

SECTION 26 20 05

ELECTRICAL DISTRIBUTION EQUIPMENT

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PART 1 GENERAL

1.1 EQUIPMENT DESCRIPTIONS

- A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install equipment as listed below:
1. Dry-Type Low-Voltage Distribution Transformers.
 2. Switchboards.
 3. Panelboards.
 4. Low-Voltage Receptacles.
 5. Snap Switches.
 6. Disconnect Switches.
 7. Enclosed Circuit Breakers.
 8. Surge Protective Devices.

1.2 REFERENCES

- A. Dry-Type Low-Voltage Distribution Transformers standards referenced are:
 - 1. NEMA ST-20, Dry Type Transformers for General Applications.
 - 2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
 - 3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
 - 4. UL 1561, Dry Type General Purpose and Power Transformers.

- B. Switchboards standards referenced are:
 - 1. NEMA PB2, Dead-Front Distribution Switchboards.
 - 2. UL 891, Dead-Front Switchboards.

- C. Panelboards standards referenced are:
 - 1. NEMA PB 1, Panelboards.
 - 2. UL 67, Panelboards.

- D. Low-Voltage Receptacles standards referenced are:
 - 1. UL 498, Standard for Attachment Plugs and Receptacles.
 - 2. UL 514D, Cover Plates for Flush-Mounted Wiring Devices.
 - 3. UL 943, Standard for Ground-Fault Circuit-Interrupters.
 - 4. UL 1449, Standard for Surge Protective Devices.

- E. Snap Switches standards referenced are:
 - 1. UL 20, General Use Snap Switches.

- F. Disconnect Switches Standards referenced are:
 - 1. UL 98, Enclosed and Dead-Front Switches.
 - 2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

- G. Enclosed Circuit Breaker Standards referenced in this Section are:
 - 1. NFPA 70, National Electrical Code.
 - 2. NEMA AB 1, Molded-case Circuit Breakers
 - 3. UL 50, Enclosures for Electrical Equipment
 - 4. UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
 - 5. UL 489, Molded-case Circuit Breakers

- H. Surge Protective Devices Standards referenced are:
 - 1. ANSI/UL 1449, Surge Protective Devices.
 - 2. IEEE C62.11, Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)
 - 3. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
 - 4. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
 - 5. UL 1283, Electromagnetic Interference Filters.

1.3 QUALITY ASSURANCE

- A. Dry-Type Low-Voltage Distribution Transformers Regulatory Requirements:
 - 1. NEC Article 450, Transformers.
- B. Switchboards Qualifications:
 - 1. Manufacturer: Shall have not less than five years' experience manufacturing and servicing materials and equipment substantially similar to those required and upon request shall submit documentation of not less than five installations in satisfactory operation for at least five years each.
 - 2. Manufacturer shall manufacture circuit protective devices within the assembly.
- C. Switchboards Component Supply and Compatibility:
 - 1. Obtain all materials and equipment included in this Section regardless of component manufacturer from a single switchboard manufacturer.
 - 2. Switchboard manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by switchboard manufacturer.
- D. Switchboards Regulatory Requirements: Comply with the following:
 - 1. NEC Article 408, Switchboards and Panelboards.
- E. Panelboards Regulatory Requirements; Comply with the following:
 - 1. NEC Article 408, Switchboards and Panelboards.
- F. Low-Voltage Receptacles Regulatory Requirements: Comply with the following:
 - 1. Americans with Disabilities Act.
 - 2. NEC Article 406, Receptacles, Cord Connectors, and Attachment Plugs (Caps).
- G. Snap Switches Regulatory Requirements
 - 1. Americans with Disabilities Act
- H. Disconnect Switches Regulatory Requirements:
 - 1. NEC Article 404, Switches.
 - 2. Disconnect switches shall bear the UL label.
- I. Enclosed Circuit Breaker Qualifications:
 - 1. Manufacturer: Manufacturer shall have not less than five years of experience producing substantially similar equipment to that required and, upon request, shall submit documentation of not less than five installations in satisfactory operation for not less than five years in the United States.
- J. Surge Protective Devices Qualifications:
 - 1. Manufacturer: Shall have at least five years' experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
- K. Surge Protective Devices Component Supply and Compatibility:
 - 1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.

2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.
- L. Surge Protective Devices Regulatory Requirements: Comply with the following:
1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
 2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.4 SUBMITTALS

- A. Dry-Type Low-Voltage Distribution Transformers Action Submittals:
1. Shop Drawings: Schedule of transformers to be furnished with ratings and other required technical data.
 2. Product Data: Supplier's technical information for transformers proposed for use.
- B. Switchboards Action Submittals:
1. Shop Drawings:
 - a. Three-line diagrams.
 - b. Dimensional information including front view elevation and plan view.
 - c. Construction details of enclosures with conduit entry locations and connection details between assemblies.
 - d. Components list and nameplate schedule.
 - e. Summary sheets with schedules of equipment.
 2. Product Data:
 - a. Manufacturer's technical information, including catalog information.
 - b. Manufacturer's technical specifications with assembly and component ratings.
 - c. Time current curves for protective devices.
- C. Switchboards Informational Submittals:
1. Certificates:
 - a. Certifications required in this Section, including seismic requirements.
 2. Source Quality Control Submittals:
 - a. Report of results of testing and inspections performed at manufacturer's shop.
 3. Site Quality Control Submittals:
 - a. Report of results of field testing.
 4. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 5. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- D. Switchboards Closeout Submittals:
1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 33 00 – Submittals and Section 01 70 00 - Execution and Closeout Requirements.
 - b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

- c. Include record drawings of control schematics, with point-to-point wiring diagrams.
- E. Panelboards Action Submittals:
 - 1. Shop Drawings: Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.
 - 2. Product Data: Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.
- F. Low-Voltage Receptacles Action Submittals:
 - 1. Product Data: Manufacturer's technical information for receptacles and cover plates proposed for use.
- G. Snap Switches Action Submittals:
 - 1. Product Data: Manufacturer's technical information for switches proposed for use.
- H. Disconnect Switches Action Submittals:
 - 1. Shop Drawings:
 - a. Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
 - 2. Product Data:
 - a. Manufacturer's technical information for disconnect switches proposed for use.
- I. Disconnect Switches Maintenance Material Submittals:
 - 1. Extra Stock Materials:
 - a. Furnish one set of spare fuses for each fused disconnect switch to be installed.
- J. Enclosed Circuit Breaker Action Submittals:
 - 1. Shop Drawings:
 - a. Outline drawings with dimensions, materials of construction, installation details, accessories, and equipment ratings for voltage, amperage and short-circuit.
 - 2. Product Data:
 - a. Manufacturer's technical information for enclosed circuit breakers proposed for use.
- K. Enclosed Circuit Breaker Informational Submittals:
 - 1. Source Quality Control Submittals:
 - a. Perform standard factory tests on equipment furnished under this Section. Tests shall be in accordance with applicable NEMA and UL standards. Submit results of required source quality control tests and inspections.
 - 2. Site Quality Control Submittals:
 - a. Results of required field quality control tests and inspections.
 - 3. Qualifications Statements:
 - a. Submit manufacturer qualifications when requested by Engineer.
- L. Enclosed Circuit Breaker Closeout Submittals:

1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, and description of operation.
 - b. Recommended Spare Parts and Extra Stock Materials: Include list of additional spare parts or extra stock materials recommended for use with enclosed molded-case circuit breakers. Describe each recommended part, quantity recommended, current unit price, and ordering information.
 - c. Comply with Section 01 70 00 - Execution and Closeout Requirements.

- M. Surge Protective Devices Action Submittals:
 1. Shop Drawings:
 - a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
 - b. Components list and nameplate schedule.
 - c. Summary sheets with schedules of equipment.
 2. Product Data:
 - a. Manufacturer's technical information, including catalog information.
 - b. Manufacturer's technical specifications with assembly and component ratings.

- N. Surge Protective Devices Informational Submittals:
 1. Certifications:
 - a. Certification that SPD devices comply with standards referenced in this Section.
 2. Source Quality Control Submittals:
 - a. Report of results of testing and inspections performed at manufacturer's shop.
 3. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 4. Qualifications Statements:
 - a. Manufacture, when requested by Engineer.

- O. Surge Protective Devices Closeout Submittals:
 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 33 00 – Submittals and Section 01 70 00 - Execution and Closeout Requirements.
 - b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
 2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by Engineer in the operations and maintenance manual for the equipment.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Switchboards
 1. Delivery: Upon delivery, check for evidence of water that may have entered equipment during transit.

2. Handle equipment in accordance with manufacturer's instructions. One copy of these instructions shall be furnished with equipment at time of delivery.
 3. Storage: Store switchboards equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
- B. Panelboards Packing, Shipping, Handling, and Unloading:
1. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.
 - c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
 2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon deliver, check materials and equipment for evidence of water that may have entered equipment during transit.
 3. Comply with Section 01 60 00 - Product Requirements.
- C. Panelboards Storage and Protection:
1. Store panelboards in a clean, dry location. Protect equipment with coverings.
 2. Comply with Section 01 60 00 - Product Requirements.
- D. Surge Protective Devices delivery, storage, and handling.
1. Delivery: Upon delivery, check for evidence of water that may have entered equipment during transit.
 2. Storage:
 - a. Store SPD equipment in a clean, dry location. Protect equipment with coverings.
 - b. Protect equipment from corrosion and deterioration.

1.6 SURGE PROTECTIVE DEVICES WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Materials and Equipment:
1. Provide manufacturer's written warranty, running to the benefit of Owner, agreeing to correct, or at option of Owner, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

PART 2 PRODUCTS

2.1 DRY-TYPE LOW-VOLTAGE DISTRIBUTION TRANSFORMERS MATERIALS

A. Dry Type Two-Winding Transformer:

1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
6. Basic impulse level shall be 10 kV.
7. Sound Level: NEMA ST-20 standard.
8. Enclosure: UL listed for the application.
 - a. Indoors in prefabricated FRP enclosures: NEMA 4X, 316 stainless steel.
 - b. Indoors in prefabricated, precast concrete enclosures: NEMA 1 when HVAC is provided for the enclosure and approved by CFPUA and recommended by the Engineer. Otherwise, enclosure shall be NEMA 4X, 316 stainless steel.
 - c. Outdoors: NEMA 3R painted stainless steel or NEMA 4X, 316 stainless steel.
9. Identification: Identify transformers in accordance with Section 26 05 02, Basic Electrical Work, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Manufacturers: Provide products of one of the following:

1. Cutler-Hammer.
2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Or equal.

2.2 SWITCHBOARDS MATERIALS

A. Manufacturers: Provide equipment of one of the following:

1. Eaton/Cutler-Hammer.

2. General Electric.
 3. Schneider Electric/Square D Company.
 4. Or equal.
- B. Ratings:
1. Switchboard shall be 600-volt class, suitable for operation on three-phase, 60-Hertz system.
 2. System operating voltage, number of wires, bus ampacity, and short circuit withstand capability and interrupting rating shall be as shown on the Drawings, or as otherwise indicated in the Contract Documents.
- C. General:
1. Switchboards shall be dead-front type with individual and group-mounted devices, front-accessible.
 2. Arrange switchboards with number of sections and compartments required for distribution arrangement shown.
 3. Provide switchboard in accordance with the arrangement shown on the Drawings. Switchboard shall consist of bus system, structure, circuit breakers, metering, and enclosure.
 4. Switchboards shall be in accordance with NEMA PB2, UL 891, and NEC Article 408.
 5. Where configured with a main service disconnect, switchboard shall be service entrance type and UL-labeled as such. Equip service entrance switchboards with bonding jumper to bond enclosure and ground bus to the neutral bus, and a barrier to isolate service bus bars and terminals.
- D. Bus Bars:
1. Switchboard bus bars shall be tin-plated copper, supported with high-impact, non-tracking insulating material. Secure bus joints with Belleville type washers, and braced bus joints for mechanical forces exerted during short circuit conditions. Mount main horizontal bus bars with all three phases arranged in the same vertical plane.
 2. Bus bar sizes shall be based upon a maximum temperature rise of 65 degrees C over a 40-degree C ambient in accordance with NEMA PB2 and UL 891.
 3. Provide copper ground bus, minimum size of 1/4-inch by two inches, secured to each vertical section and extending entire length of equipment. Ground bus current capacity shall equal one-half the capacity of main power bus.
 4. Conductor hardware shall be high-tensile strength and zinc-plated. Provide bus joints with conical spring-type washers.
- E. Structure:
1. Equipment structure shall be completely self-supporting and shall include required number of vertical sections bolted together to form a single metal-enclosed enclosure.
 2. Enclosures:
 - a. Indoors in prefabricated FRP enclosures: NEMA 4X, 316 stainless steel.
 - b. Indoors in prefabricated, precast concrete enclosures:
 - 1) When HVAC is provided for the enclosure and where approved of by CFPUA and recommended by the Engineer: NEMA 12. Exterior and interior steel surfaces of switchboard shall be properly cleaned and

provided with rust-inhibiting phosphatized coating by switchboard manufacturer. Color and finish of switchboard shall be light gray.

- 2) Otherwise, enclosure shall be NEMA 4X, 316 stainless steel.
- c. Outdoors: NEMA 4X, 316 stainless steel.
3. Enclosure structure frame shall be die-formed, 12-gauge steel bolted together and reinforced.
4. Equipment shall have identifying nameplates in accordance with Section 26 05 02 - Basic Electrical Work. Provide nameplates for each circuit breaker circuit and provide typewritten directory of circuits.
5. Cover sides and rear of enclosure with removable, bolt-on covers. Edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within enclosure.
6. Sections of switchboard shall be front- and rear-aligned with depth as shown on the Drawings. Devices shall be front-removable and load connections shall be front-accessible.
7. Provide assembly with adequate lifting means so that assembly is capable of being moved to its installation position.
8. Conduit entry and exit shall be bottom entry and coordinated by Contractor.

F. Wiring/Terminations:

1. Provide small wiring, necessary fuse blocks, and terminal blocks in switchboard as required. Control components mounted in assembly, such as fuse blocks, relays, pushbuttons, switches, and other components, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Provide mechanical-type terminals for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of size indicated on the Drawings.
3. Provide lugs in incoming line section for connection of main grounding conductor. Provide additional lugs for connection of other grounding conductors as indicated on Drawings.
4. Control wire shall be Type SIS, bundled and secured with nylon ties. Provide insulated locking spade terminals for all control connections, except where saddle type terminals are provided integral to a device. Current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to another device. Provide groups of control wires leaving switchboard with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

G. Miscellaneous Devices:

1. Provide control power transformers with primary and secondary protection, as indicated on the Drawings or as required for proper operation of equipment.

2.3 SWITCHBOARDS SOURCE QUALITY CONTROL

A. Tests:

1. Factory-test switchboards in accordance with NEMA PB2 and UL 891
2. Perform factory tests on equipment prior to shipment. Tests shall consist of the manufacturer's standard tests, and shall include:
 - a. Physical inspection and checking of all components.

- b. Operation and device function tests under simulated service conditions to verify accuracy of wiring and functioning of all equipment.
- c. Primary, control, and secondary wiring hi-pot tests.

2.4 SWITCHBOARD CIRCUIT BREAKERS MATERIALS

- A. Circuit breakers shall be molded case type with quantity of poles, voltage, and current ratings shown.
- B. Circuit breakers shall be manually-operated thermal magnetic type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by arc chutes.
- C. Circuit breakers shall be operated by a toggle-type handle and shall have quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of circuit breakers shall be clearly indicated by handle position.
- D. Where shown or required due to capacity, circuit breakers shall be insulated case type. Insulated case circuit breakers shall be manually-operated with stored energy mechanisms. Circuit breakers shall include open-close pushbuttons, five-cycle close time, and rotary operated stored energy handle mechanism providing quick make/quick-break protection.
- E. Circuit breakers shall have 100-amp frames, minimum. Provide overload protection on all poles, with trip settings as shown. Circuit breakers with frame sizes 250 amps and below shall have thermal-magnetic trip units and inverse time-current characteristics, or equal.
- F. Provide circuit breakers 400-amp frame and larger with an electronic solid state programmable trip unit. For four-wire power systems and circuits, provide a neutral current transformer, and trip unit shall be suitable to accept neutral input. Provide push-to-trip button on front of circuit breaker to provide local manual means of exercising trip mechanism. Electronic trip system shall include:
 - 1. Plug-in protection programmer, flux shift trip device, and current sensor package. Construct programmer, sensor, and flux-shifting trip device as integral elements of circuit breaker, requiring no externally mounted assemblies for proper operation.
 - 2. Solid state, microprocessor-based, nine-function programmer shall provide true RMS current sensing and include adjustable continuous and instantaneous current elements with adjustable long time, short time, zero sequence ground fault pickup and delay and zone selective interlocking. Main, tie and feeder circuit breakers shall be connected for zone selective interlocking to allow instantaneous bus protection.
- G. Where shown, provide circuit breakers with shunt trips, bell alarms, and auxiliary devices.

2.5 MAIN METER DEVICE MATERIALS

- A. Provide main meter device as shown on the Drawings, and in accordance with the following.

1. Type 1 Microprocessor-based Monitoring Device:
 - a. Device shall provide complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
 - b. Mount device on compartment door to allow personnel access to meter menu and display.
 - c. Device shall include trend analysis, event logging, and recording. Device shall include the following direct reading metered values:
 - 1) Volts: 0.2 percent accuracy
 - 2) Amperes: 0.2 percent accuracy
 - 3) Watts, Vars, and VA: 0.5 percent accuracy
 - 4) Power Factor: 1.0 percent accuracy
 - 5) Frequency: 0.05 percent accuracy
 - 6) Watts, and VA Hours: 0.5 percent accuracy
 - 7) Var Hours: 1.0 percent accuracy
 - 8) Watts, Var, and VA Demand: 0.4 percent accuracy
 - 9) THD-Voltage: 50th harmonic
 - 10) THD-Current: 50th harmonic
 - 11) Individual Ampere Harmonics: 50th harmonic
 - 12) Individual Voltage Harmonics: 50th harmonic
 - d. Metering device shall have the following additional features:
 - 1) Trend analysis that shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
 - 2) Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120. Three current transformers suitably rated shall be included.
 - 3) Alarm contacts rated five amps at 120 vac.
 - 4) Three analog outputs programmable to reflect the metered parameters, except kilowatt hours and kilovar hours.
 - 5) Communication capability, using RS-485, Modbus RTU Protocol or Ethernet as indicated on the Drawings

2.6 PANELBOARD MATERIALS

- A. Panelboards:
 1. Manufacturers: Provide products of one of the following:
 - a. General Electric Company.
 - b. Eaton/Cutler-Hammer.
 - c. Schneider Electric/Square D Company.
 - d. Or equal.
 2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
 3. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.
 4. Main: Panelboards shall have main circuit breaker unless the Drawings specifically indicate main lugs only.
 5. Connect branch circuit breakers for sequence phasing.
 6. Enclosures:
 - a. Indoors in prefabricated FRP enclosures: NEMA 4X, 316 stainless steel.

- b. Indoors in prefabricated, precast concrete enclosures: NEMA 1 when HVAC is provided for the enclosure and approved by CFPUA and recommended by the Engineer. Otherwise, enclosure shall be NEMA 4X, 316 stainless steel.
- c. Outdoors: NEMA 4X, 316 stainless steel.
- 7. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
- 8. Trim: Surface.
- 9. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
- 10. Identification: Identify panelboards in accordance with Section 26 05 02 - Basic Electrical Work. Identification shall indicate panel number and voltage.
- 11. Directory of Existing Panelboards: When adding or removing circuit breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.

B. Panelboard Circuit Breakers

- 1. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
- 2. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 14,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 10,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.

C. Integrated Panelboard and Transformer:

- 1. Products and Manufacturers: Provide products of one of the following:
 - a. Mini-Power Zone by Schneider Electric/Square D Company.
 - b. Mini-Power Center by Eaton/Cutler-Hammer.
 - c. Panel Tran by Acme Electric Corporation.
 - d. Or equal.
- 2. General: Unit shall consist of encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
- 3. Transformer Rating: Transformer portion shall comply with this Section, Dry-type Low-Voltage Distribution Transformers. KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown or indicated on the Drawings.
- 4. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown or indicated on the Drawings.
- 5. Enclosure: Enclosures shall be as required for the area classifications indicated in This Section, Dry-Type Low-Voltage Distribution Transformers Materials, unless otherwise indicated on the Drawings.

2.7 LOW-VOLTAGE RECEPTACLES MATERIALS

A. Receptacles:

- 1. Grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, brown color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5361I by Hubbell, Inc.

- b) 5361-I by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5362I by Hubbell, Inc.
 - b) PS5362-I by Pass & Seymour.
 - c) Or equal.
 - c. Weather-resistant Duplex:
 - 1) UL-listed as weather-resistant.
 - 2) Products and Manufacturers: Provide one of the following:
 - a) HBL5362IWR by Hubbell, Inc.
 - b) WR5362-I by Pass & Seymour.
 - c) Or equal.
 - 2. Grounding receptacle, two-pole, three-wire, 250-volt, 20 ampere, NEMA 6-20 configuration, brown color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5461 by Hubbell, Inc.
 - b) 5871 by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5462 by Hubbell, Inc.
 - b) 5862 by Pass & Seymour.
 - c) Or equal.
 - 3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide cast metal weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU” and provide where receptacles are located in wet or corrosive location.
 - 4. Receptacles shall comply with UL 498.
- B. Ground Fault Interrupting Receptacles:
 - 1. Duplex grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, 125-volt AC, 20 amperes, gray color with ground fault circuit interrupting (GFCI) protection.
 - 2. Ground fault interrupting receptacles shall comply with UL 943.
 - 3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide cast metal weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU”, and provide where located in wet or corrosive location.
 - 4. Products and Manufacturers: Provide one of the following:
 - a. GFR5362SGY by Hubbell, Inc.
 - b. 2091-GRY by Pass & Seymour.
 - c. Or equal.
 - 5. Weather-resistant Ground Fault Interrupting Receptacles
 - a. Products and Manufacturers: Provide one of the following:
 - 1) 2095TRWRGRY by Pass & Seymour.
 - 2) Or equal.
- C. Weatherproof-While-in-Use Covers:
 - 1. Where receptacles are shown on the Drawings as “WP” or “WPU”, and where receptacles are installed in wet locations as defined in area classification portion

- of Section 26 05 02 - Basic Electrical Work, provide receptacles as specified in this Section, as applicable, with weatherproof-while-in-use covers as specified below.
2. Provide covers that are UL-listed, weatherproof while receptacle is in use, and are of ultraviolet-resistant construction suitable for outdoor use in accordance with NEC 406.
 3. Material:
 - a. Cast aluminum box with cast aluminum cover.
 - b. Stainless steel screws and hardware.
 - c. Color: Gray finish
 4. Products and Manufacturers: Provide one of the following:
 - a. TayMac Corporation.
 - b. Red Dot
 - c. Or equal.
- D. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown or indicated. Coordinate with equipment plugs. Provide matching plug for each receptacle.

2.8 SNAP SWITCHES MATERIALS

- A. Switches for Non-Hazardous Locations:
1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Brown, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1221-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1991-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC1-I, by Pass & Seymour.
 - 4) Or equal.
 2. Single pole, three-way AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Brown, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1223-I, by Harvey Hubbell, Inc.
 - 2) Catalog No. 1993-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC3-I, by Pass & Seymour.
 - 4) Or equal.
 3. Two-pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Brown, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1222-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1992-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC2-I, by Pass & Seymour.
 - 4) Or equal.
 4. Switches in non-hazardous areas shall be UL-listed in accordance with UL 20.
- B. Switch Covers:
1. Indoor covers shall be Type 304 stainless steel.
 2. Outdoor, wet, or corrosive location covers shall be weatherproof and corrosion resistant cast aluminum.
- C. Key Operated On-Off Switches:

1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

2.9 DISCONNECT SWITCHES MATERIALS

- A. Manufacturers: Provide products of one of the following:
 1. Square-D Company.
 2. Cutler-Hammer.
 3. General Electric Company.
 4. Siemens.
 5. Or equal.
- B. Service Disconnect Switches:
 1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in "OFF" position and safety handle.
 2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
- C. Single Throw, Circuit Disconnect Switches:
 1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick- make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
- D. Double Throw Safety Switches:
 1. Type: Unfused, double throw with center "OFF" position, quick-make, quick-break mechanism, visible blades in the "OFF" position, and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for circuits being disconnected. Switches shall bear UL label and shall comply with UL 98, NEMA KS 1, and NEMA 250.
- E. Disconnect Switches for 120-volt, Single-phase Circuits:
 1. Refer to this Section, Snap Switches.
- F. Enclosures: NEMA rating shall be as required for area classifications specified in Section 26 05 02 – Basic Electrical Work, General Provisions for Electrical Systems.
- G. Identification:
 1. Identify enclosures in accordance with Section 26 05 02 - Basic Electrical Work, Identification for Electrical Systems.
 2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

2.10 ENCLOSED CIRCUIT BREAKER MATERIALS

- A. Manufacturer: Provide equipment by one of the following:
 1. Eaton Cutler Hammer
 2. General Electric

3. Siemens
 4. Square-D
 5. Or equal
- B. Type:
1. Breakers shall be molded-case with inverse time and instantaneous tripping characteristics.
 2. Circuit breakers shall be operated by toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip-free. Automatic tripping of circuit breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy with arc-extinction chutes.
 3. For frame sizes 225-ampere and above, provide with interchangeable trip unit.
 4. For frame sizes 150-ampere and below, provide with non-interchangeable trip.
 5. Terminations: Provide terminals for accommodating two normal-range copper cables per phase.
 6. Enclosed circuit breakers shall be UL-listed and bear the UL label, and shall comply with UL 489 and NEMA AB 1.
- C. Interrupting Capacities:
1. 400-ampere Frame and Above: Minimum 35,000 amperes RMS symmetrical at 480-volt, three-phase, 60 Hertz, or as shown.
 2. 100-ampere, 150-ampere, and 225-ampere Frame: Minimum 22,000 amperes RMS symmetrical at 480-volt, three-phase, 60 Hertz, or as shown.
- D. Enclosure:
1. Indoors in prefabricated FRP enclosures: NEMA 4X, 316 stainless steel.
 2. Indoors in prefabricated, precast concrete enclosures: NEMA 1 when HVAC is provided for the enclosure, and approved by CFPUA and recommended by the Engineer. Otherwise, enclosure shall be NEMA 4X, 316 stainless steel.
 3. Outdoors: NEMA 4X, 316 stainless steel.
 4. Access Door Interlock: Provide disconnect device to prevent unintentional opening of door while circuit breaker is energized and unintentional application of load power while door is open, with provisions for releasing interlock for intentional access or application of power by authorized personnel.
 5. External operating handle shall be integral part of the associated box, not the door. Operating handle shall have provisions for padlocking in the "OFF" position with door open or closed, and shall include prominent trip indication.
 6. Identification: Provide nameplate identification of circuit breaker in accordance with Section 26 05 02 - Basic Electrical Work, Identification for Electrical Systems. Identify load side equipment controlled and line side source.
 7. Enclosures shall be UL-listed and comply with UL 50 and UL 50E.

2.11 ENCLOSED CIRCUIT BREAKER SOURCE QUALITY CONTROL

- A. Tests:
1. Perform standard factory tests on equipment furnished under this Section. Tests shall be in accordance with applicable NEMA and UL standards.

2.12 SURGE PROTECTIVE DEVICES MATERIALS

- A. Manufacturers: Provide equipment of one of the following:
1. General Electric.
 2. Schneider Electric/Square-D Company.
 3. Eaton/Cutler-Hammer.
 4. Or equal.
- B. General:
1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.
 2. SPD shall comply with requirements of the following:
 - a. ANSI/UL 1449.
 - b. UL 1283.
 - c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.
 3. SPD shall be suitable for operation under the following environmental conditions:
 - a. Relative Humidity: Zero to 95 percent, non-condensing.
 - b. Frequency: 47 to 63 Hertz.
 - c. Temperature: Zero to 149 degrees F.
 4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
- C. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
1. Line-to-line.
 2. Line-to-neutral.
 3. Line-to-ground.
 4. Neutral-to-ground.
- D. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.
- E. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.
- F. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

- G. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA

B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.13 SURGE PROTECTIVE DEVICES ACCESSORIES

- A. Provide SPD equipped with the following accessories:
1. Surge counter with display for indicating the number of surges detected.
 2. LED indicators for monitoring device status.
 3. Dry contacts, "Form C", for remote annunciation of unit status.
 4. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD.
 5. Enclosure for each externally-mounted SPD: NEMA rating shall be as required for area classifications specified in Section 26 05 02 - Basic Electrical Work, General Provisions for Electrical Systems.

2.14 SURGE PROTECTIVE DEVICES SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 EXECUTION

3.1 INSPECTION

- A. Dry-Type Low-Voltage Distribution Transformers Inspection, Switchboards Inspection, Panelboards Inspection, Low-Voltage Receptacles Inspection, Snap Switches Inspection, Disconnect Switches Inspection, Enclosed Circuit Breaker Inspection and Surge Protective Devices Inspection: Examine the conditions under which the equipment is to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Dry-Type Low-Voltage Distribution Transformers Installation:
1. Install transformers on walls, rack or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.
 2. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.
 3. Adjust tap settings to provide proper voltage at panelboards.
 4. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.
- B. Switchboards Installation:
1. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

2. Install equipment on concrete pad, as shown. Coordinate pad dimensions to fit equipment furnished.
 3. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Do not energize equipment without permission of Owner.
- C. Panelboards Installation:
1. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.
 2. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.
 3. Identify panelboards in accordance with Section 26 05 02 - Basic Electrical Work, Identification for Electrical Systems.
 4. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.
- D. Low-Voltage Receptacles Installation:
1. Install receptacles at locations shown, in outlet or device boxes in accordance with Section 26 05 02 – Basic Electrical Work, Outlet Boxes.
 2. Install receptacles with ground pole in the down position.
 3. Install in conformance with Laws and Regulations.
 4. Identification:
 - a. Identify each conductor with circuit number and lighting panel number in accordance with Section 26 05 02 - Basic Electrical Work, Identification for Electrical Systems.
 - b. Identify each receptacle with permanent phenolic tag. Tags shall include circuit number and panelboard designation.
- E. Snap Switches Installation:
1. Install switches at locations as shown or indicated in the Contract Documents in outlet or device boxes, in accordance with Section 26 05 02 - Basic Electrical Work, Outlet Boxes.
 2. Mount wall switches 4.0 feet above finished floor, in accordance with the Americans with Disability Act, unless otherwise noted.
 3. Identify each conductor with circuit number and lighting panel number. Identification shall be in accordance with Section 26 05 02 - Basic Electrical Work, Identification for Electrical Systems.
- F. Disconnect Switches Installation:
1. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
 2. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.
 3. Provide suitable ¼-inch spacers to prevent mounting enclosure directly against walls.
- G. Enclosed Circuit Breaker Installation:

1. Install in accordance with NFPA 70, and Laws and Regulations.
2. Mounting and Installation:
 - a. Install equipment to provide sufficient access and working space for ready and safe operation and maintenance. Equipment centerline shall not be less than four feet above finished floor.
 - b. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports complying with Section 26 05 02 - Basic Electrical, Hangers and Supports, where there is no wall or other surface capable of supporting the equipment.
 - c. Provide suitable ¼-inch spacers to prevent mounting enclosure directly against walls.
3. Adjustments: Perform field adjustments of circuit breakers as required to place equipment in operating condition. Adjustable breaker settings shall be in accordance with the accepted power distribution coordination study prepared under Section 26 05 02 – Basic Electrical Work, Electrical Power Distribution System Studies, or as directed by Engineer.

H. Surge Protective Devices Installation:

1. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer's recommendations, Laws, and Regulations, and the Contract Documents.
2. Conductor length between suppressor and connection point shall be as short and as straight as possible.

3.3 SWITCHBOARDS FIELD QUALITY CONTROL

A. Site Tests:

1. After installation, inspect and perform field testing of each switchboard. Testing and inspections shall be by Supplier's factory-trained representative, in accordance with manufacturer's recommendations. Inform Owner and Engineer when Supplier's representative indicates that equipment is correctly installed.
2. Perform the following tests and checks before energizing equipment:
 - a. Verify proper installation.
 - b. Inspect all mechanical and electrical devices for proper operation.
 - c. Check tightness of bolted connections.
 - d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
 - e. Measure insulation resistance of each circuit breaker, pole-to-pole and from pole-to-ground.
 - f. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
 - g. Clean and lubricate as required.
 - h. Perform other tests and adjustments recommended by equipment manufacturer.

B. Manufacturer's Services: Provide services of qualified, factory-trained serviceman to perform the following:

1. Instruct Contractor in installing equipment.
2. Inspect and adjust equipment after installation and ensure proper operation.

3. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
4. Manufacturer's technician shall make visits to the Site as follows:
 - a. For instructing Contractor in proper equipment installation and assisting in installing equipment.
 - b. For checking completed installation, start-up of system; and performing field quality control testing.
 - c. To instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct Owner's operations and maintenance personnel in recommended operation and maintenance of equipment.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 SWITCHBOARDS ADJUSTING

- A. Calibrate, set and program protective devices. Coordinate the protective devices furnished under this Section and provide proper settings of devices per the results of the study specified in Section 26 05 02 - Basic Electrical Work, Electrical Power Distribution System Studies.

3.5 ENCLOSED CIRCUIT BREAKER FIELD QUALITY CONTROL

- A. Field Tests and Inspections:
 1. All test equipment and material shall be by Contractor.
 2. Perform visual and mechanical inspection including:
 - a. Inspect for physical, electrical, and mechanical condition.
 - b. Check for proper installation, required area clearances, physical damage and proper alignment.
 - c. Check electrical and mechanical interlock systems for proper operation.
 - d. Clean and lubricate as required.
 - e. Other testing and inspections recommended by manufacturer.
- B. Manufacturer's Services:
 1. Provide services of qualified, factory-trained manufacturer's representative to advise Contractor on installation of the equipment and to check the installed equipment prior to start-up.
 2. Qualified factory-trained manufacturer's representative shall certify in writing that equipment has been installed, adjusted, and tested in accordance with manufacturer's recommendations.
 3. Furnish services of qualified trained specialist, with minimum of five years' experience, from manufacturer to instruct Owner's operations and maintenance personnel in recommended operation and maintenance of the equipment.

END OF SECTION