

Section 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the work as indicated on the Drawings and specified herein.
- B. This Section covers the work necessary to furnish and install, complete, the materials specified hereinafter.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

1. Comply with the latest editions of the following codes and standards:

NEC National Fire Protection Association (NFPA) – 70
National Electrical Code (NEC), latest adopted
version.

CCR Title 8, Industrial Relations, Subchapter 5, Electrical
Safety Orders, California Code of Regulations.

2. Government Standards:

FS W-C-596E/GEN (1) Connector, Plug, Receptacle and Cable Outlet,
Electrical Power.

FS W-S-896E/GEN (1) Switches, Toggle (Toggle and Lode), Flush Mounted
(ac).

FS WW-C-581E Conduit, Metal, Rigid, And Intermediate; And
Coupling, Elbow, and Nipple, Electrical Conduit:
Steel, Zinc Coated.

3. Commercial Standards:

ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel
Alloy, and Other Special Alloys.

ANSI C80.1 Rigid Steel Conduit, Zinc Coated, specification for.

ANSI Z55.1 Gray Finishes for Industrial Apparatus and
Equipment.

ANSI/UL 467 Grounding and Bonding Equipment, Safety Standard
For.

NEMA WD-1-1.10	General Requirements for Wiring Devices.
NEMA AB-1	Molded Case Circuit Breakers.
NEMA PB-1	Panelboards.
NEMA KS-1	Enclosed Switches.
NEMA VE-1	Ventilated Cable Tray.

4. ICEA Wire and Cable standards

UL 943	Ground Fault Circuit Interrupters.
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- B. All equipment furnished by the CONTRACTOR shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or of an independent testing laboratory acceptable to OCSD.
- C. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the Cal/OSHA Safety Orders (Title 8, CCR), State Building Standards, and applicable local codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Section 16010, Electrical General Provisions.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with all applicable requirements of Section 16010, Electrical General Provisions.

PART 2 - PRODUCTS

2.1 HAZARDOUS AREAS (NOT USED)

2.2 OUTLET AND DEVICE BOXES

- A. General: Provide boxes not less than 2-inches deep, unless shallower boxes are required by structural conditions and are specifically accepted by the ENGINEER. Do not use box extensions to provide wiring space required by the NEC. For hollow masonry construction, provide boxes of sufficient depth so that conduit knockouts or hubs are in the masonry void space.
- B. Sheet Steel (~~SS~~) Boxes: Provide zinc- or cadmium-plated boxes of the one-piece drawn type. Install 4-inch minimum octagonal boxes for ceiling outlets, except where smaller boxes are required for the particular fixture being installed. Use concrete type boxes in poured concrete slabs. Provide 4-inch by 4-inch minimum boxes with 3/4" knockouts for switches and receptacles. Provide plaster rings where required.
- C. Cast Steel (CS) Boxes: Provide boxes of cast ferrous metal with gasketed, watertight, cast ferrous metal covers and stainless steel screws. Provide boxes with threaded conduit hubs and cast mounting lugs where lugs are required. Use Crouse-Hinds or Appleton Type FS or FE boxes, or equal.

- D. Cast Aluminum (CA) Boxes: Provide boxes of cast, copper-free aluminum with gasketed, watertight, cast copper-free aluminum covers and stainless steel screws. Provide boxes with threaded conduit hubs and cast mounting lugs where lugs are required. Use Crouse-Hinds or Appleton Type FS or FE boxes, or equal.
- E. Nonmetallic (NM) Boxes: Provide fiberglass boxes with gasketed, watertight covers and stainless steel screws. Provide boxes with conduit hubs and any required mounting lugs. Use Crouse-Hinds, Stahlin or equal.
- F. Provide a box suitable for the conditions encountered at each outlet in the wiring or raceway system and sized in accordance with the NEC. Use the listed types unless otherwise indicated or accepted.
- G. **Unless otherwise indicated on the Contract Documents, device boxes and outlet boxes shall be heavy duty, and shall be compatible with the location and conduit system being used, and shall be manufactured by Crouse-Hinds, Appleton, or equal, with stainless steel cover screws and with cover gaskets. Device boxes shall be "FD" type. Types to be provided are as follows:** ~~Unless otherwise indicated on the Contract Documents, device boxes and junction boxes shall be heavy duty, and shall be compatible with the location and conduit system being used, and shall be manufactured by Crouse-Hinds, Appleton, or equal, with stainless steel cover screws and with cover gaskets. Device boxes shall be "FD" type.~~

Location	Box Type
Exposed in General Purpose Dry Location	Cast Steel
Exposed in Wet and Corrosive Area	PVC Coated Cast Steel
Encased in Concrete or Concealed	Cast Steel

- 1. ~~Types to be provided, PVC-coated Steel Raceway System;~~

~~Locations _____ Box Type~~

~~All _____ Cast steel~~

- 2. ~~Exterior Locations, with:~~

~~Exposed Raceways _____ Stainless steel~~

~~Concealed Raceways _____ Stainless steel~~

~~Concrete Encased Raceways _____ Stainless steel~~

- 3. ~~Interior Dry Locations, with:~~

~~Exposed Rigid Conduit _____ Sheet metal~~

~~Exposed EMT _____ Sheet steel~~

~~Concealed Raceways _____ Sheet steel~~

~~Concrete Encased Raceways _____ Cast steel~~

~~Lighting Circuits, Ceiling Portion Sheet steel~~

4. ~~Interior Wet Locations, with:~~

~~Exposed Raceways _____ Stainless steel(NEMA 4X)~~

~~Concealed Raceways _____ Cast steel~~

~~Concrete Encased Raceways _____ Cast steel~~

~~Lighting Circuits, Ceiling Portion Sheet steel~~

5. ~~Types to be Provided, Nonmetallic Raceway System:~~

~~Locations _____ Box Type~~

~~All _____ Nonmetallic~~

~~Exposed Raceways _____ Nonmetallic~~

~~Concealed Raceways _____ Nonmetallic~~

~~Concrete Encased Raceways _____ Nonmetallic~~

H. **Device Plates:**

1. **Types to be Provided:**

Locations	Plate Type
General Purpose Dry Area All	Metal
Wet and Corrosive Area	Weatherproof 316 Stainless Steel
All Interior _____	Metal
Office _____	Metal
WP Designation _____	Weatherproof
Interior _____	Metal
Flush Mounted Boxes _____	Metal
Surface Mounted Cast Metal Boxes _____	Cast metal
Surface Mounted Sheet Metal Boxes _____	Metal

2.3 JUNCTION AND PULL BOXES

- A. **Utilize NEMA 4X, 316 stainless steel enclosures for wet and corrosive locations as well as where subscript WP is indicated at the box location on the Plans** ~~of fiberglass UV-rated enclosures for outdoor or wet or corrosive locations as well as where subscript WP is indicated at the box location on the Plans.~~

- B. Where outlet boxes are used as junction or pull boxes, use materials as specified under article 2.2, OUTLET AND DEVICE BOXES.
- C. Where larger sheet steel boxes are required, utilize boxes of code-gauge, galvanized steel with full-access screw covers mounted with corrosion-resistant machine screws.
- D. Where larger cast metal boxes are required, use neoprene gasketed, watertight boxes with hinged, cast metal full-access covers, stainless steel cover hardware, and drilled and tapped conduit entrances. Use Crouse-Hinds Series W, O.Z./Gedney Series Y boxes, or equal. For below grade conduit, use Crouse-Hinds Type WJBF, O.Z./Gedney Series YR, or equal, minimum size 8-inches by 8-inches by 6-inches. For hazardous areas, use boxes applicable for the location and hazardous atmosphere present.
- ~~E. Where larger nonmetallic boxes are required, they shall be gasketed, NEMA 4X, corrosive resistant, and have a hinged, full access screw cover. The hinge and machine screws shall be stainless steel. The box and cover shall be of high impact strength fiberglass reinforced polyester material with stability to high heat. The boxes shall have conduit hubs and any required mounting lugs. The minimum size shall be 7-inches by 10-inches by 6 1/2-inches deep. Use Crouse Hinds Type NJB boxes, or equal.~~
- F. Use concrete boxes of reinforced, cast concrete, 10-inches by 17-inches minimum inside dimensions, Brooks Products, Inc., No. 3-1/2T, Quikset W.17 Associated, or equal. Mark cast iron cover, as per DISTRICT standards. Boxes shall be inspected and approved by the DISTRICT prior to site delivery.
- G. Use special boxes where indicated on the Drawings.

2.4 TERMINAL JUNCTION BOXES (TJB)

- A. **Provide hinged-cover terminal junction boxes of the required type and size where indicated. Utilize NEMA 12 enclosures for general purpose dry locations. Utilize NEMA 4X 316 stainless steel enclosures, as described under article 2.3, JUNCTION AND PULL BOXES, for wet and corrosive locations and where subscript WP is indicated at the box location on the Drawings. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide 50 percent spare terminal points for DISTRICT use following completion of installation. Paint interior surfaces with white enamel or lacquer.**~~Provide hinged-cover terminal junction boxes of the required type and size where indicated. Utilize NEMA 12 enclosures for indoor dry locations. Utilize NEMA 4X watertight enclosures, as described under article 2.4, JUNCTION AND PULL BOXES, for outdoor or wet locations and where subscript WP is indicated at the box location on the Drawings. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide 50 percent spare terminal points for DISTRICT use following completion of installation. Paint interior surfaces with white enamel or lacquer.~~

2.5 TELEPHONE TERMINAL CABINETS, PUNCH BOARDS, PUNCH BLOCKS, AND BACKBOARD~~TELEPHONE TERMINAL CABINETS~~

- A. Provide telephone terminal cabinets of the type and size indicated for incoming telephone service. Provide hinged doors code-gauge galvanized steel box containing a 3/4-inch plywood backboard. Utilize cabinet conforming to the requirements of the telephone company. Provide terminal blocks with 25 percent spare termination points for DISTRICT use following completion of installation. Label and identify all conductors.

2.6 WIRING DEVICES

A. Switches:

1. General Use Switches: Provide specification grade, totally-enclosed, ac type, quiet tumbler switches meeting NEMA WD 1 performance standards and Federal Specification W-S-896E, and capable of control of 100 percent tungsten filament and fluorescent lamp loads. Use switches rated at 20 amps, 120/277 volts. Provide operating handles colored ivory in all areas. Switches shall have screw terminals.
2. Switches with Integral Timers: Provide specification grade, totally-enclosed, AC type switches with an integral rotary dial 60 minute timer with manual bypass capability rated at 20 amps, 120/277 volts, where shown on drawings.
3. Weatherproof Switches: Use switches mounted in a cast metal box with gasketed, weatherproof device plate.
4. Switches with Pilot Lights: Provide switches with 125-volt, neon light with red jewel, or lighted toggle which is lighted when the switch is ON
5. Acceptable Manufacturers: Bryant, General Electric, Hubbell, Pass and Seymour, Leviton, or equal.

B. Receptacles:

1. Single and Duplex: Provide specification grade receptacles meeting NEMA WD 1 performance standards and Federal Specification W-C-596, and having a contact arrangement such that contact is made on two sides of each inserted blade without detent. Use two-pole, three-wire grounding type receptacles rated 20 amps, 125 volts, NEMA Configuration 5-20R, and with screw type wire terminals suitable for No. 10 AWG. Provide high strength thermoplastic bases colored ivory in all areas. Acceptable manufacturers: Bryant, General Electric, Hubbell, Pass and Seymour, Sierra, or equal.
2. **Weatherproof Receptacles: Receptacles shall be as specified in Sections 2.6.B.1 and 2.6.B.3 and provided with stainless steel weatherproof gasketed device plate with heavy duty industrial grade weatherproof cover that would allow a plug to be left in the receptacle while still being protected. Acceptable manufacturers: Cooper, Hubbell, or equal**~~Receptacles shall be as specified in Sections 2.6.B.1 and 2.6.B.3 and mounted in a cast metal box with gasketed weatherproof device plate with electrical cover that would allow a plug to be left in an outside receptacle.~~
3. Ground Fault Interrupter (GFI) Receptacles: Provide duplex specification grade GFI receptacles tripping at 5 milliamps; rated 20 amps, 120 volts, NEMA Configuration 5-20R and capable of interrupting 1,000 amps without damage. Use units meeting NEMA WD 1, fitting standard sized outlet boxes, having No. 12 AWG copper TW insulated pigtails, having provision for testing, and brown in color. Use standard model where ground fault protection is needed at an individual location. Use feed-thru model where ground fault protection is specified for "downstream" conventional receptacles. Provide receptacles accepting standard device plates. Acceptable manufacturers: Pass and Seymour, Square D, General Electric, or equal.

4. Special Purpose Receptacles: Provide receptacles of the type, rating, and number of poles indicated or required for the anticipated purpose. Furnish a matching plug with cord-grip features for each special purpose receptacle.
 5. Receptacles in Classified Areas: Receptacles located in classified areas shall comply with the requirements of NEC Article 500.
- C. Telephone Outlets: Provide empty outlet boxes and cover plates conforming to the requirements of the telephone company where telephone outlets are indicated.
- D. Device Plates:
1. General:
 - a. Provide plates fitting closely and tightly to the box on which they are to be installed. On surface mounted boxes, provide plates, which do not extend beyond the sides of the box unless the plates do not have sharp corners or edges.
 - b. Use plate material compatible with the box material such that galvanic corrosion of the plate and/or box does not occur.
 2. Plastic (P) Plates: Provide specification grade device plates manufactured of 0.10-inch minimum thickness, noncombustible, thermosetting material. Provide brown one-piece with smooth exterior faces and with oval-head metal mounting screws of a color matching that of the plate.
 3. Metal (M) Plates: Provide specification grade, one-piece, 0.040-inch nominal minimal thickness, No. 430 satin finish stainless steel device plates with oval-head, matching mounting screws.
 4. Engraved Plates: Where device titles are indicated, provide device plates engraved with the designated titles. Provide engraved letters, numbers, or characters 3/16 - inch high with filler of white color.
 5. ~~Cast Metal (CM) Plates: Provide cast metal device plates of malleable ferrous metal with gaskets and stainless steel screws with oval heads.~~
 6. Weatherproof (WP) Plates:
 - a. **Where switches are located in wet or corrosive areas, the switch shall be installed in the specified box with a gasketed, weatherproof, stainless steel cover plate incorporating an external operator for the internal switch and with stainless steel mounting screws. Acceptable manufactures and types: Crouse-Hinds, Appleton or equal.** ~~Where weatherproof receptacles are designated, the receptacle shall be installed in the specified box with a gasketed, weatherproof, cast metal or stainless steel cover plate with individual cap over each receptacle opening and stainless steel mounting screws. Utilize plates with caps held tightly closed with stainless steel springs when receptacle is not in use. Acceptable manufacturers: General Electric, Bryant, Hubbell, Sierra, Pass and Seymour, Crouse Hinds, Bell, or equal.~~

- b. Where weatherproof switches are designated, the switch shall be installed in the specified box with a gasketed, weatherproof, cast metal cover plate incorporating an external operator for the internal switch and with stainless steel mounting screws. Acceptable manufacturers and types: Crouse-Hinds DS-181 or DS-185, Appleton FSK-1VTS or FSK-1VS, or equal.
7. Raised Sheet Metal (SM) Plates: Provide 1/2-inch high zinc or cadmium-plated steel device plates designed for one-piece drawn type sheet steel boxes.

2.7 LIGHTING AND POWER DISTRIBUTION PANELBOARDS

- A. General: Provide circuit breaker panelboards including those in motor control equipment meeting standards established by UL, NEMA PB 1, and the NEC. Where used as service entrance equipment, provide panels UL labeled for that use. Furnish panels with fully rated short circuit current equipment rating. Series connected equipment ratings are not acceptable. Provide panels rated for connection to an electric system having an available amperes rms symmetrical short circuit current of the indicated value at 208Y/120 or 480Y/277 volts. Provide panelboards and circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
- B. Cabinets: Furnish boxes large enough to provide a minimum wiring gutter space on both sides and top and bottom of 4-inches by 4-inches minimum. Provide flush or surface mounted boxes as indicated manufactured with reinforced steel frame and code-gauge, hot-dip galvanized sheet steel. Utilize front trim the same size as the box for surface mounted panelboards and 3/4-inch larger all around than the box for flush mounted panelboards. Panel covers shall be installed with direct screw connections. Adjustable clamps shall not be used. Utilize fronts having doors with concealed hinges and flush type lock and catch device. Provide multi-point locking devices for all doors over 30-inches in height. Key all locks alike, and furnish two milled type keys with each lock. Furnish on door interior a metal directory frame with transparent plastic face and enclosed directory card. Furnish an engraved, laminated plastic nameplate screwed (no adhesives) to the cabinet exterior face indicating the panelboard designation, service voltage, and phases. Nameplates shall be white, engraved to a black core Letter height shall be 1/4 inch. **Panel NEMA ratings shall be as indicated on the Drawings. NEMA 4X panelboards shall be stainless steel.**
- C. Interiors:
 1. Furnished factory assembled panelboard interiors complete with circuit breakers as shown. In addition, space for future circuit breakers shall be provided with easily removable front cover. Utilize panelboards with interiors designed so that circuit breakers can be replaced without disturbing adjacent circuit breakers or without removing the main bus.
 2. Provide tin plated copper bus bars full sized throughout their length. Make complete provisions for mounting future circuit breakers throughout the full length of the bus. Provide all machining, drilling, or tapping required to add or to change circuit breakers in the future. Bolt together and rigidly support bus bars and connection straps on molded insulators.
 3. Furnish an insulated neutral bus bar rated the same as the phase bus bars and having at least one terminal screw for each branch circuit. Furnish a copper ground bus bar installed on the panelboard frame, bonded to the box, and containing at least one terminal screw for each circuit. Provide solderless main lugs for main, neutral, and ground bus bars. Provide sub-feed or thru-feed lugs where indicated. Provide

lugs and connection points on phase, neutral, and ground buses suitable for copper conductors.

D. Circuit Breakers:

1. Furnish indicating type molded circuit breakers providing ON/OFF and TRIPPED positions of the operating handle. Furnish thermal magnetic, quick-make, quick-break circuit breakers which are noninterchangeable in accordance with the NEC. Do not use tandem or dual circuit breakers in normal single-pole spaces. Do not use single-pole circuit breakers with handle ties where multiple circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting requirements of NEMA AB 1. Install bolt-on circuit breakers in all panelboards. Provide circuit breaker handle padlocking provisions where indicated or required.
2. Where ground fault interrupter (GFI) circuit breakers are indicated or required by the NEC, provide a unit containing a conventional thermal magnetic trip and a ground fault sensor rated to trip the circuit breaker in approximately 0.025 second for a 5-milliampere ground fault (UL Class A sensitivity). Utilize a ground fault sensor having the same rating as the circuit breaker and having a push-to-test button.

E. Acceptable Manufacturers: Bryant, Cutler-Hammer, General Electric, Gould I-T-E, Square D, Westinghouse, or equal.

2.8 CIRCUIT BREAKERS, INDIVIDUAL, 600 VOLTS AND LESS

- A. **Mount individual circuit breakers in NEMA 12 enclosure for general purpose dry locations, unless otherwise indicated. Provide NEMA 4X, 316 stainless steel raintight enclosures for circuit breakers mounted in wet and corrosive locations.** ~~Mount individual circuit breakers in NEMA 12, industrial use enclosure unless otherwise indicated. Provide NEMA 4X, 316 stainless steel raintight enclosures for circuit breakers mounted outdoors and wherever the subscript WP is indicated on the Drawings.~~ Provide circuit breakers with handles that can be locked in the OFF position. Interlock enclosure and circuit breaker to prevent opening the cover with the circuit breaker in the ON position. Provide quick-make, quick-break, thermal magnetic circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the operating handle. Do not use single-pole circuit breakers with handle ties where multipole circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB 1 and having a minimum interrupting rating of 65,000 amps rms symmetrical at 480 volts. Provide circuit breakers with terminals suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

2.9 FUSED SWITCHES, INDIVIDUAL, 600 VOLTS AND LESS

- A. **Mount individual fused switches in NEMA 12 enclosure for general purpose dry locations, unless otherwise indicated. Provide NEMA 4X, 316 stainless steel raintight enclosures for circuit breakers mounted in wet and corrosive locations.** ~~Mount individual fused switches in NEMA 12, industrial use enclosures unless otherwise indicated. Provide NEMA 4X, 316 stainless steel raintight enclosures for fused switches mounted outdoors and wherever the subscript WP is indicated on the Drawings.~~ Provide fused switches that can be locked in the OFF position. Interlock enclosure and switch to prevent opening the cover with the switch in the ON position. Provide fused switches, which are quick-make, quick-break, motor rated, load-break, heavy-duty (HD)

type having external marking clearly indicating ON and OFF positions. Provide fuses of the current ratings indicated and types specified herein. Utilize fuse mountings that reject Class H fuses and will accept only the current-limiting fuses specified. Provide fused switches meeting the requirements of NEMA KS 1 and UL listed for application to a system having an available short circuit current 65,000 amps rms symmetrical. Provide switches with terminals suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

2.10 NONFUSED SWITCHES, INDIVIDUAL, 600 VOLTS AND LESS

- A. **Mount individual disconnect switches in NEMA 12 enclosure for general purpose dry locations, unless otherwise indicated. Provide NEMA 4X, 316 stainless steel raintight enclosures for circuit breakers mounted in wet and corrosive locations.** ~~Mount individual disconnect switches in NEMA 12, industrial use enclosure unless otherwise indicated. Provide NEMA 4X, Type 316 stainless steel rain tight enclosure for switches mounted outdoors and wherever the subscript WP is indicated on the Drawings.~~ Provide switches that can be locked in the OFF position. Interlock enclosure and switches to prevent opening the cover with the switch in the ON position. In addition, each disconnect switch at a motorized actuator shall include two auxiliary (interlock) contacts (1 NO and 1 NC) for control power interruption, rated for 120 VAC, 5 A minimum. Provide switches, which are quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type having external marking clearly indicating ON and OFF positions. Furnish switches meeting the requirements of NEMA KS 1. Provide switches with terminals suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

2.11 FUSES, 600 VOLTS AND LESS

- A. Provide a complete set of current-limiting fuses wherever fuses are indicated. Provide a listing of quantities of each type and each current rating installed. Utilize fuses that fit mountings specified with switches and which provide features rejecting Class H fuses. Provide the following types:
1. For motor and transformer circuits, 600 volts and less, 0 to 600 amps, UL Class RK-1 with time delay, Bussmann Type LPS-RK, Shawmut Type A6D-R, or equal.
 2. For motor and transformer circuits, 250 volts and less, 0 to 600 amps, UL Class RK-1 with time delay, Bussmann Type LPN-RK, Shawmut Type A2D-R, or equal.
 3. For feeder and service circuits, 600 volts and less, 0 to 600 amps, UL Class RK-1, Bussmann Type KTS-R, Shawmut Type A6K-R, or equal.
 4. For feeder and service circuits, 250 volts and less, 0 to 600 amps, UL Class RK-1, Bussmann Type KTN-R, Shawmut Type A2K-R, or equal.
 5. For feeder and service circuits, 600 volts and less, 601 to 6,000 amps, UL Class L, Bussmann Type KRP-C, Shawmut Type A4BY, or equal.

2.12 LOCAL CONTROL STATIONS, PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

- A. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and local control stations, provide heavy-duty, oil tight type pushbuttons, indicating lights, selector switches, and local control station enclosures for these devices. Utilize General Electric Type CR 104P, or equivalent by Square D, Cutler-Hammer, or equal.

- B. **For nonhazardous, wet and corrosive locations, or where otherwise indicated, provide heavy-duty corrosion-resistant, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4X 316 stainless steel watertight local control stations. Provide special gasketing required to make complete local control station watertight. Utilize Square D Type SK, or equivalent by General Electric, Cutler-Hammer, or equal.** ~~For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4X FRP (for corrosive environments) or 316 stainless steel (for noncorrosive environments) watertight local control stations, NEMA 4X non metallic in outdoor corrosive areas. Provide special gasketing required to make complete local control station watertight. Utilize Square D Type SK, or equivalent by General Electric, Cutler Hammer, or equal.~~
- C. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide pushbutton stations with laminated plastic nameplates indicating the drive they control and in accordance with Section 16075, Electrical ID Nameplates, Warning Signs. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated.
- D. Utilize selector switches having standard spring-return if so specified operating levers. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.
- E. **Red, green, amber, or yellow indicating lights shall be 120V, push-to-test LED-type, and shall be heavy-duty, oil-tight (NEMA 13) for enclosures in general purpose dry areas and corrosion resistant, and watertight (NEMA 4X) for enclosures in wet and corrosive areas.** ~~Red, green, amber, or yellow indicating lights shall be 120V, push to test LED type, and shall be heavy-duty, oil-tight (NEMA 13) for indoor enclosures and corrosion resistant, and water tight (NEMA 4X) for outdoor enclosures.~~ Other colored indicating lights shall be 120V, push-to-test transformer-type, and shall be heavy-duty, oil-tight (NEMA 13) for indoor enclosures and corrosion resistant, and water tight (NEMA 4X) for outdoor enclosures. Each shall be nickel-plated with a screwed-on glass prismatic lens approximately one-inch in diameter. Each light shall have a factory-engraved legend plate, as shown on the Drawings. Indicating lights shall be General Electric Type CR104, Square D Class 9001 Type SK and K, Allen-Bradley 800T and 800H series, or equal.
- F. Control Stations: Pushbuttons, selector switches and pilot lights shall be heavy duty, oiltight/watertight devices installed in NEMA 4X enclosures, MCCs and control panels. These devices shall be as manufactured by Allen-Bradley, Square D Company, General Electric or equal. "JOG / LOCKOUT-STOP" pushbutton stations shall be installed adjacent to each motor unless specifically indicated otherwise on the Contract Documents.
- G. Emergency stop pushbuttons shall have a large, red mushroom head, maintained contacts, push-to-stop, pull-to-reset, Allen-Bradley Bulletin 800T or equal.

2.13 TERMINAL BLOCKS 600 VOLTS AND LESS

- A. Provide 600-volts terminal blocks for termination of all control circuits entering or leaving equipment, panels, or boxes. Provide screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screw

constructed of high strength and high conductivity metal. Utilize yoke that guides all strands of wire into the terminal. Utilize current bar providing dependable vibration-proof connection. Supply terminals constructed to allow connection of wire without any special preparation other than stripping. Rail mount individual terminals to create a complete assembly and provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

- B. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Supply UL approved terminal blocks manufactured by Weidmuller, Ideal, Electrovert, or equal. Provide terminal blocks with 50 percent spare termination points for OWNER use following completion of installation.

2.14 CONTROL RELAYS

- A. Open frame industrial relays shall not be used unless a high ampacity requirement exists. Provide magnetic control relays with operating coils of the proper voltage rating as required by the control circuit, NEMA Class A300 (300 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control type with field convertible contacts, and meeting the requirements of NEMA ICS 2. Provide Cutler-Hammer Type M-300, General Electric Type CR120A, or equal. A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control type with field convertible contacts, and meeting the requirements of NEMA ICS 2.
- B. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with an electronic timer adjustable over the range specified on the Drawings.
- C. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing easy manual latching and unlatching.
- D. Intrinsically safe relays shall allow the use of any type of remote pilot device located in Class 1 (hazardous) locations by providing a pilot circuit incapable of releasing sufficient electrical energy to ignite gases or vapors classified in Groups A, B, C and D. The units shall have an output relay with double pole, double throw (DPDT) contacts rated at least 10 A at 120 VAC and 24 VDC, resistive load. They shall operate on the AC supply voltage indicated on the Contract Documents. The intrinsically safe relays shall be Cutler-Hammer BW Series or equal.

2.15 RESET TIMERS

- A. Provide synchronous-motor-driven reset timers with a solenoid-operated clutch and suitable for semiflush, panel mounting. Utilize timers with time range indicated and 10-amp, 120-volts contacts. Provide Eagle Signal Bulletin 125 timers, Automatic Timing and Controls Bulletin 305 timers, or equal.
- B. Timers that require pins or other removable trip devices shall be provided with at least one pin or trip device for each possible time setting.
 - 1. Reset timers and repeat cycle timers shall be heavy duty, industrial-type timers as manufactured by Eagle, Paragon, or equal.

2. Twenty-four hour timers shall be heavy duty, industrial-type timers as manufactured by Paragon, Tork, or equal.
3. Timing relays shall be Automatic Timing and Controls (ATC) Type 328A or equal.

2.16 MAGNETIC CONTACTORS

- A. Provide contactors of the NEMA sizes indicated. Mount contactors in NEMA 12, dust-tight, drip-tight, industrial use enclosures unless otherwise indicated. Utilize contactors manufactured and rated in accordance with NEMA ICS 2.

2.17 MAGNETIC LIGHTING CONTACTORS

- A. Provide mechanically held lighting contactors of the current ratings indicated. Mount contactors in NEMA 12, dust-tight, drip-tight, industrial use enclosures unless otherwise indicated. Provide coil-clearing contacts on mechanically-held units. Utilize contactors manufactured and rated in accordance with NEMA ICS 2.

2.18 AUTOMATIC TRANSFER SWITCHES

- A. Provide, where indicated, automatic load transfer switches with ratings as indicated on drawings. Provide switches automatically transferring from normal to alternate source on failure of the normal source.
- B. Provide switch control with adjustable 0- to 5 -minute timers to permit a delay on transfer after power failure, and to permit a 10 minute delay on retransfer following restoration of normal power. Cause transfer to alternate source to occur when any phase of the normal source drops below 80 - 85 percent of rated voltage and all phases of the alternate source are at least 95 percent of rated voltage. Cause retransfer to occur when all phases of the normal source have returned to at least 90 percent of rated voltage.
- C. Supply transfer switches which are mechanically held and electrically operated with operating current from the source to which load is being transferred. Supply switches constructed to prevent a neutral position and electrically and mechanically interlocked to prevent connection of the load simultaneously to both sources. Include a TEST/OFF/AUTOMATIC operation selector switch, the TEST position to simulate power failure, normal source two-position selector switch, RED/GREEN lights indicating alternate and normal switch position, and one normally open and one normally closed 5-amp, 120-volt, auxiliary contact for future remote indication of transfer.
- D. Provide switch housed in a wall mounted NEMA 12 enclosure with lockable hinged front cover. Supply transfer switches with terminals suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity. Enclosure material shall comply with Article 2.2 OUTLET AND DEVICE BOXES of this specification.
- E. Acceptable manufacturers are ASCO, Russell Electric, Inc., or equal.

2.19 MANUAL TRANSFER SWITCHES

- A. Provide, where indicated, manual double-throw safety switches with ratings as indicated on drawings. The withstand rating shall be 65,000 Amp.

- B. Provide switch housed in a wall mounted NEMA 12 enclosure with lockable hinged front cover. Supply transfer switches with terminals suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
- C. Acceptable manufacturers are General Electric, Square D, Cutler Hammer, or equal.

2.20 DRY TYPE SMALL POWER TRANSFORMERS (600-VOLTS AND LESS PRIMARY)

- A. Provide self-cooled, two-winding, dry type transformers of the ratings indicated and built in accordance with the latest IEEE, ANSI, and NEMA standards. Utilize units with manufacturer's standard insulation class and not to exceed 115 degrees C temperature rise. For ratings 3 to 25 kVA single-phase and 3 to 15 kVA 3-phase, provide units with core and coils completely enclosed in a nonventilated, NEMA 3R weatherproof enclosure. Utilize encapsulated windings on single-phase units 0 to 25 kVA. On all transformers 15 kVA and larger provide units with at least four, 2-1/2 percent, full capacity voltage taps; two above and two below normal voltage rating. On units 75 kVA and larger, provide an impedance of 4.5 percent minimum.
- B. Supply units where sound levels determined by tests in accordance with NEMA and ANSI standards do not exceed:
 - 1. 40 decibels for 0 to 9 kVA
 - 2. 45 decibels for 10 to 50 kVA
 - 3. 50 decibels for 51 to 150 kVA
 - 4. 55 decibels for 151 to 300 kVA
 - 5. 60 decibels for 301 to 500 kVA
- C. For transformers 30 kVA and larger, equip units with integral vibration isolators completely isolating the core and coil assembly from the transformer enclosure. For smaller transformers, provide integral vibration isolators or install external vibration isolators which isolate the entire unit from the structure on which it is mounted. Utilize only integral or external vibration isolators, which are rated for the weight of the transformer and provide 99 percent isolation efficiency at the fundamental frequency of sound emitted by the transformer.
- D. Acceptable manufacturers: General Electric, Square D, Cutler-Hammer, or equal.

2.21 DRY TYPE, SHIELDED, ISOLATION TRANSFORMERS (600-VOLTS AND LESS PRIMARY)

- A. General: Supply dry type transformers providing electrical isolation and noise suppression between the electrical supply system and the critical load. Supply transformers of the ratings and connections indicated, built in accordance with current IEEE, ANSI, NEMA, and UL standards in a general purpose indoor enclosure. Provide units having 2-1/2 percent full capacity primary winding taps, above and below rated voltage. Provide units with a minimum 80 degrees C and maximum 150 degrees C temperature rise above ambient.

B. Isolation and Noise Suppress:

1. Provide units including core and coils having two foil type electrostatic shields, one located between the primary and secondary windings, and the other located between the core and the secondary winding. Provide a ground lead from each shield out into the unit enclosure.

2. Supply isolation transformers with electrical noise attenuation and other characteristics as follows:

Common mode attenuation B: 146 dB

Transverse mode attenuation B: 40 dB

Impedance B: 4.4

Reactance Minimum 3 percent; Maximum 4.2

Regulation, no-load to percent full-load B: 1

Output distortion None added

3. Provide fused transient suppression as follows:

Peak transient current 30,000 amps (8 x 20 microsecond wave)

Maximum clamping voltage 360 volts at 1,000 amps

Pulse transient energy 420 joules

Response time <25 nano-seconds

4. Provide primary surge protection as follows:

Peak transient current 40,000 amps

10-microsecond rise time volts 2.9 kV

C. Additional Features Required:

1. Magnetic field strength around transformer shall be less than 0.1-gauss at 1-1/2-feet.
2. Two thermal switches located in the center cove "hot spot" to provide two-stage (high and high-high alarm) thermal sensing. Each switch rated 5 amps, 120 volts, and having one normally open and one normally closed contact.
3. Provide visual indicator to signal blown transient suppressor fuse.

- D. Acceptable manufacturer: Emergency Power Engineering, Square D, General Electric, or equal.

2.22 LOW VOLTAGE SURGE PROTECTIVE EQUIPMENT

- A. Provide secondary surge protective equipment consisting of a surge capacitor and surge arrester combination located where indicated on the Drawings. Utilize components for all surge protective equipment covered by this Specification, designed and tested in accordance with NEMA LA-1 and ANSI/IEEE C62.41.
- B. Provide a surge capacitor impregnated with non-pcb biodegradable dielectric fluid. Include an integral discharge resistor, which will drain the residual voltage to 50 volts crest in less than 5 minutes after the unit has been disconnected from the circuit.
- C. Provide an arrester consisting of an assembly of high strength metal oxide valve elements enclosed in a high strength, corrosion-resistant, molded resin housing.
- D. Provide a capacitor and arrester having a mounting nipple, flat washer, and nut suitable for knockout mounting. Install capacitors and arrestors in NEMA 4X (stainless steel) enclosures.

2.23 PENETRATION SEALING SYSTEMS (FIRE STOPS)

- A. Provide sealing systems for conduits and cablebus penetrating through walls meeting UL Standard 1479 (Fire Tests of Through-Penetration Fire Stops) and the requirements of ASTM E-814 (Fire Tests of through-Penetration Fire Stops). Sealing systems are required to be installed regardless of whether or not the walls through which penetrations are being made are fire rated.

2.24 ENCLOSURE PAINT AND FINISH

- A. **Refer to SPECIFICATIONS, COATING SYSTEMS SECTION 09900 for painting and coating requirements**~~All metallic enclosures, except for stainless steel, shall be finished with a prime coat of rust inhibitor and painted as per ANSI No. 61 or as per the ENGINEER'S instructions.~~

PART 3 - EXECUTION

3.1 OUTLET AND DEVICE BOXES

A. Installation:

1. Mount boxes at the following heights unless otherwise required by the Americans with Disabilities Act (heights are to the centerline of the box):

Wall switches	48-inches above floor
Thermostats	48-inches above floor
Wall telephone outlets	6-inches above counter tops; 12-inches above floor
Wall mounted telephone	52-inches above floor outlets for public pay telephone, 52-inches above floor for standard wall telephone

Office, Lab Receptacles: Flush device plate bottom or side with top of the splashback on use areas, halls, etc. or 6-inches above counter tops without splashback; 12-inches above floor unless otherwise indicated.

- a. Where above heights do not suit the building construction or finish, locate boxes where directed by the ENGINEER.
- b. Locations indicated are approximate. Study the Drawings in relation to spaces and equipment surrounding each outlet. When necessary, with the approval of the ENGINEER, relocate outlets to avoid interference with mechanical equipment or structural features. Locate all light switches on lock side of doors. Locate all light fixture outlets in a symmetrical pattern according to the room layout unless otherwise indicated.
- c. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits. Make edges of boxes flush with finished surface. Provide proper type extension rings or plaster covers for this purpose. For flush mounted boxes, make holes in the surrounding surface no larger than required to receive the box.
- d. Install boxes in a secure, substantial manner supported independently of conduit by attachment to the building structure or a structural member. Fasten boxes with bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded, threaded studs on steelwork. No power accuated tools are permissible. Threaded studs driven in by a powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields. Boxes embedded in concrete or masonry need not be additionally supported. **Utilize 316 stainless steel mounting hardware in wet and corrosive areas** ~~Utilize galvanized mounting hardware in industrial areas.~~
- e. Provide flush or recessed lighting fixtures with separate junction boxes when required by the fixture terminal temperature. Where boxes support fixtures, provide proper means of attachment with adequate strength.
- f. Open no more knockouts in sheet steel boxes than are actually required. Seal any used openings in any type box.

3.2 JUNCTION AND PULL BOXES

- A. Where indicated on the Drawings, and where necessary to terminate, tap-off, or redirect multiple conduit runs, provide and install appropriately designed junction boxes. Furnish and install pull boxes where necessary in the raceway system to facilitate conductor installation. Provide pull boxes to limit conduit runs to less than 150-feet and to contain no more than the equivalent of three right-angle bends unless accepted by the ENGINEER.
 1. Types to be provided:
 - a. Use boxes of the types listed for specific locations under article 2.2, OUTLET AND DEVICE BOXES.
 - b. Use outlet boxes as junction boxes and pull boxes wherever possible and allowed by applicable codes.

- c. Provide stainless steel (NEMA 4X) boxes for belowgrade conduit. Provide Stainless steel (NEMA 4X) boxes for abovegrade locations.

2. Installation:

- a. Make all boxes accessible. Do not install boxes in finished areas unless accepted by the ENGINEER. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits. Make edges of recessed boxes flush with the final surface.
- b. Mount boxes in a secure, substantial manner, supported independently of conduit by attachment to the building structure or a structural member. Fasten boxes with bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork. Threaded studs provided with lock washers and nuts as provided with Redhead or Hilti Kwik-bolt concrete anchors, **or equal**. Hilti HIT adhesive anchors, **or equal** may be used for bolt sizes 3/8" and smaller are acceptable in lieu of expansion shields. Boxes embedded in concrete or masonry need not be additionally supported. No Powder-charged tools are allowed. Utilize 316 stainless steel mounting hardware in industrial areas.
- c. Install boxes for conduits under grade flush with finished grade in locations outside of paved areas, roadways, or walkways.
- d. If adjacent structure is available, the box may be mounted on the structure surface just above finished grade in accessible but unobtrusive location. If it is found desirable to locate boxes in paved areas, roadways, or walkways, obtain ENGINEER's written approval and utilize boxes and covers suitable for the weights to which they may be subjected.

3.3 TERMINAL JUNCTION BOXES (TJB)

- A. Install in accordance with all the requirements detailed under article 3.2, JUNCTION AND PULL BOXES above. Label each block and terminal with a permanently attached, non-destructible tag.

3.4 TELEPHONE TERMINAL CABINETS

- A. Install telephone terminal cabinets where indicated so top of the cabinet is approximately 6-feet above the floor. Mount cabinet where door can open at least 120 degrees and far enough to give full access to the insides.

3.5 WIRING DEVICES

- A. Switches: Mount switches at the heights indicated under article 3.1, OUTLET AND DEVICE BOXES. Mount switches for switch operation in the vertical position.
- B. Receptacles: Mount receptacles at heights indicated under article 3.1, OUTLET AND DEVICE BOXES. Mount receptacles with grounding slot down except where horizontal mounting is indicated, in which case mount with neutral slot up. Ground receptacles to boxes with grounding wire, not by yoke or screw contact. Mount weatherproof receptacles with the hinge for the protective cover above (not at side, or below) the receptacle opening.

1. Special Purpose Receptacles: Locate special purpose receptacles where shown. Install and mount the receptacles in accordance with the manufacturer's instructions and the applicable codes.
- C. Multioutlet Surface Raceway System: Locate multi-outlet surface raceway systems where shown and install in accordance with the manufacturer's instructions.
- D. Telephone Outlets: Mount outlets at the heights indicated under article 3.1, OUTLET AND DEVICE BOXES. Mount outlets in the vertical position unless otherwise indicated.
- E. Device Plates:
 1. Installation: Securely fasten device plates to switch or receptacle boxes or the wiring device contained therein. Install device plates used with flush mounted boxes with all four edges in continuous contact with the finished wall surfaces without the use of mats or similar materials. Plaster fillings shall not be acceptable. Install device plates vertically or horizontally with an alignment tolerance of 1/16-inch. Do not use sectional type device plates.

3.6 LIGHTING AND DISTRIBUTION PANELBOARDS

- A. Mount panelboards securely where indicated, plumb, in-line, and square with walls. Unless otherwise indicated, mount panelboard with top of its cabinet approximately 6-feet above the floor. Provide a typewritten circuit directory under a metal-framed transparent plastic cover inside each panelboard. Provide an engraved, laminated plastic nameplate on the outside of the panelboard showing the panelboard designation, voltage, and phases.

3.7 DRY TYPE TRANSFORMERS (600-VOLTS AND LESS PRIMARY)

- A. Mount transformers approximately where indicated. Load any vibration isolators external to the unit properly and provide complete isolation with no direct transformer unit metal in contact with the mounting surface. Connect electrical circuits to transformers by means of moisture proof, flexible conduit in a manner that prevents transformer vibrations from being transmitted to the building or other equipment.
- B. Ground neutrals and enclosures of all transformers and all moisture proof flexible conduits in accordance with applicable codes and as otherwise may be indicated. Connect voltage taps on all transformers to give as close as possible to rated output voltage under normal plant load conditions.

3.8 DRY TYPE, SHIELDED, ISOLATION TRANSFORMERS (600-VOLTS AND LESS PRIMARY)

- A. Follow instructions for DRY TYPE TRANSFORMERS (600-VOLTS AND LESS PRIMARY) above. In addition, ground isolation shields to the unit enclosure with a conductor of the same material, and at least as big, as the shield ground lead provided with the unit.

3.9 LOW VOLTAGE SURGE PROTECTIVE EQUIPMENT

- A. TVSS devices shall be installed at the following low voltage locations:

1. At 480V switchgear line-ups that are being supplied directly from an outside source, e.g. from a 12-KV to 480-V transformer or from a long feeder from a separate building.
2. At all 480V motor control centers.
3. At the 120V panelboards closest to where sensitive 120V equipment is connected. These TVSS devices are intended to protect against building internal surges and shall be installed regardless of and in addition to the TVSS devices installed at 480V buses upstream.
4. The exact connection point of the TVSS devices within the distribution line-up shall be in accordance with the latest edition of NEC.

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