PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and the following specification sections apply to all Work herein:
1. Section 26 00 10 - General Requirements
2. Section 26 00 20 - Scope of Work
3. Section 26 05 11 - Electrical Service
4. Section 26 05 19 - Electrical Conductors - 600 Volts
5. Section 26 05 26 - Grounding and Bonding
6. Section 26 05 73 - Electrical Power System Study
7. Section 26 08 13 - Testing
8. Section 26 25 00 - Busways
9. Section 26 28 13 - Fuses
10. Section 26 43 13 - Surge Protective Devices for Low-Voltage Electrical Power Circuits

1.2 SUMMARY

A. Furnish and install free standing, dead front type 600 Volt switchboards utilizing individual and group mounted circuit protective devices as herein specified, as indicated on the Drawings and as required for the distribution of power throughout the building.

1.3 REFERENCE STANDARDS

A. Each switchboard and all components shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:
1. UL Standard 891 - Dead Front Distribution Switchboards
2. UL Standard 489 - Molded Case Circuit Breakers
3. NEMA PB2 - Dead Front Distribution Switchboards
4. NEMA AB1 - Molded Case Circuit Breakers
5. NFPA 70 - National Electrical Code (NEC)

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and Section 26 00 10 and shall include, but not be limited to:
1. Switchboards* complete with physical dimensions, elevations, plan views, schematic diagram, nameplate data, voltage, current and short circuit ratings, materials, bus capacity data, circuit schedule, connector details, factory test reports, verification of Division 25 BMCS interface, installation details, etc.
2. Proposed test procedures, recording forms, test equipment, and list of personnel and qualifications for all tests proposed. Refer to Section 26 08 13 titled “Testing” for additional requirements.
3. Factory Test Schedule.
4. Factory Test Reports.
5. Field Test Schedule.
6. Field Test Reports.

B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification “MCA” as set forth in Section 26 00 10. See Section 26 00 10 for certification requirements.

1.5 WARRANTY

A. Comply with the requirements of the General Conditions and Section 26 00 10.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. If it complies with these Specifications, switchboards manufactured one of the following will be acceptable:
   1. Eaton/Cutler Hammer
   2. General Electric
   3. Siemens
   4. Square D

2.2 RATINGS

A. Switchboards shall be of indoor switchboard construction, arranged for 480Y/277 Volts, three (3) phase, four (4) conductor, full neutral as indicated on the Drawings and assembled complete with spare spaces and circuit protective devices with capacities as indicated on the Drawings. Switchboards shall be listed by UL and have a minimum short circuit interrupting rating of 200,000 amperes RMS symmetrical at 480 Volts.

2.3 CONSTRUCTION

A. Enclosure Construction:
   1. The indoor enclosure shall meet the applicable requirements of UL for NEMA 1 type construction.
   2. The enclosure shall consist of formed up steel sheets bolted together to make a rigid support for all circuit protective devices and bus work. The front, side and rear panels on switchboards shall be screw removable for hookup and maintenance purposes.
   3. Front, side and rear panels shall be formed up on all 4 sides to eliminate sharp edges and shall be a minimum of #14 gauge HRP steel.
   4. Lifting angles shall be provided for each section of the switchboard in accordance with the shipping requirements and shall be as shown on the manufacturer's Shop Drawings.
   5. The entire structure shall be painted after fabrication with two coats of enamel over a rust inhibiting primer coat or protected by an electro deposition or powder coat paint process.

B. Bus Construction:
   1. Busbar supports shall be noncarbonizing, nontracking insulators arranged to provide short circuit bracing as herein specified.
   2. Busbars shall be designed, supported and braced for a minimum short circuit equal to the short circuit interrupting rating of the switchboard as described hereinbefore.
   3. Busbars shall be sized to limit the temperature rise within the switchboard to 65ºC over a maximum 40ºC ambient temperature per UL891. Busbars shall be 55% conductivity aluminum or 98% conductivity round edge copper with bolted joint connections. If a mixing of copper and aluminum bar materials is used, the material shall be plated as set forth in Subparagraph 8. hereinafter and shall be joined in accordance with the UL listing of the equipment. Bolted joint connections shall be readily accessible for inspection and proper maintenance.
   4. The horizontal and vertical main busbars shall remain full size throughout their full length as indicated on the Drawings. Bus reductions other than those indicated on the Drawings are not acceptable.
   5. Neutral bars shall be full size unless otherwise indicated on the Drawings or specified hereinafter.
   6. Section bussing shall be sized for the combined ampacity of all circuit protective devices and spaces indicated on the Drawings. Where “space” is indicated on the Drawings, space shall be bussed.
   7. A full length copper ground bus with ground lugs shall be furnished in each cubicle to facilitate connection to the building grounding system.
   8. Bolted joint connection surfaces for copper bus shall be silver plated. Bolted joint connection surfaces for aluminum bus shall be tin plated or silver plated. Aluminum bus plating process shall be Alstan and shall be so marked. All bolted joint connections for aluminum bus shall have Belleville washers sized to maintain maximum contact pressure area between busses.
   9. Bolted joint connections shall be made using two (2) bolts with nuts per joint per phase. Clamp type joints are acceptable only when using “E-connectors” as manufactured by Square D. The joint laps shall lap sufficiently to limit the maximum ampere density to 200 amperes per square inch. Torque settings shall be provided on submittal data for use during installation.
   10. The switchboard manufacturer shall provide a laminated plastic detailed bussing Drawing showing location of all bolted connections with notations covering bolt maintenance and torque settings listed

thereon. This laminated skeleton Drawing shall be attached to a rear cover (on switchboards with rear access) or on a side or front cover (for switchboards placed against a wall).

11. All internal conductors other than busbars as specified in Subparagraph 3 hereinbefore shall be copper with insulation and as required for UL 891 standard.
12. For arcing fault protection, the main incoming bus for all switchboards shall be isolated from other bus structures within the switchboard. Complete coordination shall be made for all outgoing busways so that outgoing bus is isolated from the main bus section.
13. Where conductor connections are required to the main bus as indicated on the Drawings, the main bus shall be furnished with compression connectors. Where conductor connections are required to the outgoing circuit protective devices in switchboards, the load side connection devices shall be furnished with compression connectors. Adequate wiring space shall be provided to accommodate the required compression connectors and shall be certified on the submittal data. Refer to Section 26 05 19 titled “Electrical Conductors - 600 Volts” for compression connector requirements. Compression tool die sizes and bolt torque data shall be provided on the Shop Drawings for use during installation.

C. Switchboard structure shall be designed so that extension in either direction may be accomplished in the future by the addition of new cubicles and by simple splice plates on the horizontal bus. An air space of at least 2" or a minimum 1/8" thickness insulating barrier shall be provided between end of busbar and end panel.

D. Complete coordination shall be accomplished for incoming service bus duct from the utility service transformers into each switchboard as indicated on the Drawings. Barrier off the incoming bus from the main bus structure. Also, provide horizontal and vertical barriers for complete separation of the fire pump tap and/or switch cubicle from the other bus structure.

E. Detailed Drawings of the switchboard, including the metering compartment and the service entrance bus shall be submitted to the electrical utility for review prior to submitting same to the Engineer for review. Each Shop Drawing shall bear the review stamp of the electrical utility or it will be returned for resubmittal.

2.4 SWITCHBOARD CIRCUIT PROTECTIVE DEVICES

A. Circuit protective device frame sizes larger than 1200 amps shall be 100% rated General Electric Type HPC or Siemens Type HCP high pressure contact switches or 100% rated Pringle Type CBC or Square D Type BP Bolt Loc bolted pressure switches in combination with coordinated Bussmann Type KRP-C “Low Peak” or Ferraz-Shawmut Amptrap 2000 Class L dual element current limiting fuses. The pressure switches shall be equipped with a blown fuse device, which will open the switch and prevent the switch from being reclosed when one fuse is blown and thus prevent single phasing. The pressure switches shall be stationary mounted and manually operated with interlocks to prevent access to fuses until the switch is in the “open” position. The pressure switches shall have a stored energy closing and opening mechanism. The pressure switches shall have a shunt trip mechanism for operation in conjunction with ground fault relays where shown on the Drawings.

B. Circuit protective device frame sizes 100 amps through 1200 amps shall be similar and approved equal to General Electric Type ADS, Siemens Type VB or Square D Type QMB quick make, quick break fusible switches, except devices serving water chilling units. Devices serving water chilling units shall be General Electric Type HPC or Siemens Type HCP high pressure contact switches or Pringle Type CBC or Square D Type BP Bolt-Loc bolted pressure switches with a blown fuse device, which will open the switch and prevent the switch from being reclosed when one fuse is blown. Fuses over 600 amps shall be Bussmann Type KRP-C “Low Peak” or Ferraz Shawmut Amptrap 2000 Class L dual element current limiting fuses. Fuses 600 amps and smaller shall be Bussmann Type LPS-RK “Low Peak” or Ferraz Shawmut Amptrap 2000 dual element Class J. Devices may be group mounted (panel mounted) in distribution switchboards.

C. Circuit protective devices shall meet the interrupting capacity requirements indicated on the Drawings and be of the types specified hereinbefore.

D. Switchboards and circuit protective devices shall be identified with nameplates. See Section 26 00 10 for identification requirements.

E. All main switchboard breakers used as service disconnecting means shall have auxiliary contacts and bell alarm contacts for monitoring breaker position (open/closed/tripped) by the BMCS. These contacts

terminals shall be accessible. The switchboard manufacturer shall provide a wiring diagrams to be utilized by the contractor for field wiring of contacts.

F. All circuit protective devices shall be provided with provisions for locking in the “off” position.

2.5 UTILITY METERING

A. Furnish and install a separate barriered off utility metering compartment complete with provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company. Provide service entrance label and additional features as required by the NEC and the authorities having jurisdiction. Coordinate requirements with the local utility.

2.6 CUSTOMER METERING

A. Each switchboard shall be provided with a UL listed electronic meter, which meets ANSI C12.16 Standards. The electronic meter shall accept inputs from industry standard instrument transformers. The current and voltage signals shall be digitally sampled to provide accurate RMS sensing.

B. The meter shall be powered via internal control power transformers (CPT’s) with individual fuse protection. The CPT’s shall be connected ahead of the main and any sub-main breakers.

C. All setup parameters and metered readings shall be available from a meter mounted alphanumeric display. The display shall be able to be manually advanced through display readings or shall be able to display in an auto scroll format.

D. The electronic power meter shall be mounted on the front panel of the switchboard incoming line or main breaker compartment. The meter shall be installed by the switchboard manufacturer. All control power, CT, PT and output components shall be factory installed and wired within the switchboard lineup. Initial set-up and programming shall be performed by the electrical subcontractor in accordance with the manufacturer’s instructions.

E. The electronic meter shall be a General Electric Multilin PQM-II, Siemens PAC 4200, Square D PM 870, or Cutler Hammer Power Expert 4000.

F. The electronic meter shall provide, at a minimum, the following readings at its display (accuracy indicated in parenthesis) and through the digital interface port specified hereinafter:
1. rms current per phase (0.2%).
2. rms voltage phase-to-phase and phase-to-neutral (0.2%).
3. Current demand (0.2%).
4. kW (0.4%).
5. Watt hours three (3) phase total (0.5%).
6. kVA three phase total (0.4%).
7. kW demand (0.4%).
8. kVA demand (0.4%).
9. kVAR three (3) phase total (0.4%).
10. kVAR demand (0.4%).
11. Power factor average (1%).
12. kVARH (0.4%).
13. kVAH (0.4%).
14. Frequency (0.02 Hz).
15. Total harmonic distortion - amps (2.0%).
16. Total harmonic distortion - Volts (2.0%).
17. Crest Factor (0.4%).

G. Demand reading intervals shall be adjustable from 5 to 60 minutes in steps of 1 minute.

H. The meter shall be provided with a digital Modbus RTU RS-485 open protocol interface port for connection to the BMCS (wiring by the Division 25 Subcontractor). Coordinate requirements with Division 25. Refer to Section 26 00 10 for requirements related to testing and documentation of Division 25 BMCS interfaces.

I. Provide an RS-232, infrared, or optical port on front panel or within the meter compartment for operator programming via Owner supplied laptop. Software for the Owner supplied laptop shall be provided to allow display, control or analysis of all metered data.

2.7 PROTECTIVE RELAYING

A. Where indicated on the Drawings, pressure switch type circuit protective devices shall be provided with ground fault protection using a ground fault relay, current transformers and a fused control power transformer as required for tripping and/or indication under any ground fault condition. The unit shall consist of coordinated current sensor, solid state relay and monitor panel all of the same manufacturer. The current sensors shall be arranged as a zero sequence type detector around all conductors and the neutral. Solid state relays shall be adjustable from 100 to 1200 amperes and from instantaneous to one second time delay by means of lockable, direct indicating knobs on the front of the relay. Monitor panel shall be mounted on the front panel with a light to indicate when a ground fault function has occurred. It shall also contain a reset push button, a push to test push button and a control power “on” pilot light. Ground fault setting shall be set at minimum setting for both current and time during construction. The switchboard manufacturer shall include in the Shop Drawing data for the switchboard, the minimum setting of the devices and the recommended setting for normal building operation. The ground fault system provided for circuit protective devices serving emergency systems and/or fire pumps shall only signal the occurrence of a ground fault and shall not trip the emergency circuit protective device.

2.8 SURGE PROTECTIVE DEVICES (SPD)

A. Where indicated on the Drawings, provide an integral SPD within the switchboard enclosure.

B. Refer to Section 26 43 13 for requirements related to the SPD devices.

C. The surge current diversion conductor path between the SPD and the main bus within the switchboard and the SPD connection to ground shall be as short as possible and in no case shall they be installed longer than recommended by the SPD manufacturer. If shorter conductor lengths are achievable as determined by the owner, the switchboard manufacturer shall modify the switchboard in its final location to reduce the surge current diversion conductor lengths. Such modifications shall be done in accordance with UL 891 and not void the UL listing of the switchboard section. Required modifications will be considered covered under warranty and shall be done without cost to the owner.

2.9 ELECTRICAL POWER SYSTEM STUDY

A. Refer to Section 26 05 73 for requirements related to the electrical power system study.

PART 3 EXECUTION

3.1 INSTALLATION

A. The assembled switchboard structure shall be securely anchored to continuous 1-1/2" x 6" channels the full length of the switchboard, which shall be embedded in the concrete equipment pad. Bolt studs shall be at least 3/8" in diameter and located not more than 30" apart center to center for switchboard mounting. The mounting channels shall be continuous one piece structural channels mounted along the front and rear for each continuous switchboard lineup, leveled and embedded in the concrete equipment pads. The channel and bolt studs shall be furnished and installed by the Electrical Subcontractor.

B. Three spare fuses or current limiters of each type and size used in conjunction with circuit protective devices for the switchboards shall be furnished and delivered to the Owner at Substantial Completion. See Section 26 28 13 titled “Fuses” for fuse cabinet requirements.

C. Field wiring of bell alarms and auxiliary contacts shall be provided and installed by the electrical contractor within the switchboard. Conductors shall be SIS type providing connection between breaker monitoring points and UL Listed terminal strip rated for the application provided and installed by the Electrical Contractor. The terminal strip shall be field installed within the switchboard customer metering compartment. Wiring shall be installed per the National Electrical Code and managed, organized and

secured to prevent interference with the installation and termination of power feeders or the addition or removal of circuit breakers. The terminal strip shall be accessible by the Division 25 contractor for monitoring these breakers. Coordinate BMCS monitoring requirements with Division 25.

3.2 FACTORY TESTING

A. All standard factory tests shall be performed in accordance with the latest version of NEMA and UL Standards.

B. The switchboards shall be factory tested at the manufacturer's factory prior to shipment as specified herein:
1. The switchboard manufacturer shall provide a ground fault protection system test for circuit testing and verification of the tripping of the ground fault relays at the factory location. The manufacturer shall pass predetermined values of current through the relay sensors and measure the relay tripping time for each phase and the neutral sensor (if one is required). The measured time current relationships shall be compared to the trip characteristic curves for each relay. If the relay trips outside the range of values indicated on the curve the relays shall be replaced or recalibrated. This test shall include a polarity verification of the interconnection of the ground sensor circuits.
2. Additional auxiliary, pilot and control relays, electrically operated breakers, shunt trip operated breakers, switches, etc. shall have the proper voltages applied to their circuits and satisfactory operation demonstrated.
3. Provide factory testing of the communication interface to the BMCS as specified in Section 26 00 10 and in Division 25.
4. Upon completion of the factory ground fault protection system tests the current and time adjustment on each relay will be set on their minimum values.

C. Five (5) copies of all test results certified by the manufacturer shall be submitted by the Subcontractor to the Engineer for review and two (2) copies to the Owner. See Section 26 00 10 for requirements.

D. A representative from the Engineer and/or the Owner’s representative may witness factory testing of the equipment at the time of manufacture. The Subcontractor shall notify the Engineer and Owner in writing at least three (3) weeks prior to the day of the factory test. The Subcontractors shall have a representative attend the factory test with the Engineer and/or Owner’s representative.

3.3 FIELD TESTING

A. Prior to execution of testing, submit test procedures, recording forms, and test equipment to the Engineer for review. Refer to Section 26 00 20 titled “Scope of Work” for “Scheduling Procedures”.

B. After construction Work is complete and prior to energizing of the switchboard, field testing and inspection shall be conducted on the switchboard by one of the following companies: General Electric Engineering and Service, Cutler Hammer Engineering and Service, Siemens Westinghouse Technical Services, Square D Technical Services or a manufacturer authorized service and testing organization.
1. Conduct field test of the ground fault protection system and reset to the setting identified in the approved Power System Study for both current and time. Procedure shall be similar to that specified for the factory test.
2. Verify the nameplate data of the equipment complies with the voltage and capacity indicated on the Contract Drawings and Specifications.
3. Verify circuit breaker size, type, and rating are in accordance with Contract Documents.
4. Verify the switchboard is clean.
5. Verify all shipping bolts, brackets, etc. have been removed.
6. Verify unit is anchored and secured and is aligned across shipping splits.
7. Verify all equipment internal barriers are installed.
8. Verify the unit enclosure and ground bar are grounded and ground bar is continuous the entire length of the equipment
9. Verify working space around the equipment complies with the manufacturers recommendations.
10. Verify insulated conductors are properly braced and supported and are not subject to damage due to vibration and physical contact with the enclosure or other abrasive contact.
11. Test bolted electrical connections to verify tightness with a calibrated torque wrench.
12. Test and verify all safety and electrical interlocks are working as designed and specified.
13. Verify all movable parts are properly lubricated and apply lubricant as needed.

14. Verify correct operation of all electrical and mechanical indicating and control devices.
15. Test and confirm proper operation of all auxiliary contacts, shunt trips, control relays, potential transformers, control power transformers, protective relays, and all other control and protection devices.
16. Remove temporary wiring jumper on current transformers after external connections have been made.
17. Perform test on each circuit breaker:
    a. Trip and close the circuit breaker manually and electrically if breaker is electrically operated. Use an ohmmeter or other indicating device to verify that all the contacts are closing and opening respective to the handle position.
    b. Use a static trip test set or other suitable source of current to trip the circuit breaker through the static trip device.
    c. If protective relays are provided, trip electrically operated circuit breaker by passing sufficient current (or voltage if applicable) through the coils of protective relays.
    d. Trip and close electrically operated circuit breakers from all remote control locations.
    e. Operate and test auxiliary devices.
    f. Test the phase sequence.
    g. Perform other tests and checks in accordance with the circuit breaker and trip device instruction manuals.
    h. Test for correct phasing across the bus tie circuit (if applicable).
18. Set protective relays and circuit breakers to protective settings defined in the approved Power System Study.
19. Perform insulation resistance tests phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturers published data.
20. Perform DC dielectric withstand voltage test before energizing. Test each phase-to-ground with all other phases grounded. Field test voltages and procedures shall be in accordance with manufacturer's published data and recommendations.
21. Verify metering equipment is working properly and programmed according to its application including voltage and current settings and ratios. Clear all historical logs within the meter. Verify meter is communicating through specified communication ports as specified.
22. Perform all additional field testing and verification recommended by the manufacturer.

C. The Subcontractor shall notify the Engineer and Owner in writing at least two (2) weeks prior to the day of the field test. The Engineer and/or Owner may witness the field test if he so desires.

D. The field test results shall be submitted by the Subcontractor for review. Field test reports shall include, but not be limited to:
1. Equipment Name and Nameplate information
2. Test performed.
3. Test procedure.
4. Date(s) and time(s) of testing and verification.
5. Checksheet(s) indicating Specification compliance of all items specified herein to be field verified.
6. Final test values.
7. Additional pertinent data.
8. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
9. Personnel printed name, title, company, and signature of persons who performed the test.

E. Refer to Section 26 08 13 for additional testing requirements for switchboards.

END OF SECTION