three-ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item. Include product or equipment, date of beginning of warranty or bond, duration of warranty or bond, and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.24 GUARANTEE

- A. The Contractor shall guarantee all work to be free from defects for a period of one (1) year after acceptance. Any and all work found defective or not in accordance with the Contract during this

period shall be corrected promptly by the Contractor after written notification from the Owner. The Contractor shall repair or correct the work within ten (10) days of the written notification and if the Contractor does not comply, the Owner may have the work corrected and charge all such work to the Contractor.

1.25 PHASING/WORK SEQUENCING

- A. Refer to General Conditions and Division 1 sections, and to the Construction Manager's and Architect's phasing and/or work sequencing descriptions and/or plan(s), for necessary phasing/sequencing of this project.
- B. Coordinate with the Construction Manager or General Contractor in order to determine all phasing/sequencing requirements and to schedule work. Electrical work shall be executed in such a manner as to cause minimal or no disruption of other trades' activities in the building. Coordinate all deliveries, installations, etc. as required to avoid disruption and/or inconvenience. Continue to inform the Construction Manager and the Architect of work anticipated to take place each day and/or week, sufficiently in advance of the work for comment and potential redirection of those activities to avoid conflict and/or disruption

1.26 CADD DISCS

- A. Following the receipt of a written request from the Contractor, RFS will furnish CADD discs/CD-ROMs for electrical drawings. Signing of the following disclaimer shall be considered prerequisite for the release of CADD discs/CD-ROMs.

"The file recipient agrees to accept computer diskettes/CD-ROMs and electronic files from Rist-Frost-Shumway Engineering (RFS) without any warranties, guarantees, and/or representations of any nature whatsoever regarding the correctness, accuracy, and/or completeness of any information contained herein.

"The recipient acknowledges that the use of diskettes and electronic files is entirely at its own risk, and agrees to release, indemnify, hold harmless, and defend RFS with respect to any claims, costs, losses, damages and/or liabilities arising out of or relating to the use, misuse, modification, interpretation, misinterpretation and/or misrepresentation of any such information."

1.27 ALTERNATES

- A. Refer to General Conditions and other Division 1 sections for additional information concerning bid alternates associated with this project.
- B. Alternate No. 1: Provide an ADD ALTERNATE price for providing the panelboard B2C and associated feeder conduit with cable from panel D2N2A.
- C. Alternate No. 2: Provide an ADD ALTERNATE price for providing the panelboard B3C and associated feeder conduit with cable from panel D2N2A.
- D. Alternate No. 3: Provide an ADD ALTERNATE price for providing the replacement of the corridor lighting as shown on drawing E1.1.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Power system grounding.
- B. Equipment grounding.
- C. Building ground grid.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Product Data: Subject manufacturer's data on grounding systems and accessories.
 - 1. Grounding conductors and connectors.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Firms regularly engaged in manufacturer of electrical connectors, terminals and fittings of types and ratings required and ancillary grounding materials, including stranded cable, copper braid, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring.
- D. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467, 486A and 869 pertaining to electrical grounding and bonding. Provide grounding products which are UL-listed and labeled.
- E. IEEE Compliance: Comply with applicable requirements of IEEE Standard 80 and 142 pertaining to electrical grounding.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle electrical grounding accessories and components carefully to avoid damage; store in original wrappings and protect from dirt and weather.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, providing grounding products of one of the following:
 - 1. Mechanical and compression connectors and fittings:
 - a. Anderson
 - b. Blackburn
 - c. Burndy
 - d. Dossert
 - e. OZ/Gedney
 - f. Thomas & Betts
 - 2. Exothermic connectors:
 - a. Erico Products, Inc. (Cadweld)
- B. Substitutions: Items of equal quality, function, and performance may be proposed for substitution by following procedures outlined in Section 16010.

2.02 MATERIALS AND COMPONENTS

- A. General: Except as otherwise indicated, provide electrical grounding systems indicated, with assembly of materials including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.
- B. Conductors: Provide bare, stranded, concentric lay, soft drawn annealed copper cable, Class A or B. Where insulated grounding cables are required, they shall be stranded, 600 volt, Class B., with high molecular weight polyethylene (HMWPE) insulation. Provide conductors in sizes as specified on the Drawings. In instances where sizes are not specified or where NEC requirements are more stringent, provide conductors sized according to NEC.
- C. Provide miscellaneous grounding materials (nuts, bolts, washers, etc.) fabricated of copper-silicon alloy or stainless steel.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Installer must examine areas and conditions under which electrical grounding connectors are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 GROUNDING AND BONDING

- A. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- B. Flexible metal conduit and fittings not approved for ground bonding shall have bonding jumper.
- C. All equipment enclosures, control panels, motor frames, conduit systems, cable armor, cable tray system, exposed structural steel and similar items shall be grounded.
- D. Conduit runs, metallic wireways and cable trays shall be joined together to form a continuous electrical conductor through standard fittings and connectors.
- E. The Contractor shall exercise care to ensure good ground continuity, in particular between conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.
- F. Circuit Grounding: Install grounding bushings, grounding studs, and grounding jumpers at pullboxes, motor control centers and panelboards.
- G. Bonding Jumpers: Provide green insulation, sized correlated with over-current device protecting the wire, attached to grounding bushings on conduit or to lugs on boxes and other enclosures.
- H. Bonding Wires: Install bonding wire when using flexible conduit connected at each end to a grounding bushing.
- I. Where a grounding connection requires the removal of, or disturbs a galvanized or other finished surface, the entire connection shall be suitably finished to provide equal protection.

- J. All contact surfaces that are bolted connectors shall be thoroughly cleaned to bright metal and coated with "NO-OX-ID," or equal, before connections are made.

3.03 BONDING FOR OTHER TRADES

- A. All bonding conductors shall be installed in a neat and workmanlike manner, properly shaped for contour of surface involved and properly supported. At locations remote from the switch gear, bond to the largest raceway nearby.
- B. The points of attachment of the bonding jumper shall be accessible.

END OF SECTION

SECTION 16070
SUPPORTING DEVICES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Hangars, straps, clamps, steel channel, and fastening hardware for supporting and anchoring conduit and electrical equipment.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 16010.
- B. Provide manufacturer's catalog data for supporting devices and fastening systems.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements provide products by the following:
1. Hangars, straps, and beam clamps:
 - a. Appleton
 - b. Raco, Inc.
 - c. Steel City
 - d. O.Z./Gedney Co.
 - e. Midland Ross
 - f. Erico
 - g. Minneralac
 2. U-channel systems, slotted angle, and fittings (1-5/8" x 1-5/8", 12-gauge):
 - a. B-line
 - b. Unistrut
 - c. Globe Strut
 3. Anchors:
 - a. B-line
 - b. Hilti
 - c. Acherman-Johnson Corp.
- B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 16010.

2.02 CONDUIT SUPPORTS

- A. Single Runs: One-hole malleable conduit strap with backer or ring bolt type hangers with clamp backs.
- B. Multiple Runs: Conduit rack with 25% spare capacity. Rack shall be of galvanized steel channel supported by double nuts on 3/8-inch continuous thread, galvanized or cadmium plated steel hanger rods.
- C. Vertical Runs: Channel support with conduit fittings.

2.03 MC/AC TYPE CABLE SUPPORTS

- A. Only metallic snap-in type support clips approved for armored MC or AC type cable may be used.

2.04 EQUIPMENT SUPPORTS

- A. Equipment to be mounted on exterior block or concrete walls or where indicated shall be mounted on 1-5/8" x 1-5/8" minimum galvanized steel channel anchored to the wall.

- B. Equipment weights shall not exceed supporting device capacity.

2.05 ANCHOR METHODS

- A. Hollow Masonry: Toggle bolts shall be all steel spring head type.
- B. Concrete and Solid Masonry: Steel expansion anchors or preset inserts. Steel sleeve and expansion anchors utilizing a threaded bolt, lag bolt or threaded stud.
- C. Metal Surfaces: Machine screws, bolts, or welded studs. Machine screws, bolted clamps or power-driven threaded studs.
- D. Wood Surfaces: Wood screws. Pan head sheet metal screws or lag bolts.
- E. Concrete Surfaces: Self-drilling anchors or power-driven studs.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Layout to maintain headroom, neat mechanical appearance and to support equipment loads required.
- B. Conduit and equipment supports shall not impair the building structural integrity. Structural steel joists shall not be drilled or cut. Secure hangers to these materials with mechanical clips.

3.02 SUPPORTS FOR EQUIPMENT

- A. Contractor shall provide all necessary supports for equipment installed under this Specification Section. Supports shall consist of steel frames, plates, brackets, racks and other shapes of adequate size and fastened with bolts, screws or by welding, to provide rigid support. Welds shall be continuous and, where exposed, ground smooth. Thoroughly clean metal surfaces and apply one coat of primer as required and two coats of finish paint to match equipment. Any other material to be used for support shall have the Engineer's prior approval.
- B. Contractor shall be responsible for fabricating and installing all necessary supplemental supporting structures, including clips, brackets, etc., for conduits, fixtures, and electrical equipment not otherwise provided on pipeways, buildings, vessels, and structures. These shall be adequate for spare or future facilities where applicable.
- C. Contractor shall check for the extent of fireproofing on all structures and install, as approved, the necessary clips or brackets, required for the support on conduits, fixtures, devices and equipment. Conduits shall not be imbedded in fireproofing.
- D. The Contractor shall be fully responsible for the proper sizing and assembling of support systems to adequately and rigidly support raceways and/or equipment mounted thereon with a safety factor of at least three.

END OF SECTION

SECTION 16075
ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Nameplates for all panelboards, cabinets, safety switches, contactors, motor-controllers, individual circuit breakers, control devices, motor control centers, unit substations, switchgear and any other equipment used to control, switch or disconnect electrical circuits shall be provided by the Contractor under Division 16 of the specifications.
- B. Provide warning labels regarding potential electric arc flash hazards in all switchboards, panelboards, motor control centers, and industrial control panels per NEC 110-16.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit product data and listing of equipment nameplate lettering.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Brady
 - 2. Ideal Industries
 - 3. Thomas & Betts
 - 4. Panduit
- B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 16010.

2.02 NAMEPLATES

- A. Equipment nameplates shall be 1/16" thick laminated phenolic with engraved block letters, white on a black background, securely fasten nameplates to front covers of enclosure with brass screws.
- B. Nameplates for panelboards, switchboards, motor control centers, transformers, unit substations and switchgear shall have 1-inch high letters. Identifying the equipment name indicated on the one-line diagram and the voltage. Include the identification of series rated components within this equipment with nameplates using 1/4-inch letters.
- C. Nameplates for individual circuit breakers, disconnect switches, junction boxes, VFDs, and motor starters shall have 1/2-inch letters and shall be as indicated on the one-line diagram and plans, or shall describe the equipment being controlled.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated on the plans. Install numbers, lettering, and colors as approved by submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC and ANSI standards.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance or equipment.
- E. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instruction or explanations are needed for system or equipment operation.

END OF SECTION

SECTION 16080
ELECTRICAL TESTING

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work shall include complete testing of all equipment and wiring at the completion of the work, the making of any connection changes or adjustments necessary for the proper functioning of the system and equipment and all testing described in this Section. Power distribution, lighting, control and all miscellaneous systems shall be properly adjusted and in working order, as required, at time of final acceptance.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contactor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit test data and results in accordance with Section 16010.
- B. Submit certification that all required factory testing has been completed by the manufacturer.
- C. Prior to commencing work, submit draft reports indicating testing procedures, sample report forms, and testing data required for approval by the Engineer.
- D. Submit draft copies of completed test reports for review prior to final acceptance of the project.
- E. After Architect and Engineer review, make final requested adjustments and provide final copies of report for inclusion in Operating and Maintenance Manuals by the Architect.
- F. Provide test reports in soft cover, letter size, three-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 REQUIREMENTS

- A. Furnish all equipment and personnel and conduct all tests required to secure approval of the installation from all agencies having jurisdiction.
- B. Coordinate with other trades in testing equipment furnished by others, including but not limited to:
 - 1. Checking motors for rotation.
- C. Contractor shall provide Owner with two (2) working days notice prior to performing all tests to allow Owner to arrange to witness the tests.
- D. All testing shall be witnessed by the Owner or Owner's representative. The results of all quantitative tests shall be furnished to the Owner in a typed, approved format as indicated herein.
- E. All test results must be accepted by the Owner before the Contractor is relieved of responsibility for the work.
- F. Insulation resistance tests shall not be made on any equipment until the manufacturer's instructions have been checked and an inspection made to see if any components such as surge protection devices, semi-conductors, control relay coils, etc., exist which may be damaged by such tests. Such components shall be isolated from the test potentials before the tests are performed.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. The Contractor shall be responsible for all equipment and materials required to perform all tests as specified herein. All test equipment shall be in first-class condition, correctly calibrated and shall be operated by qualified personnel experienced in the use of the equipment.

PART 3 – EXECUTION

3.01 TESTING

- A. All systems shall test free from mechanical and electrical defects.
- B. Operations tests shall be made of all systems as a condition of acceptance.

- C. Balance connected loads across phases at all panels and load centers.

3.02 WIRE AND CABLE

- A. Testing of conductors shall be done with the conductors disconnected from all equipment.
- B. All conductors shall be tested for continuity, shorts, and grounds. All faulty cables shall be replaced at no cost to the Owner.
- C. Power conductors rated 600 volts and below shall be given insulation resistance tests with a 500-volt test voltage. The tests shall be between each phase and ground, and between phases. A satisfactory test shall indicate a minimum insulation resistance of 20 megohms.
- D. When splicing into existing power cable or rewiring existing power cable, the cable shall be tested for proper phase sequence.
- E. Contractor shall cooperate after reconnection of existing equipment, with the testing of all systems involved. This shall include, but not be limited to:
 - 1. Checking motors for proper rotation.
 - 2. Coordination and testing control wiring and interlocks.

3.03 TRANSFORMERS

- A. Each transformer shall be visually inspected for physical damage.
- B. The insulation resistance of each transformer winding shall be checked with a test voltage recommended by the manufacturer. The minimum acceptable one minute reading will be 2 megohms per 1000 volts of nameplate voltage rating, but in no case less than 2 megohms.
- C. The windings of each transformer shall be checked for continuity.
- D. Any additional tests recommended in the manufacturer's instructions shall be completed.

END OF SECTION

SECTION 16091
ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Scope of work under this section shall be to furnish all equipment, materials, and labor to remove the existing buildings electrical systems to the limits necessary to install the new electrical systems.

In general, the scope of work to be done includes, but is not necessarily limited to the following:

1. Removal of selected light fixtures, outlets, and associated conduit and wire to the limits they must remain to incorporate the new work.

- B. Project Phasing and Owner's Occupancy:

1. Refer to the General Conditions and Section 16010 for the necessary phasing of this project.
2. The existing building will be occupied throughout this project as described in the General Conditions. All demolition shall be phased to maintain service to areas occupied during this project.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.
- D. All related Specification Sections shall be used in conjunction with this Section.
- E. Refer to Architectural, Electrical, Mechanical, and (HVAC) Demolition Drawings for details of demolition necessary for this project.

1.03 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. As required for the indicated and needed removals, patching and extending of circuits.

PART 3 – EXECUTION

3.01 SPECIAL CONDITIONS

- A. Drawings are based on casual field observation. The Contractor shall visit the project site prior to bidding and field verify all measurements, and locate all equipment and circuiting arrangements for all electrical systems and accessories, plus examine access and all existing conditions prior to submission of his bid. Coordinate visit with Architect.
- B. Arrange, provide, and pay for any permits and inspections that are required by local codes and ordinances for any parts of the work done by this Contractor under this section.
- C. This Contractor shall coordinate his work with that of the General Contractor such that all separate sections of the Contract are done in a logical sequence, and arrange so that no trade interferes with the work area, work time or schedule of another trade.
- D. Commencement of the Demolition Phase means Contractor accepts existing conditions.

3.02 DEMOLITION AND REMOVALS

- A. Remove and dispose of existing electrical equipment and associated boxes, conduit and wire where indicated or where located on or within walls, ceilings and floors being demolished or altered as a result of this Contract, unless otherwise indicated. Equipment to remain shall be recircuited, if necessary, to ensure continued operation.
- B. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.
- C. Cut conduit flush with surface and patch surfaces.
- D. Provide temporary wiring and connections to maintain existing systems in service during construction to minimize Owner inconvenience.

- E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system and minimize outage duration to a schedule acceptable to the Owner.

3.03 INSTALLATION

- A. Equipment indicated on the Drawings to be relocated shall be removed with care so it is not damaged and so it is relocated as indicated. Equipment shall operate the same or better than its original state. If required, safely store equipment removed and to be installed at a later date.
- B. Provide blank covers for abandoned boxes not being removed.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards shall be cleaned, have connections tightened, have a new directory typed if any circuits have changed, have circuit breakers replaced if damaged and have cover plates installed for any empty spaces.
- C. Light fixture lenses shall be removed and cleaned with a mild detergent and water and [any defective lamps or ballasts shall be replaced. All lamps replaced, and any defective ballasts shall be removed and replaced.

3.05 DISPOSAL OF FLUORESCENT AND HID LAMPS

- A. Fluorescent and HID lamps shall be packaged and transported to minimize breakage to a recycler. Lamps shall be shipped to an authorized Universal waste handler, or treatment or disposal facility.

END OF SECTION

SECTION 16120
CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Extent of electrical wire and cable work is indicated by Drawings and schedules.
- B. Types of electrical wire and cable specified in this section include the following:
 - 1. Single conductor copper cables with 600V insulation and jacket.
 - 2. Type MC Cable.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit manufacturer's data on conductors and cables in accordance with Section 16010.
- B. Provide product data on conductors, cables, and connectors.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacturer of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.
- C. Codes and Standards:
 1. NEC Compliance: Comply with NEC requirements as applicable to construction, installation, and color coding of electrical wires and cables.
 2. UL Compliance: Provide wiring/cabling and connector products which are UL-listed and labeled.
 3. NEMA/ICEA Compliance: Comply with applicable NEMA/ICEA Standards. Follow an approved ICEA color coding method.
 4. IEEE Compliance: Comply with applicable requirements of IEEE Standards 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors," and Standard 141, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants" pertaining to wiring systems.
 5. ASTM Compliance: Comply with applicable requirements of ASTM B1, 12, 3, 8, and D-753. Provide copper conductors with conductivity of not less than 98% at 20°F (68°F).

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.
- B. The Contractor shall receive all cable shipments, and shall inspect them for damage to reels, lagging or packing material and for integrity of cable and seals. If damage is apparent, lagging or packing shall be removed and cable inspected. All damage or defective cable, reels, packing or end seals shall be promptly reported, in writing, to the Owner. If so directed by the Owner, the Contractor shall check conductor continuity and shall megger test insulation resistance of such cable. Cable with visible water in the interstices shall be reported to the Owner. Contractor has the option of completely replacing damaged reels of cable or trimming away damaged portions. However, trimming shall not be permitted where it would result in need for splices.
- C. After receipt and inspection, cable shall be moved promptly to storage. For outdoor storage, all reels shall be blocked to prevent rolling, and non-reel type containers shall be blocked at least 6 inches above ground and shall be so placed as to be protected against snow, or long exposure to sunlight. Store small wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.
- D. All ends of cable in storage shall be sealed to exclude moisture, and cut ends shall be immediately resealed. Cable sealing shall be by taping with waterproof tapes. For large cables,

heat shrinkable caps of proper size may be used for sealing. The cut ends of cable lengths removed for use shall be protected during installation against dirt and water or other liquids.

- E. Partially used cable reels, if stored outdoors, shall be repacked to prevent weathering of the remaining cable.
- F. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.
- G. Returnable reels, when empty, shall be returned to the cable manufacturer in accordance with established procedures or shall be stored, subject to Owner's instructions, for later disposal. Nonreturnable reels shall be disposed of by the Contractor.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. All wire and cable shall be sunlight and moisture resistant, rated for use in wet locations and in cable tray. Except as otherwise indicated, provide stranded copper conductors with conductivity of not less than 98% at 20 deg. C (68 deg. F).
- B. Wire Conformation: Provide THWN or XHHW. Only wires with "W" in the designation shall be used in wet or damp locations.
 - 1. 600-volt wires and cables for building exterior and underground raceway use: Conductor sizes are indicated by American Wire Gauge (AWG). All wire shall be copper, of the highest commercial conductivity. All cables shall be 600 VAC single conductor, #12 AWG stranded, as a minimum, rated to withstand conductor temperatures of 90°C in dry locations and 75°C in wet locations without deterioration.
 - 2. Wire connectors and terminals for use with copper conductors: UL 486A. Solderless connectors for #8 AWG and larger. Mechanically perfect pressure connectors shall be installed at each termination using an Owner-approved crimping method. Pliers that are not designed to be a crimping tool shall not be permitted.
- C. Low Voltage Wiring and Cable:
 - 1. Low voltage power cable shall be single copper conductor with 600V THHN/THWN or XHHW insulation and jacket of flame retardant PVC, CPE or CSPE.
 - 2. Control cable shall be single copper stranded Class B conductors, 600V, THHN/THWN or XHHW insulation and jacket of flame retardant PVC, CPE, or CSPE. Conductor insulation shall be color coded or otherwise labeled to delineate phases.
 - 3. Lighting cables shall be single copper conductor Class B, 600V, THWN/THWN insulation.
 - 4. Solid conductor shall be used for wiring to all low voltage electrical devices including switches and receptacles. Stranded conductor shall be used elsewhere, unless otherwise noted.

D. Type MC Cable:

1. 600 volt aluminum, interlocked armor, Class B stranded, copper conductors Type THHN insulation.
2. Filling shall be non-hygroscopic and non-wicking. Core binder shall be polyester tape. Armor shall be interlocked aluminum.
3. Insulated ground wire shall be provided.
4. Where MC cable is used to feed isolated ground receptacle (or equipment) circuits, an isolated grounding conductor shall be supplied in addition to the insulated ground wire.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable, and connector):

1. Wire and cable:
 - a. Cablec Corp.
 - b. Kerite Co.
 - c. Okonite Co.
 - d. Prysmian Cables & Systems.
 - e. Southwire Co.
 - f. Triangle Wire & Cable, Inc.
2. MC cable:
 - a. AFC Cable Systems.
 - b. Southwire Co.

B. Substitutions: Items of equal quality, function, and performance may be proposed for substituting by following the procedures in Section 16010.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:

1. Install electrical cables, wires, and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard for Installation," and in accordance with recognized industry practices.
2. Coordinate wire/cable installation with electrical raceway, cable tray, and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

B. Wire and Cable Installation:

1. Pull conductors simultaneously where more than one is being installed in same raceway. Unless otherwise noted, install all three phases of a three-phase system in one conduit to

- avoid inductive currents on the surface of metallic conduit. Grounding conductor shall be run in the same raceway as the current-carrying conductors.
2. Use pulling compound or lubricant (powdered soapstone or Wyrease), where necessary; compound used must not deteriorate conductor or insulation.
 3. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.
 4. Pulling may be by hand or by power winch. Winches used shall have sufficient capacity to exert a steady, continuous pull. Maximum pulling tension shall be monitored. Values for maximum allowable pulling tension given by the manufacturer shall be observed.
 5. Cables which have been pulled in and awaiting termination at some later date shall be sealed in accordance with the cable manufacturer's instructions.
 6. Conductors in all panelboards, switchboards, and terminal cabinets shall be neatly fanned in the gutter space and tied.
 7. Wiring for all single phase circuits, 20A or smaller, shall be a minimum of 2#12&1#12G-3/4"C for circuit lengths under 100 feet and 2#10&1#10G-3/4"C for circuit lengths 100 feet and over, unless otherwise noted. Circuits for isolated ground receptacles shall include additional isolated ground conductor. Circuits for double switched light fixtures shall include additional switched conductor(s) as required. The sharing of neutral conductors is not allowed.
 8. Do not install any wire or cable with less than the minimum bending radius specified by the manufacturer. During pull-in, maintain minimum bending radius as specified by manufacturer.
 9. Do not pull cables over sharp corners of trays and supports.
 10. Unless otherwise specified, all conduits, wires, and cable that are required to make the electrical connections to equipment, shall be furnished and installed by the Electrical Contractor. All connections to equipment shall be made as shown, specified, and directed, and in accordance with the approved Shop Drawings.
 11. In general, control wiring is not shown on the Plans. Refer to individual equipment specifications and control drawings for information.
 12. Wire sizes shown on Drawings and otherwise specified are minimum sizes; if wire of sizes specified is not available, furnish wire of next larger size and if required by NEC, also increase the raceway size to accommodate the larger wire used. Make this substitution at no increase to contract cost.
 13. All conductors shall have a single, continuous length without splices, except with the approval of the Engineer. Provide junction box where splices are made. In general, terminate all conductors at terminal blocks.
 14. All cable in a raceway shall have the same insulation rating.
 15. All low voltage signal cable is to be run in a separate raceway from 120-600 VAC cable.
 16. If raceway is installed in a manner that varies from what is indicated on the Contract Documents, or so that the shortest distance is not utilized, contact Engineer to determine if

voltage drop will affect the size of cable to be installed in the raceway. Cable size shall be adjusted at no cost to the Owner.

17. Power cables coding shall be as indicated below or existing color coding:

<u>120/208 Volt, 3-Phase</u>	<u>277/480 Volt, 3-Phase</u>
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - White with colored (not green) stripe
Ground - Green	Ground - Green

18. Control wiring shall be color-coded with tracers, no solid color. Where wiring extends outside equipment, provide overcurrent protection in accordance with wire size per NEC.
19. Junction boxes for use with six or more control circuits or low voltage signals shall utilize terminal blocks sized for the intended use with 20% spare termination points in addition to those for all wires (including spare wires).
20. Control wiring terminating at the main control panel shall be terminated by the Contractor at terminal blocks as directed by the manufacturer.

C. MC Cable Installation:

1. Type MC cable shall not be utilized for homeruns to a panelboard or switchboard. Provide cable in conduit for homeruns.
2. Type MC cable shall not be utilized for circuits to kitchen equipment.
3. MC cable shall be installed in concealed locations only, where allowed. It shall not be run exposed to sight in finished spaces.
4. Cable shall be properly run through the center of wall studs, and upper and lower plates. No cable shall be run around the face of a stud, plate, or structural member.
5. MC cable shall be properly supported in both vertical and horizontal installations. Fastening supports shall be as approved for type MC cable, by Caddy or equivalent. Plastic ties shall not be used as a supporting method for the cable. MC cable shall be run parallel to, and attached to, building structural steel; it shall not be run across open spaces.
6. Stripping of the armor jacket shall be done by an approved tool, or by scoring and breaking the jacket. Stripping and removal of the jacket shall be done without damage to the interior conductors or their insulation.
7. Fittings approved for Type MC cable shall be used to terminate the cable as required.
8. MC cable shall not be installed in, or near, the ribs of steel roof deck.

D. Splices:

1. Splices and taps shall only be allowed inside approved wireways, junction boxes and outlet boxes.
2. Proper sized wrenuts shall be allowed for splices and taps on conductors of #10AWG or smaller.
3. Where splices or taps are required for conductors of #8AWG or larger, use solderless splice and tap connectors that are compatible with the conductor material. Insulate (wrap) 600 volt splices and taps with minimum of three (3) lap wound layers of 3M Scotch Super 33+ tape, or equivalent.
4. Multi-conductor, pre-insulated, set-screw type connection blocks, of the proper size for the conductors, shall be permitted. Burndy or equivalent.
5. All feeder circuits and single-load branch circuits shall be of continuous, unspliced conductors from source to terminal point.
6. In wet locations, underground, etc., all splices, taps and connections shall be made waterproof. Conductor insulation shall be well penciled and roughened before applying connector insulation. Apply a minimum of three (3) layers of Scotch 33 tape and coated with Scotch Kote paint. Conductors shall be formed into drip loops so that water will not collect on connections.

E. Schedule of Use:

1. Type MC cable shall only be permitted for wiring to be extended concealed in walls and in accessible ceilings, and for lighting fixture whips not exceeding 6'0" in length. No MC cable shall be allowed where finished space is open and exposed to sight.
2. Cable in conduit shall be used in all other locations unless otherwise noted. Conduits for branch circuit wiring shall be run directly from the panelboard to the room where the load is to be connected. Type MC cable can then be used concealed within that room for extension of circuit wiring as allowed.

3.02 FIELD QUALITY CONTROL

- A. Test wire and cable in accordance with Section 16080.

END OF SECTION

SECTION 16130
RACEWAYS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide all raceways including conduit and couplings. Extent of raceway work is indicated by Drawings and schedules.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Division 1 and Section 16010 of the Specifications.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with electrical raceway work similar to what required for this project.
- C. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.
 - 3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

PART 2 – PRODUCTS

2.01 METAL CONDUIT

- A. General: Provide metal conduit, and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Owner to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.
- B. Rigid Steel Conduit:
 - 1. Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1, UL 6, and in conformity with NEC Article 344.

Provide zinc coating fused to inside and outside walls by hot dipped galvanizing. Couplings and elbows shall be protected against corrosion in the same manner as the conduit. Threads shall be cut before the zinc coating is applied and the surplus coating removed from the threads after coating.
 - 2. Provide factory-applied, closed-end thread protectors.
- C. Rigid Metal Conduit Fittings: Provide cast malleable iron, threaded zinc plated fittings, conforming to FS W-F-408 with steel conduit.
- D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit; construct of single strip, flexible, continuous, interlocked and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- E. Liquid-tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide zinc plated, malleable iron fittings with compression-type steel ferrule and neoprene gasket sealing rings, with insulated or non-insulated throat.

- F. Electrical Metallic Tubing (EMT): Provide EMT that conforms to FS WW-C-563, ANSI C809.3 and UL 797. Only zinc coated ferrous type is acceptable.
- G. EMT Fittings: Provide zinc coated steel fittings (set screw type) with locknut for thin wall conduit, concrete tight. For EMT 1-1/4" and above, provide a minimum of four set screws per coupling and two for connectors and fittings. Set screws shall be of steel.
- H. Snap-in type connectors that do not utilize a locknut are not acceptable.

2.02 CONDUIT ACCESSORIES AND BODIES

- A. Conduit Accessories: Provide conduit accessories of types, sizes, and materials required or indicated, complying with manufacturer's published product information, which mate and match conduit.
- B. Conduit Bodies: Provide galvanized cast-iron (for use with steel raceways), conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Provide conduit bodies with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

2.03 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide rigid steel conduit, electrical metallic tubing, and liquid-tight flexible metal conduit manufactured by one of the following:
 - 1. Triangle Conduit & Cable Company, Inc.
 - 2. Republic Steel Corporation.
 - 3. Allied Tube and Conduit Corp.
 - 4. Wheeling Pittsburgh Corp.
 - 5. Wheatland Tube Company.
 - 6. Gould Inc., EFCOR Division.
- B. Subject to compliance with requirements, provide plastic conduit and fittings of one of the following:
 - 1. Carlon, Lamson & Sessions
 - 2. Johns-Manville Corp.
 - 3. SEDCO Corp.
- C. Subject to compliance with requirements, provide conduit bodies of one of the following:
 - 1. Appleton Electric; Div. of Emerson Electric Co.
 - 2. Arrow-Hart Div.; Crouse-Hinds Co.
 - 3. Bell Electric Div.; Square D Co.
 - 4. Crouse-Hinds Electrical Construction Materials.
 - 5. Killark Electric Mfg. Co.
 - 6. O-Z/Gedney Div.; General Signal Co.
 - 7. Spring City Electrical Mfg. Co.

- D. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.04 CONDUIT SEALING BUSHINGS

- A. Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls, consisting of steel sleeve with malleable iron body, neoprene sealing grommets or rings, pressure rings, and cap screws.

PART 3 – EXECUTION

3.01 GENERAL

- A. All wiring shall be in conduits or raceways, unless otherwise indicated. Minimum conduit size shall be as follows:
 - 3/4" for power and security.
- B. Install conduit concealed in all areas, except:
 1. Motor connections.
 2. Exterior of structures.
 3. Connections to surface-mounted equipment cabinets.
 4. Mechanical and utility areas.
- C. Coordinate installation of conduit in masonry work, or wall construction.
- D. Where indicated on the Contract Drawings, conduits are shown diagrammatically to outline the general routing of the raceway. Actual routes shall be determined by installer and installed at no extra charge. Where a general routing is not indicated, the conduit and cable routing may be developed by the Contractor. However, all routes must be approved by Engineer before being installed. Avoid interference with pipes, ducts, structural members or other equipment. It is anticipated that the shortest conduit and cable route will be utilized to minimize voltage drop.
- E. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- F. All metal conduits entering boxes, panels, etc., shall be terminated with insulating bushings. Where bushings fabricated entirely of insulating material are used, two locknuts shall be installed to ensure proper rigid connection and electrical grounding continuity between box and conduit.
- G. Provide standard fittings wherever possible. Avoid field bends wherever possible. Bends and offsets shall be made with factory fittings or with an approved hydraulic bender.
- H. Provide standard fittings or field bends with inside radius greater than cable bending radius. Limit the number of bends between pulling points to four 90° bends or the equivalent.
- I. Field bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- J. Provide 200 lb. test nylon pull cord, or AWG No. 12 wire in empty conduits. For conduits required to be installed, but left empty, test with ball mandrel. Clear any conduit which rejects ball

mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.

- K. Conduit penetrations through walls, floors, etc., shall not compromise the fire rating. All penetrations shall be sealed with appropriate fire stop material having an equal to or greater than fire rating of the surrounding structure.
- L. Provide a listed conduit seal where conduits leave heated area and enter unheated area, cooler or freezer. Seal conduit using a non-drying sealing putty. Duxseal or equal.
- M. Provide expansion fittings for all conduits in straight runs of over 100 feet in length.
- N. Where conduits penetrate non-fire rated walls, seal around conduits with expanding foam insulation.
- O. Provide spacing of raceways a minimum of 6 inches from parallel runs of heating system pipes, flues, or other heat radiating piping systems and other heat sources. The minimum spacing shall be increased to ensure that raceways experience no significant temperature rise from external sources. Raceways shall not be embedded in any spray-applied insulation, fireproofing, or other materials that would restrict heat dissipation.
- P. Provide deflection/expansion fittings in conduit runs at all expansion and seismic joints to allow for displacement of conduit by expansion, contraction, and misalignment.
- Q. Conduit shall not be installed in, or near, the ribs of steel roof deck.

3.02 METAL CONDUITS

- A. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Coat all cut threads with a listed zinc-rich paint, Thomas and Betts, CP8 KOPR-Shield or equal.
- B. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with grounding type bushing. Install locknuts inside and outside enclosure.
- C. Mechanically fasten together metal conduits to form continuous electrical conductor. Connect to cable trays, electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.
- D. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
- E. Install liquid-tight flexible conduit for connections to vibrating equipment such as motors, or to equipment which may move due to expansion or adjustment such as motor operated valves or belt-driven equipment, or to equipment which must be capable of ready removal for maintenance. The maximum length of flexible conduit used shall not exceed 6 feet without the prior approval of the Owner. The fixed end of the rigid conduit shall be terminated with a box or, where necessary, a "condulet" type fitting, and, where linear motion of the connected equipment will occur, shall be located approximately at the midpoint of the expected range of movement. Where practicable, the flexible conduit shall have approximately a 90° bend to allow free movement.

3.03 EXPOSED CONDUITS

- A. Support exposed conduit by use of hangers, clamps or clips. Support conduit on each side of bends and on spacing not to exceed NEC requirements.
- B. Conduit placed against concrete above ground shall be fastened to the concrete with pipe straps or on screw conduit clamps attached to the concrete by means of lead expansion screw anchors and screws or preset inserts. Plastic anchors shall not be used.
- C. Install conduits to avoid conflict with passageways or access to, operation or maintenance of, or removal of, electrical or other equipment.
- D. Allow minimum of 6 inches clearance at flues, steam pipes, and heat sources.
- E. Route all conduits parallel or perpendicular to building lines, structural members and building walls. Routing shall provide maximum clear space.
- F. Provide flashing and pitchpockets making watertight joints where conduits pass through roof or waterproofing membranes.

3.04 SCHEDULE OF USE

- A. Use rigid galvanized conduit for:
 - 1. Exposed exterior conduit.
 - 2. Where in compliance with NEC.
- B. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
 - 1. Moist or humid atmosphere where condensate can be expected to accumulate.
 - 2. Subjected to water spray or dripping oil.
 - 3. Connections to vibrating equipment.
- C. Use electrical metallic tubing:
 - 1. Where not restricted by the above in interior areas.
 - 2. Where in compliance with NEC.

3.05 ADJUSTING AND CLEANING

- A. Clean raceway interior surfaces before and after installation. Interior surfaces shall be free of imperfections (burrs, dirt, construction debris, etc.), likely to damage cable(s). Clean completed conduit runs with an approved tube cleaner equipped with cylindrical mandrel. Mandrel diameter not less than 85% of conduit inside diameter. Cap conduit ends after cleaning to prevent entrance of water or debris.
- B. Close upper ends of all vertical conduit during construction.
- C. Cap spare conduits using suitable conduit caps/plugs.

END OF SECTION

SECTION 16137
OUTLET BOXES AND ENCLOSURES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide outlet boxes.
- B. Provide wireways, pull and junction boxes.
- C. Provide all cabinets and enclosures for the installation of electrical equipment, electrical controls, and process equipment as indicated on the Drawings and as described herein.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit product data and listing of equipment nameplate lettering.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Steel Boxes:

1. Appleton
2. Raco
3. Steel City

B. Cast Boxes:

1. Crouse-Hinds
2. Killark
3. Appleton

C. Recessed Floor Boxes:

1. Hubbell
2. Walker

D. Pull Boxes, Enclosures, Wireways and Cabinets:

1. Hoffman
2. Square D

- #### E. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.02 WALL BOX MATERIALS

- #### A. Interior Dry Location Boxes: Pressed sheet steel, blanked for conduit or provided with knockouts and clamps for cable, where applicable. Provide side-mounted bracket for locating on stud.

- #### B. Exterior, Damp Location or Weatherproof Box: Cast aluminum, deep type, with mounting ears.

- #### C. For Flush-Mounting in Walls: Boxes with matching plaster rings for single- or two-gang outlets. For larger boxes, use solid type or special units. In masonry use deep boxes.

- #### D. Wall boxes for power devices shall not be less than 2-1/2 inches deep, of physical size as required by NEC for the number and size of conductors involved; shall be securely mounted to the building structure with supporting facilities independent of the raceways entering or leaving. Gang boxes shall be used on multiple outlets.

- #### E. Square conduit boxes shall not be less than 2-1/8 inches deep, of physical size as required by NEC for the number and size of conductors involved; shall be securely mounted to the building structure with supporting facilities independent of the raceways entering or leaving. Provide plaster ring where applicable.

2.03 PULL BOX, WIREWAY, AND ENCLOSURE MATERIALS

- A. Pullboxes and Junction Boxes: Metal construction, conforming to National Electrical Code, with screw-on or hinged cover.
- B. Flush-Mounted Pullboxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.
- C. Wireway shall be constructed of enamel finish. Size shall be in accordance with manufacturer and NEC for intended fill. Minimum cross section shall be 6" x 6".
- D. Unless otherwise indicated, enclosure types shall be used as follows:
 - 1. NEMA 1 - Interior locations, dry.
 - 2. NEMA 4 - Wet areas, on outdoor structures, in equipment vaults, where moisture is present.
 - 3. NEMA 12 - Interior locations subject to oil seepage or dust may be used in lieu of NEMA 1.If location is questionable, consult Engineer.
- E. Enclosures shall be fabricated from 16-gauge steel (min.) or equivalent rust-resistant steel with rust-inhibiting primer.
- F. Enclosures shall be sized, as a minimum, as indicated on the Drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Mount outlet boxes flush where conduit is concealed.
- B. Adjust position of outlets in finished masonry walls to suit masonry course lines.
- C. Do not install boxes back-to-back in same wall. Where located on opposite sides of common walls, device boxes shall not be installed back-to-back in the same stud bay. Where possible, all boxes shall be one complete stud bay apart.
- D. Locate boxes in masonry walls so that only a corner needs to be cut from masonry units. Coordinate cutting of masonry walls to achieve neat openings for boxes. Use rotary cutting equipment to cut masonry work for installation of electrical fittings.
- E. Do not use sectional or handy boxes unless specifically requested.
- F. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
- G. Wall boxes in block or concrete construction shall be masonry boxes with inside ears and shall be concrete tight.
- H. Locate pullboxes and junction boxes in electrical rooms, utility rooms, above suspended ceilings or storage areas, where accessible, and allowed by the National Electrical Code.
- I. Boxes shall have no openings except through which conduits or cable pass.

- J. Install enclosure(s) in accordance with manufacturer's recommendation, Section 16070 and as shown on the Drawings.
- K. Provide proper grounding for all enclosures in accordance with the NEC and Section 16060.
- L. Verify exact dimensions to ensure that the cabinets specified have space available for the arrangement of equipment provided.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide wall switches.
- B. Provide receptacles.
- C. Provide cover plates.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - WALL SWITCHES

- A. Subject to compliance with requirements, provide products by the following:
1. Wall switches:
 - a. Bryant
 - b. Hubbell
 - c. Pass & Seymour
 - d. Cooper Wiring Devices
 - e. Leviton
 2. Receptacles:
 - a. Bryant
 - b. Hubbell
 - c. Pass & Seymour
 - d. Cooper Wiring Devices
 - e. Leviton
 3. Cover plates:
 - a. Bryant
 - b. Hubbell
 - c. Pass & Seymour
 - d. Cooper Wiring Devices
 - e. Leviton
- B. Substitutions: Items of equal quality, function and performance may be proposed for substituting by following the procedures outlined in Section 16010.

2.02 SWITCHES

- A. 120-277 Volt Switches: Quiet type, toggle handle, with totally enclosed case, rated 20 ampere or as indicated on the Drawings with silver cadmium oxide contacts. Provide matching two-pole, 3-way and 4-way switches as indicated. Switches shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.
- B. Switches shall be horsepower rated when used to control motor loads.
- C. Color: Ivory handles unless otherwise indicated
- D. Handles shall be lighted if indicated.

2.03 RECEPTACLES

- A. Ground fault interrupter receptacles shall be rated 20 amperes with built in test and reset buttons, and shall conform to U.L. 943. Feed through feature will protect standard receptacles located downstream. Receptacles shall have a grounding terminal which shall be connected to the outlet box with a grounding conductor to establish continuity.

2.04 COVER PLATES

- A. Materials:
 - 1. Stainless Steel: 0.040 inch thick minimum, accurately die cut, protected with release paper.
 - 2. Weatherproof while in use: Polycarbonate self-closing receptacle cover rated NEMA 3R. Weatherproof when attachment plug cap is inserted two exit ports for 12/3 cord. Complies with NEC 406-8(b) and UL 514D.
- B. Schedule of Use:
 - 1. Stainless Steel: To be used in interior dry locations
 - 2. Thermoplastic: To be used in interior dry locations unless otherwise indicated.
 - 3. Weatherproof while in use: To be used for all exterior receptacles or areas of high moisture.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Switches:
 - 1. Mount switches 48 inches above floor to center of device unless otherwise indicated.
 - 2. Switches shall be located to agree with architectural features and shall not interfere with work by other Trades.
 - 3. The location of all devices shall be subject to the approval of the Engineer. The Drawings show approximate locations only.
 - 4. Where groups of switches are shown, they shall be installed in approved gangable boxes with one piece faceplates that completely cover opening in wall.
- B. Receptacles:
 - 1. Mount receptacles 18" above finished floor or grade to center of device, unless otherwise noted on the Drawings, with grounding pole at bottom.
 - 2. Outlets shall be located to agree with architectural features and shall not interfere with work by other trades.
- C. Cover plates:
 - 1. Install cover plates on all wiring devices.

2. Metal faceplates shall be grounded.

END OF SECTION

SECTION 16410
ENCLOSED SWITCHES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide all motor and circuit disconnect switches as required by NEC and as indicated.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit data including switch or circuit breaker size, voltage, and NEMA rating.
- C. Submit dimensional data of all motor and circuit switches or circuit breakers.
- D. Submit test results in accordance with Section 16080.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Disconnect Switches:
 - a. Siemens
 - b. General Electric
 - c. Square D
 - d. Cutler-Hammer
- B. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.02 ENCLOSURES

- A. Enclosures shall be fabricated from 16-gauge minimum galvanized or equivalent rust-resistant steel with rust-inhibiting primer and baked-enamel finish.

2.03 DISCONNECT SWITCHES

- A. Shall be quick-make, quick-break single-throw externally operated manual type disconnect switches in NEMA 1 enclosure for interior dry use and NEMA 3R for exterior. If indicated on the Drawings, the unit shall be fused according to the protected equipment manufacturers' recommendations.
- B. Switches shall be capable of being locked in the open position.
- C. Switches shall be heavy-duty type.
- D. Where required for elevator control, provide an auxiliary dry contact with a minimum rating of 1 ampere at 48 VDC. Contact shall be dry and isolated with a contact configuration of SPST. Contact set shall be sealed.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Surface-mount switches and circuit breakers so as not to interfere with other equipment.
- B. Mount according to manufacturer's recommendations, NEC, and Section 16070.
- C. Verify exact wall dimensions in field to ensure that standard enclosures specified can be arranged in the space allocated.
- D. Provide fuses for all disconnect switches.

END OF SECTION

SECTION 16411
CIRCUIT BREAKERS IN EXISTING INSTALLATIONS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide indicated circuit breakers in existing switchboards, panelboards, or control centers.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit data including circuit breaker current, voltage and interrupting ratings and construction.
- C. Submit time-current curves for all overcurrent protective devices with applicable settings indicated.
- D. Submit test results in accordance with Section 16080.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.

2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
 1. Circuit Breakers:
 - a. Siemens
 - b. Square D
 - c. General Electric
- B. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.02 CIRCUIT BREAKERS

- A. Circuit breakers shall be molded case, bolt-on heavy-duty type having quick-make, quick-break manually operated toggle mechanism. Handle shall be trip-free with three positions that clearly indicate when the breakers are "on," "off," or "tripped." Multiple-pole circuit breakers shall operate on a common trip principle. All circuit breakers shall provide overcurrent and short-circuit protection.
- B. The minimum AIC rating shall be 22,000 amperes, unless otherwise indicated on the Drawings. It shall be the responsibility of the equipment supplier to coordinate all secondary breaker interrupting capacities and to indicate them on applicable submittals.
- C. Where new circuit breakers are to be added to existing switchboards, panelboards, or control centers, they shall be compatible with the existing enclosure.
- D. Where sprinklers are provided in the elevator shaft, provide shunt trip unit on circuit breaker for elevator power.
- E. Where the application of a series rated circuit breaker is required, verify the series combination of devices is UL listed and will meet the system short circuit current rating requirement.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Provide filler pieces for unused spaces.
- B. Update typewritten directory on inside cover of switchboards, panelboards, or control centers indicating loads controlled by each circuit.
- C. All circuit breakers shall be mounted in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 16440
SWITCHBOARDS AND PANELBOARDS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide indicated switchboards and panelboards.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit as a minimum data including current, voltage and interrupting ratings and layout drawing including dimensions.
- C. Submit test results in accordance with Section 16080.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Switchboards and panelboards:
 - a. Siemens
 - b. General Electric
 - c. Square D
 - d. Cutler-Hammer
- B. Substitutions: Items of equal quality, function and performance may be proposed for substituting by following the procedures outlined in Section 16010.

2.02 PANELBOARDS

- A. Panelboards shall be of a dead front safety type, equipped with thermal magnetic molded case circuit breakers as indicated on the Drawings. All panels shall be of the same manufacture.
- B. Gutter space shall be a minimum of 4" on all sides.
- C. Panelboards shall have full capacity neutral bus, ground bus and bolt on circuit breakers.
- D. All buses including neutral and ground buses shall be of high conductivity copper or aluminum.
- E. Panelboard Enclosures:
 - 1. Enclosures shall be fabricated from 16-gauge minimum galvanized or equivalent rust-resistant steel with rust-inhibiting primer and baked-enamel finish.
 - 2. Panels shall be furnished with standard doors and locks. Key all locks alike and furnish two sets of keys.
 - 3. Enclosure for panels rated 100 amperes and over shall have a hinged front cover so as to be a "door-on-door" arrangement.
- F. Circuit Breakers:
 - 1. Circuit breakers shall be molded case, bolt on heavy-duty type having quick make, quick break manually operated toggle mechanism. Handle shall be trip free with three positions that clearly indicate when the breakers are "on," "off," or "tripped." Multiple pole circuit breakers shall operate on a common trip principle. All circuit breakers shall provide overcurrent and short circuit protection.
 - 2. Circuit breakers shall be manufactured such that amperages shall be clearly visible on all breakers (stamped or labeled) without having to remove any components of the panelboard to obtain this information.
 - 3. The minimum AIC rating shall be as indicated on the drawings. It shall be the responsibility of the equipment supplier to coordinate all secondary breaker interrupting capacities and to indicate them on applicable submittals.

4. Where new circuit breakers are to be added to existing panelboards, they shall be compatible with the panelboard. Where new circuit breakers are not part of an existing or new panelboard, they shall be housed in a NEMA 1 enclosure for dry locations and NEMA 3R for damp or exterior locations.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Switchboard and panelboard installation shall conform to NEC requirements, in particular Article 110-16.
- B. Install switchboards and panelboards according to manufacturer's recommendations.
- C. Test switchboards and panelboards in accordance with Section 16080.
- D. Provide filler pieces for unused spaces in switchboards and panelboards.
- E. Prepare and affix typewritten directory to inside cover of switchboard and panelboard doors indicating loads controlled by each circuit. Protect directory with plastic.
- F. All panels shall be mounted in accordance with Section 16070.
- G. Unless otherwise indicated on the Drawings, install all switchboards and panelboards with the top breaker handle 6'6" maximum above the finished floor, or concrete pad.
- H. Verify exact wall dimensions in field to ensure that standard panelboard cabinets specified can be arranged in the space allocated.
- I. All scratched or marred surfaces shall be repaired to match original condition.
- J. All switchboards and panelboards shall have permanently affixed circuit numbers at each circuit space.

END OF SECTION

SECTION 16460
DRY-TYPE TRANSFORMERS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide dry type transformers, 600 volts or less.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.
- B. Submit data including transformer dimensions, construction, sound level, temperature power ratings, and efficiency ratings.
- C. Submit test results in accordance with Section 16080.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 - 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 - 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

- A. Transformers shall be listed by Underwriter's Laboratories.
- B. Transformers shall be tested in accordance with NEMA 5720.
- C. Energy efficient transformers shall be tested in accordance with NEMA TP-1.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Dry-Type Transformer
 - 1. Square D
 - 2. Siemens
 - 3. Hammond Power Solutions
 - 4. Acme Electric Corp.
 - 5. Cutler-Hammer
- B. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.02 K-RATED TRANSFORMERS

- A. Transformers shall be air-cooled, dry type, designed and constructed in accordance with the latest applicable NEMA, ANSI, and IEEE Standards.
- B. Transformers 15KVA and larger enclosure shall be of heavy-gauge, sheet steel with ventilation openings that will not allow any rod of 1/2" diameter to be inserted into the transformer. Enclosure shall be finished with gray, baked enamel.
- C. Transformers 25KVA and larger shall have full capacity taps above and below high-voltage and with the following minimum quantity and ratings, 2-2½% FCAN and 2 - 2½% FCBN.
- D. Primary Voltage/Phase/Wire and Secondary Voltage/Phase/Wire shall be as designed on the drawings of the Transformer Schedule. Frequency shall be 60HZ.
- E. Transformers 15 kVA and larger shall be a 220°C insulation system with a 80°C temperature rise above 40°C ambient.
- F. Impedance shall be 4.5% maximum.
- G. All winding shall be of high conductivity aluminum.
- H. UL listed and labeled K-13, as defined as the sum of fundamental and harmonic, per UL 1561.
- I. Supplied with full-width electrostatic shield.
- J. 200% neutral with double-size neutral terminal.

- K. Sound levels for transformers with a K-13 rating shall be warranted by the transformer manufacturer not to exceed levels listed here:

NEMA Standard ST-20	
KVA Rating	Sound Level
15 to 50 kVA	45 dB
51 to 150 kVA	47 dB
151 to 300 kVA	52 dB
301 to 500 kVA	57 dB

- L. Transformers shall be constructed with internal vibration isolation pads located between the transformer core and coil assembly and the transformer enclosure. Bolts at isolation pads that are tightened for shipping shall be loosened per manufacturer recommendations, prior to energizing of transformer.
- M. Transformers shall meet the current energy efficiency standards of NEMA TP-1 and shall have the EPA "ENERGY STAR" label.

Efficiency ratings shall not exceed the following:

Single Phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
–	–	750	98.8
–	–	1000	98.9

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Neoprene pads shall be provided between transformer mounting feet and building mounting surface. Flexible conduits of sufficient lengths shall be used for termination of primary and secondary wiring to transformers, so as to reduce the transmission of vibration to the building structure.
- B. Transformers shall be located a minimum of 10 inches from all walls and/or other obstructions or, if greater, the required clearances marked on the transformer by the manufacturer. Wherever possible, transformers shall not be located in corners of rooms.
- C. Provide grounding conductor from transformer secondary to nearest building ground for each separately derived system. Grounding electrode conductor shall be sized in accordance with NEC Article 250 for the derived phase conductors.

- D. All transformers shall be labeled to match the designation on the one-line diagram, or the designation noted on the plans. Nameplates shall be laminated, phenolic, with 1/2" high white block letters on a black background. Nameplates shall be securely fastened to front covers of equipment with brass screws.
- E. Transformers shall be tested in accordance with Section 16080.

END OF SECTION

SECTION 16501
LAMPS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide lamps in all fixtures as indicated on Drawings.
- B. Lamps shall be completely compatible with ballasts and lighting fixtures.

1.02 SUBMITTALS

- A. Submit manufacturer's product information including power consumption, color type, rated lumen output and life in accordance with Section 16010.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Lamps:
 - 1. General Electric
 - 2. Osram Sylvania
 - 3. Philips.
- B. Substitutions: Items of equal quality, function and performance may be proposed for substitution by following the procedures outlined in Section 16010.

2.02 FLUORESCENT LAMPS

- A. Linear T8 fluorescent lamps shall be "High Performance T8", 3500K, rapid start, medium bi-pin, with minimum 24,000 hours rated average life with 3 or more starts per hour. Lumen maintenance rating shall be greater than 94%. Lamps shall be TCLP compliant.
 - 1. Four-foot fluorescent lamps shall be 32 watt, T8, CRI index shall be 85 or greater and light output lumens shall be 3,100 initial, 2,900 mean. Philips Advantage High Vision Alto; G.E. Extra-Life, Starcoat Phosphor, High Lumen ECO; Sylvania Xtreme XPS EcoLogic or equivalent.
 - 2. Three-foot fluorescent lamps shall be 25 watt, 2,225 initial lumens, 82 CRI.
 - 3. Two-foot lamp shall be 17 watt, 1,400 initial lumens, 82 CRI.
- B. Linear T5 fluorescent lamps shall be 3500K, slim profile with minimum 20,000 hours rated average life. Lumen maintenance rating shall be 95%. CRI shall be 85.
 - 1. 46" lamps shall be 28 watt and have an initial lumen output of 2900.
 - 2. 34" lamps shall be 21 watt and have an initial lumen output of 2100.

3. 22" lamps shall be 14 watt and have an initial lumen output of 1350.
- C. PL triple, 4-pin, compact fluorescent lamps shall be 3500K, 10,000 hours rated average life with 3200 approximate initial lumens for 42 watt lamps; 2,400 approximate initial lumens for 32 watt lamps; 1,800 approximate lumens for 26 watt lamps; 1,200 initial lumens for 18 watt lamps; and 900 approximate initial lumens for 13 watt lamps. CRI shall be 82.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install lamps in accordance with manufacturer's instructions.
- B. Lamp all fixtures with lamps of the designated rating.
- C. Five percent (5%) spare lamps of each type shall be provided to the Owner, two lamps of each type minimum.

END OF SECTION

SECTION 16502
BALLASTS AND ACCESSORIES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide all required ballasts and control equipment.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

- A. The latest issue of the following specifications and standards at the time of contract award form a part of this Section:
 - 1. National Electric Code (NEC) (NFPA 70).
 - 2. Illuminating Engineering Society of North America (IESNA) Handbook.
 - 3. Certified Ballast Manufacturers Standards (CBM)
 - 4. American National Standards Institute (ANSI)
 - 5. Underwriters laboratories Inc. (UL)

1.03 SUBMITTALS

- A. Submit product data in accordance with Section 16010.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ballasts:
 - 1. Advance
 - 2. Universal
 - 3. Robertson
 - 4. Osram Sylvania

2.02 FLUORESCENT BALLASTS - T8

- A. Ballasts shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.
- B. Ballasts shall be provided with integral leads color coded per ANSI C82.11.
- C. Ballasts shall be Instant Start.
- D. Ballasts shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail.
- E. Ballasts shall contain auto restart circuitry in order to restart lamps without resetting power.

- F. Ballasts shall operate from 60 Hz input source of 120V, 277V, or 347V as applicable with sustained variations of $\pm 10\%$ (voltage and frequency) with no damage to the ballasts.
- G. Ballasts shall be high frequency electronic type and operate lamps at a frequency above 42 kHz ("GCN" models between 20kHz and 30kHz) to avoid interference with infrared devices and eliminate visible flicker.
- H. Ballasts shall have a Power Factor greater than 0.98 for primary lamp.
- I. Ballasts shall have a minimum ballast factor of 0.75 for low watt, 0.85 for normal light output and 1.20 for high light.

Performance Characteristics				
Ballast Efficacy Factor (BEF)	Instant-Start Ballast (BEF)			
	Lamps	Low BF ≤ 0.85	Norm $0.85 < BF \leq 1.0$	High BF ≥ 1.01
BEF = $[BF \times 100] / \text{Ballast Input Watts}$ Based on: 1) Type of ballast 2) No. of lamps driven by ballast 3) Ballast Factor	1	≥ 3.08	≥ 3.11	N/A
	2	≥ 1.60	≥ 1.58	≥ 1.55
	3	≥ 1.04	≥ 1.05	≥ 1.04
	4	≥ 0.79	≥ 0.80	≥ 0.77

- J. Ballasts shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.
- K. Ballasts input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
- L. Ballasts shall have a Class A sound rating.
- M. Ballasts shall have a minimum starting temperature of -18 deg. C (0 deg. F).
- N. Ballasts shall tolerate sustained open circuit and short circuit output conditions without damage.
- O. Ballasts shall not contain any Polychlorinated Biphenyl (PCB).
- P. Ballasts shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.
- Q. Ballasts shall comply with ANSI C62.41 Category A for transient protection.
- R. Ballasts shall comply with ANSI C82.11 where applicable.
- S. Ballasts shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- T. Ballasts shall be manufactured in a factory certified to ISO 9002 Quality System Standards.

- U. Ballasts shall carry a 5-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70 deg. C.
- V. Manufacturer shall have a 15-year history of producing electronic ballasts for the North American market.
- W. Advance Optanium T8 or equivalent and shall fully comply with utility rebate requirements.

2.03 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
- B. Lamp end-of-life detection and shutdown circuit.
- C. Automatic lamp starting after lamp replacement.
- D. Sound Rating: Class A.
- E. Total Harmonic Distortion Rating: Less than 20 percent.
- F. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
- G. Operating Frequency: 20 kHz or higher.
- H. Lamp Current Crest Factor: 1.7 or less.
- I. BF: 0.95 or higher unless otherwise indicated.
- J. Power Factor: 0.95 or higher.
- K. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Ballasts shall be securely fastened to the luminaire house for good thermal contact and prevent vibration.
- B. Ensure all ballasts are suited for lamp operation.
- C. Provide ballasts of compatible design to lamps specified.
- D. Cold location ballasts shall be provided for all fixtures located outdoors or in an area where the temperature will routinely drop below the standard ballast temperature rating.

END OF SECTION

SECTION 16510
LIGHTING

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide fixtures, supports and accessories, trim rings and backboxes.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 1 specification sections, apply to this Section and to all Contractors, Subcontractors, or other persons supplying materials and/or labor, entering into the Project site and/or premises, directly, or indirectly.
- B. The Specifications and Drawings are intended to be complementary. A particular section, paragraph or heading in a Division may not describe each and every detail concerning work to be done and materials to be furnished. The Drawings are diagrammatic and may not show all of the work required or all construction details. Dimensions are shown for critical areas only; all dimensions and actual placements are to be verified in the field. It is to be understood that the best trade practices of the Division will prevail. It remains the responsibility of the Contractor or Subcontractor to provide all items, equipment, construction, and services required to the proper execution and completion of the Work.
- C. Reference listings are provided as a convenience to the Contractor or Subcontractor providing the Work of this Section and may not contain all the requirements affecting this Section. It remains the responsibility of the Contractor or Subcontractor to locate and comply with all requirements of the Contract Documents.

1.03 SUBMITTALS

- A. Submit shop drawings and product data including photometric and pertinent physical characteristics of luminaire data in accordance with Section 16010.
- B. Substitutions:
 - 1. Reference in the specifications to any lighting fixture by name shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any product, which in the judgment of the Consultant expressed in writing to all Bidders before opening of bids as an addendum, is an acceptable substitute to the specified.
 - 2. Substitutions during bid time: Whenever any particular brand or make of material or apparatus is called for in the specifications, a Bidders Proposal must be based upon such material or apparatus, or upon a brand or make which has been specifically approved as a substitution in an Addendum issued to all Bidders during the bidding time.
 - 3. If a Bidder, firm, etc., desires that consideration be given to another brand or make, etc., then he may submit to the Consultant, not later than ten (10) days before the hour and day set for bid opening, a written request for the "Acceptable Substitute" of such material or apparatus, and clearly defining and describing same, together with necessary manufacturer's literature, specifications, drawings and performance data. Requests received after above deadline will not be considered.

4. If the Consultant approves the material submitted, or if he should accept a substitute, then an Addendum would be issued to each Bidder who has received a set of bidding documents, so that all Bidders may avail themselves of the change in submitting their proposals.
5. Substitutions after bid opening: No substitutions will be considered after bids have been opened unless necessary due to strikes, lockouts, bankruptcy, or discontinuance of manufacturer, etc. In such cases, the Contractor shall apply to the Consultant/Engineer, in writing, within ten (10) days of realizing his inability to furnish the article specified, describing completely the substitution he desires to make.

1.04 REGULATORY REFERENCES

- A. All specified items or systems shall be designed, manufactured, tested, and installed in compliance with applicable provisions of all governing codes, rules, laws, and ordinances in accordance with Section 16010.
 1. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to all applicable documents and to the most recent release when developing the proposal for installation.
 2. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years experience.

1.06 COORDINATION

- A. Confirm compatibility and interface of other materials with fixture and area. Report discrepancies to the Engineer, and defer ordering until clarified.
- B. Supply frames, trim rings and backboxes to other trades, as may be required.
- C. Coordinate with other trades to avoid conflicts between fixtures, supports, fittings, mechanical equipment and other utilities.
- D. Subsequent to review of shop drawings and prior to ordering fixtures verify voltage at each fixture also consult with all others to determine the type of ceiling and ceiling suspension system in each and every room and order fixtures to suit and fit the particular ceiling and ceiling suspension system. Any extra costs because of failure on the part of this Contractor to verify voltage or ceiling requirements shall be paid for by this Contractor. It is not the intent of fixture catalog numbers shown to classify the voltage, ceiling or ceiling suspension.
- E. Fixtures shall be described herein and on the Drawings and be appropriate for the intended location. All necessary lamps shall be provided with the fixtures. Where indicated on the Drawings, fixtures shall have emergency ballast suitable for emergency use.

PART 2 – PRODUCTS

2.01 LIGHTING FIXTURES

- A. Provide light fixtures as indicated on the Drawings. See Lighting Fixture Schedule.

2.02 EMERGENCY LIGHTS

- A. Emergency lights shall be 12-volt, self recharging power packs with number of lamp heads as indicated on the Drawings. Power pack shall have premium grade, pure lead or (nickel cadmium), maintenance-free battery, all metal chassis with injection-molded thermoplastic cover and lamp housings, and low voltage disconnect. Units shall be rated to power the indicated number of lamps for a minimum of 2 hours. Lamps shall be capable of being side mounted. Lamps shall be fully adjustable, halogen sealed beam type, 7.2 watts nominal.
- B. Lamp head shall be suitable for unit, wall, or ceiling mount as indicated.
- C. Units for use in areas utilizing HID lighting systems shall have built-in time delay for operation during main lighting system startup.
- D. Units shall be UL 924 listed.
- E. Emergency lights shall be Dual Lite LM Series or equivalent.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The care and protection of all fixtures shall be the responsibility of this Contractor until the work under this Contract is accepted by the Owner.
- B. All fixture wiring shall be in accordance with NEC Art. 410 whenever high temperature insulation is required instead of normal branch circuit wiring.
- C. Install fixtures to dissipate ballast and lamp heat.
- D. Exit signs and emergency lights shall be wired ahead of all switching.
- E. Verify lighting switching with Engineer, if necessary for intended operation.
- F. Provide junction boxes as necessary for installation with 1 box for every 2 fixtures being minimum.

3.02 SUPPORTS

- A. Refer to Section 16070.
- B. Wall-mounted fixtures shall be supported in accordance with manufacturer's recommendations, including any recommended junction boxes and mounting hardware.

3.03 ALIGNMENT

- A. Align fixtures and clean diffusers prior to final acceptance.
- B. All fixtures shall be mounted straight and true and shall be located as indicated on the Drawings.

END OF SECTION