



LOCKLEAR, LOCKLEAR & JACOBS, PLLC

P.O. Box 3119 Pembroke, NC 28372 Phone: (910) 774-9306 Fax: (866) 649-7235

**RAMSEY STREET HIGH SCHOOL PHASE 1 HVAC
UPGRADE**

CUMBERLAND COUNTY SCHOOLS

(PROJECT SPECIFICATIONS)

PREPARED

BY

LOCKLEAR, LOCKLEAR & JACOBS
CONSULTING ENGINEERS
114 WEST THIRD STREET
PEMBROKE, NC 28372

APRIL 2021

TABLE OF CONTENTS

DIVISION 23 –HVAC

23010	Mechanical General Requirements
23050	Wall Mounted Heat Pump with Dehumidification
23600	Air Cooled Through the Wall Packaged Terminal Heat Pump

DIVISION 26 – ELECTRICAL

26 05 00	Basic Electrical Materials and Methods
26 05 10	Electrical Identification
26 05 21	Cables and Wires
26 05 28	Grounding
26 05 34	Raceways, Boxes, Fittings and Supports
26 28 23	Disconnect Switches
26740	Electrical Panelboards

SECTION 23010

MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 INSTRUCTIONS AND TERMS:

- A. All pertinent conditions of the Bidding Requirements, Conditions of the Contract and General Requirements shall govern work under this and all Division 23 sections.
- B. All materials of a given type shall be manufactured by a single source, and supplied by a single supplier.

1.2 SCOPE OF WORK:

- A. Refer to supplied drawings for scope of work to be performed.

1.3 INTERPRETATION OF DRAWINGS:

- A. The Drawings show the location and general arrangement of equipment, piping, ductwork and related items. They shall be followed as closely as elements of the construction will permit. Examine the drawings of other trades and verify the conditions governing the work on the job site. Drawings are schematic in nature, and installation may require additional offsets and modifications, including fittings, traps, valves and accessories.
- B. The architectural and structural drawings take precedence in all matters pertaining to the building structure, mechanical drawings in all matters pertaining to mechanical trades and electrical drawings in all matters pertaining to electrical trades. Report conflicts or differences to the architect/ engineer for resolution.

1.4 PROJECT RECORD DOCUMENTS:

- A. For underground piping, record dimensions and invert elevations of all piping, including all offsets, fittings, cathodic protection and accessories. Locate dimensions from benchmarks that will be preserved after construction is complete.
- B. For fire protection systems, record actual locations of sprinkler heads, and valves and deviations of piping from drawings. Indicate drain and test locations.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store and handle all materials to keep clean and protected from damage.
- B. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
- C. Protect equipment and other materials from damage after installed from construction debris and other damage.

1.6 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with the following:
 - 1. 2012 North Carolina Mechanical Code.
 - 2. 2012 North Carolina Plumbing Code.
 - 3. 2012 North Carolina Fuel Gas Code.
- B. Labeling requirement for packaged equipment:
 - 1. Electrical panels on packaged mechanical equipment shall bear UL label or label of other approved testing agency (ETL, CSA).
- C. Other referenced standards:
 - 1. Comply with referenced standards, guidelines, data sheets from various associations, including NFPA, ANSI, ASTM, ASME, ASHRAE

PART 2 - PRODUCTS

2.1 FIRE STOPPING:

- A. Provide UL classified firestopping system for mechanical penetrations through rated walls and floors to maintain the fire rating.
Manufacturers: TREMCO Fyrshield, Manville Duxseal, 3M or approved equal.

2.2 ACCESS PANELS:

- A. Furnish access panels to access valves, traps, control valves or devices, dampers, damper motors, etc. Access panels shall be sized as necessary for ample access, or as indicated on drawings, but no smaller than 12" x 12" where devices are within easy reach of operator, and at least 24"x24" when operator must pass through opening in order to reach the devices. Architectural Trades shall install access panels coordinated with Mechanical Trades.
- B. Access panels in fire rated walls or ceiling must be U.L. labeled for intended use. Unless otherwise indicated on plans, access doors shall be hinged flush type steel framed panel, 14 gauge minimum for frame, and with anchor straps. Only narrow border shall be exposed. Hinges shall be concealed type. Locking device shall be flush type and screw driver operated. Metal surfaces shall be prime coated with rust-inhibitive paint. Panels shall be compatible with architectural adjacent materials
Manufacturer: Milcor, Bilco or approved equal.

2.3 BUILDING ATTACHMENTS FOR MECHANICAL WORK SUPPORTS:

- A. General Requirements:
 - 1. Provide building attachments required for supporting mechanical work, suitably selected and installed for the loads applied with a minimum additional safety factor of 3.
 - 2. Where specified attachments are not suitable for conditions, submit to Engineer for approval, proposal for alternate building attachments.
 - 3. Approved Manufacturers: Grinnell, or equivalent products by Michigan Hanger and B-Line.

4. Provide supplemental trapeze supports where necessary. Design trapeze to support all trades. Coordinate loads, and supports with all trades. Size trapeze for maximum deflection of 1/64 of the span.

B. Attachments to Structural Steel:

1. Support mechanical work from building structural steel where possible and approved. No welding or bolting to structural steel is permitted unless authorized by Architect. C-clamps are not permitted unless approved by Engineer in certain situations.
 - a. Center beam clamp - for loads over 120 lb.: Malleable center hung Grinnell Fig. 228.
 - b. Side beam clamp with retaining clips - for loads up to 120 lb.

C. Cast in Place Concrete Inserts:

1. Provide inserts selected for applied load of present load plus 100% for future, and coordinated with concrete work. Except as detailed on drawings, inserts shall be Unistrut or Grinnell. Plan, lay out and coordinate setting of inserts prior to concrete pour. Use Grinnell Fig. 285 or approved equal lightweight concrete insert for loads up to 400# or Grinnell Fig. 281 or approved equal Wedge Type concrete insert for loads up to 1200#.

D. Drilled Insert Anchors:

1. Where mechanical work cannot be supported from structural steel, or cast in place concrete inserts, provide drilled concrete insert anchors. Submit for approval, project specific installation drawings for all loads over 100 lbs. Install inserts in web of beam if possible and approved. Insert depth shall not exceed two thirds the thickness of the concrete. Where existing concrete appears to be deteriorating, or where applied load at insert exceeds 1000 lbs., conduct test of concrete to determine derated capacity of insert. Anchors may be adhesive or expansion type up to 1000 lbs., and shall be adhesive type for loads over 1000 lbs. Manufacturers: Hilti or approved equal.

2.4 BELT DRIVES:

- A. Provide V style motor pulleys, belts and driven sheaves in compliance with Rubber Manufacturers Association (RMA) standards, and as specified herein.
- B. Pulleys and sheaves shall be fixed pitch for motors 5 HP and larger, statically and dynamically balanced, and shall be adjustable pitch for motor smaller than 5 HP.
- C. All drive systems shall be rated for rated motor horsepower, with a service factor of 1.2.
- D. For multiple belt drives, match belts as a set. Groove spacing for motor pulley and equipment sheave shall align.
- E. Replace belts, pulleys and sheaves to attain specified equipment performance. Coordinate work with test and balance contractor.
- F. Minimum V-belt sheave diameter shall comply with RMA recommendations.
- G. Provide OSHA approved belt guard for all belt driven equipment. Coordinate with equipment supplier. Guard shall include 1" tachometer access hole.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Install equipment and materials in accordance with manufacturer's written and illustrated instructions, as detailed on drawings and as described in these specifications. Bring discrepancies in installation methods to the attention of the owner and A/E.
- B. Install hanger rod straight, without bending.

3.2 REFRIGERANT HANDLING

- A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:
 - 1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
 - 2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
 - 3. United States Environmental Protection Agency (US EPA) requirements of Section 808 (Prohibition of Venting and Regulation of CFC) and applicable State and local regulations of authorities having jurisdiction.
- B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations of authorities having jurisdiction.

END OF SECTION

SECTION 23050

WALL MOUNTED HEAT PUMP WITH DEHUMIDIFICATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install a self-contained, vertical, exterior wall mount, through-the-wall heat pump to be manufactured by Bard Manufacturing Company, Inc. The unit shall be approved and listed by Intertek ETL Listed (ETL US/C).
- B. Unit shall be factory assembled, pre-charged, pre-wired, tested and ready to operate.
- C. Unit performance shall be certified in accordance with the Air Conditioning Heating and Refrigeration Institute (AHRI) Standard 390-2003 for Single Package Vertical Units.
- D. Unit efficiency shall be specified by EER and COP. Manufacturers: Capacities shall be as indicated on drawings and units shall be manufactured by Bard Manufacturing Company, Inc. or prior approved equal.

PART 2 PRODUCTS

2.01 APPROVED MFG'S.

- A. Bard is basis of design. Contractors must get approval of alternate before bidding.

2.02 CABINET

- A. Construction shall be a single, enclosed, weatherproof casing constructed of 20-gauge galvanized steel.
- B. Unit base is constructed of 16-gauge galvanized steel. Each exterior casing panel to be bonderized and finished with baked-on exterior polyester enamel paint prior to assembly.
- C. The baked-on cured paint finish shall pass the industry rub test with a minimum of 72 rubs MEK (Methyl Ethyl Ketone) or standard rub test of a minimum of 100 rubs using Toluene.
- D. Cooling section shall be fully insulated with 1-inch fiberglass to prevent sweating and to muffle sounds. Openings shall be provided for power connections.

- E. Access openings appropriate for outside structure to all fan motors and compressor for making repairs and for removing internal components without removing unit from its permanent installation.
- F. Fresh air intake and outdoor coil shall be protected from intrusions by a sturdy metal grating with less than 1/4 inch openings. Unit Shall be of White Finish.

2.03 REFRIGERATION SYSTEM

- A. All models shall use a high efficiency scroll compressor. The compressor shall be covered by a 5-year parts warranty.
- B. The refrigeration circuit shall be equipped with factory installed high- and low-pressure controls and liquid line filter dryer.
- C. The refrigeration control shall be a factory installed capillary tube. Compressor shall be mounted rubber grommets.
- D. Unit shall be provided with R-410A (HFC) non-ozone depleting refrigerant.

2.04 INDOOR BLOWER MOTOR

- A. The indoor blower motor shall be high efficiency ECM motor.
- B. It shall include soft start and shall be self-adjusting to provide proper airflow at varying static pressure.
- C. Blower wheels shall be curve blades.

2.05 ELECTRICAL COMPONENTS

- A. Electrical components are easily accessible for routine inspection and maintenance through front service panels.
- B. Circuit breaker is standard on all 208/230-volt models and toggle disconnect standard on all 460-volt models.
- C. Circuit breaker/toggle disconnect access is through lockable access panel.

2.06 CONTROL CIRCUIT

- A. The internal control circuit shall consist of a current limiting 24VAC type 50VA transformer.

- B. The defrost circuit shall consist of a solid-state electronic heat pump control. A 30-minute timer shall initiate a defrost cycle if the outdoor coil temperature indicates the possibility of an iced condition.
- C. The thermistor sensor, speed-up terminal for service, and a ten-minute defrost override shall be standard on the electronic heat pump control. To prevent rapid compressor short cycling, a five-minute time delay circuit shall be factory installed.
- D. A F1992 (2017 07) Page 3 of 5 low-pressure bypass shall be factory installed to prevent nuisance tripping during low temperature start-up.
- E. All units with 3-phase power shall include factory mounted phase rotation monitor. This device shall protect scroll compressor from reverse rotation and protect unit from phase failure.
- F. If 3-phase power is incorrectly connected at the field power connections, the phase monitor shall lock out the unit and a red light will illuminate indicating incorrect phase.
- G. Also, if a power leg is lost, the phase monitor will lockout the unit due to phase imbalance. Once the condition is corrected, turning the power off at the circuit breaker or disconnect will reset the phase monitor.

PART 3 HEAT OPTIONS

3.02 ELECTRIC HEAT

- A. The heat pump shall have a factory installed electric resistance heater available that is designed specifically for application in the WH Series heat pump.
- B. Heater shall include automatic limit safety controls.

PART 4 VENTILATION OPTIONS

4.01 VENTILATION PACKAGES

- A. WH models are designed to provide optional ventilation packages to meet all of your ventilation and indoor air quality requirements.
- B. All ventilation packages are factory or field installed, and easily removable for service.

4.02 COMMERCIAL ROOM VENTILATOR OPTIONAL

- A. The built-in commercial room ventilator is internally mounted and allows outside ventilation air, up to 100% of the total air flow rating of the unit, to be introduced through the air inlet openings. It includes a built-in exhaust air damper. The damper can be easily adjusted to control the amount of fresh air supplied into the building.

- B. Automatic control shall be provided to maintain desired ventilation rate during the different supply airflows of fan only and Stage 1 modes of operation.
- C. The CRV can be controlled by indoor blower operation or field controlled based on room occupancy using CO2 controller.
- D. Unit complies with ANSI/ASHRAE Standard 62.1 Ventilation for Acceptable Air Quality.

PART 5 FILTER OPTIONS

5.01 2" Pleated – MERV 8

PART 6 UNIT CONTROL OPTIONS

6.01 Low ambient control

PART 7 OPERATING CONTROLS

7.01 Electronic programmable, auto changeover with Humidity Control

PART 9 HOT GAS REHEAT

9.01

- A. The dehumidification circuit incorporates an independent heat exchanger coil in the supply air stream in addition to the standard evaporator coil. This coil reheats the supply air after it passes over the cooling coil and is sized to nominally match the sensible cooling capacity of the evaporator coil.
- B. Extended run times in dehumidification mode can be achieved using waste heat from the refrigeration cycle to achieve the reheat process, while at the same time large amounts of moisture can be extracted from the passing air stream.
- C. Models that also have electric heaters installed have the electric heat inhibited during dehumidification mode, although it remains available for additional reheat during certain conditions.
- D. The dehumidification cycle shall be energized by a rise in relative humidity above set point. The unit shall energize in the cooling mode and a two-position valve will energize, allowing hot refrigerant gas to pass thru the reheat coil, reheating the cold air leaving the evaporator coil.

- E. The dehumidification cycle shall have on/off capability. If the thermostat calls for cooling or heating during the dehumidification cycle, the unit shall drop out of dehumidification to satisfy the call from the thermostat.
- F. A solid-state circuit board shall control the dehumidification function. The dehumidification option shall be factory installed.

PART 10 WARRANTY

10.01

- A. The Bard product specified shall be free from defects in materials and workmanship for a period of 5 years for compressor, and for a period of 5 years for all parts.
- B. Warranty period shall start from date of installation as stated on warranty card; or from date of shipment if no warranty card is returned to Bard Manufacturing.
- C. Equipment must be used under normal conditions and warranty is subject to Bard Manufacturing's standard limited warranty statement.

END OF SECTION

SECTION 23600

AIR COOLED THROUGH THE WALL PACKAGED TERMINAL HEAT PUMP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air Cooled Through The Wall Packaged Terminal Heat Pump.
- B. Unit Controls.

1.02 RELATED REFERENCES

- A. ARI 310/380-93 — Unitary Air Conditioning Equipment.
- B. NFPA 70 — National Electrical Code.
- C. NFPA 90A — Installation of Air Conditioning and Ventilation Systems.
- D. UL 465 — Central Cooling Air Conditioners.
- E. EFL and CSA Standards.

1.03 SUBMITTALS FOR REVIEW

- A. Section 01340 — Submittals: Procedures for submittals.
- B. Product Data: Provide data for manufactured products and assemblies. Indicate drain and electrical rough-in connections with electrical characteristics and connection requirements.

1.04 SUBMITTALS FOR INFORMATION

- A. Section 01340 — Submittals: Procedures for submittals.
- B. Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements and include start-up instructions.

1.05 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories, Inc., as suitable for the purpose specified and indicated.

1.06 WARRANTY

- A. The warranty is for full one year on the entire unit. Full 2nd through 5th year on the entire sealed refrigerant system components. Limited 2nd through 5th year on functional parts only.

1.07 EXTRA MATERIALS

- A. Provide one spare set of filters for each unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. GE.
- B. Amana.

2.02 UNIT CHASIS

- A. Each unit must be slide out design shipped with room cabinet front installed. Unit chassis must have the ability to be installed with 0 clearance from finished floor. An electrical power cord must be included with chassis and installed by the manufacturer to assure proper NEMA 6 or 7 configuration and UL-approved length. Units less than 250 volts must also have a LCDI power cord. Unit must be tested for conformance to ASTM water infiltration specification ASTM 331-86, which ensures no water infiltration when tested at 8" rain per hour at 63 mph wind for 15 minutes.

2.03 ROOM CABINET

- A. The monochromatic front of the room cabinet must be able to be field-secured to chassis to inhibit tampering. Filter must be accessible without removing room front. Cabinet depth must not exceed 7 5/8" to minimize unit's impact on room space.

2.04 COILS

- A. Unit's coils must have rifled copper tubing expanded into rippled-edge louvered aluminum fins. Exterior coil must be of a two-row bent coil design with removable shroud top to allow easy-access for cleaning of the exterior coil.

2.05 HEAT PUMPS

- A. Each unit must include a change-over thermistor that senses an outside ambient switch-over temperature as low as 24°F, lock- open refrigerant reversing valve during heat pump operation, temperature-activated defrost drain and automatic emergency heat operation to override the heat pump's change-over thermostat and bring on electric resistance heaters in the event of a sealed system failure. Unit must not operate compressor and electric heaters simultaneously.

2.06 COMPRESSOR

- A. The compressor must be hermetically sealed, internally isolated, rotary-type and permanently mounted on rubber isolators. No removal or adjustment of compressor hold-down bolts is to be required during installation.

2.07 UNIT DIGITAL CONTROLS

- A. The unit's control must be completely wired and accessible from the top of the chassis. Controls shall be a LED touch-pad design with seven large, easy-to-read and use buttons: Heat – Cool – Off – Fan – Temp+ (plus) – Temp- (minus) and two red seven- segment LED temperature displays. Unit shall have a green status LED to advise owner of operational diagnostic messages. Unit shall have one-button activation via membrane touch-pad. Unit control board shall have an 18-pin low-voltage connector to allow for easy connection to remote wired devices. Unit shall have two serial-port connectors for easy connection to wired or wireless EMS (Energy Management Systems). Unit must have the ability to easily configure owner-selectable and programmable functions:

- Fan-cycle operation
- Electronic temperature limiting for cooling
- Electronic temperature limiting for heating
- Enhanced dehumidification cooling operation
- Unoccupied 18-hour temperature set-back
- Un-rented temperature set-back
- Multiple unit twinning to one wired thermostat
- Load-shedding operation
- Front-desk on-off or temperature set-back

Unit must be able to connect to approved remote devices:

- Wired thermostat
- Wired door motion sensor
- Wired room motion sensor
- Wired room-to-room transfer fan
- Front Desk Control
- Future RF wireless communications devices

Unit must be able to acquire and display operational temperature data from up to six installed thermistors to include:

- IAT—Indoor air temperature (black)
- ICT—Indoor coil temperature (red)
- IDT—Indoor discharge temperature (yellow)
- OCT—Outdoor coil temperature (blue) (heat pumps & Wireless cooler models)
- OAT— Outdoor Air Temperature (Wireless-ready models only)
- Orange—Miscellaneous thermistor or analog device (optional)

2.08 EVAPORATOR/CONDENSER FANS

- A. Direct drive with a permanent, split-capacitor, two-speed indoor motor. Condensate must be directed onto the back and sides of the coil to aid in evaporation and removal.

2.10 FACTORY OPTIONS

- A. Wall Sleeve
- B. Outdoor Grille

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturers' instructions.
- B. Pipe condensate from drain pan to location shown on plans.

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide conduits, cable trays, surface raceways, boxes, fittings and supports to form a complete, coordinated, and continuously grounded raceway system.

1.2 CONDUIT REQUIREMENTS

- A. Conduits indoors in hazardous areas, encased in concrete floor slabs or subjected to water, physical damage or abuse shall be galvanized rigid steel (RS).
- B. Conduits other than above shall be EMT.
- C. Final connections to motors, transformers and equipment subject to vibration or removal for maintenance shall be 1/2" minimum liquid tight flexible metallic conduit with steel liquid tight fittings. Transformer connections may be non-liquid tight flexible metallic conduit in electrical rooms only.

1.3 BOX REQUIREMENTS

- A. Provide metal outlet boxes and covers for EMT.
- B. Boxes shall be sized for all conductors and devices to be contained within. Box extensions shall not be used to correct for undersized boxes.

1.4 SUPPORT REQUIREMENTS

- A. Surface mounted equipment shall be secured using uni-strut. The channels shall be attached with toggle bolts to hollow tile, block or similar surfaces, and attached with screws or bolts and expansion shields to solid masonry or concrete.

PART 2 - PRODUCTS

2.1 CONDUITS

- A. EMT shall be hot dipped galvanized inside and outside, in 10' lengths and threaded on both ends. Fittings and bushings shall be cast or malleable iron, and hot dipped galvanized inside and outside.
- B. Liquid tight flexible metallic conduit shall consist of a flexible, galvanized steel core, a continuous copper ground strip and a polyvinyl chloride jacket. Fittings shall be steel liquid tight grounding type from the same manufacturer as the conduit.

2.2 SURFACE RACEWAYS

- A. Shall be EMT.
- B. Surface raceways shall consist of a base and cover, sized for the number of conductors contained within, complete with all connectors, fittings, bushings, boxes, covers and mounting hardware.
- C. Raceways shall be 600 volt rated, and be in compliance with the applicable paragraphs of NEC Article 352.
- D. They shall be non-flammable, and UL labeled, under UL 5, or UL 5A (as applicable).

- E. The completed raceway system shall be vandal resistant.
- F. The cover plates used for wiring devices and telecommunication outlets shall be of the 'overlapping' type, and shall therefore cover the 'cut-end' of the raceway cover.

2.3 BOXES

- A. Boxes for fixtures, outlets, switches, equipment connections and wire pulling shall be
 1. Cast or formed from carbon steel sheets of commercial grade steel not less than 14-gauge,
 2. One-piece construction, zinc, or cadmium plated,
 3. Tapped for mounting plates and covers as required.
- B. Pull and junction boxes shall be
 1. Fabricated from galvanized or painted code gauge cold rolled carbon steel sheets.
 2. Welded construction with flat removable covers fastened to the box with machine screws.
 3. Seams and joints shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by continuous welding which will provide equivalent strength to flange construction.
 4. Preferably not provided with 'knockouts'.
- C. Box covers shall be fastened in place by machine screws or hinges and latches. Self-tapping or sheet metal fasteners are not acceptable.

2.4 SUPPORTS

- A. Hangers and brackets shall be made of steel pipe, channel iron, angle iron or prefabricated steel channel. Prefabricated steel channel shall be by B-Line, Hilti, Powerstrut, Unistrut or approved equal.
- B. Anchors shall be lead shield anchors or plastic expansion anchors for small loads, and expansion or epoxy anchors for large loads. Powder-driven anchors shall not be used.

2.5 LABELS AND DIRECTORIES

- A. Equipment nameplates shall be engraved .125 inch (1/8") thick lamacoid plastic. White, with black letters. The engraved letters shall be at least one quarter inch (1/4") high.
- B. Receptacles and lighting switches shall be labeled using clear adhesive backed nylon or Mylar tape with black text permanently laminated to the tape.
- C. Panel directories shall be typed on supplied card stock with panel, or card stock similar in thickness and material as those supplied with the panels. Install supplied clear plastic cover, or one of like material.

PART 3 - EXECUTION

3.1 RACEWAYS

- A. Size conduits in accordance with the NEC, but not less than the sizes shown on the drawings. Minimum power and control conduit size shall be 1/2".
- B. All branch circuits and feeders require an equipment grounding conductor be run in each raceway.
- C. Install concealed and exposed conduits and cable trays parallel to or at right angles to building lines. Conduits shall not be embedded in concrete slabs except where specifically shown. Install surface raceways as close to room corners or trim features as possible to make the surface raceways less obvious.
- D. Make directional changes in primary power distribution conduits above ground with sweeps and long radius elbows, and underground with 20' minimum radius bends.

- E. Conceal conduits wherever possible and practical. When conduits cannot be concealed in finished areas, use surface raceways with matching boxes from the same manufacturer as the raceways.
- F. Metal conduits, fittings, enclosures and raceways shall be mechanically joined together in a firm assembly to form a continuous electrical conductor providing effective electrical grounding continuity.
- G. Provide expansion fittings at the intervals specified in the manufacturer's instructions.
- H. Conduits entering panels located outdoors, in parking structures, in steam tunnels and on cooling towers shall enter from the sides, back, or bottom. Conduits shall not enter from the top.
- I. Separate raceways from uninsulated steam pipes, hot water pipes, and other hot surfaces by a minimum of 4" horizontally or 12" vertically. Separate raceways from ventilation ducts and insulated pipes so that they do not come into contact with each other.
- J. EMT conduit shall be secured with locknut inside and set screw connector on outside. Sufficient thread on the connector or conduit shall extend into the enclosure so that the bushing will butt tight into the connector or conduit. Bushings shall not be used as jamb nuts or in lieu of locknuts.
- K. Flexible metallic conduit to motors and similar equipment shall not exceed 3'-0" in length, and shall have adequate slack to absorb the maximum vibration. Flexible conduit connections to lighting fixtures shall not exceed 6'-0" in length.

3.2 MOUNTING HEIGHTS

- A. Except where shown otherwise, install equipment and devices at the following heights:
 1. Receptacles (Wall): 18" A.F.F. to center
 2. Light Switches: 48" A.F.F. to center
 3. Thermostats/HVAC Controls: 48" A.F.F. to center
 4. Electrical Panels: 72" A.F.F. to top
 5. Safety Switches/Motor Starters/Variable Frequency Drives: 72" A.F.F. to top (except top of handle shall not exceed 78" A.F.F.)

3.3 SUPPORTS

- A. Support all electrical items independently of supports provided by the other trades.
- B. Support conduits and boxes using steel conduit straps or uni-strut. Suspended ceiling hangers or hanger wire shall not be used (except to support flexible metallic conduit and manufactured wiring systems).
- C. Hangers shall be of sufficient strength that their deflection at mid span does not exceed 1/240 of the hanger span length after the cables are installed.

3.4 PENETRATIONS, SLEEVES AND FIRE SEALS

- A. Cut floor and wall penetrations neatly and to the minimum size required for installation of the equipment and raceways.
- B. Provide galvanized steel pipe sleeves for all conduits penetrating floors, exterior walls and roofs.
 1. Extend floor sleeves above the floor a minimum of 2 inches.
 2. Seal exterior wall and roof penetrations water tight.
- C. Patch both sides of wall penetrations cut for electrical equipment and raceways to seal against the passage of air, sound and fire.
 1. Seal cable tray penetrations in fire rated walls using fire sealant bags approved by a Nationally Recognized Testing Laboratory.
 2. Seal conduit penetrations in fire rated walls using fire-sealing caulk approved by a Nationally Recognized Testing Laboratory.

3. Seal conduit penetrations in non-rated walls using masonry materials that match the wall construction.
4. Fire seal between recessed outlet boxes located on opposite sides of a fire rated wall if the box openings are over 16 square inches and the boxes are less than 24 inches apart.

3.5 EXPANSION FITTINGS

- A. Provide expansion fittings at all building expansion joints. Expansion fittings shall be bonded to the raceway on both sides.
- B. Provide expansion fittings, in accordance with manufacture recommendations, in all areas subject to swings in temperature of more than 15 degrees C.
- C. Install expansion fittings in all locations where expected expansion difference is $\frac{1}{4}$ ", or more, between boxes

3.6 IDENTIFICATION

- A. Provide nameplates and labels in accordance with Article 2.5.
 1. Lamacoid labels shall be mechanically secured in place with sheet metal screws and/or bolts and nuts
 2. Labels shall be neatly centered. Place labels in like positions on similar equipment.
- B. Color code wiring as noted in Section 26120
- C. Color code junction boxes and box covers of emergency and fire alarm circuits with red paint. Color code junction boxes and box covers of temperature control circuits with blue paint.
- D. Mark junction box covers in indelible ink with the panel and breaker numbers of the circuits contained within.
- E. Provide a 3" by 5" yellow "Warning Arc Flash Hazard" label on the outside of panels in 'occupant areas' - Brady Type 99454 or equivalent from another manufacturer. Center the label horizontally and vertically on outside of door.
- F. Provide a 4" by 6" red "Danger Arc Flash and Shock Hazard" label on the outside of panels in areas open only to 'qualified personnel', and on the inside panel door of panels in 'occupant areas' - Brady Type 99459. Center label on gutter areas of distribution panels, centered above or below the directory of panels, and otherwise centered in other applications. In all cases, label will be no lower than 48" or above 84" AFF

END OF SECTION

SECTION 26 05 10

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.02 DESCRIPTION OF WORK

- A. Provide identification on all equipment, raceways, boxes and conductors.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:
 - 1. Electrical General Provisions
 - 2. Raceways and Boxes
 - 3. Wire and Cable
 - 4. Wiring Devices

PART 2 - PRODUCTS

2.01 Nameplates

- A. Unless otherwise noted, nameplates shall be black lamacoid plates with white engraved upper case letters enclosed by white border on beveled edge.
- B. Nameplates for equipment, supplied by the emergency system, shall be red lamacoid with white lettering.
- C. All nameplates shall be engraved and must be secured with rivets, brass or cadmium plate screws. The use of Dymo tape or the like is unacceptable.
- D. Nameplate inscriptions shall bear the name and number of equipment to which they are attached as indicated on the Drawings. The engineer reserves the right to make modifications in the inscriptions as necessary.

2.02 Cable tags and wire identification labels.

- A. Cable tags shall be flameproof secured with nylon ties.
- B. Wire markers shall be preprinted cloth tape type or approved equivalent.

2.03 Identification Labels

- 1. Acceptable Manufacturers
 - a) W.H. Brady Company (Style A)
 - b) Thomas & Betts Company (T&B), Style A.
- 2. Plasticized Cloth
 - a) Non-conductive.
 - b) Waterproof.
 - c) Capable of withstanding continuous temperatures of 235 degrees F and intermittent temperatures to 300 degrees F.
 - d) Overcoating for protection against oil, solvents, chemicals, moisture, abrasion and dirt.

3. Heavy, thermo-resistant industrial grade adhesive, for adhesion of label to any surface without curling, peeling or falling off.
4. Label Designations, Nominal System Voltages Applied to the covers of all medium and low voltage pull, splice and junction boxes.
5. Machine printed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Switchboards.

1. Furnish and install a master nameplate for each switchboard, engraved with the equipment identification indicated on the Drawings. Mount at top of incoming section.
2. Provide on each main switch an identifying nameplate. Where multiple mains are employed each switch shall be numbered. Inscription shall be "main switch" or "main switch no. 1" et al.

B. Panelboards and Load Centers.

1. Furnish and install a nameplate for each panelboard and load center engraved with the identification indicated on the Drawings. Mount at top of panel.
2. After installations are complete, provide and mount under sturdy transparent shield in the directory frame of each panel door, a neat, accurate, and carefully typed directory properly identifying the lighting, receptacles, outlets, and equipment each overcurrent device controls.
3. Include on directory the panel or load center identification, the cable and raceway size of panel feeder, and the feeder origination point.

C. Disconnect Switches.

1. Furnish and install a nameplate for each disconnect switch engraved with the equipment designation which the disconnect serves.

D. Motor Controllers.

1. Furnish and install a nameplate for each motor controller or combination motor controller for both individual motor controllers and those in a motor control center. Engraving must indicate the motor served and the type of service (e.g., AC-8 - 1st floor supply, EF-2 electric closet exhaust.)

E. Feeder Switches.

1. Furnish and install for each feeder switch including, but not limited to those in switchboards, switch and fuse panelboards, take-offs at bus ducts, motor control centers, multiple meter centers, etc., two (2) nameplates as follows:
 - a) The first nameplate must be white background with red lettering. Engrave with the words "REPLACE ONLY WITH _____ FUSE." Engrave with proper fuse trade name and ampere rating (i.e. Bussman LPS-R 100).
 - b) The second nameplate shall indicate the load served, the size and type of cable and raceway example:
 - i) LP-4, LP-5, LP-6
 - ii) 4#500 KCM I LS-THW-CU-3-1 /2"C

F. Remote Smoke Detector Lamps and Test Stations.

1. Furnish and install a nameplate on each remote smoke detector lamp and/or test station.
2. Engraving must indicate the location of the device to which the lamp is connected, as approved by the Engineer.

G. Switches.

1. Furnish and install an engraved nameplate for each switch, controlling loads that are not local to the switch. Engraving shall be as directed by the Engineer.

H. Pullboxes, Enclosures, and Cable Terminations.

1. Circuits rated over 40 Amp and all cables over 600V:
 - a) Provide identification label with circuit numbers on enclosure cover.
 - b) Furnish and install cable tags on each cable that enters a pullbox, enclosure, switchboard, and at terminations. Mark tags with type written inscription noting the load served, type and size of cable, and the overcurrent device protecting the cable.
2. Branch circuits:
 - a) Provide identification label with panel and circuit numbers on enclosure cover.
 - b) Identify each circuit with wire markers when enclosure label and wire colors do not provide enough information to identify each circuit without tracing.
 - c) 4 square box covers hidden above lay-in ceilings may be marked with indelible ink marker in lieu of using printed labels.

I. Fire Alarm Terminal Cabinets.

1. Furnish and install an approved nameplate on each fire alarm terminal cabinet.
2. Nameplates shall indicate floor and where multiple terminal cabinets are installed a prime designation for each cabinet (e.g. FATC-1A, FATC-1 B).
3. Terminals shall be permanently identified in an approved manner.
4. Label all wiring.

J. Telecommunications System.

1. Each horizontal cable from a termination block or patch panel to a telecommunications outlet shall be labeled at both ends. Tags shall be consecutively numbered so that no two (2) cables have the same identification. In addition cable tag shall note the room number in which the data transmission outlet is located.
2. Each backbone cable shall have a flameproof tag attached at both ends of the tag. Tags shall be consecutively numbered so that no two (2) cables have the same identification. Additional inscriptions shall be provided as directed by the Owner.
3. Patch panel ports shall be consecutively numbered so that no two (2) ports have the same number.

K. Generator Control Panel.

1. Furnish and install a red nameplate for each generator control panel. Engraving shall indicate the generator controlled by the panel.

L. UPS & Computer Power Centers.

1. Furnish and install a black with lettering nameplate for each unit.

M. Provide identification labels for all low voltage and medium voltage pull, splice and junction boxes in main feeder and subfeeder runs, indicating nominal system voltage.

1. Apply labels after painting of boxes, conduits, and surrounding areas have been completed.
2. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.
3. Apply labels on cover and minimum of one (1) fixed side; one (1) label visible from floor where boxes are installed exposed.

N. Provide identification for all equipment, boxes, enclosures and devices according to the following table:

Type	Identification material	Information/example
Equipment Cabinet	Nameplate	Equipment identification / "Outdoor lighting control"
Major Equipment	Nameplate	Equipment identification / "Panel
Minor Equipment	Identification Label	Equipment identification / "Fire alarm relay R-2"
J-box, enclosure (screw cover)	Identification Label, indelible ink marker above lay-in ceilings.	System type and circuit numbers / "Fire Alarm zone 3"
Receptacle	Identification Label	Circuit identification / "PNL A2- CKT1 8"

Fire alarm device	Identification Label	Device id number & zone / "SD3-4"
Security device	Identification Label	Device identification /

END OF SECTION

CABLES AND WIRES

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 CABLE (MEDIUM VOLTAGE PRIMARY)(NOT APPLICABLE)

- A. Primary cable shall be single conductor stranded copper, with ethylene propylene rubber (EPR) insulation rated 15kV, 90 degrees C, 133 percent insulation level, a 5-mil thick minimum tape shield with 12-1/2 percent minimum overlap, and a polyvinyl chloride (PVC) jacket. The cable shall be suitable for use on a 13.2 kV, 3-phase, 3-wire, ungrounded, system. General, Kerite, Okonite, or Southwire.

2.2 CABLE AND WIRE (600 VOLTS AND BELOW)

- A. Secondary distribution and power cable shall be single conductor stranded copper, No. 12 AWG minimum; with NEC Type THHN insulation rated 90 degrees C, 600 volts. Alan Wire, American Insulated Wire, General, Cerro Wire, Encore, Republic Wire, Rockbestos, Service Wire, or United Copper Industries.
- B. Lighting wire for above ground use shall be single conductor stranded copper, No. 12 AWG minimum, with NEC Type THHN insulation rated 90 degrees C, 600 volts. Alan Wire, American Insulated Wire, General, Cerro Wire, Encore, Republic Wire, Rockbestos, Service Wire, or United Copper Industries.
- C. Lighting wire for underground use in conduit shall be single conductor stranded copper, No. 12 AWG minimum, with NEC Type XHHW insulation rated 90 degrees C in dry locations and 75 degrees C in wet locations, 600 volts. American Insulated Wire, General, Cerro Wire, Encore, Republic Wire, Rockbestos, Service Wire, or United Copper Industries.
- D. Control cable shall be single conductor stranded copper No. 14 AWG minimum; with NEC Type THHN insulation rated 90 degrees C, 600 volts.
- E. Instrumentation and special systems wire shall be in accordance with manufacturers' recommendations, but shall not be less than 20 AWG.
- F. Type MC cable shall be made up of individual conductors as noted above, be color coded, include a separate ground conductor, and shall have a corrugated metal armor over its entire length.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. Install all cables and wires (including telecommunications, low voltage control and power limited circuits) in raceways. Telecommunications raceways shall be continuous from outlet boxes to telecommunications rooms or cable trays.
- B. Use cable lubricant when pulling primary cables and secondary feeder cables. Avoid exceeding manufacturer's recommendations on pulling tensions; sidewall pressures and cable bend radii.
- C. Segregate wiring of different voltage levels. Except as follows, circuits operating at different voltages shall not share raceways.
 - 1. Power wiring to rooftop motors and rooftop receptacles may be routed together.

- D. Splice power cables with solderless compression butt splices or ring lugs. Terminate power cables including motor leads with solderless compression ring lugs. Splice branch circuit wiring, lighting wiring, and control and instrumentation wiring with wire nut connectors. Terminate control and instrumentation wiring with solderless compression ring or spade lugs. Compression connectors and lugs shall be crimped with tools specifically designed for the terminations being crimped.
- E. If no color coding system exists for each indicated system function and voltage, color code circuits as follows:
1. Three Phase Power Over 600 Volts:
 - Phase X (A): Black
 - Phase Y (B): Red
 - Phase Z (C): Blue
 2. Three Phase Power 480/277 Volts:
 - Phase X (A): Brown
 - Phase Y (B): Orange
 - Phase Z (C): Yellow
 - Neutral: Gray
 - Ground: Green
 3. Three Phase Power 208/120 Volts:
 - Phase X (A): Black
 - Phase Y (B): Red
 - Phase Z (C): Blue
 - Neutral: White
 - Ground: Green
 4. Single Phase Power 240/120 Volts:
 - Phase X (A): Black
 - Phase Y (B): Red
 - Neutral: White
 - Ground: Green
 5. Control wires to light fixtures for light dimming shall be:
 - a. 'Hot control wire' - Black with white stripe
 - b. 'Neutral control wire' - White with Black stripe
 6. Less Than 120 Volts: Use Industry Standard Methods
- F. Provide home runs of No. 10 AWG wire for 20 amp branch circuits that exceed 150' in length.
- G. Ground the shields of shielded instrumentation and control cables at one end only. The shields at the other end shall be insulated from ground.
- H. Provide identification tags on all cables and conductors terminated in panels.

END OF SECTION

SECTION 26 05 28

GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide grounding for all systems and equipment.

1.2 GROUNDING SYSTEM REQUIREMENTS

- A. Each ground rod shall have a maximum resistance to ground of 10 ohms before connection to the other ground rods. If reading is above 10-ohms, drive one extension. Further testing of that individual rod is not needed.
- B. The total grounding system with all connections completed shall have a maximum resistance to ground of 2 ohms for primary services or 5 ohms for secondary services.

1.3 CONNECTION REQUIREMENTS

- A. Provide exothermic weld type, or Burndy Hyground, ground connections for concealed, underground, and concrete encased ground connections, for ground connections to structural steel, connections between sections of the main ground bus and all connections to the substation room ground bus bars.
- B. Exposed ground connections (except connections to structural steel and substation room ground bus bars) may be made with copper or bronze compression ground fittings or bolted compression ring lugs.
- C. Provide exothermic weld type, or Burndy Hyground ground connections for splices and taps of grounding conductors No. 8 AWG and larger. Exposed splices and taps shall be taped.

PART 2 - PRODUCTS

2.1 GROUND RODS

- A. Unless shown otherwise, ground rods shall be 3/4" diameter by 10' long, copper clad steel. Ground rods shall be capable of being extended when additional length is required.

2.2 GROUNDING CONDUCTORS

- A. Grounding conductors for direct burial underground, for encasement in concrete, and for grounding of unit substations shall be No. 4/0 AWG minimum, bare, stranded copper.
- B. Grounding conductors for general use shall be stranded, copper conductor, sized in accordance with the NEC unless shown otherwise on the drawings, and insulated with green NEC Type THHN insulation rated 90 degrees C, 600 volts.

2.3 GROUND CONNECTIONS

- A. Ground connections shall be Burndy Hyground, Cadweld, Thermo-weld or Thomas & Betts Blackburn only.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. Ground duct banks and manholes in accordance with Specification Section 16110.
- B. Ground the shields of medium voltage primary cables in accordance with Specification Section 16300, and the shields of shielded instrumentation and control cable in accordance with Specification Section 16120.
- C. Provide bare copper grounding conductors from duct banks, manholes, unit substations, primary switches, transformers, switchgear, panelboards, motor control centers and control panels to the building grounding system. Equipment rated above 480 volts or 600 amps shall be grounded by a minimum of two independent grounding conductors.
- D. Bond transformer, UPS system, central battery/inverter system, emergency generator, and separately derived electrical system neutrals to the building grounding system.
- E. Ground motors rated 460 volts and below by motor feeder equipment grounding conductors. Stranded copper grounding conductors connected to building steel shall also bond motors rated over 460 volts.
- F. Provide green insulated equipment grounding conductors in all service, feeder, and branch circuits for connection of load devices to the power source ground. Raceways shall not be used as equipment grounding conductors.
 - 1. Equipment grounding conductors shall not be daisy-chained.
 - 2. Bond equipment-grounding conductors in boxes and enclosures where the grounding conductors are terminated or spliced.
- G. Bond conduits, cable trays, wireways, surface raceways, boxes, and enclosures together, and to the building grounding system. Provide bonding bushings and bonding jumpers to bond conduits where they enter a box or enclosure.
- H. Ground the lightning protection system with separate ground rods. The building grounding system ground rods shall not be used. After completion of both systems, the lightning protection system shall be bonded to the building grounding system.
- I. Protect separately routed grounding conductors subject to damage or physical abuse by Schedule 40 PVC nonmetallic conduits. Grounding conductors shall not be routed in metallic conduits except when routed with phase conductors.

3.2 FIELD QUALITY CONTROL

- A. Test the grounding in accordance with Specification Section 16950, and submit a test report.
- B. When the total grounding system fails its test by having a higher resistance to ground than specified in Section 16950, contact the Project Electrical Engineer for corrective action.

END OF SECTION

SECTION 26 05 34

RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.02 DESCRIPTION OF WORK

- A. Provide complete raceways systems, boxes and fittings for all required electrical systems.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:

1. Electrical General Provisions
2. Wiring Devices
3. Electrical Identification

1.03 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Rigid Steel Conduit
 - a) U.L. Standard UL-6
 - b) A.N.S.I. C80-1
 - c) Federal Specification WW-C-581 E
2. Intermediate Metallic Conduit
 - a) U.L. Standard UL-1242
 - b) Federal Specification WW-C-581 E
3. Electrical Metallic Tubing
 - a) U.L. Standard UL-797
 - b) A.N.S.I. C80-3
 - c) Federal Specification WW-C-563
4. Flexible Steel Conduit
 - a) U.L. Standard UL-1
5. Liquid Tight Flexible Conduit
 - a) U.L. Standard UL-360
6. Non-Metallic Conduit
 - a) U.L. Standard UL-651

- b) A.N.S.I. Standard F512
- c) N.E.M.A. Standard TC-2
- d) Federal Specifications GSA-FSS and W-C-1094-A

7. Wireways and Auxiliary Gutters

- a) U.L. Standard UL-870

8. Rigid Aluminum Conduit

- a) A.N.S.I. C80.5

1.05 SUBMITTALS

- A. Provide manufacturer's catalog cuts of fittings.
- B. Where wireways and/or auxiliary gutters are employed full erection drawings must be submitted. Drawings to include plan views, elevations, size of wireways, type and quantity of conductors proposed to be installed therein, etc.
- C. Indicate duct banks or multi-trade coordinated shop drawings.
- D. Submit shop drawings or catalog descriptive data on boxes exceeding twenty-four (24") inches for any one dimension.
- E. Submit shop drawings or catalog descriptive for floor boxes and accessories.

PART 2 - PRODUCTS

2.01 RACEWAY TYPES

A. Standard Threaded Rigid Steel Conduit.

- 1. Rigid conduit heavy wall galvanized.
- 2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

B. Intermediate Metallic Conduit

- 1. Light weight rigid steel conduit.
- 2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

C. Electrical Metallic Tubing

- 1. Continuous, seamless tubing, galvanized or sheradized on the exterior, coated on the interior with a smooth hard finish of lacquer, varnish, or enamel.
- 2. Couplings and connectors:
 - a) Indoor and two (2") inches in size and smaller, shall be steel set-screw type fittings.
 - b) 2-1/2 inch size and larger must employ steel compression gland fittings.
 - c) Outdoor shall be raintight steel compression gland fittings.
- 3. Indent type fittings shall not be used.
- 4. All connectors shall have insulated throat.
- 5. Where installed in slab or concrete work, provide approved concrete tight fittings.

D. Flexible Steel Conduit

- 1. Single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel.
- 2. Maximum length: (six 6) feet.
- 3. Each section of raceway must contain an equipment grounding wire bonded at each end and sized as required. Provide connectors with insulating bushings.
- 4. Steel squeeze-type or steel set screw type fittings.

E. Liquid Tight Flexible Electrical Conduit

1. Same as flexible steel conduit except with tough, insert water-tight plastic outer jacket.
2. Cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings which thread to interior of conduit. Spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.

F. Non-Metallic Raceway

1. Composed of polyvinyl chloride suitable for 90 degrees C.
2. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years experience in manufacturing the products.
3. Materials must have a tensile strength of 7,000-7,200 psi at 73.4 degrees F., flexural strength of 12,000 psi and compressive strength of 9,000 psi.
4. All joints shall be solvent cemented in accordance with the recommendations of the manufacturer.

G. Wireways and Auxiliary Gutters

1. Painted steel or galvanized steel.
2. Of sizes and shapes indicated on the Drawings and as required.
3. Provide all necessary elbows, tees, connectors, adapters, etc.
4. Wire retainers not less than twelve (12") inches on center.

H. Duct Banks

1. Provide duct banks and concrete encasements for both interior and exterior work as indicated on the Drawings and for all circuits in excess of 600 volts and as otherwise indicated.
2. Concrete shall be minimum $f_c = 3,000$ pounds per square inch.
3. Support raceways installed in duct banks every five (5) feet to assure correct alignment.
4. Terminate raceways with flared bells to enable ease of pulling cable and to eliminate stress on the cable. Free bells and raceway terminations of burrs and rough edges.
5. Provide concrete markers at grade where duct banks are stubbed out for future use.
6. Install utility duct banks not less than thirty (30") inches below grade top elevation.
7. Provide rigid steel elbows for vertical risers.
8. Provide vinyl tracer ribbon twelve (12") inches above each duct bank buried in backfill.

I. Aluminum Conduit

1. Do not use aluminum conduit unless specifically indicated on the drawings for special purposes.

2.02 LOCKNUTS AND BUSHINGS

- A. Locknuts shall be steel. Die cast locknuts shall not be used.
- B. All bushings shall be insulated. Use nylon insulated metallic bushings for sizes 1" and larger. Plastic bushings may be used in 1/2" and 3/4" sizes.

2.03 OUTLET, JUNCTION, AND PULL BOXES

A. Cast Type Conduit Boxes, Outlet Bodies and Fittings

1. Provide surface mounted outlet and junction boxes, in indoor locations, where exposed to moisture and in outdoor locations.
2. Use Ferrous Alloy boxes and conduit bodies with Rigid Steel or IMC.
3. Use Ferrous Alloy or cast aluminum boxes and conduit bodies with Electrical Metallic

Tubing.

4. Covers: Cast or sheet metal unless otherwise required.
5. Tapered threads for hubs.

B. Galvanized Pressed Steel Outlet Boxes

1. General
 - a) Pressed steel, galvanized or cadmium-plated, minimum of four (4") inches, octagonal or square, with galvanized cover or extension ring as required.
2. Concrete Box
 - a) Four (4") inch octagon with a removable backplate and 3/8" fixture stud, if required. Depth of box shall allow for a minimum of one (1") inch of concrete to be poured above the backplate.
3. Switch and Receptacle Box, Indoors
 - a) Nominal four (4") inches square, 1-1/2" or 2-1/8" deep as required, with raised cover unless otherwise indicated on drawings. Gangable boxes shall not be used.
4. Telephone outlet box, Indoors
 - a) Nominal four (4") inches square, 2-1/8" deep, with raised cover unless otherwise indicated on drawings. Gangable boxes shall not be used.
5. Lighting Fixture Box
 - a) Four (4") inch octagon with 3/8" fixture stud.
 - b) For suspended ceiling work, four (4") inch octagon with removable backplate where required, and two (2) parallel bars for securing to the cross-furring channels and extend flexible conduit to each fixture.
6. Plug any open knockouts not utilized.

C. Sheet Steel Boxes Indoors

1. No. 12 USS gauge sheet steel for boxes with maximum side less than forty (40") inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
2. No. 10 USS gauge sheet steel for boxes with maximum side forty (40") to sixty (60") inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners.
3. No. 10 USS gauge sheet steel riveted or welded to 1-1/2 by 1-1/2" by 1/4" welded angle iron framework for boxes with a maximum side exceeding sixty (60") inches and more than 1,500 square inches in area.
4. Covers
 - a) Same gauge steel as box.
 - b) Subdivided single covers so no section of cover exceeds fifty (50) pounds.
 - c) Machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required; maximum spacing twelve (12") inches.
5. Paint
 - a) Rust inhibiting primer; ANSI No. 61 light gray finish coat.
6. Where size of box is not indicated, size to permit pulling, racking and splicing of cables.
7. For Boxes over 600 Volts
 - a) Provide insulated cable supports and removable steel barriers to isolate each feeder. Stencil cable voltage class in red letters on the front cover of the box.
 - b) Braze a ground connector suitable for copper cables to the inside of the box.

D. Pull and Splice Boxes, Outdoors

1. Aluminum reinforced, with removable covers secured by brass machine screws.
2. Where size of box is not indicated, size to permit pulling, racking, and splicing of the cables.
3. Braze a ground connector suitable for copper cables to the inside of the box.

E. Junction Box, Sidewalk Type

1. Cast iron, hot-dipped galvanized with threaded conduit entrance hubs, flanged, reinforced checkered cover, gasketed with pry bar slots and countersunk stainless steel screws.

F. Floor Boxes

1. General

- a) Class I, water-tight, normal depth cast iron construction Type I, fully adjustable, for use in concrete.
- b) Single Gang Round type.
- c) Multiple Gang or Combination. i) Rectangular type partitions for separating power from communication sections.

2. Floor Box Covers

- a) Rugged construction, impervious to cleaning detergents.
- b) Compatible with floor covering.
- c) Brass or bronze for flush mounting.
- d) Providing continuous ground path to box.
- e) Provide carpet flange in carpeted areas.

PART 3 - EXECUTION

3.01 APPLICATION OF RACEWAYS

- A. The following applications must be adhered to except as otherwise required by Code. Raceways not conforming to this listing must be removed by this Contractor and replaced with the specified material at this Contractors expense.
 1. Rigid Steel - Application: Where exposed to mechanical injury, where specifically required, where required by codes and for all circuits in excess of 600 volts.
 2. I.M.C. - Application: Same as standard threaded rigid steel conduit.
 3. E.M.T. - Applications: Use in every instance except where another material is specified. EMT shall not be used underground or in slab on grade.
 4. Flexible Steel - Applications: Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings at bus duct takeoffs, at all transformer or equipment raceway connections where sound and vibration isolation is required.
 5. Liquid-Tight Flexible Conduit - Applications: Use in areas subject to moisture where flexible steel is unacceptable at connections to all motors, and all raised floor areas.
 6. Non-Metallic Conduit - Application: Schedule 40 - Where specifically indicated on the drawings and for raceways in slab or below grade. All bends shall be made with wrapped steel elbows unless the bend is encased in concrete.
 7. Wireways and Auxiliary Gutters - Application: Where indicated on the Drawings and as otherwise specifically approved.

3.02 RACEWAY SYSTEMS IN GENERAL

- A. Provide raceways for all wiring systems, including security, data transmission, paging, low voltage etc. All 277/480 volt wiring shall be kept independent of 120/208 volt wiring. Emergency system wiring shall be kept independent of the normal system wiring. Where non-metallic raceways are utilized, provide sizes as required with the grounding conductor considered as an insulated additional conductor. Wiring of each type and system must be installed in separate raceways.
- B. Install capped bushings on raceways as soon as installed and remove only when wires are

pulled. Securely tie embedded raceway in place prior to embedment. Lay out the work in advance to avoid excessive concentrations of multiple raceway runs.

- C. Locate raceways so that the strength of structural members is unaffected and they do not conflict with the services of other trades. Install one (1") inch or larger raceways, in or through structural members (beams, slabs, etc.) only when and in the manner accepted by the Architect/Engineer. Draw up couplings and fittings full and tight.
- D. Above-grade raceways to comply with the following:
 - 1. Install raceways concealed except at surface cabinets and for motor and equipment connection in electrical and mechanical rooms. Install a minimum of six (6") inches from flues, steam pipes, or other heated lines. Provide flashing and counter-flashing for waterproofing of raceways, outlets, fittings, etc., which penetrate the roof. Route exposed raceways parallel or perpendicular to building lines with right-angle turns and symmetrical bends. Run concealed raceways in a direct line and, where possible, with long sweep bends and offsets. Provide sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways. Waterproof sleeved raceways where required.
 - 2. Raceways shall not be run on roofs or exposed on the outside of the buildings unless specifically noted as exposed on the drawings or approved by the Architect/Engineer.
 - 3. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding conductor at building expansion joints and between buildings or structures and where required to compensate for raceway or building thermal expansion and contraction. Provide expansion fittings every 200 feet on outdoor conduit.
 - 4. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduit in a junction box, which after completion, is accessible to facilitate future branch circuit extension.
 - 5. Provide raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.) in special occupancy area, as required. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling, or floors which separate adjacent rooms having substantially different maintained temperatures, as in refrigeration or cold storage rooms.
 - 6. Provide pull string in spare or empty raceways. Allow five (5) feet of slack at each end and in each pull box. Tie each end of the string to a washer or equivalent that does not fit into the conduit. Tag both ends of string denoting opposite end termination location.

F. Below Grade

- 1. Below grade raceways to comply to the following:
 - a) Do not penetrate waterproof membranes unless proper seal is provided.
- 2. Protect steel raceway in earth or fill with two (2) coats of asphalt base paint. Touch up abrasions and wrench marks after conduit is in place.
- 3. In lieu of the above, protect steel raceways with a minimum of ten (10) mil tape approved for the purpose and overlapped a minimum of one-half tape width to provide a minimum twenty (20) mil thickness.

G. No raceway may be installed in a concrete slab or members except with the permission of the Structural Engineer and with the written consent of the Owner.

- 1. Conduits embedded in structural concrete slabs shall have an outside diameter less than one third of the thickness of the concrete slab and shall be installed entirely within the center one third of the concrete slab.
- 2. Raceways embedded in concrete slabs shall be spaced not less than eight (8") inches on

- centers and as widely spaced as possible where they converge at panels or junction boxes.
3. In no case will installation of raceways be permitted to interfere with the proper placement of principal reinforcement.
 4. Raceways running parallel to slab supports, such as beams, columns, and structural walls, shall be installed not less than twelve (12") inches from such supporting elements.
 5. To prevent displacement during concrete pour of lift slab, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured with suitable adhesives.
- H. Non-metallic raceway installation shall conform to the following:
1. All joints are to be made by the solvent cementing method using the material recommended by the raceway manufacturer. To insure good joints, components shall be cleaned prior to assembly.
 2. Raceway cut-offs shall be square and made by handsaw or other approved means which does not deform the conduit. Raceway shall be reamed prior to solvent cementing to couplings, adapters, or fittings.
 3. Electrical devices which are served by PVC raceways shall be grounded by means of a ground wire pulled in the raceway.
 4. Bends shall be made by methods that do not deform or damage the conduit. The radii of field bends shall not be less than those established by the N.E.C.
 5. Raceway expansion fittings shall be provided where necessary. The position of the expansion fitting shall be adjusted proportional to the temperature at installation.
 6. Raceway supports shall be installed, in such a manner, to allow the PVC conduit to slide through the supports as the temperature changes.
 7. Elbows must be galvanized rigid steel, intermediate metallic conduit or concrete encased.
- I. Raceways in hung ceiling shall be run on and secured to slab or primary structural members of ceiling, not to lathing channels or T-bars, Z-bars, or other elements which are the direct supports of the ceiling panels. Secure conduit firmly to steel by clips and fittings designed for that purpose. Install as high as possible, but not less than 1'-0" above hung ceilings.
- J. Exposed raceways shall be run parallel or at right angles with building lines. Secure raceway clamps or supports to masonry materials by toggle bolts, expansion bolts, or steel inserts. Install raceway on steel construction with approved clamps which do not depend on friction or set screw pressure alone.
- K. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. This shall be done with ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt, or similar material. This assembly may be pulled in together with, but ahead of, the cable being installed. All empty raceways shall be similarly cleaned. Clear any raceway which rejects ball mandrel.
- L. Support raceways at intervals no greater than ten (10) feet and with one support within three (3) feet of each coupling, box, fitting, or outlet box. Provide one support within three (3) feet of each elbow or bend.

3.03 OUTLET, JUNCTION, AND PULLBOXES

- A. Provide outlet, junction, and pullboxes as indicated on the drawings and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of wires and cables. J-boxes and pullboxes shall be sized per electrical code minimum. Boxes on empty conduit systems shall be sized as if containing conductors of #4 AWG.
- B. Install boxes and covers for wiring devices so that the wiring devices will be installed with a vertical orientation unless otherwise noted on the drawings.
- C. The exact location of outlets and equipment is governed by structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures

or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with Architect.

- D. Back-to-back outlets in the same wall, or "thru-wall" type boxes not permitted. Provide twelve (12") inch (minimum) spacing for outlets shown on opposite sides of a common wall to minimize sound transmission. Provide twenty four (24") inch (minimum) horizontal spacing for outlets shown on opposite sides of a fire rated wall to maintain fire rating.
- E. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide Series "GW" (Steel City) tile box, or as accepted, or a four (4") inch square box with tile ring in masonry walls, which will not be plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of the type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in same box, provide suitable barrier.

F. Pull Box Spacing

- 1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360 degrees total).
- 2. Conduit Sizes 1-1/4" and Larger.
 - a) Provide boxes to prevent cable or wire from being excessively twisted, stretched, or flexed during installation.
 - b) Provide boxes for medium voltage cables so that maximum pulling tensions do not exceed cable manufacturer's recommendations.
 - c) Provide support racks for boxes with multiple sets of conductors do not rest on any metal work inside box.
- 3. Conduit Sizes one (1") inch and smaller, low voltage wire and cable (maximum distances)
 - a) 200 feet straight runs.
 - b) 150 feet runs with one 90 degree bend or equivalent.
 - c) 125 feet runs with two 90 degree bends or equivalent.
 - d) 100 feet runs with three or four 90 degree bends or equivalent.

G. Floor Boxes

- 1. Prior to Concrete Pour
 - a) Firmly support boxes.
 - b) Adjust leveling screws to insure box covers are flush with finished floor.
 - c) Plug unused opening with proper fittings and seal joints with compound for exclusion of concrete and moisture.
- 2. After Concrete Pour
 - a) As soon as traffic is permitted on slab, remove any accumulation of water and foreign matter to avoid corrosion and rust.
 - b) Insure covers are flush with finished floor.
 - c) Install cover plates and accessories after floor finishing materials have been installed.

END OF SECTION

SECTION 26 28 23

ELECTRICAL DISCONNECT SWITCHES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.02 DESCRIPTION OF WORK

- A. Provide circuit and equipment disconnect switches as indicated on the drawings and as required by code.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:

1. Electrical General Provisions
2. Electrical Identification
3. Fuses 600v and Less

1.04 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. U.L. Standards #98 (File #4776) and #508.
 2. Federal Specifications W-S-865C.
 3. NEMA Standard KS1-1975.
 4. U.L. 20 and Federal Specification Test Standards for Toggle Switches.

1.05 SUBMITTALS

- A. Submit manufacturer's data for all disconnect switches.
- B. Identify motor or equipment served by each switch; indicate nameplate inscription.

PART 2 - PRODUCTS

2.01 SAFETY SWITCHES

- A. Heavy-duty, horsepower rated, single-throw knife switch with quick-make, quick-break mechanism, capable of full load operations. Meet NEMA and U.S. Government specifications for Class A switches.
- B. Provide with contact arc-quenching devices, such as magnetic blowouts or snuffing plates. Provide self-aligning switchblades with silver alloy contact areas and designed so that arcing upon making and breaking does not occur on the final contact surfaces. Provide with high-pressure, spring-loaded contact. Mount switch parts on high-grade insulating base.
- C. Enclosure - NEMA I with hinged door, and defeatable interlock when switch is in "ON"

position and can be positively padlocked in "ON" and "OFF" positions. Utilize NEMA 3R (rain-tight) enclosure for exterior installations.

- D. Size, fusing and number of poles as shown or as required. Where fused, the devices must be provided with UL listed rejection feature to reject all but Class R fuses. Provide horsepower rated switch to match motor load if no size is shown. Use 3 pole plus solid neutral switches on four wire circuits and 3 pole switches on all other circuits, unless otherwise noted.
- E. Lugs must be UL listed for aluminum and/or copper conductors and be front removable. Circumferential fittings must be used on all aluminum conductors.
- F. Provide six (6) pole switches for connection to motors with the following starter types:
 - 1. Non-reversing - two-step - part winding - star connected.
 - 2. Non-reversing - full voltage - two speed separate winding.
 - 3. Non-reversing - full voltage - two speed single winding.
 - 4. Where otherwise required.
 - 5. Provide auxiliary contacts for switches where required or where indicated on the drawings.
 - a) Provide auxiliary contacts for all disconnect switches fed from a variable frequency drive or adjustable frequency drive. The auxiliary switch shall be arranged to operate before the main switch contacts and shall be connected to the VFD controls to shut down the VFD before the switch opens.

2.02 TOGGLE TYPE MANUAL CONTROL SWITCHES

- A. Provide switches that operate at their full rating with fluorescent, tungsten and resistance loads, and at 80% of their rated capacity with motor loads.
- B. Switches to be heavy duty and have:
 - 1. Arc-resisting bodies
 - 2. Quick make-and-break mechanisms
 - 3. Silver alloy contact buttons
 - 4. Side or back wiring with up to No. 10 AWG solid conductors

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Each motor over 1/2 HP shall be provided with a horsepower-rated safety-type disconnect switch.
- B. Each piece of equipment utilizing multi-phase power shall be supplied with a safety-type disconnect switch.
- C. Each piece of equipment utilizing single-phase power but protected at over 30 amperes shall be supplied with a safety-type disconnect switch.
- D. Equipment other than that mentioned above may utilize a toggle type manual control switch properly sized and rated for the equipment it disconnects.
- E. Factory installed disconnect switches may be used to satisfy the above requirements with the Architect/Engineer's prior approval.

3.02 MOUNTING

- A. Mount switch enclosure rigidly and with proper alignment on building structure or steel supports with centerline of operating handle not more than 6 feet above finished floor unless otherwise required. Use steel supports fabricated from standard rolled structural steel shapes or framing channel to provide one-inch separation between enclosure and building wall for vertical flow of air.

3.03 IDENTIFICATION

- A. Provide identification of all disconnect switches in accordance with Section 16195 of these specifications.

END OF SECTION

SECTION 26470

ELECTRICAL PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the contract including General and Special Conditions and General Requirements shall apply to all work under this Section.

1.02 DESCRIPTION OF WORK

- A. Provide complete panelboards.

1.03 RELATED WORK IN OTHER SECTIONS

- A. Related work in other sections:

1. Electrical General Provisions
2. Raceways and Boxes
3. Wire and Cable
4. Electrical Identification
5. Grounding

1.04 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Panelboards
 - a) U.L. Standards #50 & #67
 - b) Federal Standard W-P-1 15C
 - c) NEMA Standard PB-1
2. Circuit Breakers
 - a) U.L. Standard #489
 - b) Federal Standard W-C-375A Amendment No.4
 - c) NEMA Standard AB-1-1969

1.05 SUBMITTALS

- A. Submit complete shop drawings and catalog data. With each panelboard drawing the following is required:

1. Show main devices and lug sizes
2. Branch circuit device sizes and arrangement. Identify available spaces
3. Dimensions and construction
4. Gutter and backbox dimensions, conduit entry/exit locations.
5. Nameplate and legend
6. Protective coating
7. All pertinent details of panel, enclosure, cover, and method of securing cover and lock
8. Assembly ratings including:
 - a) Short-circuit rating
 - b) Voltage
 - c) Continuous current
9. Major component ratings including:
 - a) Voltage
 - b) Continuous current
 - c) Interrupting ratings
10. Cable terminal sizes.

- B. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in section A.
2. Installation information
3. Seismic certification and equipment anchorage details.

1.06 QUALITY ASSURANCE

- A. Each panelboard as a complete and finished product shall receive a single integrated equipment rating by the manufacturer. The integrated equipment manufacturer shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value specified on the Drawings. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed to each panelboard.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. These instructions shall be included with the equipment at time of shipment.

1.08 EXTRA MATERIALS

- A. Provide two (2) keys for each cabinet lock. PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. All panelboards are to be of the same manufacturer as the switchboards (If Applicable)
- B. Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. Cutler-Hammer
 2. General Electric
 3. Siemens ITE
 4. Square D

2.02 PANELBOARDS IN GENERAL

- A. Provide panelboards consisting of an assembly of branch circuits switching and protective devices (circuit breakers, switch and fuse units, or combination thereof) mounted inside a dead front enclosure. Provide the number and size of these branch circuit devices as indicated by the circuiting, on the drawings, and in the schedules. Locations of circuit breakers shall be as indicated in the schedules.
- B. Provide the following modifications and additional equipment as shown on the Drawings:
 1. Main circuit breakers
 2. Shunt trip circuit breakers
 3. Integral remote control switches
 4. Subfeed switches
 4. Feed through lugs and/or bus
 5. Feed through cabling arrangement
 6. Double lugs for multiple cables or for future provisions
 7. Circumferential compression lugs where aluminum conductors are employed
 8. Ground fault interrupting circuit breakers
 9. Oversized gutters
 10. Door in door construction for power panels

C. Interiors

1. Rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.
2. Bus bars sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
3. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units; without removing main bus or branch circuit connectors and without machining, drilling, or tapping in the field.
4. Arrange bus in sequence or distributed phasing so that multipole circuit breaker can replace any group of single circuit breakers of the same size.

5. Full-size (100%-rated) insulated neutral bars shall be included for panelboards shown with neutral. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors and panels served from K-rated transformers.
6. Provide ground bus in each panelboard. On 120/208 volt panelboards provide an additional isolated ground bus where required.

D. Enclosure

1. Code gauge steel box galvanized.
2. Provide a bolt-on ground connector to inside of enclosure.
3. Flush mounted in finished areas and where indicated. Surface mount elsewhere.

E. Front

1. Doors must be provided on all lighting and power panels. On switch and fuse panelboards doors over overcurrent devices are not to be provided unless rated for same.
2. Heavy code gauge steel as required to maintain panel face flat.
3. Hold front closed with trim clamps.
4. Factory finished in medium gray enamel or two coats of air-drying lacquer over a rust inhibitor.
5. Provide cylinder lock . All panels keyed alike.
6. Welded angle rest at the bottom of the door to facilitate cover installation.
7. Doors over 48" in height shall have auxiliary fasteners at top and bottom of door in addition to lock and catch.

F. Multiple Section Panelboards

1. Each section of multiple section panelboards shall be the same height.
2. Multiple sections shall each contain the same number of poles (e.g. 72 poles equals 2-36 pole panels).

G. Terminal Lugs

1. Bolted type, labeled for either copper or aluminum conductors.
2. Locate main lugs properly at top or bottom, depending where main feeder enters.

H. Electrical Ratings

1. Short circuit withstand ratings shall be as indicated on the Drawings. Panelboards shall be labeled with a UL short-circuit rating. All circuit breakers shall be fully-rated unless the drawings specifically indicate series rated. When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided. It shall state the conditions of the UL series ratings including:
 - a) Size and type of upstream device
 - b) Branch devices that can be used
 - c) UL series short-circuit rating.
2. Where indicated, provide panelboards having a "service entrance" Type UL label with neutrals factory bonded to frame or enclosure.

I. Circuit Breaker Devices

1. Plastic molded case. Completely sealed enclosure. Toggle type operating handle. Trip ampere rating and ON/OFF indication clearly visible.
2. Thermal-magnetic trip-free, trip-indicating, quick-make, quick-break, with inverse time delay characteristics. Single-handle and common tripping multipole breakers.
3. Silver alloy contacts with auxiliary arc-quenching devices.
4. Panelboard must be of the type which will accept the field installation of shunt trip devices of 60 amperes or less on the branch devices.
5. Interrupting capacities shall be as indicated on the Drawings. As a minimum, 240 volt devices shall be not less than 10,000 AIC and 480 volt devices not less than 14,000 AIC.
6. For lighting circuits provide devices labeled "SWD" for switching purposes.
7. Bolted type terminals U.L. listed for either aluminum or copper 75 degrees C cables.
8. Provide main breakers in panels served from transformers unless separate transformer secondary protection is provided.
9. Locate next to each breaker or space unit an individual number.
10. Circuit breakers serving computer equipment and those serving kitchen equipment beneath cooking hoods shall include a shunt trip coil.

11. Shunt trip breakers shall be supplied with 120 volt coils. Provide 120 volt circuit from nearest 120 volt panel to coil. Where shunt trip breakers are in emergency panels provide emergency 120 volt source for same from nearest 120 volt emergency panel.
12. Provide locking device for designated breakers.
13. For HVAC equipment provide UL listed "HACR" type devices.

J. Ground Fault Interrupters

1. Ground fault interrupter branch circuit breakers shall be as indicated on the Drawings. Circuit breakers shall be circuit interrupting which will operate manually for normal switching functions and automatically under overload, short circuit, and 0.005 amp line-to-ground fault conditions. The operating mechanism shall be entirely trip-free so that contact cannot be held closed against an abnormal overcurrent, short circuit, or ground fault condition. The device shall be bolt-on type with case construction.

K. Switch and Fuse Devices

1. Quick-make/quick-break, horsepower rated, dead-front type. Each switch a self-contained unit, externally operable from the front. Provision for padlocking handle in OFF position.
2. Fuse and switch compartment interlocked to prevent access to the fuse compartment until switch is thrown to "OFF" position. Interlock intentionally releasable by externally applied tool to permit checking switch and fuses under load.
3. Switch units interchangeable for replacement, without disturbing balance of distribution panelboard's operation.
4. Provide with rejection-type clips for Class R type fuses.
5. Provide Class R rejection type fuses as specified elsewhere.
6. Provide spare fuses as specified elsewhere.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount all panels at a maximum height of 6 feet 6 inches to top unless otherwise noted.
- B. Where flushed mounted, the fire integrity of the wall in which it is installed must be maintained.
- C. Neatly arrange branch circuit wires and tie together in each gutter with Thomas & Betts nylon "Ty-Raps", or approved equal at minimum 4 inch intervals.
- D. Plug all knockouts removed and not utilized.
- E. Provide nameplate and fill out panel directory. For remodel work or changes, trace circuits to determine loads and provide new updated directory.
- F. Provide grounding and bonding jumpers per Section 26450 and as indicated on the Drawings.

3.02 TOUCH UP AND CLEANING

- A. Vacuum all backboxes clean of debris after installation and prior to contract closeout.
- B. Touch up scratch marks, etc. with matching paint.

3.03 OBSERVATIONS

- A. All panel fronts shall be removed by the Contractor for observation of the panel interiors by the Engineers.
- B. Panel fronts shall be removed when directed by the Engineer/Architect for observation and reinstalled immediately after the observations.

END OF SECTION