February 3, 2025

ADDENDUM #4

TO CONTRACT DOCUMENTS FOR:	Project #CP231541 – Virginia Avenue Substation and Underground Ductbank
ADVERTISEMENT DATE:	November 21, 2024
PREPARED FOR:	The Curators of the University of Missouri
CONSULTANT:	Jacobs Engineering Group, Inc. 777 Main Street, 23rd Floor Fort Worth, Texas 76102

The contract documents for the above noted project and the work covered thereby and herein modified.

PROJECT MANUAL(VOLUME 2):

1) Replace Section 261326 – MEDIUM VOLTAGE METAL CLAD SWITCHGEAR
2) Replace Section 263330 – BATTERY EQUIPMENT

SECTION 261326 – MEDIUM VOLTAGE METALCLAD SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. The quotation documents shall include the following:

1. Total price of all purchased equipment
2. Separate “optional adder” prices as detailed in this specfication.
3. Clarifications and exceptions to this specification or the drawings.
4. Length of warranty inclduing details of the warranty.

1.2 SUMMARY

A. Provide two separate medium voltage switchgear lineups per drawings. Both are 15 kV rated (13.8 kV system voltage), 3-phase, 3-wire, solidly grounded at the transformer only (no neutral bus in the switchgear), 60 Hz metal-clad, drawout, vacuum interrupter, circuit-breaker switchgear with the following components, features, and accessories:

1. Copper, silver-plated main bus.
2. Relays.
3. Station Class Surge Arresters (Mains Only).
4. Provisions for future devices.
5. NEMA 1 enclosure
6. UL labeling
7. Suitable for service entrance equipment.

1.3 REFERENCES

A. ASTM (ASTM): ASTM B187 "Standard Specification for Copper, Bus Bar, Rod, and Shapes".

1. Code of Federal Regulations (CFR):

   a) CFR 47 Parts 15 and 18, Code of Federal Regulations - Federal Communications Commission (FCC) Rules and Regulations pertaining to EMI.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

   a) ANSI/IEEE C37.010 - "Application Guide for AC High Voltage Circuit Breakers > 1000VAC Rated on a Symmetrical Current Basis."
   b) IEEE C37.04 - "IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers"

c) IEEE C37.06 – “IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis— Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V”
d) IEEE C37.2 - "Electrical Power System Device Function Numbers, Acronyms, and Contact Designations".
e) C37.20.2 - "Metal Clad Switchgear"
f) IEEE C37.21 - "Control Switchboards"
g) IEEE C37.90 - Relays and Relay Systems Associated with Electric Power Apparatus.
h) IEEE C37.100 - "IEEE Standard Definitions for Power Switchgear"
i) IEEE C57.13 – “IEEE Standard Requirements for Instrument Transformers”
j) IEEE-1613: Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations

3. International Electrotechnical Commission (IEC):

a) IEC 60068-2: Environmental Tests
b) IEC 60255-21: Vibration and shock Tests
c) IEC-60255-22: RFI and Interference Tests
d) 60825-1: Laser (LED) Safety
e) IEC-61000-4: Electromagnetic Compatibility
f) IEC-61000-6: Electromagnetic Compatibility
g) IEC-61850 Series: Communication Networks and Systems for Power Utility Automation

4. National Electrical Contractors Association (NECA):

a) NECA 430-2016 Standard for Installing and Maintaining Medium-Voltage Switchgear

5. National Electrical Manufacturers Association (NEMA):

a) NEMA SG 4 - "Alternating Current High Voltage Circuit Breakers".
b) NEMA C37.55 "Conformance Test Procedures for Switchgear – Medium Voltage Metal Clad Assemblies".

6. National Fire Protection Association (NFPA):

a) NFPA 70 - "National Electrical Code" (copyrighted by NFPA, ANSI approved) hereinafter referred to as NEC.
b) NFPA 70B - "Recommended Practice for Electrical Equipment Maintenance" (copyrighted by NFPA, ANSI approved).
c) NFPA 70E – “Standard for Electrical Safety In The Workplace” (copyrighted by NFPA, ANSI approved) hereinafter referred to as NEC.

7. Underwriters Laboratories, Inc. (UL):

a) UL 486A-B - "UL Standard for Safety Wire Connectors.

1.4 SITE CONDITIONS

A. Seismic Loads

1. The switchgear must be capable of withstanding the forces listed in the International Building Code, IBC-the most recent edition for the Columbia, Missouri seismic zone, in addition to any other applicable codes. The vendor shall include signed and sealed data in a drawing or a report to confirm the switchgear meets these requirements.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data showing material and equipment proposed. Approval drawings prior to release for manufacturing are required.

1. Product data shall include, but shall not be limited to, the following equipment and materials:

a) Circuit breakers.
b) Buses.
c) Instrument Transformers.
d) Control, Relaying, test switches, relays, and Metering equipment.
e) Wire and cable.
f) Station Class Surge Arresters.
g) Fuses.

2. The ratings for the equipment shall include, but shall not be limited to, the following:

a) Voltages.
b) Frequency.
c) Number of phases.
d) Current, continuous and interrupting.
e) Accuracy.
f) Power requirements.
g) Power losses at full and half load.

3. Physical characteristics and materials shall include, but shall not be limited to, the following:

a) Size/dimensions.
b) Weight.
c) Finishes.

4. Accessories shall include, but shall not be limited to, the following:

a) Indicating lights.
b) Terminal blocks.
c) Test switches.
d) Auxiliary contacts.

B. Shop Drawings: Submit complete shop drawings as required to determine acceptability. Shop drawings shall include, but shall not be limited to, the following:

1. Bill of materials and components.
2. Outline drawings, dimensioned plans, elevations, sections, supports, materials, and finishes, showing weights, bolt spacing, clearances, tolerances, conduit, cable entrances, terminal strips, and methods of assembly.
3. Cubicle and compartment layouts.
4. Bus and circuit breaker ratings and arrangements including dimensions of bus bars, including the ground bus, and the type and spacing of bus supports.
5. Nameplate details (size and legend).
6. Detail drawings showing incoming line terminations and location of cable termination with dimensions. Shop drawings shall verify sufficient conductor space and compliance with codes.
7. Mimic bus diagram showing it installed on the front of the switchgear.
8. Shipping arrangements and packaging methods.

C. Wiring Diagrams: Submit with shop drawings, specific wiring diagrams and instructions for equipment, controls, communications, or devices which are furnished, or which are to be field wired and connected. The diagrams and instructions shall not be of a general or typical nature, but shall be applicable only to this Project. Include identical diagrams and instructions to install the equipment as are included in the operating and maintenance manuals. Wiring diagrams shall include, but shall not be limited to, the following:

1. Single- and three-line diagrams.
2. Electrical wiring diagrams for communications, instrumentation, metering and relaying.
3. Control schematic diagrams including interface diagrams having terminals identified for remote equipment.

    a) Indicate all field wires with Cable Tag, Size, Color, Equipment To, Equipment From per Jacobs cable schedule, in addition to Terminal Block, and Terminal Number where wire is to be landed. In the case that a cable is required but not indicated on Jacobs cable schedule, notify engineer and cable information shall be provided.

4. Wiring diagrams for switchgear showing connections to distribution branches.

D. Calculations: Submit calculations supporting the selection of the devices and components if being furnished. Devices requiring submittal of calculations shall include, but shall not be limited to, the following:

1. Instrument Transformers: Sizes and burdens.
2. Control power transformers.
3. DC Power System components.
4. Low Voltage AC Power system components.
5. Seismic withstand calculations.

E. Operating and Maintenance Manuals: Prepare and deliver complete operating and maintenance manuals. Provide information pertinent to the equipment for preventive maintenance and for replacement of expendable components. Manuals shall include the items listed below and other information recommended by the manufacturer:

1. Manufacturer's published information.
2. Set of shop drawings.
3. Wiring diagrams of electrical components.
4. Acceptance test reports.
5. Electrical characteristics and ratings of components.
6. Recommended spare parts list.
7. Maintenance Procedures
8. Complete list of parts.
9. Factory Test Data: Provide factory test data certified by a professional engineer that switchgear test results fulfill the specified requirements.

F. Submit with proposals.

1. Preliminary Data Sheets.
2. Preliminary one-line diagrams.
3. Elevations showing overall dimensions, weights, and layout of accessories.
4. Conduit area availability in both top and bottom of switchgear for power and control/communication cable/wires.
5. Bill of materials for each cubicle with manufacturer reference number.
6. Complete list of spare parts and special tools that will be furnished with equipment, which are included in lump sum price. In addition, provide an itemized price listing of recommended spare parts with prices guaranteed for at least 1 year after acceptance of equipment.
7. Complete data and listing of items requiring field assembly and installation and special equipment required.
8. Manufacturer’s ISO certification certificate.
9. Location of manufacture of each unit.
10. Circuit Breaker control power requirements for 125VDC: close current coil (amps), trip coil (amps), spring charge motor current (amps) and maximum run duration (seconds), close voltage operation range (volts), trip voltage range (volts).

G. Submit after Notice of Award

1. Certified Data Sheets.
2. Master drawing index.
3. One-line diagrams.
4. Three-line diagrams.
5. Conduit entry and exit locations.
6. Schematic diagrams and elementary wiring and connection diagrams.
7. Control and equipment wire terminations.
8. Material lists with manufacturer reference numbers.
9. Ratings and nameplate schedules.
10. Elevations showing overall dimensions, weights, and layout of accessories.
11. Switchgear cross-sections to indicate interior bus arrangement and equipment locations.
12. Floor plan drawing showing location for anchor bolts and leveling channels.
13. Location of floor and pad openings required for entrance of conduits and cables.

14. Performance curves for each ratio and type of current and voltage transformer.
15. Detailed instruction books for all equipment, meters, and each type of relay.
16. Detailed characteristics of surge arresters.
17. Detailed procedures and processes for factory acceptance tests.
18. Certified test report of manufacturer's standard production tests

H. Submittal Review

1. Allow for minimum of two full weeks (14 calendar days, 10 working days) owner and EOR to review all submittals.
2. Owner reserves the right to perform an onsite review of shop drawings.
3. Provide the price per day of shop drawing review at the factory and switchgear inspection. The cost of customer travel expenses shall be the responsibility of the customer. The manufacturer normal M-F business hours are assumed.

1.6 SYSTEM DESCRIPTION

A. Provide complete free-standing assembly as shown on drawings consisting of circuit breakers, fuses, protective relays and control devices for operation and control of the distribution feeders, tie breaker(s) and the main breaker(s).

1.7 QUALITY ASSURANCE

A. After fabrication, perform an operational test in the manufacturer's plant to check out the entire system before delivery. Include calibration of meters, operation of temperature sensors, relays and device settings; control wiring, including polarity, of all instrument transformers; complete assembly and control function testing. Submit certified written test reports.

B. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

C. The Manufacturer shall have in place a complete and functioning comprehensive Quality Assurance program covering the design, procurement, fabrication, packaging and delivery of the specified equipment and materials. This program shall ensure that the equipment and materials furnished by the Manufacturer meet the requirements of this Specification as well as the Manufacturer’s own procedures and processes.

D. It shall be the Manufacturer's responsibility to ensure that the Suppliers, Sub-Suppliers and Sub-Contractors meet the intent of this requirement and are able to demonstrate their compliance.

E. The owner reserves the right to reject equipment and/or components which require major alteration to meet specifications.

F. Non-conformances to this Specification and major equipment or component repairs that occur shall be documented and approved by the Owner in writing prior to testing and shipment.

G. Retain first paragraph below to allow drawing details based on one manufacturer's product to establish requirements and still allow competition. Coordinate with Division 01 requirements.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

I. Provide written data certifying a minimum of ten years' experience in the building of metal clad switchgear and at least ten successful working installations of this type of equipment.

1.8 WARRANTY

A. The manufacturer shall provide a warranty against defects in material and workmanship for a period of 36 months after shipment or 30 months from the date of commissioning, whichever occurs first. During the warranty period, there shall be no cost to the owner for any corrective repairs.

B. Provide Owner with any additional component warranty information in excess of the above.

1.9 DELIVERY, STORAGE, AND HANDLING

A. The shipping sections of all switchgear shall be broken down into sections to allow moving equipment through openings into the electrical room.

B. All shipments shall be wrapped in plastic.

C. Gravity and tilt recording meters shall be provided on all shipments to ensure equipment was handled properly during transport.

1.10 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, equipment, and adjacent surfaces of electrical room.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers:

1. Powell Industries.

2.2 GENERAL

A. Standards: The switchgear shall consist of stationary steel structures containing vacuum type, drawout power circuit breakers with overcurrent devices, instruments, buses, and system control devices. The switchgear shall be UL approved as service entrance equipment and designed, built, and tested in accordance with ANSI/IEEE and NEMA standards for metal clad switchgear.

B. Unless otherwise specified this equipment is intended for use in temperature-controlled building.

C. This equipment is intended for use in an area where the elevation is less than 3300 feet above sea level. Above 3300 feet a de-rating factor as prescribed by ANSI standards will apply.

D. The switchgear shall be suitable, tested and certified to meet all applicable seismic requirements of the latest International Building Code specifically for seismic zone requirements.

2.3 SWITCHGEAR RATINGS:

A. Rated Maximum Voltage: 15 kV.

B. Power Frequency: 60 hertz.

C. System Voltage: 13.8 kV.

D. Phase: Three.

E. System: Three phase, 3-wire, neutral solidly grounded at each transformer (no neutral bus in switchgear).

F. Rated Voltage Range Factor (k): 1.0.

G. Rated Continuous Current:

1. Main Bus: 3000A
2. Main and Bus Tie Breakers: 2000A
3. Feeder Breakers: 1200A

H. Interrupting time: 3 Cycles

I. Rated short-circuit and short-time current:36 kAIC

J. Closing and Latching Capability: 130 kA peak

K. Low Frequency Withstand Voltage Insulation Level: 36 kV.

L. Impulse Withstand Voltage Insulation Level: 95 kV.

M. Nominal Control Voltage: 125 volts DC for close, trip, and spring motor operation. Customer provided power.

2.4 ENCLOSURE

A. Vertical Sections: The stationary enclosure shall consist of self supported, vertical sections housing circuit breakers, buses, cables, system controls, and accessories. The vertical sections shall be bolted together to form a rigid metal clad switchgear assembly. The vertical sections shall have separate front compartments for circuit breakers and controls, and rear compartments for buses and outgoing cables. The vertical section framework shall consist of a welded and bolted steel frame with reinforcing gussets. Assembled to this framework shall be doors and top, side, and rear covers.

B. Base: The vertical sections shall be supported on a steel base assembly consisting of die formed steel and commercial channel welded and bolted together. The base shall provide a rigid support for the switchgear assembly.

C. Each front and rear compartment door shall be provided with a formed steel hinged door with hand operated heavy duty door latches with 'T' handles, see below for example photo. Each door shall have provisions for padlocking. Rear doors with 3-point latching for access to cable compartments. Rear doors shall be equipped with IR viewing windows with removable dustproof covers; two high sections shall include IR viewing windows for each upper and lower compartment. Each breaker cubicle front door shall have a manual "Pull To Trip" switch with spring cover, see below for example photo.

D. Lifting Equipment: Circuit breaker lifting equipment shall be provided to remove circuit breakers. The equipment shall be a portable lifting device manufactured by the equipment supplier.

E. Breaker Compartment: The front compartment of the switchgear shall contain the drawout circuit breakers. Each vertical feeder section shall provide the space to accommodate two circuit breakers if frame size allows. Each circuit breaker shall be mounted in a barriered cell. Breaker

compartments for future use as indicated as “SPACE” on the drawings, shall be fully equipped with drawout assemblies and current carrying parts required to permit completion of the unit by the addition of only a circuit breaker. Provide an LED light source in the top and bottom of the front and rear compartments operated by a light switch on the door.

F. Cable Compartment: The cable compartment shall be sized to accommodate incoming and outgoing cables or busway required for each vertical section. The bus compartment shall be segregated from the feeder cable compartment by means of grounded metal barriers. The cable compartment shall also contain a copper ground bus bolted directly to the switchgear frame. The incoming main breaker, tie breaker, and feeder breaker cable compartments shall be capable of terminating the correct quantity of copper cables with NEMA 2 hole compression lugs and sizes as noted on the contract drawings up to 6-750 kcmil, 15 kV, MV-105, 133% insulated conductors at a minimum. The depth of the finished equipment shall be sufficient to allow for entrance, bending, and termination of power cables. Individual units shall be provided for bottom entrance. A minimum of 26 inches of vertical clearance between terminal pads and the cable entrance shall be provided. Two high sections shall provide a separate chute or channel to isolate and route bottom entry cables to upper compartments. The quantity of lugs per phase provided shall be based on MV-105, 15kV cable, Cu conductor, type EPR insulation, with 133% concentric neutral. Terminal pads shall be provided with cable support.

G. Each switchgear cubicle shall have at a minimum 11-gauge sheet steel side panels. Construction shall provide two (2) steel sheets between adjacent sections so as to minimize the chance of fault propagation between sections.

H. Provide electric heaters in each switchgear compartment.

1. Voltage: 240 Volt single-phase operated at 120V from an external source.
2. Watts: As required to maintain temperature.
3. Provide thermostat for each compartment with a minimum set point of 50°F.

I. Finish: Indoor: The switchgear enclosure parts shall be given an iron phosphate pretreatment, a primer, and a coat of baked enamel. After assembly, a finish coat of air-drying enamel of gray color (ANSI #61) shall be applied to exterior surfaces.

2.5 BUSES

A. General: The bus structure shall consist of copper bus with silver plated bolted connections mounted on track resistant glass polyester and porcelain insulators. The bus system shall be insulated with fluidized bed epoxy insulation. The copper bus shall be of sufficient size to limit the temperature rise as specified in ANSI/IEEE C37.20.2. Bus bracing shall be adequate to withstand mechanical and thermal stresses due to short circuits at least equal to those specified for the main circuit breaker. Provide ASTM B 187 copper throughout the switchgear. Bus joints shall be provided in each unit. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by a design test.

B. Provide removable insulating covers for line and load terminations.

C. Power bus orientation shall be 1-2-3 top to bottom, front to back, and left to right when viewed from the front of the switchgear.

D. Phase Buses: Provide continuous phase buses for the full length of the switchgear lineup. Tap buses shall have the same ampacity as the section design rating.

E. Ground Bus: Provide a minimum size ground bus of 2 inch by 1/4-inch cross sectional area, for the full length of the switchgear lineup. Provide compression indent type lugs to accept No. 4/0 AWG copper cable.

F. Connections: Bus connections for shipping breaks, extension, and taps shall be silver plated bolted pressure joints. Provide insulating boots for bus joints and cable terminations. Selection of cable termination boots to be based on installed cable diameter (15kV cable terminations will be live skirted terminations 3M QT-III).

G. All cables will be entering and exiting the botom of the switchgear.

H. Safety Shutters: The switchgear shall be furnished with grounded shutters or a means by which to cover the stationary primary disconnects when the breaker is moved from the connected position.

2.6 POWER CIRCUIT BREAKERS

A. General: The power circuit breakers shall be medium voltage, drawout, vacuum circuit breaker type, having electrically charged, stored energy mechanisms which shall be mechanically and electrically trip free. Provision shall be included for manual charging of the operating mechanism. The breakers shall be mounted on a rigid, self-aligning drawout mechanism. The breaker shall be removable and shall roll out on horizontal guide rails. All breakers shall be the 3-cycle.

B. Trip coils:

1. Provide dual trip coils for main and tie breakers.

    a) Provide one of the “SPARE” breakers rated at 2000A with dual trip coils mounted in Spare 1200A cubicle for each line-up per drawings.

2. Provide single trip coil for feeder breakers.

C. Breaker Positions: Each drawout breaker shall be provided with three position operation. Each position shall be clearly identified by an indicator on the circuit breaker front panel.

1. Connected Position: In the connected position, the main line and load terminals and auxiliary control contacts and circuitry shall be connected, and the breaker shall be fully operable. The breaker shall be interlocked to automatically trip before racking into or out of position.
2. Test Position: In the test position, the circuit breaker auxiliary control contacts are manually connected from the front of the breaker and circuitry only shall be connected to permit testing of the complete control system without actually connecting the sources or loads to the main bus. Control contacts are mechanically interlocked with the breaker.

3. Remove Position: In the remove position circuitry shall be disconnected and the breaker can be removed from the compartment.

D. Operating Mechanism:

1. The breaker operating mechanism shall be the two step, stored energy quick make, quick break type. The close operation of the circuit breaker shall automatically charge the opening springs. The operating mechanism shall be front located and designed for servicing without removing breaker from rails.
2. Manual charging of the breaker shall be possible by means of a manual charging lever.
3. Close trip indicator, mechanically connected to the breaker, shall be provided to indicate the breaker position.
4. Circuit breaker operating mechanism shall be completely trip free both mechanically and electrically. Mechanical tripping of a closed-circuit breaker shall be possible with the front cubicle door closed.
5. A contact wear gap indicator shall be provided and shall be easily visible.

E. Mechanical Interlocks: The switchgear shall be provided with mechanical interlocks to:

1. Prevent moving the breaker to or from the connected position when the breaker contacts are in the closed position.
2. Prevent closing the breaker unless the primary disconnects are fully engaged or the breaker is in the test or disconnect position.
3. Automatically discharge the closing springs when the breaker is moved between the connected and test positions or when it is inserted into or withdrawn from the compartment.

F. Mechanism Operator Cell Breaker Auxiliary Switches: Each circuit breaker shall be equipped with mechanism operated auxiliary switches which shall operate when the breaker is open or closed. These switches shall be enabled in the operating and test position. Provide four normally open and four normally closed contacts in addition to those required for the circuit breaker operating mechanism and control schemes. Wire all spare contacts to terminal blocks for customer use.

G. Truck Operated Cell Switches: Each breaker compartment shall be equipped with cell mounted switches which shall operate when the circuit breaker is levered into or out of the operating

position. Provide two six stage switches, each six-stage switch shall provide six normally open and six normally closed contacts. Wire all spare contacts to terminal blocks for customer use.

H. Breakers shall have secondary connections on the front of the breaker, see below for example photo.

I. A steel interference plate shall be mounted in the bottom of each circuit breaker cell assembly which only allows the same or higher rated circuit breaker (voltage, current, interrupting rating) to be inserted into a lower rated cell assembly.

J. For operator safety the circuit breaker shall have provision for padlocking it in the disconnected position.

K. Circuit breaker shall have the capability of racking between the connected, disconnected and test positions with the cubicle door closed.

L. Power circuit breakers shall be shipped and packaged separately from the switchgear structure.

M. The power circuit breaker ground connection must be capable of carrying the short circuit rating of the circuit breaker for a minimum of 2 seconds and must also be capable of withstanding the peak current value (or 2.7 times the rated short circuit current) of the circuit breaker.

2.7 REMOTE RACKING

A. Each metalclad switchgear lineup shall be provided with remote closed door racking provisions for all circuit breakers. Closed door racking provisions for circuit breakers shall not require the end user to install any extension arms through the door for operation of the racking mechanism. Each circuit breaker shall have integrated racking motor for this function. Cubicle mounted racking motor shall not be permitted.

1. Provide remote racking via HMI interface. Provide terminal blocks for field wiring to interface with HMI and control remote racking of each breaker.
2. Provide freestanding HMI shipped loose for installation in Control room.
3. Provide remote racking pendant with minimum ten (10) meter cord for remote racking by personnel in addition to remote racking by HMI. Pendant shall have Open, Close, Rack IN, and Rack OUT push buttons with LCD Display indicating breaker status.
4. Provide pad-lockable door mounted switch to enable/disable racking capability for that cubicle.

2.8 DIGITAL POWER MONITOR

A. Digital Main Meters (DMM): General metering information is to be available through the Schweitzer relays. In addition to devices below:

1. Provide single phase digital switchboard monitor Electro Industries F series or approved equal for each feeder cubicle equipped with a line side PT, not required on Mains or Ties.
2. MVSG-North:

    a) Frequency Transducer: Ohio Semitronics Model AFT-060-10E (or equal). Provide twisted shielded pair for connection of transducer and logger.
    b) Datalogger: Delphin Technology, Expert Logger 100.
    c) Bus voltage meter: Shark 250 part number Shark250-60-10-V1-D2-INP100S-X-X.

    d) Dranetz PQ3000 power quality, Energy and Demand, and Process Monitoring.
3. MVSG-South:

    a) Dranetz PQ3000 power quality, Energy and Demand, and Process Monitoring.
    b) Bus voltage meter: Shark 250 part number Shark250-60-10-V1-D2-INP100S-X-X.

2.9 CIRCUIT BREAKER MONITOR

A. Provide real-time circuit breaker data acquisition & diagnostics system. Circuit breaker monitoring system shall proactively monitor circuit breaker health by using advanced algorithms, analyzing past and present data, to determine equipment health and inform of potential problems. Circuit breaker monitor shall have a condition status light mounted in a clearly visible location on the inside of the breaker cubicle. Light shall be green for normal, yellow for warning, red for alarm. Provide USB diagnostics port on the front of each circuit breaker cubicle to allow for access of monitor with laptop computer without opening cubicle door. Provide licensed copy of software on USB drive. Circuit breaker monitor shall be provided with form C dry contact which operates when alarm function is triggered for external customer use. Wire contact to protective relay in that cubicle. Monitor shall capture the following data at a minimum:

1. Operating coil condition.
2. Mechanism operation.
3. Circuit breaker environmental conditions.
4. Thermal status of circuit breaker primary conductors.
5. Trip/close timing.
6. Charging motor condition.
7. Digital operation count.

B. For 2000A breakers provide fiber optic temperature monitoring system. System shall be designed and tested to comply with IEC 61010. Provide display unit with LCD screen and USB port. Monitor shall measure the temperature of all three phases on the line and bus side cable and bus terminations.

2.10 ACCESSORIES

A. Lockout Relays.

1. Electroswitch Type LOR Series 24, part number as indicated on Contract Drawings.
2. Integral LEDs:

    a) Lockout relay coil intact and ready – White.
    b) Lockout relay trip applied – Red.
    c) Rated operating trip voltage shall be low enough to allow coil operation at 75% of rated voltage.

3. Part number indicates number of decks, and therefore number of contacts.

B. Breaker Control switches.

1. Electroswitch Series 24.

    a) Rated operating trip voltage shall be low enough to allow coil operation at 75% of rated voltage.
    b) Pistol Grip handle.

C. Local/Remote Switch.

1. Electroswitch Series 24.
2. Oval Shank handle.
3. Contacts: Minimum 4 N.C. and 4 N.O, wired to terminal blocks for owner's use.

D. Circuit Breaker status lights (LED):

1. Open (Green).
2. Closed (Red).

E. Trip Coil Monitor:

1. SEL 2652 Trip Coil Monitor SEL Part Number 2652B5XX.
2. Trip Coil healthy LED: Blue.
3. Alarm contacts for trip coil discontinuity.
4. Quantity:

a) Main and Tie: Two each.
b) Feeder: One each.

5. Mounted in cubicle door

F. Kirk-Key Interlock:

1. Provide key interlock for capacitor bank circuit breaker cubicles. Key can only be removed with breaker racked out. Mount interlock in cubicle door. Key shall be operable with cubicle door closed. Interlock shall be Kirk-key brand or approved equal.
2. Lock shall be re-keyed in the field to match key provided by capacitor bank vendor.

2.11 ELECTRONIC PROTECTIVE RELAYS

A. Protective relays shall be Schweitzer Engineering Laboratories (SEL) as specified herein under the breaker type classification specification sections in this document. The relays shall meet the following performance requirements:

1. Standards: Shall meet applicable IEEE C37.90 and IEEE C37.2 standards.
2. Temperature Range: 2 degrees C (28 degrees F) to 55 degrees C (131 degrees F) (operating), 4 degrees C (25 degrees F) to 70 degrees C (158 degrees F) (storage).
3. Alarm Contact: Normally closed contact (contact closed if loss of power or self check failure).
4. The relays shall be capable of transmitting metering, event, alarm and status information to a RTAC controller.
5. Breaker Type:

a) MVSG-NORTH and MVSG-SOUTH Bus Differential:

1) SEL-787Z part number 0787Z001A1A1A0X85A6310110.
2) Quantity: 2

b) Main Breaker:

1) SEL-700GT+ part number 0700GT1A1A1A7585A2C0.
2) Quantity: 2

c) MVSG-NORTH Tie Breaker:

1) SEL-751 part number 751201A1A1A7A85AF30.
2) Quantity: 1

d) MVSG-SOUTH Tie Breaker:

1) SEL-787 part number 07873SE1A1A1A7585A630.
2) Quantity: 1

e) Feeder Breakers:

1) SEL-751 part number 751201A1A1A7A85AF30
2) Quantity: 26

B. Manufacturer to supply a minimum of one (1) license for all software required to communicate with and set relays as well as analyze oscillography obtained from event reports. Provide 2 communication interface cables for each lineup. Fully optioned software for advanced analysis and setting capabilities is required. Minimal freeware versions of software will not be accepted.

C. Relay settings shall be determined by a coordination study provided by contractor. Refer to specification 260573.16.

D. The Main and Tie Breaker control logic is permitted to allow continuous paralleling of sources based on the sync-check relay (Device 25). See drawings for specific breaker control relay logic. (Information Note: a current limiting tie reactor is provided to limit campus symmetrical short circuit amps to 25kA or less.

2.12 DC OVERCURRENT CIRCUIT PROTECTION AND WIRING

A. All DC-fusing shall be ganged, + and -, in dead-front, “finger safe” shot-gun style pull-out type with lighted blown fuse indication visible from the front of the fuseblock.

B. Each metal-clad vacuum circuit breaker shall have a separate set of fuses for the trip circuit, close circuit, and relay power/inputs.

C. Customer provided DC circuit(s) shall terminate on finger safe disconnect switch then distributed to the individual breaker cubicles.

2.13 WIRING

A. Class B for stranding and flexibility for all control wiring, No. 14 AWG minimum (Current transformer wiring #10 AWG minimum).

B. Wiring over door hinges or other locations where leads may be subject to flexing shall employ the use of No. 14 AWG (minimum), 41 strand, extra flexible copper conductors.

C. Ring tongue type lugs connected on all control wiring except relay connections (wire ferrule for relay connections).

D. Terminal block connections used shall be GE Type EB=25 or similar style with terminal marking strip in the middle of the block. All current transformers terminal blocks (SCTB) shall be GE type EB-27 and shall terminate immediately into shorting terminal blocks with knurled conductive thumbscrews (one in each corner) for shorting out the current transformer. All CT taps shall be wired out to SCTB.

E. All wiring shall utilize mechanical fastening means only. The use of adhesives for fastening wiring to the switchgear or the use of adhesives for any purpose is not permitted.

F. Terminations:

1. Wiring shall not have more than two wires connected to a terminal point.

    a) Only one wire shall terminate on “phoenix” type connectors. (Back of SEL relays for example).

2. External wiring termination points for Owner’s connections shall be arranged for one wire to each terminal point.
3. Twenty percent (20%) spare terminal points shall be provided.
4. Terminal blocks shall be furnished and installed at switchgear splits or shipping splits for wiring reconnection at the jobsite. Shipping split connections shall be clearly tagged.

G. Wire Markings: Every wire shall have source and destination identification which shall be visible at each termination point. All wire marker identification shall use typewritten text. Wire markers shall be heat shrinkable or plastic interlocking sleeve type. The marker shall not be heat-shrinked in order to be able to turn the marker to get a better view of the marking. Cloth wire markers are not acceptable. Spare contacts on relays, lockout relays, control switches, etc., shall be assigned wire numbers, wired to terminal blocks, and labeled accordingly.

H. Methods: Hinge wiring shall be arranged so that any twisting shall take place in the longitudinal plane of the conductor, rather than across the conductor. Control wires shall be armored or enclosed in grounded metal troughs where they pass through primary compartments.

2.14 NETWORK CONNECTIONS

A. Provide DIN rail mounted keystone block for each external network connection as shown on drawings. Field wire external ethernet cable to keystone block.

1. Signamax Keystone Industrial DIN-Rail Mounting Module KI-DIN-RMM-SL.
2. Signamax Keystone Cat 6 MT-Series Unscreened Keystone Jacks KJ458MT-C6C-BK (Black).

B. Provide patch cord from keystone block to device.

1. Commscope GigaSPEED XL Stranded Cordage Modular Patch Cord.
2. Jacket:

    a) “A” Network: Yellow.
    b) “B” Network: Purple.
    c) EtherCAT: Orange.
    d) Control Room HMI PC: Blue.
    e) Other: Blue.

2.15 INSTRUMENT TRANSFORMERS

A. General: Instrument transformers shall be the type for switchgear installations. Transformers and associated components shall be in a drawout section

1. Voltage transformers and associated fuse assemblies shall be installed in drawout assemblies so that they may be readily disengaged from the power bus.
2. Where physical size restrictions do not allow the Voltage transformer to be mounted in a drawout assembly, the voltage transformer may be stationary mounted with the fuses only mounted in the drawout unit. The appropriate interlocks shall be provided to ensure maximum operator safety.
3. When moved to the withdrawn position, the transformer drawout unit shall automatically ground the transformer primary windings and the fuses. A visible indication of positive ground is required. The ground may be a momentary or sweeping action that occurs as the unit moved out of the connected position.
4. Voltage transformers shall have 120-volt secondaries unless otherwise specified.

    a) Voltage transformers shall have an accuracy rating comparable to the metering equipment and a burden capacity equal to twice the initial load.

5. Current limiting fuse protection shall be provided on the primary side of each Voltage transformer.
6. Voltage transformers shall be designed to withstand the basic impulse level of the switchgear.
7. ANSI accuracy class of 0.15 with burdens of W, X, and Y.
8. Provide fused access to secondary output of each Voltage transformer in a readily accessible dedicated terminal block for future connection to synchronization equipment.

B. Current Transformers

1. Unless specified otherwise, the polarity marking shall be towards the circuit breaker.
2. Each current transformer shall be rated to withstand the thermal and mechanical stresses imposed by the short circuit rating of the applied circuit breaker.
3. The secondary termination of current transformers shall be on a shorting terminal block.
4. Current transformers shall have a rated 5 ampere secondary current unless otherwise specified.
5. Current transformers shall be rated as shown on project drawings.
6. Bus differential protective current transformers shall be identical throughout the entire bus differential protective circuit as shown on the drawings with fixed ratio.
7. Relaying accuracy classification shall be suitable for the connected burden.
8. Current transformers, when installed, shall be fully rated for the appropriate voltage class.
9. Current transformers shall have a minimum thermal rating of 2.0.
10. Relaying CTs: refer to single line diagram for ratio.

    a) Accuracy Class: ANSI 0.3S
    b) Burden: B1.8
    c) C200 at a minimum unless otherwise noted.
    d) Multi-ratio with 5 taps.

2.16 TEST SWITCHES

A. Provide test switches with stud type terminals for metering and for all relays.

B. Test switches:

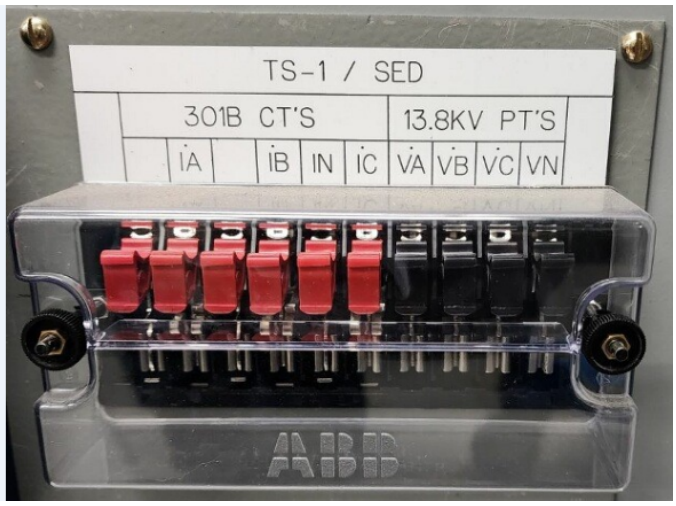
1. Knife blade test switch: 10-pole with Control Power, Voltage and Current elements as required, clear cover, ABB "Flexitest" Type FT-1, or equal.
2. Identify each voltage and each pair of current switches with a "V" or "I" and phase designation "A," "B," or "C" or ‘G’ with an engraved nameplate. (See example photo of test switch below-next page).
3. All trip circuit test switches shall be RED in color and labeled with an engraved nameplate according to relay output.
4. All test switches wired to current transformers shall be shorting type switch which shorts out the CT, make before break, when the switch is operated.

C. Extend 3-phase bus voltage circuits to all cubicles and combine with metering current transformer circuits on common test block for use with OWNER’s portable instruments.

D. Lockout test switches: 10 single-pole potential elements, cover, wired in series with coils and normally open contacts of lockout relays, ABB"Flexitest" Type FT-1, or equal.

E. Covers: Clear cover, shallow cover with thumbnuts.

F. FT Test Switches: White w/Black lettering. Handles color: Red for Outputs/Trips and CT’s, Black for all else. Refer to photo below for example:



2.17 NAMEPLATES

A. Nameplates shall be provided for each section, unit, instrument, transformer, light, meter, switch, control, terminal strip, rear panel mounted component (including fuses), fuse blocks, timers, relays, auxiliary relays, etc., in accordance with a nameplate schedule. Color coding shall be used for equipment and functional identification as indicated below.

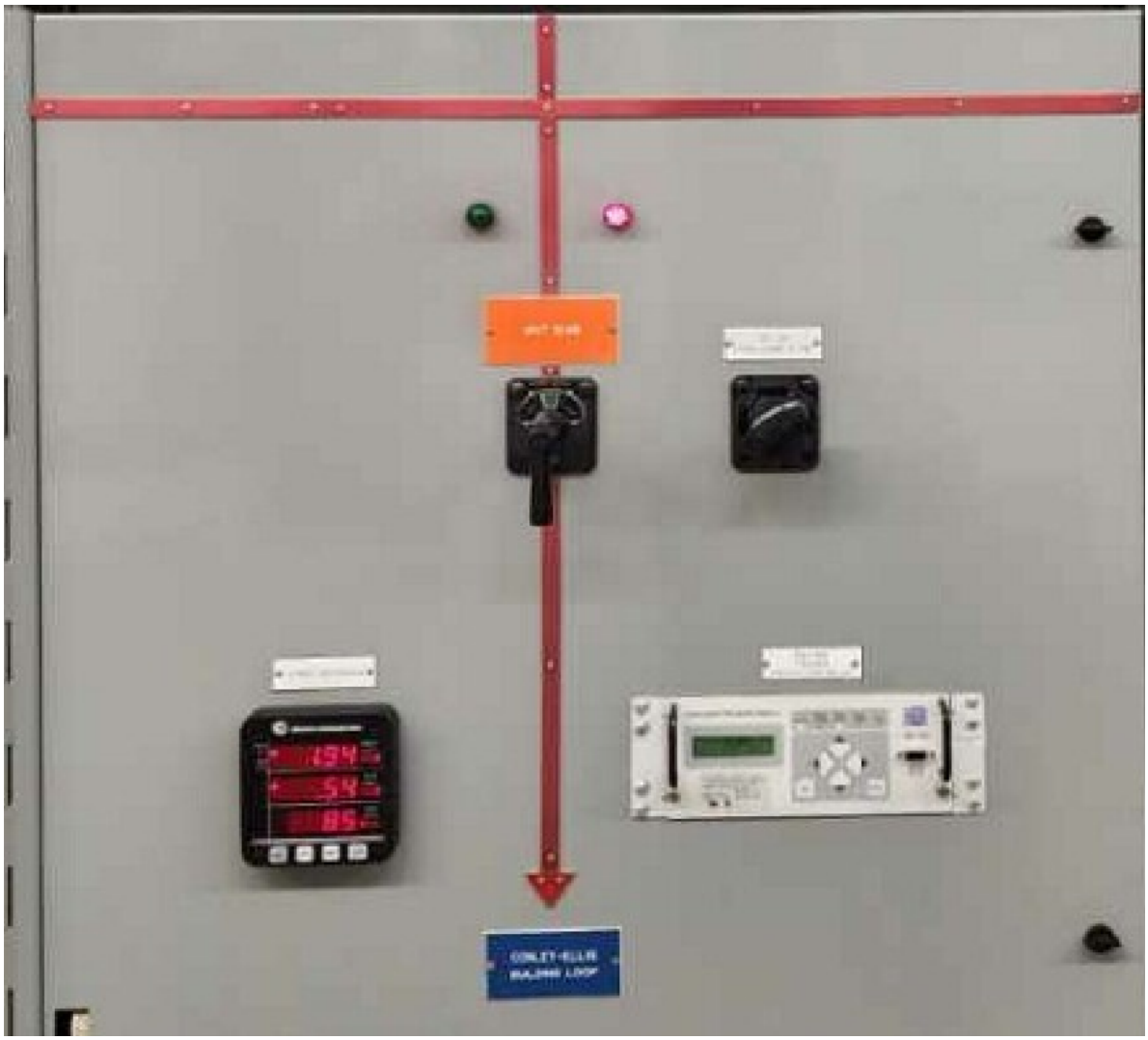
1. Manufacturer Nameplate shall be engraved (AL or SS) with Manufacture Date, order number, and Ratings. One for each vertical section in upper cubicle.
2. All other nameplates shall be laminated phenolic two-ply mplastic.
3. Characters shall be uniform block style not smaller than 1/2 inch for switchgear and not smaller than 1/4 inch for instrument transformers, relays, alarms, instruments, and control devices.

    a) Breaker Number: Orange background with white lettering (Duplicate on rear)
    b) Circuit Description: Blue with white lettering (Duplicate on rear)
    c) Device: White background with black lettering
    d) PT symbol: Red background with white lines.
    e) FT Test Switches: White background with Black lettering.

4. Nameplates shall be secured using No. 4, 36 RH stainless steel or nickel plated brass machine screws.

2.18 MIMIC BUS

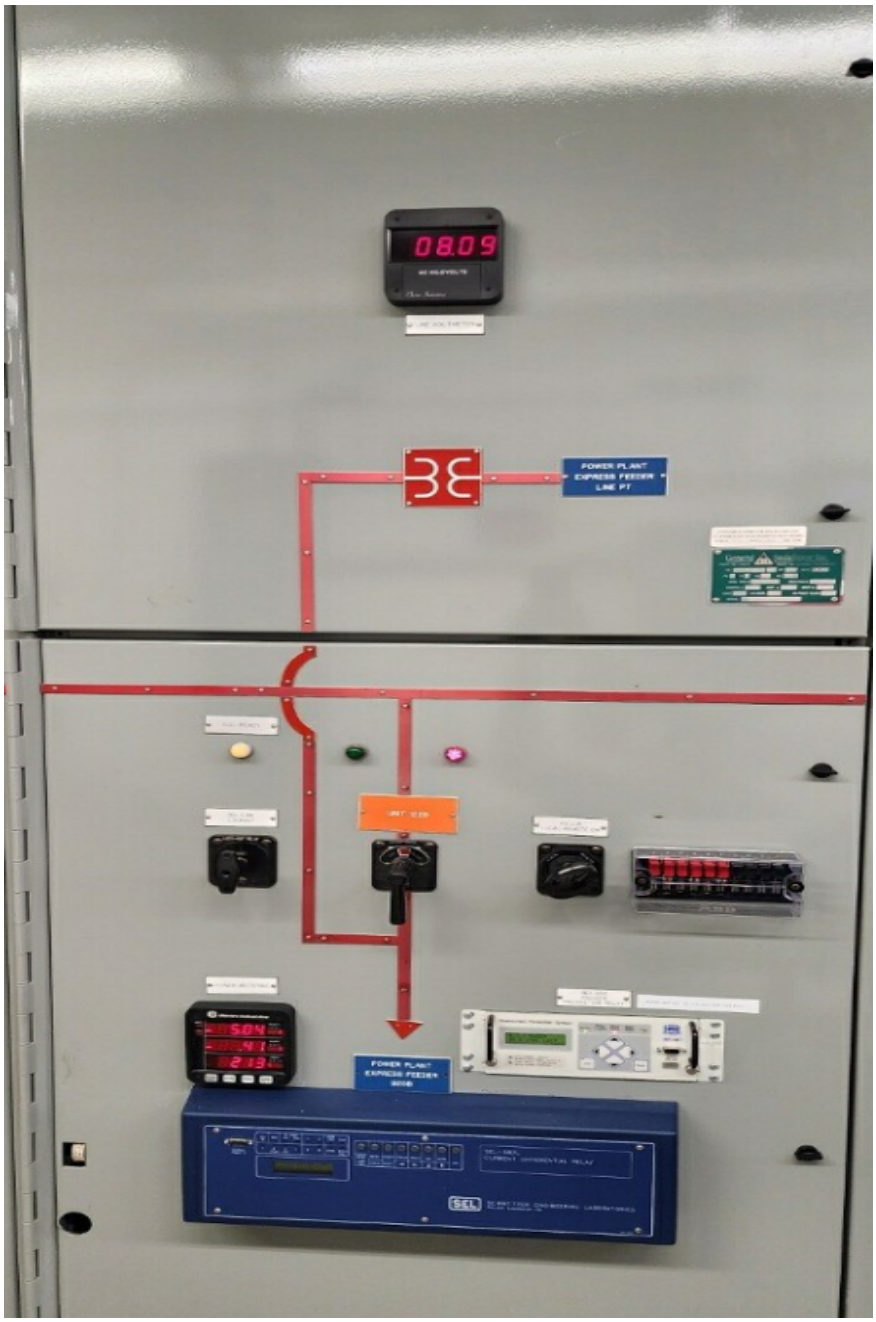
1. Mimic bus shall be provided in phenolic segments fastened using No. 4, 36 RH stainless steel or nickel plated brass machine screws. Example photos illustrating example details are shown below.



2. Provide the following features:

    a) LEDs for indicator lights
    b) Mimic bus panel display:

        1) Primary Bus: Red
        2) Nameplates and mimic bus screw fastened.
        3) Manufacturer nameplate (engraved AL or SS) with Manufacturer Date, ord number, and Ratings. One for each vertical section.
        4) Breaker number: Orange w/white lettering
        5) Circuit Description: Blue w/white lettering
        6) Device: White w/Black lettering. Refer to photo below for example.



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2.19 ACCESSORIES (one provided for each free-standing switchgear unless noted otherwise).

A. Ground and test (G&T) device (total quantity=2)
1. G&T device shall be capable of being racked in/out both electrically and manually.
2. G&T shall include ground contacts, primary disconnects, grounding cables, test ports, and wheels.

B. Fuse-handling tool

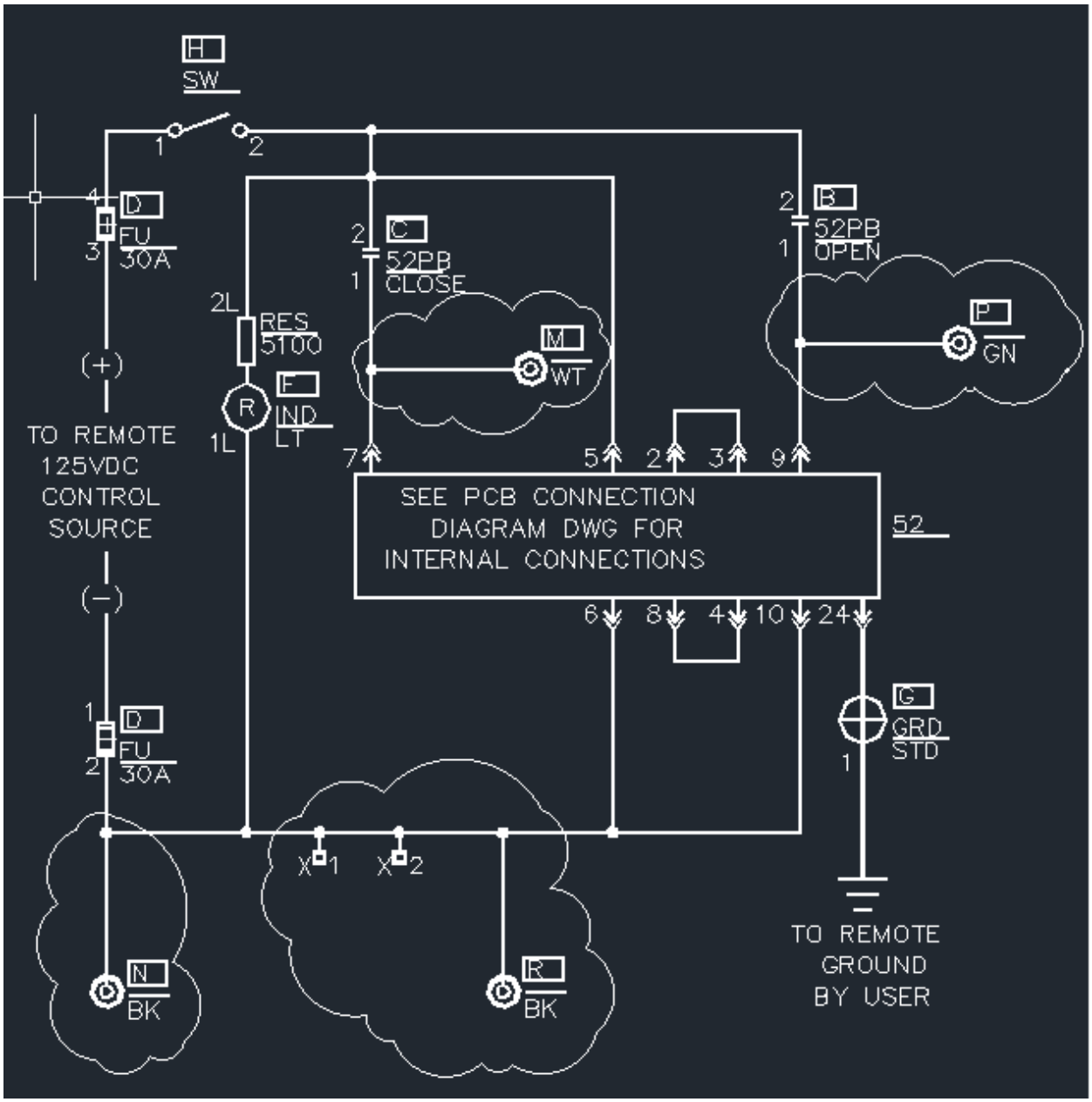
C. Breaker Lifting Truck

D. Breaker Racking Equipment and tools.

E. Remote racking pendant: Qty. = 1 per bus, 2 total.

F. Single Shunt Trip Breaker Test Cell and umbilical cord shipped loose for field installation. Install on wall inside switchgear room. Provide banana jacks for interface with timing unit. See below for example photo:

a. Nameplate
b. Control Circuit Power Indicator Light
c. Close Push Button
d. 8 Foot Cable
e. Test Cabinet Control Power Selector Switch
f. Open Push Button
g. Secondary Disconnect Plug



2.20 EXTRA MATERIALS (per switchgear lineup)

A. Touch up paint: Provide 2 quarts of each color used.

B. Spare fuses: 10% of each style and rating installed.

C. Spare Indicating lights: Provide 2 of each color installed.

D. Spare Lockout Relays: Provide 1 of each Cat #.

E. Terminal Blocks: Provide 2 of each size and style installed.

F. Test Switches: Provide 2 of each style installed.

2.21 QUALITY CONTROL

A. Factory Test: Each switchgear shall be completely assembled, wired, and functionally tested at the factory (as integrated switchgear sections with simulated inputs, as appropriate) in accordance with NETA ATS, latest edition, ANSI/IEEE C37.09, ANSI/IEEE C37.20.2, NEMA C37.55, and NFPA 70B. The factory tests shall include, but shall not be limited to, the following:

1. Design Tests: The manufacturer shall certify that representative breakers of basically the same design, the same interrupter, the same contact speed, and similar dielectric strength have been tested for design adequacy in accordance with ANSI/IEEE C37.09.
2. Production Tests: Production tests shall be made and shall include the following as appropriate for the type of equipment concerned:

    a) Medium Voltage Power Circuit Breaker:

        1) Calibration.
        2) Control and secondary wiring and device check tests.
        3) Dielectric withstand tests.
        4) No load operating tests.
        5) Mechanical test.

    b) Switchgear Lineup (in accordance with ANSI/IEEE C37.20.2):

        1) Dielectric tests.
        2) Mechanical operation tests.
        3) Grounding of instrument transformer cases tests.
        4) Electrical operation and control wiring tests.

3. Functional Tests: The intent of functional tests is to prove the proper interactions of sensors, instruments, protective devices, communications equipment, and control system so as to ensure total system operating capability. Local, remote, and interlocking control modes shall be tested. The manufacturer shall provide devices necessary to simulate such control for test purposes. Device operation, control and interlock operation, protective operations, and alarm and status system activation shall be tested and verified. All protective relays undergo acceptance testing, commissioning and primary and secondary current injection testing.
4. Witness: Manufacturer shall allow for three (3) representatives of the Owner to witness testing of the equipment.

B. Provide a competent factory trained engineer/technician by the manufacturer that is available for service on a 24 hour call basis for duration of warranty period.

PART 3 - EXECUTION

3.1 CONTRACTOR RECEIPT AND EXAMINATION

A. Equipment shall not be removed from the truck upon arrival until both the Contractor and the University Engineer responsible for the project are present to witness removal of equipment to the storage site or jobsite.

B. The Contractor shall inspect the assembly prior to unloading and notify Manufacturer of deficiencies and provide a log of all deficiencies and the resolutions to engineer and owner.

C. Photos shall be taken if any damage is found. Inspect “tip-n-tell” indictors or gravity meters, whichever has been provided. The Contractor/University Engineer shall be responsible for a timely resolution of any damages with the switchgear manufacturer.

D. Contractor shall provide personnel and tools to support and assist with completion of tasks identified in section: FIELD INSTALLATION SUPPORT BY MANUFACTURER’S REPRESENTATIVE.

3.2 FIELD SUPPORT BY MANUFACTURER’S REPRESENTATIVE

A. Prior to Contractor installing, Manufacturer’s field representative shall inspect the installation site and report any deficiencies in writing to Owner’s Representative and Engineer.

B. Manufacturer’s field representative(s) shall inspect the area and assist with lifting and installation of the switchgear only after unsatisfactory conditions have been corrected or accommodated as previously noted.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

D. Provide plugs for any enclosure openings created by removal of temporary lifting eyes, channels, etc.

E. Remove all packing and shipping materials.

F. Remove crating and place breakers in proper cubicles.

G. Tighten and torque bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

H. Verify that ground connections are in place.

3.3 IDENTIFICATION

A. Provide warning signs as specified by OSHA and Industry Standards.

B. See Section 2.15 in ths specification for additional identification requirements.

3.4 Programmable Devices

A. UEM will provide relay setpoint and coordination data.

B. Contractor shall be responsible for:

1. Implementing the settings (provide relay programming/settings files) in accordance with the information provided as well as relay control and protection logic.
2. Inputting or programming all devices accordingly.

C. Total I/O count:
1. Digital I/O (alarms, status singles, control outputs, etc.): 550
2. Analog I/O (include AC and DC values): 300

3.5 TESTING AT THE JOBSITE

A. A third-party testing agency who is a NETA certified company, shall be hired by the Contractor as long as they are approved by the University Engineer. Testing shall be completed within a year after equipment has been shipped but before commissioning. Tests as recommended by the NETA Acceptance Testing Publication NETA-ATS (most current version) shall be the requirement for testing of all electrical apparatus (switchgear, circuit breakers, vacuum breakers, relays, and meters, potential transformers, and current transformers). All data shall be recorded on professional and typewritten, legible test sheets (fill in the blank), All tests shall be reviewed by the testing agency and copies of all completed test sheets provided for review by EOR and owner. Any equipment failed by this testing shall be brought to the University Engineer's attention and forwarded to the factory for timely resolution to the problem.

3.6 DATA SHEETS

A. If values submitted by manufacturer are estimated, Data Sheets shall be updated and resubmitted after values are known.

B. Single set of data sheets for multiple switchgear with exact same characteristics may be used as long as tag numbers contained on sheets are clearly identifiable.

C. Data Sheets may require information that will not be known until engineering is complete. Data shall be estimated based on good engineering judgment for similar projects completed, and so indicated on the data sheets indicating "est." next to data.

D. Do not leave items blank or labeled "To Be Determined", or "Later".

E. Do not submit manufacturer product data sheets in place of Data Sheets.

3.7 EQUIPMENT START UP

A. Provide training at the jobsite of customer's personnel by a factory trained field service engineer with at least 10 years experience doing similar training. Provide video recording of training on USB thumb drive. All training materials are to be supplied by the factory. Provide training topics and schedule in advance for approval by owner.

a) Certified Test Reports from the factory shall be included with the operation and maintenance manuals. Five (5) hard copies are required including one set provided inside the switchgear shipment. A copy of all documentation in PDF format shall be provided on a USB in each manual.

END OF SECTION 261326

SECTION 263300 - BATTERY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Batteries
   2. Battery Racks
   3. Battery Chargers
   4. Battery Enclosure

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. Section 260500 – Common Work Results for Electrical and General Provisions.

1.3 DEFINITIONS

A. “ATS”: Acceptance Testing Specifications.

1.4 REFERENCES

A. IEEE 485 - IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications

B. National Fire Protection Association (NFPA):

   1. NFPA 70 - "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.
   2. NFPA 70B - "Recommended Practice for Electrical Equipment Maintenance" (copyrighted by NFPA, ANSI approved).

C. Underwriters Laboratories, Inc. (UL):

   1. UL 486A - "UL Standard for Safety - Wire Connectors and Soldering Lugs for Use with Copper Conductors".
   2. UL 1236 - "UL Standard for Safety - Battery Chargers" (copyrighted by UL, ANSI approved).

D. While a number of applicable sections of the aforementioned codes and standards have been identified in portions of this Specification, the Vendor has the ultimate responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

E. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

F. These codes and standards set forth the minimum requirements. These may be exceeded by the Vendor if, in its judgment and with Owner's acceptance, superior or more economical designs or materials are available.

G. If any law, regulation, standard or code is added, changed or deleted after the release of an order, such addition or change shall be discussed between the Owner and Contractor and resolved in accordance with the order.

1.5 SUBMITTALS

A. Submit a compliance sheet for each submittal indicating the submittal is in full compliance with the drawings and specifications. Indicate by drawing number or specification section number and paragraph numbers all exceptions taken and include an explanation.

B. The review of submittals does not relieve or modify Vendor's responsibility for compliance with Contract Documents or dimensions or errors contained in the submittal or quantity count. It is clearly understood that, in the review process, noting of some discrepancies but overlooking others does not grant Vendor permission to proceed in error. Regardless of any information contained in the submittals, Contract Documents govern the work, and are neither waived nor suspended in any way by the review of the submittals.

C. Submittals with Bid:

1. Product Data: For each type of equipment, include rated capacities, operating characteristics, furnished specialties, and accessories for individual charger.
2. Batteries and Chargers: submit product details and warranty information with bid.
3. Production schedule including submittal document dates and equipment delivery dates. Allow two weeks for review of submittals.
4. Drawings:

    a. Base plan including mounting details, cable entry area, and door swing requirements.

D. Submittals after bid acceptance

1. Shop Drawings: Prior to fabrication the following drawings shall be submitted by the manufacturer for approval.

    a. Front elevation view.
    b. Cross section view of each different section.
    c. Component bill of material indicating quantity, description, and part number.
    d. Control or schematic diagram for each different unit.

E. Following the return of approval drawings the manufacturer shall prepare and submit wiring diagrams indicating physical location of secondary control components and the appropriate wiring connections. Each control wire will be labeled. Copies of these drawings shall be submitted to the customer, upon completion, for record.

F. After the return of approval drawings or after any change made to previously approved drawings, the manufacturer shall submit a record copy of any and all drawings that contained revisions.

G. After completion of the inspection and testing procedures the manufacturer shall submit a complete set of “as-built” drawings. These drawings shall function as a record of the final construction of the equipment at the time it left the factory.

H. All submittals should be electronic:

1. Text and/or manuals: .pdf, .xls, or .doc.

I. Approved drawings shall be provided in .dwf, or .dxf format.

J. Source quality-control test reports.

K. Field quality-control test reports.

L. Operation and Maintenance Manuals:

1. At the time of shipment the manufacturer shall provide six (6) copies of the operating and maintenance instructions for all major components contained in the assembly.
2. Manuals shall contain a table of contents to allow for easy reference.

M. Upon completion of the engineering phase, a quotation for one (1) year’s recommended spare parts shall be submitted.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. After fabrication and prior to shipment, the manufacturer shall perform an operational test in the manufacturer's plant to check out the entire system before delivery. Include calibration of meters device settings; control wiring, complete assembly and control function testing.

C. Electrical Components, Devices, and Accessories: Where applicable, components shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated. Installing contractor and vendor shall coordinate shipping splits.

B. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover equipment to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside equipment.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 26 deg C
2. Altitude not exceeding 3300 ft. above sea level.

PART 2 - PRODUCTS

2.1 VALVE-REGULATED LEAD-ACID (VRLA) BATTERIES

A. Manufacturers:

1. C&D Technologies.
2. GNB Industrial Power.
3. Power Battery Co., Inc.
4. Storage Battery Systems, Inc.

B. The cells shall be sealed, non-spillable, valve-regulated, lead acid, absorbed glass mat separator, reduced maintenance type. Gel mat type design is not acceptable.

1. Cycling Characteristics: Each battery shall provide 1200 cycles to eighty percent depth of discharge (DOD) at the 8-hour discharge rate at 77 degrees F (25 degrees C). Cycle capabilities must be confirmed through independent lab testing.
2. Deep Discharge: Following an equalization charge, battery shall be capable of being recharged to rated capacity from a discharge down to zero volts per cell.
3. Float Voltage: Float voltage shall be 2.23-2.27 volts per cell at 25°C (77°F) and shall remain stable (+/- 0.05V from average) throughout the battery life. When

the battery is floated at this voltage, the battery shall not require any scheduled equalization charge. If required, the equalization voltage shall be 2.30-2.35 volts per cell at 25°C (77°F).

4. Recombination Efficiency: Recombination efficiency shall be 99%, or greater, when operated at 25°C (77°F) and at the specified float voltages. Water additions shall not be required under normal battery operating conditions.
5. Recharge Rate: The battery shall be capable of a 90% recharge within 12 hours when adhering to the manufacturer defined recharging parameters.
6. Operating Temperatures: The battery shall be capable of operating in temperatures ranging from -40°C to +40°C. Battery shall withstand hard freezing without damage to the alloy, plates, or cell containment assembly.
7. Coup de Fouet: Initial voltage drop during discharge (Coup de Fouet) shall not fall below the manufacturer specified end voltage.
8. Life Expectancy: Cells shall have a design life of twenty years when operated in float service at the manufacturer recommended temperature and float voltages.
9. Gassing: No special ventilation shall be required during the battery operation. No specialized "battery room" shall be required to house the battery unit.
10. Self-Discharge: The battery shall have a maximum self-discharge rate of 0.5-1.0% per week at 25°C (77°F).

C. Valve-regulated cell containers shall be impact and heat resistant polypropylene, or equivalent, with a water vapor permeability coefficient less than 4.43×10^{-9}. The cover should be attached to the container using a heat based double-sealing process. The heat seal bead shall be smoothed to increase the cover-container bond strength.

1. Plates: Valve-regulated type batteries shall be lead-acid, flat pasted-plate type with lead alloy grids. The positive grid alloy shall be constructed of MFX alloy, or equivalent, and shall be capable of deep cycle operation with low gassing, low corrosion rate, and low water loss characteristics. The negative grid shall be constructed of a lead-calcium alloy.
2. Separator: The positive and negative plates shall be separated by a low resistance absorbent microporous glass fiber mat to immobilize and retain the battery electrolyte. The positive plate shall be individually wrapped, allowing maximum active material utilization. The separator shall be compressed sufficiently to maintain separator to plate contact throughout the life of the cell.
3. Electrolyte: The electrolyte shall be introduced to the cell through a computer controlled fill-by-weight process with a deviation not to exceed +/- 1.00 percent. The electrolyte specific gravity of a fully charged cell shall be 1.310 +/-0.010.
4. Pressure Relief Valve: Each cell shall have a self-resealing safety valve that operates under a nominal pressure of 6 P.S.I. (maximum of 10 P.S.I.). A flame arrester shall be incorporated in the valve design. The valve assembly shall be removable and replaceable.
5. Housing: Cells shall be housed in a protective modular 12 gauge steel tray that provides thermal management attributes. Each cell shall be compartmentalized to maintain consistent compression throughout the life of the battery, and to simplify single cell removal and replacement. The trays shall facilitate the direct dissipation of heat and provide structural integrity for the operating battery. The trays shall maintain cell compression without requiring adjustments by the user. Tray/Cell Assembly must be capable of being stacked up to (10) units high. No separate racks shall be required.

6. Floor Supports: The standard battery support structure shall be constructed of steel I-beams. The supports shall facilitate easy assembly, provide an effective means to elevate and anchor the battery assembly to the floor.

4

D. IEEE 485 Battery sizing:

1. Batteries shall be sized on an 8 hour basis
2. Continuous load (8 hours) = 40 A
3. Reference IEEE 485 section 4.2.3. for assessing momentary loads.
4. First minute load shall include tripping all MV breakers and two 69 kV breakers plus the continuous load of 40 A.
   a. Each 69 kV breaker is equipped with dual trip coils which have a total current requirement of 12 A. Total current draw for tripping two breakers is 24 A.
5. Last Minute Load shall include the continuous load (40A) plus closing all MV breakers, two 69 kV breakers.
   a. 69 kV closing current = 1.9 A (3.8 A for two breakers)
6. Recharge factor = 1.1
7. Design margin = 1.1
8. Aging Factor = 1.25
9. Nominal DC battery system voltages:
   a. Minimum = 105 VDC
   b. Maximum = 140 VDC

E. Warranty

1. Provide a replacement warranty for 18 months from the date of shipment or 12 months from the date of energization on materials and workmanship.
2. Provide a 20 year pro-rated warranty on battery replacement.

2.2 BATTERY CHARGERS

A. Manufacturers

1. C&D Technologies
2. GNB Industrial Power
3. LaMarche Manufacturing Co.
4. Alcad

B. Input voltage: 480V, three phase, 57 – 63Hz

C. Output voltage: 130VDC

D. Output Regulation

1. Plus or minus 0.5 percent of DC setting with input voltage variations of plus or minus 10 percent and/or 5 percent frequency.
2. Plus or minus 0.5 percent of DC setting maintained with load variations from no load to full load.

3. Plus or minus 1.0 percent of DC setting maintained against the combined variations of line, load and temperature.

E. Output Current Limit: adjustable between 90 and 120 percent.

F. Output Ripple: Maximum 30mVrms filtered output.

1. Charger must operate as a DC power supply with the battery disconnected from the system.

G. Parallel Operation: Maximum 5 percent difference in output current for two chargers operating in parallel.

H. Accessories:

1. Input Circuit Breaker.
2. DC Output Fuses.
3. AC and DC Surge Suppressors.
4. DC Output Voltmeter and Ammeter.
5. Float/Equalize Timer.

I. Alarms

1. AC Power Failure
2. DC Ground
3. High-low DC Output Voltage
4. Charger Failure
5. Battery Discharging
6. End of Discharge
7. DC Current Limit
8. Common Alarm

J. Communication Board: Monitor and control battery charger over serial connection.

1. DNP3.0 or Modbus protocols
2. RS-232, RS-485 and TCP/IP ports for data communication
3. Analog inputs and setpoints

a. DC Voltage
b. DC Current
c. Equalize Timer Mode
d. Low/high DC Voltage
e. High DC Voltage Shutdown

4. Alarms

a. AC Failure
b. Blown DC Fuse
c. Low/high DC Voltage
d. High DC Voltage Shutdown
e. Low DC Current

f. DC Ground
g. Summary – selectable

K. Warranty

1. Warranty period shall be 5 years minimum or manufacturers standard, whichever is greater. Warranty shall cover material defects and workmanship.

2.3 SOURCE QUALITY CONTROL

A. Factory test complete battery system before shipment. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install system components on floor and attach by bolting.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that central battery inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

END OF SECTION 263300