SECTION 26 2414 – LOW VOLTAGE SWITCHGEAR

Maintain Section format, including the UH master spec designation and version date in bold in the center columns of the header and footer. Complete the header and footer with Project information.

Edit and finalize this Section, where prompted by Editor's notes, to suit Project specific requirements. Make selections for the Project at text identified in bold.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Individually mounted rear-accessible low voltage switchgear ANSI rated switchgear and low voltage power circuit breakers utilized in the switchgear.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction.*

1.3 STANDARDS

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI)
   a. ANSI/IEEE C37.13, "Low-Voltage AC Power Circuit Breakers Used in Enclosures"
   b. ANSI/IEEE C37.20.1 – "Metal Enclosed Low Voltage Power Circuit Breaker Switchgear"

c. ANSI/IEEE C37.20.7 – "Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults"
d. ANSI/IEEE C37.13 – "Low Voltage AC Power Circuit Breakers Used in Equipment"
e. ANSI/IEEE C37.13 – "Low Voltage AC Power Circuit Breakers used in Equipment"
f. ANSI/IEEE C37.16 – "Preferred Rating, Related Requirement and Application Recommendations for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors"
g. ANSI/IEEE C37.50 – "Testing of Low Voltage AC Power Circuit Breakers"

2. National Electrical Manufacturers Association (NEMA)
   a. NEMA SG-5, "Power Switchgear Assemblies"
   b. NEMA 250, "Enclosures for Electrical Equipment"
   c. NEMA SG-3, "Low Voltage Power Circuit Breakers"
3. National Fire Protection Agency (NFPA)
   a. NFPA 70, "National Electrical Code (NEC)"
   b. NFPA 79, "Electrical Standard for Industrial Machinery"
4. Underwriters Laboratories, Inc. (UL)
   a. UL 1558, "Switchgear Assemblies"
   b. UL 50, "Enclosures for Electrical Equipment"
   c. UL 1066, "Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures"

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Switchgear cut sheets with all bus and overcurrent device ratings, capacities, characteristics, features and associated accessories clearly indicated. Cut sheets shall include information on switchgear indicating instruments and instrument transformers.
   2. Submit dimensioned drawings of switchgear showing accurately scaled basic units including, but not limited to, auxiliary compartments and components.
   3. Submit schematics and wiring diagrams for metering and controls.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver switchgear in factory-fabricated water-resistant wrapping, and mounted on shipping skids.
B. Handle in accordance with manufacturer's instructions to avoid damage to material components, enclosure, and finish. switchgear shall be provided with adequate lifting means.

C. Store in a clean, dry space and protect from the weather. Maintain factory-wrapping or provide an additional heavy canvas or plastic cover.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products complying with these specifications and produced by one of the following:

1. Eaton.
2. ABB.
3. Square D Company.
4. Siemens.
5. Powell Electric.

2.2 MATERIALS AND COMPONENTS

A. Low voltage switchgear shall be indoor, metal-clad, and have electrically operated draw-out power circuit breakers. Insulated-case breakers may be used in place of power circuit breakers when approved by the Owner. Outdoor installation in NEMA 3R type enclosures shall be discouraged and shall require approval by the Owner. Unless approved otherwise by the Owner, the following shall be required:

1. Remote racking and operation of the circuit breaker shall be used to lessen the personnel exposure to Arc flash injuries.
2. The use of Arc resistant switchgear Type 2B. For existing installation, switchgear that uses Arc mitigating technology may be used in place of Arc resistant gear, if approved by the Owner.
3. Switchgear ampacity ratings shall be based on natural cooling, an ampacity rating based on forced cooling is not allowed.

B. General: Except as otherwise indicated, provide switchgear manufacturer's standard materials and components as indicated by the published product information, designed and constructed as recommended by the manufacturer and as required for a complete installation.

2.3 DEAD FRONT DISTRIBUTION SWITCHGEAR

A. General: Provide a factory-assembled, dead front, NEMA 1 construction, metal-enclosed, self-supporting, switchgear of the voltage, phase, ampacity and short circuit bracing shown.

1. The switchgear shall be furnished with individually mounted main, tie and feeder circuit breakers. Access to the circuit breaker load terminations shall be from the rear of the switchgear. The switchgear cable and bus compartment shall be isolated from the front-accessible protective device compartments by rigid glass-reinforced polyester barriers. Feeder breakers shall have insulated load bus extensions to the rear cable compartment. It

shall be possible to make up the outgoing feeder cable terminations without reaching into or over the switchgear horizontal or vertical busses.

2. The top, bottom and sides of each breaker and instrument compartment shall be isolated from adjacent compartments by grounded steel barriers. Cubicle doors for low voltage power circuit breakers shall not contain any ventilation openings and shall be hinged and provided with a quarter-turn latches. Breaker cubicle door latches shall have padlocking provisions.
3. Closed door drawout shall be provided so that the breakers can be racked out from the connected through test to the disconnect position while the compartment doors remain stationary and closed.
4. Provide shutters in draw-out breaker compartments to cover breaker primary line and load disconnects when the breaker is removed from the compartment.
5. Switchgear shall consist of the required number of front and rear aligned vertical sections bolted together to form one metal-enclosed rigid lineup. The switchgear shall be designed as a free-standing board with rear access to all line and load terminations.
6. Switchgear shall include all protective devices and equipment as shown with necessary interconnections, instrumentation, and control wiring. Small wiring, necessary fuse blocks, and terminal blocks within the switchgear shall be furnished. All groups of control wires leaving the switchgear shall be furnished with terminal blocks with suitable numbering strips.
7. Switchgear shall have provisions for future expansion where shown on the Drawings.
8. All PTs and CTs, including accessories (fuses, wiring terminal strip, shorting terminal blocks etc.) shall be mounted in a front accessible location without having to remove any covers for access.
9. All feeder compartments in the rear wiring section shall be isolated from any adjacent feeder breakers and the individual feeder section door shall be lockable without locking the entire feeder compartment section.
10. When rear access doors are provided, the door shall be either full height or split, hinged, and bolted. All rear access doors shall have provisions for padlocking.

B. Enclosure Construction: The switchgear framework shall be fabricated on a die-formed steel base or base assembly, consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor-mounting. The framework shall be formed code gauge steel, rigidly welded and bolted together to support all coverplates, busing and component devices during shipment and installation.

1. NEMA 1 switchgear sections shall have an open bottom and individually removable top plates for installation and termination of conduit. Top and bottom conduit areas shall be clearly shown and dimensioned on the shop

drawings. All front plates used for mounting meters, selector switches or other front-mounted devices shall be hinged, with all wiring installed and laced and with flexibility at the hinged side. All closure plates shall be screw removable and small enough for easy handling by one man. Furnish bus stubs, factory-fabricated with unit, on top of switchgear for proper entrances and exits of busway when shown on the Drawings.

2. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to prevent moisture entrance and rust formation under the paint film. The paint finish shall be manufacturer's standard gray enamel over rust inhibiting phosphate primer.
3. A traveling type, rail mounted, circuit breaker lifter shall be provided on top of switchgear to provide a means for removal of the circuit breakers and/or a breaker lift cart shall be provided.
4. Furnish full height lockable rear hinged doors for each section for access to rear cable compartments.
5. When rear access doors are provided, they shall be either, full height or split, hinged, and bolted. All rear access doors shall have provisions for pad locking.

C. Busing: The switchgear busing shall be silver-plated copper and of sufficient cross-sectional area to continuously conduct rated full load current with a maximum temperature rise of 65°C above an ambient temperature of 40°C.

1. The busbars shall be rigidly braced to comply with the integrated equipment rating of the switchgear. The main horizontal busbars between sections shall be in the middle of the switchgear to accommodate rear termination compartment. The horizontal main busbar supports, connections, and joints shall be bolted. All bolted joints shall be bolted with medium carbon steel, zinc or cadmium-plated hardware equipped with lock washers and torqued to the manufacturer's recommended settings. All draw-out breaker primary connections shall be silver-plated.
2. Provide 100 percent rated neutral.
3. Buses shall be arranged A-B-C, left-to-right, top-to-bottom, and front-to-rear throughout. A ground bus shall be secured to each vertical section structure and extend the entire length of the switchgear. Neutral busing, where installed, shall be full capacity rated, unless noted otherwise.
4. The main horizontal bus and incoming line shall be isolated and insulated from outgoing busing and cable connections.
5. Provide fully equipped spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents, as indicated on Drawings.

D. Integrated Equipment Rating: Each switchgear, as a complete unit, shall be given a single integrated equipment rating by the manufacturer. The integrated equipment short circuit rating shall certify that all equipment is capable of withstanding the

stresses of a fault equal to that shown in RMS symmetrical amperes. Such ratings shall have been established by actual tests by the manufacturer on similar equipment construction as the subject switchgear. This test data shall be available and furnished, if requested, with or before the submittal of shop drawings.

E. Indicating Instruments: Provide indicating instruments as specified, scheduled or shown on the Drawings:

1. Current Transformers: ANSI C57.13; 5 ampere secondary, window type, primary/secondary ratio as required; burden and accuracy consistent with connected metering and relay devices, 60 Hz. The CT accuracy class shall be specified by the Engineer.
2. Potential Transformers: ANSI C57.13; 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required; burden and accuracy consistent with connected metering and relay devices, 60 Hz.
3. Provide a meter for the switchgear as shown on the drawings. Meter shall be a Shark 250V4 or equivalent approved by the Owner. The unit shall be Underwriter's Laboratory listed per UL508.
    a. The electronic metering device shall have a six digit LED readout which will allow local display of the following electrical parameters:
        1) Voltmeter, phase to phase and phase to neutral.
        2) Current, per phase RMS and 3-phase average.
        3) Demand current, per phase.
        4) Power factor, per phase and 3-phase total.
        5) Real power, 3-phase total.
        6) Reactive power, 3-phase total.
        7) Apparent power, 3-phase total.
        8) Energy (MWH).
        9) Reactive Energy (MVARH).
        10) Frequency.
        11) Average demand real power.
    b. The electronic metering device shall have the following additional features and characteristics.
        1) Built-in communications capability which will allow multipoint communication to a remote PC via an RS-485 communications port and TCP/IP ethernet communication capability.
        2) Adjustable demand interval (5-60 minutes).
        3) Nonvolatile memory for storing all historical data.
        4) A "waveform capture" function to store voltage and current waveforms in memory for analysis via the communications port.
    c. Setup of the electronic metering device shall be accomplished from the front of the device. It shall not be necessary to open the front of the enclosure to reach rear-mounted dip-switches. Setup parameters shall include CT ratio, PT ratio, system type (3-wire or 4-wire) and demand interval.

d. All setup and reset functions shall be keyswitch or password protected to prevent unauthorized or accidental change of value.
   1) The accuracy of the electronic metering device in percent of full scale for various readouts shall be as follows:
   2) Current and voltage measurements +/- 0.1 percent.
   3) Power and energy +/- 0.15 percent.
   4) Frequency +/- 0.007 percent.
   5) Power factor +/- 0.2 percent.
   6) Data update time 1 S.

e. Secondary meters as required by the Riser Diagram shall be Shark 250 V4 or equivalent approved by the Owner.

f. Building Automation System (BAS) Interface: Coordinate with building controls vendor to provide interface with BAS. If BAS in not compatible with Modbus provide a BACnet interface to allow the BAS (Building Automation System) to monitor the switchgear's metering.

F. Overcurrent Devices:

1. Switchgear shall have installed circuit breakers sized as shown on the Drawings and as described below:
2. Main and tie protective devices shall be low voltage power circuit breakers. All protective devices shall be UL1066 Listed, designed and tested to ANSI C37 and NEMA SG-3 standards.
3. Circuit breakers shall have a true, two step stored energy mechanism providing quick make and quick break operation. The breaker mechanism shall be capable of being charged after closing the circuit breaker. It shall be possible to discharge the energy in the closing spring without closing the breaker main contacts. Manual charging of stored-energy mechanism and operation of devices shall be accomplished with compartment door closed and latched. All breakers shall be electrically operated using Electroswitch control switch or equivalent to open and close breaker. The breaker shall electrically charge the spring mechanism.
4. Main Breakers: The breakers shall be provided with RELT (Reduced Energy Let-thru) functionality or the manufacturer's equivalent. This provision shall provide the breaker with the capability of being set to an alternate instantaneous setting including the minimum instantaneous trip setting for the breaker to reduce arc flash energy while in a maintenance mode. The signal to set to minimum setting shall factory wired to a switch on the front of the switchgear or at a remote location as indicated on the drawings. There shall be an indicating lamp to let the operator know that control power is available to operate the RELT system and an indicating lamp or illuminated switch that indicates the settings are in the RELT mode. The signal to indicate the breaker is in the RELT mode shall be in the form of positive feedback from the trip unit and not just an indication that a signal has been sent. The switch

to initiate the RELT function shall be provided with padlock capabilities so that the operator can follow standard lockout tag-out procedures. Use RELT for existing installation. The suggested instantaneous setting for the alternate RELT function shall be included in the coordination study for the project. If instantaneous setting is left in the alternate setting mode for longer than 10 minutes, the setting shall automatically return to the normal protective settings. Arc flash detection using an SEL Arc flash point sensor or equivalent wired back to SEL 751A relay or equivalent with an Arc flash sensor module can be considered as an option. The Arc flash sensor module shall operate when the light values exceeds the setpoint and the current values exceeds the nominal operating current.

5. All breakers shall be electrically operated using Electroswitch control switch or equivalent to open and close breaker. The breaker shall electrically charge the spring mechanism.
   a. Breaker cases shall be constructed from high dielectric strength, glass-reinforced insulating material.
   b. Breakers shall be manually operated and provided with a handle for charging a spring-loaded, quick-make quick-break mechanism. When charged, the stored energy mechanism shall be capable of closing the breaker and still have sufficient capacity to open the breaker before recharging the mechanism.
   c. Breakers shall be of draw out construction for individual removal and ready replacement from front of switchgear. Draw out construction, shall permit breaker to be withdrawn from an engaged (CONNECTED) position, to test position, and to disengaged position. Draw out mechanism shall be mechanically interlocked with circuit breaker's trip mechanism so that breaker must be OPEN before it can be moved into or out of the CONNECTED position. The breaker shall automatically trip open if it is withdrawn while in CLOSED position. A CLOSED breaker shall trip open before it is racked into the engaged position.
   d. Breakers shall be equipped with a solid-state programmer, flux shift trip device, and current sensors to control the breaker operation under overload and fault conditions. Devices shall be capable of communicating via RS-485 and/or TCP/IP with a CAT 6 cable connection. The solid-state electronic programmer shall have the following features and tripping functions.
      1) Adjustable current setting. (.5-1.0X in .05 increments)
      2) Adjustable long-time delay. (19 bands)
      3) Adjustable instantaneous pick-up. (0.5X increments)
      4) Adjustable short time delay. (11 constant bands, 3 slopes)
      5) Adjustable short time pick-up. (0.5XLT increments)

Where GF is indicated on the drawings or schedules, provide the following:

6) Adjustable ground fault pickup. (0.01 increments)

7) Adjustable ground fault delay. (14 bands, 2 slopes)

e. Breakers shall have a minimum symmetrical interrupting rating of 65,000 amperes, or as scheduled or shown on the Drawings.

f. Breakers shall be equipped with a factory-installed padlock option over the "OFF" button to prevent charging the mechanism or closing the breaker.

6. If automatic residual, auto transfer scheme is specified, the system shall be provided using microprocessor based logic relay system equivalent to SEL residual automatic transfer scheme using Mirror bits communication.

G. Ground Fault Protection: Where shown on the Drawings, ground fault protection shall be achieved by integral ground fault sensing in the circuit breaker trip unit with adjustable pickup for ground fault currents, field-adjustable from 20 percent of breaker sensor rating to 1200 amperes or breaker trip rating and minimum of .058 sec to .917 sec time delay. The ground fault protection system shall include all necessary sensors, internal wiring, and relays to coordinate opening faulted circuits monitored.

1. Ground fault trip function shall also have output contacts for breaker/switch tripping and shall incorporate a memory function to recognize and initiate tripping on intermittent ground faults.

2. Ground fault protection shall be set at minimum settings for both current and time during construction. The switchgear manufacturer shall include in the submittal data for the switchgear, the minimum setting of the devices and the recommended setting for normal building operation shall be provided in the coordination study.

3. The ground fault system shall be factory-tested prior to shipment as specified herein:

a. The switchgear manufacturer shall provide a factory ground fault protection system test for circuit testing and verification of tripping characteristics. The manufacturer shall pass predetermined values of current through the relay sensors and measure the relay tripping time for each phase and neutral (if required). The measured time current relationships shall be compared to the relay trip characteristic curves. If the relay trips outside the range of values indicated on the curve the relay shall be replaced or recalibrated.

b. Additional auxiliary, pilot and control relays, electrically operated switches, shunt trip switches, and similar items shall have proper voltages applied to their circuits and satisfactory operation demonstrated.

c. Upon completion of the factory ground fault protection system test, the current and time on each relay shall be set to their minimum values.

H. Kirk key interlocks shall be provided between main-tie-main or between two main devices on manually operated throw-over scheme as shown on the one line diagrams. [**Main-Tie-Tie-Main. This will allow for momentary paralleling of the breakers while operating via manual operation or via the residual automatic transfer system.**]

I. Provide infrared scanning windows in the rear covers of main switchgear sections, including Main-Tie-Main, **[Main-Tie-Tie-Main, will allow for Tie to be tested without having total outage]** to facilitate the use of an IR camera for purposes of thermal scanning incoming and outgoing lugs of main circuit breakers. The IR windows shall be an IR “transparent” mesh for indoor NEMA 1 applications or an IR crystal window for outdoor NEMA 3R applications. IR windows shall have a gasketed cover plate secured with tamper-resistant hardware.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHGEAR

A. General: Install switchgear where shown, in accordance with the manufacturer's written instructions and recognized industry practices to ensure that the switchgear comply with the requirements and serve the intended purposes.

B. Standards: Comply with the requirements of NEMA and NEC standards and applicable portions of NECA's "Standard of Installation", for installation of switchgear.

C. Tightness: Torque bus connections and tighten mechanical fasteners.

D. Concrete Pads: Install switchgear on a reinforced concrete housekeeping pad. The housekeeping pad shall extend 3 inches beyond the housing of the switchgear unless shown otherwise. Switchgear shall be bolted to the housekeeping pad using 3/8 inch minimum galvanized bolts and anchors on 30 inch maximum centers. Furnish the exact position of any block outs, dimensions, and location of the housekeeping pads in a timely manner so as to prevent delay of the concrete work.

E. Adjustment: Adjust operating mechanisms for free mechanical movement.

F. Finish: Touch-up scratched or marred surfaces to match original finish as supplied by the manufacturer.

G. The switchgear ground bus shall be connected at a minimum of two locations to the ground grid with a minimum conductor sized per NEC Article 250. The switchgear frame shall be bonded to the ground grid with a minimum sized bonding per NEC Article 250.

3.2 TESTING

A. Pre-energization Checks: Prior to energization, check switchgear for continuity of circuits and for short circuits.

B. Switchgear Insulation Resistance Test: Each switchgear bus shall have its insulation resistance tested after the installation is complete except for line and load side connections. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage comply with NETA ATS insulation resistance values per the

operating of the equipment with resistance recorded after 30 and 60 seconds of operation at slip speed. Resistance shall be measured from phase-to-phase and from phase-to-ground. Bus which does not meet or exceed NETA ATS bus insulation acceptance values resistance specifications shall be repaired or replaced and retested until an acceptable resistance is obtained.

C. Switchgear Phasing Check: A test shall be performed to verify that the electrical system is in phase with the power source before any electrical load is placed on the system. A rotation check shall not be used as an alternate to a phasing system check.

D. All circuit breakers, individual breaker cubicles and all accessories, meters, and breaker trip units shall be tested by an independent third party testing service.

E. Ground Fault Protection System Test: Following completion of the construction work and prior to final acceptance testing, the ground fault protection system shall be field-tested and reset to the recommended settings in the coordination study for both current and time by a representative of the third party testing service per Section 26 0800 “Commissioning of Electrical Power Systems”. The field test shall be conducted in a similar manner to the factory test in that a cable from a low voltage, high-current test set shall be passed through each current sensor. The time and current values for the ground fault function of circuit breakers shall be checked against the ground fault characteristic curves and relays which fail to pick-up within the published curves shall be recalibrated or replaced. This test shall also demonstrate the complete system reliability in that the overcurrent devices shall actually open.

F. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to the Engineer for review. Test reports shall include switchgear tested, date and time of test, relative humidity, temperature, and weather conditions.

G. Thermographic Testing: Conduct a thermographic test of the switchgear and their connections using an infrared temperature scanning unit. The test shall be performed by an independent third party testing service per Section 26 0800 “Commissioning of Electrical Power Systems”. Connections indicating higher temperature levels than are acceptable shall be tightened or corrected as required to eliminate the condition. Conduct test, using test reporting forms, between 6 and 8 months after beneficial occupancy, but in no case beyond the one year warranty period. Correct unacceptable conditions prior to end of the warranty period.

3.3 IDENTIFICATION

A. Mimic Bus: Provide a mimic bus on each switchgear to show busing, connections, and devices in single line form on an engraved nameplate securely attached with screws on the front panels of the switchgear. The color shall be white and shall comply with the requirements of Section 26 0553 “Identification for Electrical Systems”.

END OF SECTION 26 2414