

## SECTION 16360 –SWITCHGEAR (MDSA) AND EM4DS

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 1, General Requirements, shall be included in, and made part of, this Section.

#### 1.2 DESCRIPTION OF WORK

- A. The Electrical Subcontractor shall furnish and install the Service Entrance Switchgear complete from the incoming line terminals to the outgoing line terminals as specified herein and as shown on the contract drawings.
- B. The Service Entrance Switchgear MDSA, and Emergency Switchgear EM4DS, shall consist of secondary equipment as specified below. The manufacturer of the switchgear shall furnish and coordinate all major components of the switchgear, including low-voltage section as well as circuit breakers, and metering components. Provide a single warranty covering all switchgear assemblies.

#### 1.3 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 16010.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

#### 1.4 REFERENCES

- A. The secondary power center shall be designed, assembled, and tested and installed in accordance with latest applicable standards of NEMA, IEEE and ANSI, applicable to its major sections as follows:
  - 1. Low Voltage Metal Enclosed Switchgear
    - a. ANSI C37.20 (Switchgear assemblies)
    - b. ANSI C37.13 (Low-voltage power circuit breakers)
    - c. ANSI C37.17 (Trip devices)

- d. ANSI C37.90 (Relays)
- e. ANSI C39.1 (Meters)
- f. NEMA SG-5 (Switchgear assemblies)
- g. NEMA SG-3 (Low-voltage power circuit breakers)
- h. UL 1558

#### 1.5 QUALITY ASSURANCE

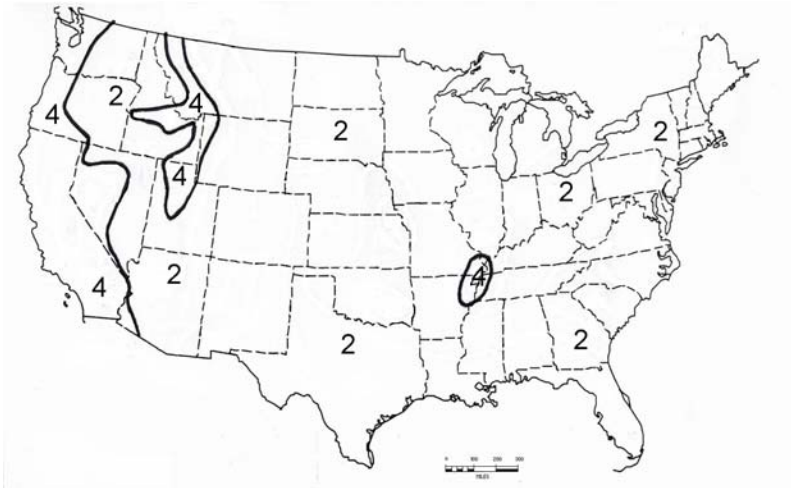
- A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.
- B. To ensure system compatibility, all low voltage distribution equipment shall be the products of one manufacturer.

#### 1.6 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements, Section 01784 - Warranties and Section 16010 – Electrical Special Conditions regarding guarantees and warranties for the work under this Contract.

#### 1.7 QUALIFICATIONS

- A. The manufacturer of the secondary power center shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.



- D. The secondary power center shall be suitable for and certified to meet all applicable seismic requirements of the latest accepted edition of the Maine State Building Code for seismic zone 2 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, with a peak acceleration and ZPA as required per the Code. The tests shall fully envelope the response spectrum for all equipment natural frequencies up to at least 35 Hz.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Electrical Subcontractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.
- B. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls shall be stored in dry, heated spaces. Equipment such as switchgear with heater elements installed shall have the heater elements energized after the equipment is received by the Electrical Subcontractor.
- C. The Electrical Subcontractor shall be responsible to fully inspect all shipments for damage and report damage to the manufacturer and the Architect.
- D. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Electrical Subcontractor's expense.

- E. The Electrical Subcontractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.
- F. The Switchgear shall be split into shipping groups for handling as directed by the Electrical Subcontractor or as the manufacturer's limitations dictate. Shipping groups shall be designed to be shipped by truck, rail or ship. Shipping groups shall be bolted to skids. Accessories shall be packaged and shipped separately. Each switchgear shipping group shall be equipped with lifting eyes for handling solely by crane.
- G. The Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

#### 1.9 ACCEPTABLE MANUFACTURERS

- A. Cutler-Hammer
- B. General Electric
- C. Siemens

#### 1.10 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 01330 in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.
- D. Shop drawings shall include, but shall not be limited to, the following:
  - 1. Low voltage switchgear
  - 2. A ¼"=1'-0" scale floor plan of the main electric room housing the substation with dimensions, Code clearances, etc., shall be submitted with the equipment shop drawings. Acceptance of these shop drawings shall be obtained prior to installation of feeder conduits:

Notes:

Equipment shop drawings will not be reviewed without the room/equipment layouts.

The Architect/Engineer reserve the right to rearrange equipment in electrical equipment rooms or spaces once final equipment dimensional information is known and prior to installation of the equipment. Install equipment in the final location selected by the Architect/Engineer at no additional cost to the Owner.

E. The switchgear manufacturer shall submit the following information with each submittal:

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line.
6. Control schematics and wiring diagrams.
7. Nameplate schedule.
8. Component list/bill of material.
9. Conduit entry/exit locations.
10. Assembly ratings including:
  - a. Short circuit rating.
  - b. Information regarding series short circuit ratings.
  - c. Voltage.
  - d. Continuous current.
  - e. Basic Impulse level for equipment over 600 volts.
  - f. KVA.
11. Major component ratings including:
  - a. Voltage.
  - b. Continuous current.
  - c. Interrupting ratings.
12. Cable terminal sizes.
13. Connection details between close-coupled assemblies.
14. Composite floor plan of close-coupled assemblies.
15. Impedance for transformers.
16. Manufacturer's catalog data sheets.
17. Test reports.
18. The following additional information shall be submitted to the Engineer:
  - a. Key interlock scheme drawing and sequence of operations.

19. The following product information shall be submitted:
  - a. Descriptive bulletins.
  - b. Product sheets.

#### 1.11 CLOSEOUT SUBMITTALS AND O & M MANUALS

- A. The following information shall be submitted for record purposes, in a binder, prior to final payment:
  1. Final as-built drawings and information for items listed above.
  2. Operation and maintenance manuals with the following information:
    - a. Instruction books and/or instruction leaflets
    - b. Recommended renewal parts
  3. Wiring diagrams.
  4. Certified production test reports.
  5. Installation information.
  6. Seismic certification and equipment anchorage details.

### PART 2 - PRODUCTS

#### 2.1 LOW-VOLTAGE DRAW-OUT METAL ENCLOSED SWITCHGEAR

- A. Ratings
  1. Voltage rating shall be 480/277 volts, 3 phase, 4 wire. The entire assembly shall be suitable for 600 volts maximum AC Service.
  2. The assembly shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 85,000 amperes symmetrical at rated voltage.
  3. The bus system shall have a minimum ANSI 4 cycle short circuit withstand rating of 100,000 amperes symmetrical.
  4. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes. To assure a fully selective system, all circuit breakers shall have 30 cycle short time withstand ratings equal to their symmetrical interrupting ratings through 65,000 amperes, regardless of whether equipped with instantaneous trip protection or not.
  5. Where circuit breakers are equipped with current limiters, the combination shall have short time ratings in accordance with the characteristics of the limiter selected.
  6. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

## B. Construction

1. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of the hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. Hinged rear doors, complete with provisions for padlocking, shall be provided.
2. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.
3. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids.
4. The switchgear shall be low voltage metal enclosed switchgear, utilizing air power circuit breakers as herein specified.
5. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cabling compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections, including the bus compartment, by means of barriers. It shall be equipped with draw-out rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, shall be located within the appropriate breaker cells.
6. Provide a separate, barriered section for the fire pump tap where shown on plan. No other components/equipment shall be located within this section.
7. The stationary part of the primary disconnecting devices for each power circuit breaker shall consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts suitably spaced shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension busses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver or tin-plated where outgoing terminals are attached.
8. The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging flat contact segments at the rear of the compartment. The secondary disconnecting devices shall be silver-plated and sliding contact engagement shall be maintained in the "connected" and "test" positions.
9. The removable power circuit breaker element shall be equipped with disconnecting contacts, wheels and interlocks for draw-out application. It shall have four positions, "connected", "test", "disconnected" and "removed" all of which permit closing the compartment door. The breaker draw-out element shall contain a worm gear levering "in" and "out" mechanism with removable lever crank. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell. The breaker shall include a provision for padlocking open to prevent manual or

electric closing. The padlocking shall also secure the breaker in the connected, test, or disconnected position by preventing levering.

10. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.
11. Provide, in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protect against accidental contact.
12. Provide a rear compartment barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.
13. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.
14. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

#### C. Bus

1. All bus bars shall be silver plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
2. In addition to full UL air clearances, the bus shall be insulated with a minimum of 5 mil thickness of epoxy resin coating. Removable non-PVC boots shall be provided to give access to the cross bus joints for inspection and maintenance.
3. Provide a full capacity neutral bus.
4. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short time withstand rating shall meet that of the largest circuit breaker within the assembly.
5. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with Bellville type washers.

#### D. Circuit Breakers

1. All protective devices shall be draw-out low-voltage power circuit breakers. Frame ratings shall be 800, 1600, 2000, 3200, 4000 or 5000 amperes. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating. Breakers shall be equivalent to Cutler Hammer Magnum DS.
2. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings or elsewhere in these specifications.
3. [Electrically operated breakers shall be complete with 120 Vac operators, control switch open/close pushbuttons, plus red and green indicating lights to indicate breaker contact position, AC source shall be taken from a control power transformer internal to the switchgear assembly with control power automatic transfer scheme on double ended units.
4. Power circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes RMS at rated voltage.



## E. Trip Units

1. Each draw-out low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker.
2. The trip unit shall have an LCD or LED display to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the display indication after an automatic trip.
3. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
  - a. All breakers shall have adjustments for long delay pick-up and time.
  - b. Main, Tie and Feeder breakers shall have individual adjustments for short delay pick-up and time, and include  $I^2t$  settings.
  - c. Tie and Feeder breakers shall have an adjustable instantaneous pick-up.
  - d. Main and Feeder breakers shall have individually adjustable ground fault current pick-up and time, and include  $I^2t$  settings.
  - e. Ground fault for EM4DS shall alarm only to trip.
4. The trip unit shall contain an integral test panel with a test selector switch and a test pushbutton or a portable full function test set. The test kit shall enable the user to select the values of test currents within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in the Trip or No trip test mode.
  - a. The test kit, when connected to a 120V, 50/60 Hz source, shall provide power for testing the trip unit while the breaker is out of the cell or in the disconnect or withdrawn position.
5. Trip unit shall have thermal memory for enhanced circuit protection.
6. The alpha-numeric display shall be provided to indicate the following data:
  - a. Cause of trip.
  - b. Instantaneous current on all three phases.
7. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, it shall maintain the cause of trip history and the trip target as long as its internal power supply is available.

8. Metering display accuracy of the complete system including current sensors, auxiliary C.T.'s, and the trip unit shall be +/- 2% of full scale for current values.
9. The trip unit shall include metering capabilities as follows:
  - a. Volts (per phase)
  - b. Amperes (per phase)
  - c. Kilowatt Hours (kWH)
  - d. Kilowatt demand (kW)
  - e. Instantaneous demand (kW)
  - f. [Kilovolt-amperes demand (kVA)
  - g. Instantaneous demand (kVA)
  - h. Power factor
  - i. Harmonic distortion (THD Voltage and current)
  - j. Waveform capture]
10. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit alpha-numeric display panel.
11. Metering display accuracy of the complete system of full scale shall be +/- 3% for power values, +/- 4% of full scale for energy values.
12. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.
13. Furnish and install all requires appurtenances, as required, within the switchgear for trip unit communications to a central software package.

F. Accessories

1. The secondary power center manufacturer shall furnish accessories for the low voltage metal enclosed switchgear for test, inspection, maintenance and operation, including:
  - a. A traveling type circuit breaker lifter, rail-mounted on top of switchgear.

2.2 WIRING/TERMINATIONS

- A. On the medium voltage load interrupter switchgear, one two hole NEMA pad per phase shall be provided for attaching Electrical Subcontractor supplied compression, crimp type cable terminal suitable for copper cable lugs for the number and sizes of conductors as indicated on the drawings. Sufficient space shall be supplied for Electrical Subcontractor supplied electrical stress relief termination devices.
- B. On the low voltage equipment, NEMA 2-hole compression, crimp type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size indicated on the drawings. A termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain the short circuit withstand ratings of the assembly through 85kA.
- C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided.

- D. All control wire shall be type SIS. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of prepunched wire lances. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device. Four shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. Provide wire markers at each end of all control wiring. Plug in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via removable trays above each circuit breakers. Control fuses for each electrically operated circuit breakers shall also be located in these trays.
- E. Small wiring, necessary fuse blocks and terminal blocks within each vertical section shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

### 2.3 CUSTOMER METERING

- A. Provide customer metering devices as specified herein. Provide a separate customer metering compartment with front hinged door. Include associated instrument transformers.
- B. Current transformers shall be wired to shorting type terminal blocks.
- C. Provide potential transformers including primary and secondary fuses with disconnecting means or fused potential taps as the potential source for metering as required.
- D. Microprocessor-based metering system.
  - 1. Provide a full function electronic meter on all secondary low voltage main and feeder devices. The meter shall have the features and functions specified below. The meter shall be UL recognized, CSA certified and also meet ANSI Standard C37.90.
  - 2. The meter shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units, and Mega-units for all metered values. Accuracy indicated below to be of read or calculated values.
    - a. AC Current (Amperes) in A, B, and C phase, 3 Phase Average and Neutral (N). Accuracy +/- 0.2% (provide phase and neutral current transformer).
    - b. AC Voltage (Volts) for A-B, B-C, and C-A, Phase Average, A-N, B-N, and C-N and Average Phase to N. Accuracy +/-0.2%.
    - c. Real Power (WATTS), Reactive Power (VARs), Apparent Power (VA), for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
    - d. Real Energy (WHR), Reactive Energy (VARHR), Apparent Energy (VAHR) for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
    - e. Frequency (HERTZ) Accuracy +/- 0.04%.

- f. Demand values for System Current (AMPERES), System Real Power (WATTS), System Reactive Power (VARs), and System Apparent Power (VA).
  - g. Power Factor both Displacement only 60 cycle fundamental WATTS to VA and Apparent total WATTS to total VARs including harmonics for A, B, and C phase and system. Accuracy +/- 0.4%.
  - h. Current Percent Total Harmonic Distortion (THD) in A, B, and C phase, and N.
  - i. Voltage percent THD in A-B, B-C, and C-A phase, A-N, B-N, and C-N.
  - j. K-Factor (sum of the squares of harmonic currents times the square of their harmonic numbers).
  - k. Transformer Derating Factor (1.414 divided by the Crest Factor)
  - l. Crest Factor (ratio of peak current to RMS current).
  - m. Waveform capture and display.
  - n. Three (3) 4-20 milliampere outputs, assignable.
- 3. Provide an addressable communication card capable of transmitting all data, remotely controlling and programming the meter over a compatible local area network to a central personal computer for storage, analysis, display and printout. The network shall also be capable of transmitting data in RS232c or RS485 format.
  - 4. Provide current transformers as required for each phase and neutral circuit with ratings sized for incoming service or associated feeder. Provide potential transformers as required for proper operation of the meter.
  - 5. The meter control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC control circuit unless a separate 120 or 240 volt source is indicated on the drawings.

## 2.4 ENCLOSURES

- A. The switchgear described in these specifications shall be indoor construction, with devices arranged as shown on contract drawings.
- B. The switchgear shall have a minimum depth of 72 inches to allow sufficient space on the top and bottom of the gear for conduit entrance.

## 2.5 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating.
- B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.
- C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings and/or wiring diagrams.

## 2.6 FINISH

- A. Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have an average thickness of not less than 3.0 mils. The finish shall have the following properties:
- |                                     |                       |
|-------------------------------------|-----------------------|
| 1. Impact resistance (ASTM D-2794): | 60 Direct/60 Indirect |
| 2. Pencil Hardness (ASTM D-3363):   | H                     |
| 3. Flexibility (ASTM D-522):        | Pass 1/8 inch mandrel |
| 4. Salt Spray(ASTM B117-85 [20]):   | 600 hours             |
| 5. Color:                           | ANSI 61 Gray          |

## PART 3 - EXECUTION

### 3.1 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible

for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- J. The Electrical Subcontractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Subcontractor shall notify the Contractor of such violations and request immediate removal.

### 3.2 INSTALLATION

#### A. General

- 1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.

2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. The Electrical Subcontractor shall coordinate the electric service installation with State Street.
6. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
7. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co. Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved by the Engineer.

B. Concrete Housekeeping Pads

1. Concrete pads shall be installed for all freestanding substations.
2. The General Contractor shall provide the concrete work. Electrical Subcontractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required. The electrical Subcontractor shall also ensure that the concrete is level to within manufacturers published tolerances.
3. All concrete housekeeping pads shall extend a minimum of 6" on each side from the equipment mounted on it. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" above finished floor. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0".

C. Electrical Distribution Equipment

1. The Electrical Subcontractor shall install the secondary power center per the manufacturers recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.
4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.

5. Floor mounted assemblies shall be installed on concrete housekeeping pads and shall be provided with adequate lifting means. Floor mounted assemblies shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. The Electrical Subcontractor shall ensure the floor is level to 1/8 inch per 3-foot distance in any direction.
6. All electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
7. The location of all electrical distribution equipment installed in mechanical or plumbing equipment rooms shall be coordinated with the respective Subcontractor.
8. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:
  - a. Checking to ensure that the pad location is level to within .125 inches.
  - b. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
  - c. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
  - d. Secure assemblies to foundation or floor channels.
  - e. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
  - f. Inspect and install all circuit breakers, components, etc. in their proper compartments.
9. Identification shall be provided for all electrical distribution equipment. The electrical system identification shall clearly describe the equipment connected. Method of identification shall be by laminated nameplate made of bakelite or similar material with engraved letters at least 1/4" high and securely attached to the equipment with galvanized screws. Adhesives or cements shall not be used. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.
10. Control wiring shall be provided as required. Interface all local and remote control wiring and operational systems for each load.

D. Switchgear

1. The switchgear, shall be installed on vibration isolators meeting seismic requirements.
2. On grade substations
  - a. Install the transformer with the manufacturer's standard vibration isolator elastomer pad with minimum thickness of 0.5 inches.
  - b. Install the entire substation cabinet on ribbed or waffle pattern elastomer vibration isolator pads, minimum 0.5 inches thick.
  - c. Select the areas and locations of pads such that the bearing pressure is within manufacturer's recommended range. Isolate hold-down bolts using elastomer bushings and washers, minimum 0.25 inches thick.



### 3.3 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

### 3.4 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
- B. Low Voltage Metal Enclosed Switchgear
  - 1. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to assure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.
  - 2. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute or 1800 volts for one second between live parts and ground, in accordance with ANSI C37.20.1.
- C. Factory tests as outlined above shall be witnessed by the Owner's representative.
  - 1. The manufacturer shall notify the Owner two (2) weeks prior to the date the tests are to be performed.

2. The manufacturer shall include the cost of transportation and lodging for up to three (3) Owner's representatives. The cost of meals and incidental expenses shall be the Owner's responsibility.

- D. The manufacturer shall provide three (3) certified copies of factory test reports.

### 3.5 FIELD SETTINGS

- A. The Electrical Subcontractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.
- B. For transformers, adjust taps to deliver appropriate voltage and measure primary and secondary voltage to confirm proper setting.

### 3.6 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Electrical Subcontractor in installation and start-up of the equipment specified under this section for a period of [ ] working days. The manufacturer's representative shall provide technical direction and assistance to the Electrical Subcontractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

### 3.7 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.
- C. A certified test report of all standard production tests shall be available to the Engineer upon request.

### 3.8 TRAINING

- A. The Electrical Subcontractor shall provide a training session for up to 4 Owner's representative for 2 normal workdays at a jobsite location determined by the owner.

- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.
- C. The training program shall include the following:
  - 1. Review of the project one-line drawings and schedules.
  - 2. Review of the factory record shop drawings.
  - 3. Review of all equipment in the electrical distribution system.
  - 4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
  - 5. Provide three ring binders to participants complete with copies of drawings and other course material covered.

END OF SECTION