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ELECTRICAL SPECIFICATION

DIVISION 16

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SECTION 16000- ELECTRICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 BASIC ELECTRICAL REQUIREMENTS

- A. Specifically applicable to Division 16 sections, in addition to Division 1- General Requirements. In case of overlap between Division 1 and Division 16 the more stringent specification or requirements shall apply.

1.2 PROJECT INCLUDES

- A. Disconnecting existing electric Hot Water Heaters and Heat Pumps remove and scrap as per schedule. Disconnect existing wires back to power panels.
- B. Connect new hot water Heater and Heat Pumps per plans. Identify in panel the appropriate breaker location.
- C. Provide new ceiling mounted light fixture per plans and schedule.
- D. Arc fault breakers and outlets for bedroom (code compliant- Not in Contract)
- E. Electrical Systems for the Following Applications: Refer to individual specification sections following for detailed requirements.
 - 1. Primary connections.
 - 2. Power connections for HVAC-ELECTRIC HEAT PUMP, and HOT WATER ELECTRICAL HEATER.

1.3 SCOPE OF WORK

- A. New Work
 - 1. Provide new power requirements to feed the new HVAC –Heat Pumps equipment.
 - 2. Connect new hot water heaters.
 - 3. Provide new light per schedule in each mechanical room

END OF SECTION 16000

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1- GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding and bonding
 - 2. Supports
 - 3. Identification
- B. Related Sections:
 - 1. Cutting and patching: Division 1.
 - 2. Painting: Division 9

1.2 REFERENCES

- A. A NFPA 70-96- National Electrical Code; National Fire Protection Association; 1996.
- B. Standard of Installation; National Electrical Contractors Association (NECA); 1990.

1.3 QUALITY ASSURANCE

- A. Conform to NFPA 70
- B. Conform to requirements of NECA 'Standard of Installation' that do not conflict with regulatory requirements or requirements of contract documents. Keep one copy at project site.
- C. Furnish products listed by Underwriters Laboratories Inc and classified as suitable for installed use and environmental conditions.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Description: Engraved plastic.
- B. Nameplate Color: Black letters on white background.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces intended to support products.
- B. Verify that each product conforms to regulatory requirements and to specification requirements.
- C. Examine existing grounding and bonding systems to verify adequacy.

3.2 PREPARATION

- A. Clean surfaces to receive work.
- B. Protect surrounding elements from work of this section.

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3.3 GROUNDING AND BONDING

- A. Make grounding and bonding connections to meet regulatory requirements.
- B. Equipment Grounding Conductor. Provide separate grounding conductor in each raceway and cable.

3.4 ANCHORS AND SUPPORTS

- A. Select fasteners and anchors that are suitable for surfaces to which they attach.
- B. Select fasteners and anchors with suitable load rating to support installed products.
- C. Do not use nails for permanent supports.
- D. Fasten supports to sheet metal framing channels using sheet metal screws.
- E. Does not use spring steel clips and clamps to fasten supports.

3.5 IDENTIFICATION

- A. Secure nameplates to equipment and enclosures using noncorrosive screws or rivets, or appropriate adhesive.

3.6 FIELD QUALITY CONTROL

- A. Correction of Defective Work:
 - 1. Replace defective products.

3.7 CLEANING

- A. Restore damaged corrosion-resistant coatings.

END OF SECTION 16050

**SECTION 16120
WIRE AND CABLE**

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wire.
- B. Related Sections:
 - 1. Cutting and patching:
 - 2. Fire-stopping.
 - 3. Painting:
- C. Owner- Furnished Products: Refer to Division 1 for description of owner-furnished products affecting work of this section.
- D. Alternates: Refer to Division 1 for description of alternates affecting work of this section.

1.2 REFERENCES

- A. NFPA 70-96 – National Electrical Code; National Fire Protection Association; 1996.
- B. Standard of Installation; National Electrical Contractors Association (NECA); 1990.

1.3 SUBMITTALS

- A. Manufacturer's qualification statement, for information.
- B. Coordination drawings, for information.
- C. Field test report for each inspection and test specified in this section, for information. Describe inspections and tests, list observations, indicate corrective action taken, and state conclusions and recommendations for future action.

1.4 QUALITY ASSURANCE

- A. Conform to NFA 70.
- B. Conform to requirements of NECA "Standard of Installation" that do not conflict with regulatory requirements or requirements of contract documents. Keep one copy at project site.
- C. Furnish products listed by Underwriters Laboratories Inc. and classified as suitable for installed use and environmental conditions.

1.5 QUALIFICATIONS

- A. Manufacturer Qualifications: A company manufacturing products of this section which have performed in a satisfactory manner under comparable conditions for a period of 5 years.

1.6 PROJECT CONDITIONS

- A. Review drawings to determine project conditions.
- B. Determine working clearance around and between construction elements such as beams, columns, walls, and ceilings.

- C. Determine access requirements around other work, including working clearances to mechanical equipment, controls, and electrical equipment.

1.7 COORDINATION

- A. Prepare coordination drawings and distribute to affected installers of related work.
 - 1. Indicate cable routing and elevation.
 - 2. Indicate required separation of cable from piping and heat generating sources
 - 3. Indicate requirements for access openings in building finished.

PART 2 – PRODUCTS

2.1 INSULATED WIRE AND CABLE

- A. Conductor: Copper.

2.2 METAL-CLAD CABLE

- A. Armor Type: Interlocked tape.
- B. Armor Material: Steel.
- C. Conductor: Copper
- D. Covering: PVC jacket.

PART 3 – EXECUTION

3.1 CONDUCTORS – 600 VOLT & UNDER

- A. GENERAL
 - 1. Sizes of conductors and thickness of metals are American Wire Gauge (AWG).
 - 2. Wire sizes #10 and smaller shall be solid. Wire sizes #8 and larger shall be stranded.
 - 3. Wire and cable shall be insulated single conductor, 98 percent conductivity copper.
 - 4. Minimum size conductors for power and lighting circuits shall be #12 AWG and signaling systems #14 AWG.
- B. CONDUCTORS SELECTION
 - 1. In areas subject to temperatures not exceeding 75 degrees C. (165 degrees F.), type THW shall be used for feeders and THWN for tenant branch circuits.
 - 2. In areas subject to temperatures not exceeding 90 degrees C. 194 degrees F.), type THHN shall be used.
 - 3. Wire and cable shall be Anaconda, General Electric, Phelps Dodge, Prelli or approved equal.

3.2 EXAMINATION

- A. Examine elements and surfaces intended to support products.
- B. Verify that each product conforms to regulatory requirements and to specification requirements.

3.3 PREPARATION

- A. Clean surfaces to receive work.

- B. Protect surrounding elements from work of this section.
- C. Clean raceways thoroughly before installing wires.

3.4 WIRING METHODS

- A. Use specified wiring methods.
- B. Underground locations:
 - 1. Underground service entrance cable
 - 2. Underground feeder and branch circuit cable.
- C. In or Under Slab-on-Grade:
- D. Wet interior Locations:
 - 1. Metal-clad cable with jacket.
- E. Concealed Dry Interior Locations:
 - 1. Metal-clad cable.
- F. Exposed Dry Interior Locations:
 - 1. Metal-clad cable.

3.5 INSTALLATION

- A. Install products in compliance with manufacturer's instructions.
- B. Install accessories specified in this section.
- C. Maintain required headroom.
- D. Conceal cable in finished spaces.
- E. Install exposed cable perpendicular and parallel to building surfaces.
- F. Identification:
 - 1. Use wire markers at each box and enclosure to identify conductors.
 - 2. Identify each feeder number with its designation shown on drawings.
 - 3. Identify each branch circuit conductor with panelboard and circuit number
 - 4. Identify each control circuit conductor with wire number shown on drawings.

3.6 FIELD QUALITY CONTROL

- A. Inspect wires and cables for physical damage.
- B. Insulation Resistance:
 - 1. Test each service and feeder circuit.
 - 2. Test each conductor with respect to ground and to its adjacent conductors.
 - 3. Apply 1000 volts dc test potential for 1 minute.
 - 4. Minimum insulation resistance; 2 megohms.
- C. Correction of Defective Work:
 - 1. Replace wire and cable damaged during installation.
 - 2. Replace defective products.

END OF SECTION 16120

**SECTION 16121
MEDIUM-VOLTAGE CABLE**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. This Section is to coordinate with and be complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Electrical Work.
- B. Section 16000 - Electrical Requirements.
- C. Section 16050 - Basic electrical materials and methods shall apply.

1.2 DESCRIPTION OF WORK

- A. The work includes the providing of cable complete with all accessories, in accordance with Drawings and Specifications and as required for a complete system

1.3 QUALITY ASSURANCE

- A. Manufacturers - Firms regularly engaged in the manufacture of cable of specified types and ratings whose products have been in satisfactory use in similar service for not less than 5 years
- B. Comply with the National Electrical Code (NFPA No. 70) and with local electrical codes, which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply
- C. Workman Competency Submit high voltage Splicer/ Terminator certification of competency and experience 30 days before splices or terminations are made in high voltage cables Splicer/Terminator experience during the immediate past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this Specification
- D. Listing Agency. Cable types for which Underwriter's Laboratories, Inc provide listing service shall be listed and bear the listing mark

1.4 SUBMITTALS

- A. Preliminary Acceptance Submittals:
 - 1. Complete manufacturer's construction details and specifications for the cable including physical and electrical characteristics of insulation, shields, and jacket
 - 2. Overall dimension and ampacity of cable.
 - 3. Cable handling and installation recommendations
- B. Final Acceptance Submittals:
 - 1. Cable manufacturer's certified test reports
 - 2. Written statement from cable manufacturer indicating acceptable pulling lubricants
 - 3. Manufacturer's catalog sheets for all products supplied.

1.5 GUARANTEE

- A. Refer to Section 16000, Special Requirements for Electrical Work.

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1.6 APPLICABLE INDUSTRY STANDARDS

- A. Cable system shall comply with or exceed applicable provisions and recommendations of the following except where otherwise shown or specified
1. National Electrical Code (NEC).
 2. ASTM B 8, Specification for Copper Conductors, Concentric-Laid- Standard, Hard, Medium-Hard, or Soft.
 3. ASTM B 3, Specification for Copper wire, Soft or Annealed
 4. UL 1072, Specification for Medium Voltage Cable (Type MV-90)
 5. ICEA S-68-516, Ethylene-Propylene-Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 6. AEIC CS6-87, Specifications for Ethylene Propylene Rubber insulated Shielded Power Cables Rated 5 through 69 KV

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Cables shall be single conductor
- B. Keep ends of cables sealed at all times, except when making splices or terminations Use heat shrinkable plastic end caps, or other methods approved by cable manufacturer.
- C. Mark and tag cables for delivery to the site the same as required for sample labels
- D. Cables shall be manufactured and tested under a quality assurance program which meets the requirements of ISO 9001 or Section 10 CFR50, appendix B, of Federal Register as defined in ANSI 45.2.

2.2 SPECIFIC REQUIREMENTS

- A. All conductors shall be annealed uncoated copper with concentric -1a Class B compressed or compact stranding to accordance with the current ASTM Standards

At the option of the purchaser, the conductor interstices of the stranded conductor shall be filled with a semi- conducting material to prevent water propagation through the insulated conductor and to alleviate water (electrochemical) freeing of the insulation The compound used shall be flexible and stable under the conditions imposed by cable operation, and compatible with the conductor, strand shield (conductor shield), and insulation. The compound shall be capable of withstanding a water penetration test of 5 psi for qualification and 10 psi for production testing

B. The conductor shield shall consist of an extruded semi-conducting thermosetting compound applied over the conductor This material shall be compatible with the conductor metal, free stripping from the stranded conductor, and shall be uniformly and firmly bonded to the overlaying insulation The thermal characteristics shall be equal to or better than those of the insulation The thickness of the extruded conductor shield shall be in accordance with the following table:

CONDUCTOR SHIELD THICKNESS (MILS)

CONDUCTOR SIZE (AWG or kcmil)	Minimum Average	Minimum Point
2 - 4/0	15	12

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MEDIUM VOLTAGE CABLE

250 - 500	20	16
600 - 1000	25	20

The volume resistivity of the extruded conductor shield shall not exceed 1000 ohm-meters at 90°C and 130°C when tested in accordance with ICEA.

- C. The primary insulation shall be high quality, heat, moisture, ozone and corona-resistant thermosetting ethylene propylene rubber based compound (such as Pirell's EpRotenax™) meeting the requirements of UL, ICEA and AEIC It shall be contrasting in color from the extruded semi-conducting shields, and it shall meet the requirements of Paragraph 3 .6.1 of ICEA 5 68 516.

The minimum average thickness of the insulation shall be 220 mils and the minimum thickness at any point shall not be less than 90% of the specified minimum average thickness (or 198 mils).

The manufacturer must be able to demonstrate and document to the satisfaction of the purchaser sufficient capability and experience in the manufacturer and field application of high quality, high voltage power cable with EPR insulation. The insulation shall have an established service record of twenty (20) years or more in industrial and utility installations.

- D. All 15 KV cable shall have an extruded semi-conducting thermosetting compound extruded directly over the insulation the thermosetting material shall be compatible with the insulation and the overlying metallic shield. The thermal characteristics of the compound shall be equal to or better than those of the insulation The thickness of the extruded insulation shield shall be in accordance with the following table:

OD Over Insulation (Inches)	INSULATION SHIELD THICKNESS (MILS)	
	Minimum Point	Maximum Point
0.000-1.000	30	70
1.001-1.500	40	85
1.501-2.000	55	100
2.001 & larger	55	115

The DC volume resistivity of the extruded insulation shield shall not exceed 500 ohm-meters at 90°C and 130°C when tested in accordance with ICEA.

The insulation shield shall be free stripping from the insulation (Without the use of a release agent), and the tension necessary to remove the extruded insulation shall be 4 to 18 pounds when tested in accordance with Paragraph C.3.1 of AEIC the shield shall strip cleanly from the insulation, leaving it free of any significant residue of semiconducting or other material, which would have to be removed before splicing or terminating

- E. The metallic shielding shall consist of a non-magnetic copper tape meeting the requirements of Section 4.112 of ICEA S-68-516, helically applied with a minimum overlap of 125%.
- F. A polyvinyl chloride (PVC) jacket shall be tightly extruded directly over the copper shielding tape. Unless otherwise specified at time of purchase, the jacket color shall be black The jacket thickness shall be in accordance with UL 1072, Table 24.14 for shielded single conductor cables

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- G. The cable shall meet or exceed the testing requirements as outlined in AEIC, ICEA and UL 1072

PART 3 - EXECUTION

3.1 GENERAL

- A. Install wire and cable in accordance with the requirements of the National Electrical Code (NEC) , the manufacturer's written instructions, and in accordance with recognized industry practices to ensure that products serve the intended functions

3.2 CABLE INSTALLATION

- A. Pull all cables with a dynamometer or strain gauge incorporated into the pulling equipment. Do not pull cables unless the Owner's Representative is present to observe readings on the dynamometer or strain gauge during the time of actual pulling. Total strain on cables shall not exceed manufacturer's recommended pulling tensions

3.3 WARRANTY

- A. The manufacturer shall provide a written product warranty effective from date of installation. Warranty shall cover replacement of product if defects are discovered during the warranty period

END OF SECTION 16121

SECTION 16130 - WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Boxes.
 - 2. Service fittings.
 - 3. Wiring devices.
 - 4. Equipment connections
- B. Related Sections:
 - 1. Cutting and patching.
 - 2. Fire-stopping:
 - 3. Painting.
- C. Owner-Furnished Products. Refer to Division 1 for description of owner- furnished products affecting work of this section
- D. Alternates: Refer to Division 1 for description of alternates affecting work of this section

1.2 REFERENCES

- A. NEMA OS 1-1989 -- Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 1989.
- B. NEMA WD 1-1983(R 1989) -- General Requirements for Wiring Devices; National Electrical Manufacturers Association; 1983 (Reaffirmed 1989)
- C. NEMA WD 6-1988 -- Wiring Devices--Dimensional Requirements; National Electrical Manufacturers Association; 1988
- D. NFPA 70-93 -- National Electrical Code; National Fire Protection Association; 1993
- E. Standard of Installation; National Electrical Contractors Association (NECA) ; 1990

1.3 SUBMITTALS

- A. Product data for each wiring device specified in this section
- B. Product data for each service fitting specified in this section
- C. Manufacturer's qualification statement, for information
- D. Coordination drawings, for information

1.4 QUALITY ASSURANCE

- A. Conform to NFPA 70
- B. Conform to requirements of NECA "Standard of Installation" that do not conflict with regulatory requirements or requirements of contract documents. Keep one copy at project site.

- C. Furnish products listed by Underwriters Laboratories Inc and classified as suitable for installed use and environmental conditions

1.5 QUALIFICATIONS

- A. Manufacturer Qualifications: A company manufacturing products of this section which have performed in a satisfactory manner under comparable conditions for a period of 5 years

1.6 PROJECT CONDITIONS

- A. Review drawings to determine project conditions.
- B. Determine working clearance around and between construction elements such as beams, columns, walls, and ceilings.
- C. Determine access requirements around other work, including working clearances to mechanical equipment, controls, and electrical equipment.
- D. Locations of outlets indicated on drawings are approximate unless dimensioned. Determine exact locations before roughing in raceway.

1.7 COORDINATION

- A. Use manufacturer's instructions and data to determine rough-in requirements and locations of products connected to electrical wiring.
- B. Prepare coordination drawings and distribute to affected installers of related work
 - 1. Indicate requirements for access openings in building finishes.

PART 2 - PRODUCTS

2.1 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel

2.2 JUNCTION AND PULL BOXES

- A. Sheet Metal Boxes: Screw covers type.

2.3 WALL SWITCHES

- A. Manufacturers: Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
 - 1. Arrow Hart Division/Cooper Industries.
 - 2. Bryant Electric Inc
 - 3. GE Wiring Devices
 - 4. Hubbell Incorporated/Wiring Device Division.
 - 5. Leviton Manufacturing Company, Inc.
- B. Wall Switch:
 - 1. Comparable products of specified manufacturers are acceptable
 - 2. Description: NEMA WD 1, heavy duty snap switch.
 - 3. Voltage: 120 volts, ac only
 - 4. Rating: 20 amperes
 - 5. Handle type: Toggle.
 - 6. Handle color: Ivory
 - 7. Wall plate: Plastic with color to match switch handle

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces intended to support products.
- B. Verify that each product conforms to regulatory requirements and to specification requirements.
- C. Verify locations of outlets before roughing in.

3.2 PREPARATION

- A. Clean surfaces to receive work.
- B. Protect surrounding elements from work of this section.

3.3 INSTALLATION

- A. Install products in compliance with manufacturer's instructions.
- B. Install accessories specified in this section.
- C. Maintain required headroom.

3.4 WIRING CONNECTIONS

- A. Make wiring connections in locations that ensure access, or provide access panel using materials and methods specified in Division 8.
- B. Fasten conduit to boxes in wet locations using conduit hubs.
- C. Use splice and tap devices compatible with conductor material.
- D. Provide closures on unused openings in boxes.
- E. Outlet and Device Boxes:
 - 1. Install at heights indicated on drawings.
 - 2. position recessed outlets carefully to allow for surface finish thickness
 - 3. Separate outlets on both sides of walls by at least 6 inches.
- F. Equipment Connections:
- G. Examine electrical outlets to verify proper location
- H. Examine branch circuit wiring to verify suitability.
 - 1. Install disconnect switches where indicated
 - 2. Make wiring connections to equipment using devices and methods recommended by equipment manufacturer
 - 3. Use conductor insulation with suitable rating for equipment connection.

3.5 COMMISSIONING

- A. Verify that products connected to wiring system are properly bonded to ground.
- B. Verify size of overcurrent protection devices.

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- C. Verify that wiring connections conform to manufacturer's instructions.
- D. Operate electrical system to allow placing connected equipment into operation.

3.6 FIELD QUALITY CONTROL

- A. Receptacle Connections: Test each receptacle for proper connection.
- B. Correction of Defective Work:
 - 1. Replace defective products.

3.7 CLEANING

- A. Restore damaged corrosion-resistant coatings.

END OF SECTION 16130

**SECTION 16140
WIRING DEVICES**

1.1 PROJECT INCLUDES

- A. Wiring devices for electrical service.

1.2 QUALITY ASSURANCE

- A. Compliance; National Electrical Code, NEMA WD 1, UL.

1.3 PRODUCTS

- A. Wiring Devices and Components:
 - 1. Heat Pumps and HP Condensers.
 - 2. Hot Water Heaters
 - 3. Thermostats

END OF SECTION 16140

**SECTION 16170
GROUNDING AND BONDING**

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical equipment grounding and bonding.

1.2 SYSTEM DESCRIPTION

- A. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables receptacles ground connectors, and plumbing systems

1.3 INSTALLATION

- A. Provide a separate, insulated equipment grounding conductor in feeder and branch circuits terminate each end of a grounding lug, bus, or grounding bushing.
- B. Ground electrical systems and provide equipment grounding as required by the National Electrical Code and the National Safety Code, including secondary neutrals
- C. The following list is representative of the parts which shall be solidly grounded
 1. Conduit systems
 2. Motor frames
 3. Pull boxes and junction boxes
- D. All raceways and cable connections entering panel boards shall be provided with plastic insulating bushings and properly fastened to assure grounding continuity.

1.4 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connection for tightness and proper installation

END OF SECTION 16170

**SECTION 16181
CIRCUIT AND MOTOR DISCONNECTS**

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of circuit and motor disconnect switch work is indicated by drawings- Heat Pump and Heat Pump Condensers.

1.2 QUALITY ASSURANCE

- A. NEC Compliance: Comply with requirements pertaining to construction and installation of electrical circuit and motor disconnect devices.
- B. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches". Provide Circuit and motor disconnect switches which have been UL-listed and labeled.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000Volts Maximum).

1.3 SUBMITTALS

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work included, but are not limited to, the following:

Crouse-Hinds Co.
Cutler-Hammer Inc.
Federal Pacific Electric Co.
Furnas Electric Co.
General Electric Co.
General Switch Corp.
GTE Sylvania Inc.
Square D Company
Westinghouse Electric Corp.

2.2 FABRICATE SWITCHES

- A. Safety Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed safety switches, of types, sizes, ratings and electrical characteristics as indicated on drawings; fusible type, solid neutral; incorporating quick-make, quick-break type switches; so constructed that switch blades are visible in off position with door open. Equip with operating handle which is integral part of enclosure base and whose position is easily recognized, and is padlockable in off position; construct current carrying parts of high – conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips. Provide NEMA 1 type enclosure unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

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- A. The Contractor for Electrical Work shall review the General, Plumbing, Heating, Air conditioning and Ventilation Specifications and Drawings for equipment furnished and installed under each of these contracts, as the Contractor for Electrical work shall provide all electrical facilities and make all electrical installation.
- B. Electrical Contractor shall provide overcurrent protection and disconnecting means as required by the National Electrical Code for all motors. Therefore, it is necessary to check equipment provided under these Divisions so as to avoid duplication of protective and disconnecting.
- C. Contractor shall connect, ready for operation, motors and starting apparatus specified under other trades.
- D. Each motor, except where disconnecting means is combined with motor branch circuit overcurrent protection in a panel or motor control center, shall be provided with a NEMA Type "H" enclosed safety switch, having quick-make and quick-break contacts. The disconnecting switch shall open all underground conductors simultaneously and shall have rating equal to, or in excess of, the motor control. Where manual control is called for in addition to automatic control, a switch in parallel with the automatic control device is acceptable. Each motor protective device shall be calibrated or selected for its rated capacity. Provide quick-make, quick-break, non-fusible disconnect switches at all motors where circuit breaker type is not required.
- E. Note that the various Contractors will furnish F.O.B. to the premises, all magnetic starters for installation and connection by the Electrical Contractor. Where more than one motor is wired to a single circuit, each motor shall be provided with a thermal protective switch.

3.3 ROTATION

- A. This Contractor shall be responsible for correct rotation of all motors.

3.4 AUTOMATIC CONTROL

- A. In general, automatic control for Heating, Ventilation, and Air Conditioning Equipment will be wired, including the installation of conduits, panels, fittings, etc., by a Temperature Control Contractor; hired as a subcontractor, however, an Electrical Contractor shall install controls and control wiring for a specific unit or apparatus is specifically indicated to be furnished by Electrical Contractor on the electrical drawings.

3.5 AUTOMATIC TEMPERATURE CONTROL

- A. Power wiring and connections for temperature control panels and air compressors shall be installed by the Electrical Contractors. Electrical wiring and connections, freeze protection thermostats, fire protection thermostats, solenoid air valves and pressure electric switches shall be furnished and installed by the Temperature Control Contractor.

3.6 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical disconnect switches where indicated.

3.7 FIELD QUALITY CONTROL

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION – 16181

**SECTION 16195
METHODS IDENTIFICATION**

PART 1 GENERAL

1.1 DESCRIPTION

- A. The work under this Section shall include all labor, material, and all else necessary for full compliance with applicable drawings, specifications and other contract requirements, or as directed by the Project Manager for furnishing and installing equipment. Related works see Basic Electrical Material & Methods requirements, Section 16050; General Electrical Requirements, Section 16000.

1.2 SECTION INCLUDES

- A. Related Work
- B. Submittals
- C. Materials
- D. Installation
- E. Wire Identification
- F. Nameplate engraving schedule
- G. Typical Plastic Cable Tags

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01300.
- B. Include schedule for nameplates and tape labels.

PART 2 PRODUCTS

1.4 MATERIALS

- A. Nameplates: Engraved three-layer laminated plastic, white letters on a black background.
- B. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates.
- B. Install nameplates parallel to equipment lines.
- C. Secure nameplates to equipment fronts using screws or rivets. Secure nameplate to inside face of recessed panel board doors in finished locations.
- D. Embossed tape will not be permitted for any application.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers at entrance and egress point on each conductor in panel board gutters, pull boxes, and at load connection, identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams for control wiring.

3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates to identify all equipment and control panels.
- B. Disconnect Switches Letter Height: $\frac{1}{2}$ inch for individual switches, $\frac{3}{8}$ inch for loads served.
- C. Panel boards and Boxes: $\frac{1}{2}$ inch; identifying equipment designation. $\frac{3}{8}$ inch; identifying voltage rating and source.
- D. Control Panels: First line, $\frac{1}{2}$ inch control panel designation, $\frac{3}{8}$ inch identifying function, title, $\frac{3}{8}$ inch identifying power source.
- E. Other Equipment: $\frac{1}{2}$ inch indicate designation.

END OF SECTION

**SECTION 16470
PANELBOARDS**

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Disconnecting existing hot water heaters and heat pumps.
- B. Connect new hot water heat pumps and hot water..

1.2 REFERENCES

- A. FS w-c375 – Circuit Breakers, Molded Case, Branch Circuit and Service.
- B. FS-W-P-115 – Power Distribution Panel.
- C. NEMA AB 1 – Molded Case Circuit Breakers.
- D. NEMA PB 1.1 – Instructions for Safe Installations, Operation and Maintenance of Panelboards Rated 600 Volts or less.

1.3 SUBMITTALS

- A. Submit shop drawings for equipment and component.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.4 SPARE PARTS.

- A. Keys: Furnish 2 each to Owner.

Part 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – PANELBOARDS

- A. Square D. or approved equal.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1: circuit breaker type.
- B. Enclosure: NEMA PB 1: Type 1.
- C. Provide flush cabinet front with concealed hinge and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- D. Provide panelboards with copper bus, ratings as scheduled on drawings. Provide copper ground bus in all panelboards.
- E. Minimum Integrated short circuit rating: 10,000 amperes rms symmetrical for 240 volt panelboards.
- F. Molded Case Circuit Breakers: NEMA AB 1 bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type

SWD for lighting circuits. Provide UL Class A ground fault interrupt circuit breakers where scheduled.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb and flush with wall finishes in conformance with NEMA PB 1.1.
- B. Provide filler plates for unused spaces in panelboards.
- C. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION 16470

**SECTION 16476
INDIVIDUAL CIRCUIT BREAKERS**

PART 1 – GENERAL

1.1 STIPULATIONS

- A. The specifications section "General Conditions" and "Special Requirements" from a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION OF WORK

- A. Furnish and install enclosed molded case circuit breakers sized as shown on drawings and as specified herein.

1.3 SUBMITTALS

- A. Submit manufacturer's product data review.

1.4 CODES AND STANDARDS

- A. National Electrical Code (NFPA-70) – latest edition (NEC)
- B. Underwriters Laboratories Inc. (UL)
- C. National Electrical Manufacturer's Association (NEMA AB-1)

PART 2 – PRODUCTS

2.1 FUNCTIONAL REQUIREMENTS

- A. Circuit breakers shall be molded case, thermal magnetic type and shall have a minimum interrupting capacity as shown on drawings.
- B. Each pole shall provide inverse time delay and instantaneous circuit protection and shall be trip free.
- C. Circuit breakers shall be ambient compensated to allow the breaker to carry rated current between 25°C and 50°C with the same tripping characteristics.
- D. Circuit breakers shall be enclosed in a NEMA 1 housing for indoor use and NEMA 4 housing for outdoor use.
- E. Multiple circuit breakers shall have common handle.
- F. Circuit breakers shall have lockable handle in the off position.

2.2 ACCEPTABLE MANUFACTURERS

- A. Circuit breakers shall be as manufactured by Westinghouse, General Electric Co. or Square "D" Co.
- B. Wherever CL breakers are called for on drawings, they shall be fuse-less current limiting type FCL and LCL by Westinghouse, or THLC by General Electric or IK, ID and IL by Square "D".

PART 3 – EXECUTION

- 3.1 Contractor shall install individual circuit breakers where shown on the drawings and shall provide all necessary mounting hardware including steel framing where required.

END OF SECTION 16476

CANNOT BE USED FOR BIDDING