

Section 16340

MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish all tools, equipment, materials and perform all labor as required for furnishing and installing a complete and operable metal-clad medium voltage switchgear assembly, all in accordance with the intent and requirements of the Contract Documents.
- B. Nameplates shall be furnished as specified in Section 16075, Electrical Identification Nameplates and Warning Signs, of these Specifications.
- C. Painting shall be manufacturer's standard. Color shall be ANSI 61 (light gray).
- D. For existing 12.47kV switchgear "ESC" retrofit requirements, refer to Section 16340 2.23, and Drawing 0E7001.

1.2 SERVICE CONDITIONS

- A. Metal-clad switchgear shall be factory assembled and factory tested. It shall have the functions, circuit assignments for each bay, the types, characteristics, ratings of buses, disconnecting and protective devices as indicated on the Contract Documents. Metal-clad switchgear shall comply with ANSI/IEEE Standard C32.20.2, "Standard for Metal-Clad and Station-Type Cubicle Switchgear."

Location of Installation:	Indoor
Environment:	Normally air conditioned
Temperature:	80 - 85°F
Relative Humidity:	50%
Outside Air Temperature:	40 - 95°F
Outside Relative Humidity:	60-90%
Outside Atmospheric Condition:	Coastal sea air typical of wastewater treatment plants, inclusive of H ₂ S at expected concentrations.
Seismic:	Zone 4, Importance Factor = 1.0

1.3 REFERENCE CODES AND STANDARDS

- A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of latest edition of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

1. Codes and Standards:

NEC	National Electrical Code
-----	--------------------------

CCR	California Code of Regulations, Subchapter 5: Electrical Safety Orders (CAL OSHA)
NESC	National Electrical Safety Code (ANSI C2)
UBC	Uniform Building Code
UL	Underwriters Laboratories

2. Commercial Standards

ANSI/IEEE C37.04	Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
ANSI/IEEE C37.09	Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
ANSI/IEEE C37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
ANSI/IEEE C37.011	Application Guide for Transient Recovery Voltage for AC High- Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
ANSI/IEEE C37.2	Electrical Power System Device Function Numbers
ANSI/IEEE C37.20.2	Standard for Metal-Clad and Station Type Cubicle Switchgear
ANSI/IEEE C37.90	Relays and Relay Systems Associated with Electric Power Apparatus.
ANSI/IEEE C57.13	Requirements for Instrument Transformers
NEMAFU-1	Low Voltage Cartridge Fuses
NEMA ICS-1	Industrial Control System
NEMA ICS-4	Terminal Blocks
NEMA SG-4	Alternating -Current High - Voltage Circuit Breakers
NEMA SG-5	Power Switchgear Assemblies
UL 508	Industrial Control Equipment

1.4 CONTRACTOR SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Section 16010, Electrical General Provisions, and the additional requirements specified herein.

- B. The following submittals and specific information shall be provided.
1. One-line diagrams
 2. Three-line diagrams
 3. Elementary diagrams
 4. Connection diagrams
 5. Interconnection diagrams
 6. Characteristic curves and instructions for coordination of fuses and settings of protective relays. Protective device time-current characteristics shall be provided on conventional-sized transparencies.
 7. The following data shall be supplied for each type of instrument transformer:
 - a. Calculations to justify rating and accuracy of CTs and PTs proposed to be furnished. In the above calculations, an allowance of 20% shall be assumed for future loads.
 - b. Ratio and phase angle error curves made in accordance with applicable codes.
 - c. Magnetization (secondary excitation) curves for CTs.
 - d. Rated output, burden designation, accuracy class, continuous and short time thermal ratings, mechanical short time ratings, voltage ratings, impulse and high-potential test ratings, and resistance of secondary windings
 8. Installation instructions
 9. Test reports (factory and field)
 10. Loading and unloading procedures
 11. Detailed Quality Assurance program documentation as specified in Section 1.6 below.
 12. All diagrams, schematics, interconnections, layouts and details submitted shall be on 24" x 36" reproducible mylars with details clearly legible. If computer generated, manufacturer shall submit both mylars and disks.
 13. Spare Parts Lists:
 - a. Complete recommended spare parts list, including parts location diagrams or drawings.
 - b. List of priced spare parts that Manufacturer recommends should be on hand during plant start-up and the first year's operation.

1.5 QUALITY ASSURANCE

- A. For the equipment specified herein, the Manufacturer shall be ISO 9001 or 9002 certified and provide detailed evidence of such certification, including the certifying agency, date of certification and dates of periodic recertification. Submittal of a blanket ISO 9000 statement is not acceptable.
- B. MANUFACTURER shall provide a Quality Assurance Program to verify that all items and services comply with the requirements of this Specification and shall submit proof of such QA program along with other submittal items. Proof shall include, but not be limited to copies of factory inspection checklists, detailed test procedures, and policies for correction of errors found.
- C. Perform any tests specified in the following paragraphs in addition to testing and other requirements for Quality Assurance in Section 16010, Electrical General Provisions, and Section 16080, Electrical Testing. Inspection and tests shall be conducted in accordance with the applicable sections of the referenced standards.
- D. All manufacturing, assembly, testing and inspection operations affecting the equipment shall be subject to quality assurance surveillance by the INSPECTOR and ENGINEER.
- E. All non-conformances to this specification that occur, must be documented and referred to the ENGINEER for disposition.
- F. INSPECTOR on site shall certify that the foundation channels for the switchgear assembly are level per the manufacturer's recommendation prior to installation of the switchgear assembly.

1.6 PERSONNEL TRAINING

- A. The CONTRACTOR shall provide a comprehensive manufacturer training program for DISTRICT personnel in the operation and maintenance of the equipment. Training shall be provided in accordance with requirements and time durations specified in GENERAL REQUIREMENTS and in Section 01820, Training.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All parts and materials shall be new, good quality and selected by the CONTRACTOR and the manufacturer to perform as specified herein.
- B. The medium voltage switchgear shall be a product of an original manufacturer in accordance with Section 16340 2.2. A product of an OEM fabrication shop is not acceptable.
- C. The model of switchgear supplied must have been in commercial production for at least five (5) years prior to supply with an established historical data base of good performance.
- D. The switchgear shall be factory assembled and tested to the greatest extent practical and so as to minimize field erection.

- E. The components of assembled unit shall be UL listed or approved by a testing laboratory acceptable to the District.
- F. The CONTRACTOR shall have full responsibility for design, fabrication and for test and inspection to ensure that the equipment provided shall comply with all regulatory codes, standards and regulations applicable to the specified service and to the requirements of these Specifications.
- G. Reliability and maximum service continuity shall be the fundamental considerations of engineering, design, operational functions, and material, used in the design of components, manufacturing, test procedures, shipping and handling.
- H. The CONTRACTOR shall furnish all necessary interfaces with devices and equipment located external to the switchgear in order to control, protect or interface with equipment and systems furnished under this Specification or by others.
- I. All medium-voltage metal-clad vacuum switchgear and individual components thereof shall be designed to perform at full nameplate rating at the ambient conditions specified.
- J. The switchgears shall be configured as shown on the drawings.
- K. The equipment and auxiliaries shall be designed to withstand earthquake loads as defined by the California Code of Regulations, Title 24 for Seismic Zone 4.

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, General Electric Co., Siemens Energy & Automation, Inc., and Cutler-Hammer/Westinghouse, **or equal**.

2.3 CIRCUIT BREAKERS

- A. Each circuit breaker shall be equipped with three vacuum interrupter pole units, one for each phase, drawout type. The circuit breakers shall be rated on a symmetrical current basis. The interrupting capabilities shall be as follows:
 - 1. The circuit breakers shall be capable of interrupting any currents from zero to rated interrupting current when used on inductive circuits, including low excitation currents of transformer banks.
 - 2. The circuit breakers shall be capable of successfully interrupting capacitive currents and shunt capacitor bank currents in accordance with NEMA SG 4.
- B. The circuit breaker characteristics and capabilities shall be as follows, according to the Contract Documents:

Nominal Voltage Class, kV, rms	15
Utilization Voltage Class, kV, rms	12.47
Frequency, Hz	60
Nominal 3-phase MVA	750
Rated Maximum kV, rms	15

Rated Voltage Range Factor	1.3
Rated Withstand Test Voltage:	
Low frequency, kV, rms	95
Impulse, kV, crest	36
Rated Continuous Current, A.	1,200
Rated Short Circuit Current at rated maximum kV, kA, rms, symm.	28
Rated Interrupting Time, cycles	5
Rated Permissible Trip Delay, cycles	2
Maximum Interrupting Capability, kA, rms, symmetrical	36
3-Second Short Time Current Carrying capacity, Ka, rms	36
Closing and Latching Capability (Momentary), kA, rms, asymm.	58
Temperature rise over 40°C ambient: Contacts and joints, °C	65
Terminals, °C	45
Insulation, °C (Class B)	80

C. The following operating requirements shall be met:

1. A suitable anti-pumping device shall be included to assure that the mechanism makes only one closing operation with each closure of the control contact device, even though the breaker trips during the closing operations while the control circuit remains closed.
2. The trip coil auxiliary "a" switch shall be so arranged that the trip coil circuit is opened within 2 cycles after the breaker contacts part. Also, on the circuit breaker closing operation, the trip coil auxiliary "a" switch shall close before the contacts touch.
3. The contacts shall be so guided that complete contact and latching is assured on all closures up to the required closing and latching capability, without a rebound .
4. The stationary and moving contact assemblies shall be designed so that loading springs, retaining pins, and parts other than the main contacts do not form part of the current-carrying circuit.
5. The terminals and connections between all current carrying parts shall be designed to assure permanently low resistance connections.
6. The circuit breakers shall be complete with all necessary auxiliary relays required for proper operation and functioning.
7. The circuit breakers shall be designed and protected by surge suppressor or other devices as required to minimize transient over-voltages on the load circuits.

- D. All devices, connections and wiring shall be arranged to satisfy the functional and performance requirements of the schematics, one-line diagrams, and other Contract Documents. Control, protection and indication circuits, including alarm circuits, must function in strict compliance with the schematic diagrams and no function or devices shall be added or deleted from those shown in the diagrams unless required for protection or functioning of the internals of the equipment furnished. However, if any departures from the drawings and specifications are deemed necessary by the CONTRACTOR, details of such departures and the reasons therefore shall be submitted in writing to the ENGINEER for approval prior to fabrication of the work.
- E. All switchgear shall be the indoor, free-standing, rigid, metal-clad type. Each cubicle shall have full-size vertical barriers to provide complete separation between sections. All parts of the enclosure shall be bonded together and grounded.
- F. Vertical sections shall be of the two-tier construction and shall form a continuous line-up and shall contain a set of insulated, copper power buses, a full-length bare copper ground bus, and an insulated AC control bus. The main bus connections shall be silver-plated and fully insulated. The ground bus shall be capable of carrying the maximum short circuit current for a period of two seconds, in accordance with ANSI C37.20. Each cubicle shall be grounded directly to this bus. The frame of each circuit breaker shall be grounded at all times through a "rugged" ground contact shoe, except when the primary disconnecting devices are separate by adequate distance.
- G. Unless noted otherwise on the drawings, all vacuum breakers shall be equipped with a minimum of three (3) normally open (N.O.), and three (3) normally closed (N.C.), direct-driven auxiliary contacts for external use, suitable for 125 VDC, 5A duty. All auxiliary contacts shall be wired to the terminal boards located in the secondary terminations compartment. Each circuit breaker cubicle shall be equipped with stationary truck operated cell (TOC) switches. A minimum of four (4) cell switch contacts shall be furnished. The contacts shall be operated when the breaker is moved from the "operating" to the "test" position. The cell switch contact arrangement shall be such that they may be connected either in parallel or in series with other breaker auxiliary switch contacts. Each cell switch and breaker auxiliary contact shall be capable of being arranged either normally open (N.O.) or normally closed (N.C.) at the jobsite.
- H. Energized high-voltage parts shall not be exposed when the vacuum breaker is in "operating" or in "test" position or when it is completely withdrawn from cubicle.
- I. Access to circuit breaker enclosures and any auxiliary compartments, or devices shall be from the front of the equipment by means of hinged doors. Hinged doors shall be provided with locking facilities to prevent unauthorized access and stops to hold the door open. Access to the cable compartment shall be from the rear of the switchgear equipment by means of hinged doors. Doors shall have locking facilities in the closed position. In order to minimize obstruction at the rear of the switchgear equipment, hinged doors shall be capable of 150 degrees opening or equipped with lift-off facilities or other approved means. The rear door of each switchgear section with power cable termination shall be equipped with an infrared inspection system for thermo-graphic inspection of the power cable terminations and bus connections with the door closed. The system shall be positioned such that all the power cable terminations are visible through the lens. The system shall consist of an infrared lens of 2-inch (50mm) diameter minimum and mounting hardware. The system shall be Hawk I.R. International Ltd. HWK-050-C-L or approved equal.

- J. Each piece of equipment shall be so mounted and wired that the removal and replacement may be accomplished without interfering with service to adjacent equipment. All equipment mounted inside the boards shall be so located that the terminals and adjustment of devices are readily accessible without the use of special tools and with terminal markings clearly visible.
- K. Voltages in panels and auxiliary compartments shall be limited to 120 VAC or 125 VDC nominal.
- L. The control circuits shall be designed and arranged so that the vacuum breaker is operable in test position via these controls mounted on the switchgear. The nominal control voltage shall be 125 VDC. In accordance with ANSI C37.5, the breakers shall be capable of operating within the following ranges of control voltage:

Operation	Range VDC,
Closing	100 - 140
Tripping	70 – 140
- 1. Bus transfer requirements, as shown on the single line diagram drawings, shall be implemented using the digital multifunction protective relays on the Main Breakers and the Tie Breaker as follows:
 - a. In the event of a Bus "A" outage, Bus "A" Main Breaker shall automatically open and the Tie Breaker shall automatically close (open transition).
 - b. In the event of a Bus "B" outage, Bus "B" Main Breaker shall automatically open and the Tie Breaker shall automatically close (open transition).
 - c. In the event of a simultaneous Bus "A" and Bus "B" outage, Bus "A" Main Breaker, Bus "B" Main Breaker, and the Tie Breaker shall maintain last position.
 - d. When either Bus "A" or Bus "B" become available, a manually initiated re-transfer back shall be required whereby the Tie Breaker shall be opened before Bus "A" and Bus "B" Main Breakers have closed.
- M. Transfer schemes based on Programmable Logic Controllers (PLC) shall not be acceptable.
- N. Bus transfer logic sequencing on the MV switchgear shall be coordinated with the bus transfer logic of the LV switchgears downstream to allow the MV switchgear bus transfer logic to react first to a power outage.

2.4 KEY INTERLOCKS

- A. When called out in the Contract Documents, a set of locks and duplicate (one spare) keys shall be provided by the switchgear manufacturer.
- B. The key interlock system shall function in the permissive closing mode or the two-out-of-three selective permissive closing mode as defined in the one-line diagrams.

- C. The switchgear manufacturer shall fit the locks and the required hardware on the mechanism of the circuit breakers. He shall furnish loose hardware to the manufacturers of the motor control center and the disconnect switches for fitting by them. The interface and coordination required shall be the responsibility of the switchgear manufacturer and the CONTRACTOR.

2.5 WIRING

- A. All instrument, control and relay wiring, except wiring that crosses hinged joints, shall be stranded, tinned, single-conductor copper wire with type SIS or XLPE insulation rated for 90 degrees C conductor temperature. Current transformer secondary wiring shall be not smaller than No. 12 AWG. Other stranded wires shall not be smaller than No. 14 AWG. Wires that cross-hinged joints, such as between hinged doors and terminal blocks in the cubicle shall be flexible hinge-type wire or have substantial service loops providing flexibility for the full (minimum 90 degrees) swing of the door or panel. Wires shall not cross over or pass in front of any terminal block. At least 10 percent of unused spare auxiliary contacts shall be connected to terminal blocks to permit future external wiring connections.
- B. Nylon cable ties may be used to bundle wiring but under no circumstance shall adhesive-type cable tie anchors be acceptable. All anchoring of cable ties shall be done with steel screws to the enclosure structure and/or direct looping of the tie through existing holes in the structure.
- C. The wiring of instrument transformer secondary shall be arranged in a manner that all secondary leads of each current transformer and each potential transformer are brought out to respective sets of terminal blocks in the terminal compartment. The terminal blocks used shall be capable of taking a ring-tongue terminal for a No. 8 AWG wire. All control and instrument wiring within the fuse compartments shall be shielded by a protective non-metallic covering. Ring tongue lugs shall be used for CT and PT wiring.
- D. All field wiring connections forming part of a circuit, scheme or system shall be from the same compartment or enclosure. If it is required to split the switchgear line-up or sections for shipping, terminal blocks shall be provided for all interconnecting wiring at one side with the wires coiled up in sufficient lengths and tagged in accordance with the drawings at the other side. Each terminal block must also be identified the same way as the interconnecting wires. Splices in the wiring shall not be used.
- E. Exposed wiring shall be kept to a minimum. Wiring duct systems shall be installed to minimize exposed wiring and to provide for easy access for inspection and modification. Where ducting is impossible to use, wires shall be properly supported and neatly bundled. External wires shall enter the duct system from their cables through the perforated grill to terminal blocks.
- F. All connections shall be made at terminal studs or terminal blocks with pressure type wire connectors or lugs. The CONTRACTOR shall be responsible for correctness of the internal wiring and for the proper functioning of the equipment being supplied. Such internal wiring shall conform to the approved schematic diagrams terminal-to-terminal connections between devices.

2.6 METERS AND INSTRUMENTS

- A. All meters and instruments shall be suitable for operation at a frequency of 60 Hz with current transformers having 5-ampere secondary circuits and potential transformers having 120-volt secondary. The instruments shall not be damaged by stresses resulting from the momentary and short circuit currents indicated in this Specification.
- B. All meters and instruments shall be LED or LCD display, digital electronic type, 1% accuracy or better.
- C. Each voltmeter and ammeter shall have 3 phase display.
- D. All instruments, meters, relay metal cases and parts, and miscellaneous devices shall be effectively grounded.

2.7 CONTROL SWITCHES AND INDICATING LIGHTS

- A. All control switches shall be of the flush or semi-flush type and mounted on the switchgear front door or instrument panels. All control switches shall be of the rotary, snap action type with silver plated contacts and equipped with standard handles and plates.
- B. All indicating lights shall be light emitting diode (LED) type suitable for continuous operation over the entire range of control voltage (70 to 140 VDC). The lights shall be mounted on the front door or on the instruments compartment door of each breaker. Each circuit breaker shall be provided with indicating lights as follows: Red = CLOSED, green = OPEN and amber = stored energy spring is charged. A white indicating light shall also be supplied for each circuit breaker to monitor the condition of the trip coil.
- C. All necessary fuses shall be furnished and shall be of the non-renewable cartridge type. All primary fuses shall be of the current-limiting type, Bussman Manufacturing Company Type FRS, Fusetron, GE fuses, or equal.

2.8 POTENTIAL TRANSFORMERS

- A. The potential transformers (PTs) shall conform to ANSI C57.13.
- B. The ratings of the potential transformers and their locations in the switchgear shall be as indicated on the Contract Documents. The voltage class shall be not less than that of the switchgear in which they are installed.
- C. PT's shall be dry type, and shall be mounted on a draw-out or "trunnion" type frame. In the disconnected position, the primary and secondary circuits shall be automatically disconnected, and primary fuses grounded.
- D. The potential transformers shall be rated minimum of 400 volt-amperes, 60 Hz.
- E. The voltage rating of the PTs shall be as shown in the Contract Documents.
- F. The maximum ratio and phase-angle errors of the potential transformers, when carrying full rated secondary load, shall not exceed 0.6Y when tested in accordance with ANSI C57.13 and NEMA SG 4.

- G. Non-renewable current limiting cartridge-type fuses shall be furnished for the primaries. Secondary fuses shall be drawout type and shall be sized to provide overload protection and coordinate with primary fuses. The fuses shall withstand the rated insulation level of the switchgear in accordance with ANSI C 37.20.2.
- H. The BIL of the transformers shall be the same as that of the switchgear.
- I. External connections to the potential transformer secondary shall be through a test block.
- J. The insulation system of the transformers shall be such that the winding temperature rise and winding hottest spot temperature rise shall not be exceeded when operating in the highest ambient temperature which may occur inside the cubicles at continuous full load.
- K. Cables used for the transformer leads shall be rated at the full voltage rating of the switchgear. Cable exiting from conduits shall pass through gasketing and rubberized bushings. At all points of support the cable shall be made corona free. Appropriate corona-relieving compounds shall be used. The low-voltage side of the transformers shall be equipped with terminals and connectors of adequate size.
- L. Polarity markings shall be clearly imprinted on each PT.
- M. Each transformer shall have a 120 V secondary winding and an ANSI C 57.13 accuracy classification in accordance with the application shown on the Contract Document.
- N. Each potential transformer compartment shall have a door-mounted warning sign reading "Notice - Opening This Door Disconnects Potential Transformers." The sign shall be laminated plastic with engraved white letters on a red background.

2.9 CURRENT TRANSFORMERS

- A. Current transformers shall be single-ratio, unless stated otherwise elsewhere. They shall be rated to withstand the specified operational, short circuit, and voltage impulse conditions, and shall conform to ANSI C57.13.
- B. The ratings of the current transformers and their locations in the switchgear shall be as indicated in the Contract Documents. The voltage class shall be not less than that of the switchgear in which they are installed. The current transformers shall be either of the wound, window, or bar type and shall have 5A secondary. The terminal and mechanical rating of the wound or bar type current transformer shall be equal to that of the assembled switchgear. Window-type current transformers used in switchgear having insulated buses shall be insulated for not less than 600 volts. The transformers shall have been permanently installed in the switchgear at the time the impulse withstand voltage test is made. Window current transformers for ground sensors shall have adequate opening for power cables of the size indicated in the Contract Documents.
- C. The metering and relaying accuracy class for current transformers shall be not less than:

Standard Metering Accuracy Primary Current Rating- (Amperes)	Relaying Class of Burden B-0.1	Accuracy Class
50	1.2	C10
75-100	1.2	C20
150-250	0.6	C20
300	0.3	C20
400-600	0.3	C50
800-1200	0.3	C100
1500-4000	0.3	C200

- D. Each secondary connection of all current transformers shall be wired to short circuiting type terminal boards or test blocks located in the secondary termination compartment.
- E. When secondary windings of current transformers are required to be grounded they shall be grounded at one point only at the terminal boards or test blocks which shall be readily accessible and clearly identified. The common or ground lead shall be a properly color-coded continuous insulated copper conductor to the ground bus.
- F. Current transformers which are used for high impedance bus differential relays shall have the following characteristics:
 - 1. Have the same ratio and shall be operated on their full tap.
 - 2. The leakage impedance of the CT's must be low or negligible.
 - 3. The junction points shall be in the switchgear equidistant from all CT's.
- G. Current transformers which are used for generator differential protection shall be accurate to within 1.5% up to twice the normal current ratings. Current transformers for differential protection of power transformers must be able to supply the relay with 8 times rated relay tap current with an error of less than 20% of the total current. In case where one set of the current transformers for differential protection is supplied by the generator manufacturer or by the utility company, or by others, the switchgear manufacturer and the CONTRACTOR shall be responsible for the coordination of the current transformer characteristics for proper differential relay operation.
- H. Current transformer shall be located so that: (1) the current ratio and polarity markings can be readily identified after the primary connections have been made; and (2) the secondary terminals are accessible after the primary connections have been made. All current transformer wiring shall be terminated with ring-type terminations.

2.10 POWER MONITORS

- A. Power monitors shall be in accordance with Specification Section 16290, Power Monitors.

- B. The medium voltage switchgear line-up incorporating power monitors must be UL certified and labeled by the assembler.

2.11 PROTECTIVE RELAYS

- A. The types of relays and their locations in the switchgear shall be as shown on the Contract Drawings and specified herein.
- B. All protective-type relays shall be suitable for operation at a frequency of 60 Hz with current transformers having 5-ampere secondary circuits, and with potential transformers having 120-volt secondary circuits. The relays shall withstand the stresses resulting from the momentary and short-circuit currents indicated in this Specification or elsewhere. The manufacturer shall guarantee the compatibility of ground sensor current transformers and the associated instantaneous overcurrent relays.
- C. External power to the relays, if required, shall be 125 VDC.
- D. All protective-type relays shall be mounted on the front door operating face of the equipment. Auxiliary relays shall be surface mounted at easily accessible locations in each cubicle. All protective relays shall be equipped with built in targets or indicating lights which indicate a trip condition.
- E. Resistors and other auxiliary components associated with the relays shall be furnished to provide a complete and functional system.
- F. Protective relays and auxiliary relays shall be of the following make and type:

Device #	Description	Manufacturer
25	Synchronism Check Relay	BE1-25 or equal
27	Under Voltage	GE MIV or equal
50/51, 51G	Time Overcurrent, Time Overcurrent-Ground	GE DSFC or equal
51V	Time Overcurrent	GE IFCV or equal
62	Time Delay	GE SAM or equal
86	Lockout Manual Reset	GE HEA or equal
87B	Bus Differential	GE PVD21 or equal
Generator Protection	Generator Protection	GE 489, Beckwith M-3425 or equal
Feeder Protection	Feeder Protection	ABB REF550, Schweitzer SEL351, GE UR or equal
Motor Protection	Motor Protection (less than 1500HP)	GE 369 or equal
Motor Protection	Motor Protection (1500HP and above)	GE 469 or equal
Transformer Protection	Transformer Protection (below 10MVA)	GE 745, GE UR or equal

Transformer Protection	Transformer Protection (10 MVA and above)	ABB TPU or equal
94	Tripping	ABB AR, GE SBA or equal
94	Test Switches	ABB FT-1 or equal

- G. Microprocessor-based or solid-state multi-function type relays by ABB, Basler, GE, Schweitzer, Siemens or approved equal and meeting the project protection requirement shall be used. All relays shall have a minimum of two years of highly reliable record of service.
- H. It shall be the responsibility of the switchgear manufacturer and the CONTRACTOR to complete the detail design of the complete protective relaying system in accordance with the functional requirements shown in the one-line and schematic diagrams attached, and to properly apply relay selection and types from the listings shown above.

2.12 SWITCHGEAR BUSES

- A. The main phase buses shall be isolated from any power and control cables by means of grounded metal barriers or enclosures.
- B. Buses shall be braced to withstand without damage the forces produced by the maximum available instantaneous short-circuit currents. Vertical bus bar risers shall have a continuous rating of not less than the sum of the nameplate ratings of the interconnected circuits. Bus bars and other heavy current carrying parts shall be made from high conductivity copper. The buses shall be supported by heavy duty, high dielectric strength, non-hygroscopic porcelain or cast resin insulating material. The rated strength of the supports, in their most probable mode of failure, shall not be less than 2.4 times the working stress. The continuous and momentary current rating of buses shall be as required by ANSI C37.20. The following requirements shall apply to bus connections:
 - 1. All bolted connections, including bus taps and circuit breaker connections, shall be silver plated. Each bus section, tap, and extension shall be held in alignment at two or more points by two or more bolts at each point.
 - 2. Each bus splice shall be designed to assure rigidity and to provide for permanent high-pressure contact between the silver-plated surfaces.
 - 3. All buses and heavy current-carrying connections shall be fully insulated with epoxy insulation of a flame retardant and non-hygroscopic material. Where possible, all buses and connections shall be completely insulated at the factory. (For other conductors and connections not insulated at the factory, suitable insulation boots of a flame retardant and non-hygroscopic type shall be furnished by the manufacturer.)
- C. The ground bus shall be provided with one bolt-type cable clamp (adjustable between No. 4/0 AWG and 500 MCM) at each end of the bus and shall have accessible drilled holes for 3/8 inch bolts in each vertical section for ground cables.

2.13 TRANSITION SECTION

- A. A transition section shall be provided as shown on the drawings. The transition section shall meet the following requirements:
 - 1. The buses in the transition section shall be in accordance with paragraph 2.12 of this specification.
 - 2. The transition section shall be same height and depth as the switchgear.

2.14 NAMEPLATES

- A. Nameplates shall be furnished as specified in Section 16075, Electrical Identification Nameplates and Warning Signs, of these Specifications and as specified herein.
- B. An engraved nameplate shall be provided for each compartment door, both on the front and inside, on the outside and inside of any rear access (if rear access is provided) panels or doors of each cubicle, and for each device, such as instruments, meters, relays, switches indicating lights, test switches, etc. mounted on the front door. Rear access panel or door nameplates shall contain the same wording as front door nameplates. In addition, rear access panels or doors of cubicles containing exposed power conductors or terminals shall include a large "DANGER 12.47 KILOVOLTS INSIDE" nameplate of red background and 1 inch high minimum white lettering.
- C. Warning nameplates shall be provided on each compartment with external (foreign) power inside not disconnected by the main circuit breakers. Warning nameplate shall be red background with white letters and shall read:

"CAUTION - THIS UNIT CONTAINS AN EXTERNAL VOLTAGE SOURCE"
- D. Inside the compartment, permanently attached tags shall be provided for each device and to indicate location of remote disconnecting means. Circuit identification and location of remote disconnecting means shall be furnished to manufacturer by the CONTRACTOR during shop drawings review. Manufacturer shall provide space for 15 letters on each tag.
- E. Nameplates on circuit breaker shall be made of non-corrosive stainless steel, not less than 1/32-inch thick, and shall be fastened by threaded machine screws.
- F. Nameplates shall in no way be obstructed, and shall be clearly legible.
- G. In addition, the unit, section or equipment name, and tag No. shall be inscribed on a separate stainless steel tag, permanently fastened by threaded machine screws at locations near the manufacturer's nameplate, on each side, front and rear of every section or line-up of switchgear.

2.15 TERMINATIONS

- A. Secondary cable terminations shall be located in a separate compartment, shielded from all primary connections and accessible with the primary circuits energized.

- B. Terminals for metering, protection, indication, control and secondary wiring shall be of the stud (with ring type lugs) type suitable for terminating conductors up to No. 8 AWG. Spade, slotted spade, flanged spade, hook terminals, or terminals of the "quick-disconnect" type shall not be used.
- C. Terminals shall have insulated sleeves.
- D. A minimum of 20% spare terminal block positions shall be provided and distributed among the occupied terminal blocks at completion of installation.
- E. Terminal blocks shall have a rating of 600 volts and shall be of the molded plastic type having screw-type terminals for No. 10 machine screws. The screws shall screw directly into the contact strips and not into nuts embedded in the terminal blocks. The contact strips shall have sufficient thickness to assure that torque applied to the No. 10 screws to hold the terminal lugs to the contact strips shall not damage the threads in the tapped holes. The screws shall not bottom on the terminal block. The contact strips shall be firmly secured to the blocks and shall be separated by insulated barriers. The blocks shall require at least two (2) mounting screws (one on each end) per block.
- F. No more than two (2) wires shall be placed under one screw, except terminals provided for connection of external wiring shall be arranged for one wire per point. Looping of wires from connection to connection is not acceptable.
- G. All terminal blocks shall be accessible with the breaker in any position. Terminal points for field connection shall be a minimum of 12 inches above the floor.
- H. Terminal blocks for field use shall have manufacturers wiring on the left side and the right side shall be available for field wiring. The terminals for the power cables shall be provided with terminal pads having holes drilled in accordance with NEMA Publication No. CC 1.
- I. High strength stainless steel bolts shall be furnished for the power terminals.
- J. The CONTRACTOR shall furnish all cable terminals for termination of the power cables. The terminals shall be Burndy Type YA or Dossert Type DPL, or equal, both with long barrels to permit double indentation.
- K. All power cable terminations shall be readily accessible.

2.16 WIRE IDENTIFICATION

- A. Wire identification labels shall be permanent and of sleeve type.
- B. All wires shall be labeled at both ends and at any points in between where the wires may terminate.
- C. Wire identifications shall be included in the wiring and the schematic diagrams submitted as vendor data for review by the ENGINEER.

2.17 PHASE SEQUENCE

- A. The phase sequence of the assembled three-phase buses and primary conductors shall be 1, 2, 3 counting from front to back, top to bottom, or left to right, as viewed from the circuit breaker operating mechanism side in accordance with ANSI C37.20. In making external power connections, the CONTRACTOR shall connect its A, B, C leads to the manufacturer's 1, 2, 3. Protective relays shall be mounted on the panels in 1, 2, 3 order, from left to right when viewed from the front of the panel.

2.18 CABLE ENTRANCES

- A. Provisions shall be made for the entrance of all power and feeder cables as shown on the Contract Drawings or as mandated by field conditions. Control and instrumentation field cables shall enter the switchgear in a similar manner. The manufacturer shall furnish cable supports of a flame retardant and non-hydroscopic material capable of withstanding the stresses resulting from the momentary and short-circuit currents specified.
- B. Space shall be provided in each compartment for the termination of power and control cables as per applicable standards.

2.19 REQUIREMENTS FOR THE VACUUM CIRCUIT BREAKER ASSEMBLIES

- A. Each cubicle containing a vacuum circuit breaker shall be provided with all the devices indicated in the Plans, and shall be complete with all necessary devices and hardware to result in a complete and operable unit. The following devices and provisions shall be included:
 - 1. A wheel-mounted, drawout-type vacuum circuit breaker with OPERATING, TEST AND ISOLATION positions suitable for the service conditions specified. Each switchgear cubicle or compartment equipped with a circuit breaker shall be provided with a mechanical means for moving the circuit breaker to and from its OPERATING position. Suitable guide rails and positive stops shall be provided for centering the circuit breaker in the proper position when inserting or removing the circuit breaker. All necessary accessories required for removing and transferring the circuit breaker shall be furnished. Each cubicle shall be provided with a positive stop to prevent over travel of the circuit breaker when moving it into the OPERATING and TEST positions. An indicator or equivalent indicating means shall be provided to clearly show when the circuit breaker is in the TEST or OPERATING position.
 - 2. A complete mechanical interlock system to prevent moving the vacuum breaker from and into OPERATING position when the vacuum breaker is closed. Removal of the circuit breaker shall be possible only by operating a mechanical device.
- B. A power terminal disconnecting system with automatic shutter, covering all high-voltage parts when the vacuum breaker is moved out of OPERATING position. All disconnecting devices shall be accurately aligned and securely mounted to maintain alignment.

- C. The main contacts and their supports shall be guaranteed not to distort or fail under any or all of the following conditions, individually or concurrently:
1. Mechanical stresses resulting from the momentary current specified.
 2. Contact attack from H₂S gases
 3. Misalignment of disconnects of <1/8 inch.
 4. All contact surfaces shall be silver-to-silver pressure contacts. In general, these contacts, whether stationary or movable, shall be of rugged silverplated copper one-piece construction, with spring(s) on fingers to provide uniform contact with the main part at all operating and environmental conditions.
- D. A continuous control bus with all necessary fuses and control disconnects. AC potential and dc or ac control bus circuits, which are common to more than one cubicle, shall be in the form of common buses. Where voltage to apparatus in a cubicle is required, the common buses shall be connected to terminal blocks to permit tap from the terminal blocks to the apparatus. Connections to the common bus shall be such that the apparatus may be disconnected without interrupting the bus circuitry. The wires shall be carried in a wire trough, gutter, or equivalent method within the switchgear assembly. All wiring shall be protected from sharp edges and corners. Terminal blocks shall be provided on one side of a shipping split for termination of the interconnecting wires, with adequate lengths and identification furnished to permit reconnecting the circuits. Wiring provided for the external connection to other locations shall be wired to terminal blocks.
- E. To protect the switchgear control power bus, each breaker control circuit shall have a set of main fuses between the control bus and the breaker control (trip) circuit. The main fuses shall provide power for the trip circuit. In addition, a set of separate (secondary) fuses (in series with the main fuses) shall be furnished down-stream for the breaker closing and indication circuits. These fuses shall be sized by the manufacturer so that a short-circuit in the closing and indication circuits shall not blow the main fuses, feeding the trip circuit.
- F. Provision for a future remotely mounted LOCAL-REMOTE selector switch shall be furnished with each circuit breaker. The switch shall be arranged for local trip, permissive remote closing, and local test (close and trip). When the switch is in LOCAL position and the circuit breaker is in the TEST position, the remote control circuit shall be made inoperable. When the switch is in REMOTE position and the circuit breaker is in the OPERATING position the local closing circuit shall be made inoperable.
- G. Vacuum circuit breakers shall be mechanically and electrically interchangeable with other vacuum circuit breakers of the same rating and duty. Means shall be provided to prevent the interchange of non-compatible vacuum circuit breakers.
- H. The vacuum circuit breaker shall be operated by an electrically charged, mechanically and electrically trip-free, stored energy operating mechanism. Provision shall be included for manual charging of the mechanism and for slow closing of the main contacts for inspection or adjustments. A manual charging lever shall be furnished with each switchgear line-up. The stored energy mechanism shall discharge when the breaker is withdrawn from the cubicle.

- I. Facilities shall be provided for padlocking the trip mechanism to block closing of the circuit breaker.
- J. The withdrawable vacuum circuit breaker assembly shall be equipped with self-coupling primary, secondary and grounding contacts.
- K. In addition to the OPERATING and ISOLATED positions, an intermediate TEST position shall be provided to facilitate operation of the vacuum circuit breaker with the primary circuit disconnected. Transfer of the vacuum circuit breaker between the OPERATING, TEST and ISOLATED positions shall be mechanically prohibited with the circuit breaker closed.
- L. Auxiliary switches shall be directly coupled to the circuit breaker mechanism to indicate the open and closed positions of the circuit breaker positively.
- M. Mechanical control of the circuit breaker shall be provided and shall be accessible at the operating face of the equipment. It shall not be possible to activate the closing mechanism of the circuit breaker if the trip circuit is energized.
- N. Facilities shall be provided for remote electrical closing and tripping of the circuit breaker.
- O. Mechanical indication of the circuit breaker position - open, closed, operating, test, isolated, shall be positively indicated at the operating face of the equipment. Electrical indication of the circuit breaker status: Open-closed-spring charged, shall also be provided at the operating face of the equipment. Power supply for electrical indication shall be derived from the 125 VDC control bus within the switchgear. An operation counter shall also be provided.
- P. A circuit-breaker lifting device, (one per switchgear double-bus assembly,) which is capable of lifting the roll out circuit breakers from the switchgear assembly, shall be provided. The lifting device shall have 4-inch diameter locking wheels, a steel platform base, and a hoist mechanism to lift the circuit breaker from the assembly and lower it to the platform base. The entire assembly shall be suitably designed to prevent capsizing during movement with the circuit breaker in place on the platform.
- Q. Close and trip circuit fuses shall be dead-front, pull-out-type.

2.20 SWITCHGEAR BUS TRANSFER DESCRIPTION

A. General Requirements:

- 1. Electrically operated breakers: Main breaker A, main breaker B, tie breaker T and maintenance tie breaker M.
- 2. Control switches on breakers A and B shall include provisions for a common future remotely mounted "Local-Remote" switch (2 position switch, maintained) "Close-Normal-Trip" switch (3 position switch, spring return to normal) and lockout relay (device 86).
- 3. Control switches on breaker T shall include provisions for a common future remotely mounted "Local-Remote" switch (2 position switch, maintained) and "Close-Normal-Trip" switch (3 position switch, spring return to normal).

4. Common control switch shall include "Trip A-Trip T-Trip B" switch (device 10) (3 position switch, maintained).
 5. Time delay relays shall be delay on energization type adjustable from 0.1 to 10 seconds.
 6. Generic breaker names are used here for convenience. Description on CONTRACTOR documents must use assigned breaker names per naming convention in EDG.
 7. Provision for open transition automatic transfer shall be provided.
- B. Automatic Transfer on Loss of Power to Bus A (Dead Bus Transfer):
1. Initial Conditions:
 - a. Breakers A, B and M are closed, breaker T is open.
 - b. Breakers A, B, T and M are racked into the "Connected" position.
 - c. Breakers A, B and T "Local-Remote" switches are at the "Remote" position.
 - d. Device 10 is at the "Trip T" position.
 - e. Both VT secondary test switches upstream of the under-voltage (UV) relays are switched on.
 - f. Both incoming sources are available.
 - g. All lockout relays are reset.
 2. Automatic Transfer (Break-Before-Make):
 - a. Bus A UV relay detects loss of incoming source A voltage (below 60 percent nominal).
 - b. The transfer control shall open breaker A after a time delay of 3 seconds and then close breaker T.
 - c. Transfer shall not occur if incoming source A voltage is restored during the time delay, incoming source B voltage is lost during the time delay and operation of any lockout relay.
 3. Remote (via SCADA) Manual Retransfer (Make-Before-Break):
 - a. The control room operator confirms, via SCADA, incoming source A is available and the system is normal.
 - b. The operator then issues a command to "Close Breaker A."
 - c. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.

4. Local (in front of switchgear) Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Local" position.
 - b. Confirm proper voltage (above 90 percent of nominal) at both incoming sources.
 - c. Turn breaker A control switch to "Close" position to initiate manual retransfer.
 - d. The transfer control shall check for all permissive interlocks (proper synchronism, proper voltage level of both incoming sources, breakers A, B, T and M are racked into the connected position, breaker M is closed and all lockout relays are reset). If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.
- C. Automatic Transfer on Loss of Power to Bus B (Dead Bus Transfer):
1. Initial Conditions: See initial conditions above.
 2. Automatic Transfer (Break-Before-Make):
 - a. Bus B UV relay detects loss of incoming source B voltage.
 - b. The transfer control shall open breaker B after a time delay of 3 seconds and close breaker T.
 - c. Transfer shall not occur if incoming source B voltage is restored during the time delay, incoming source A is lost during the time delay and operation of any lockout relay.
 3. Remote Manual Retransfer (Make-Before-Break):
 - a. The control room operation confirms, via SCADA, incoming source B is available and the system is normal.
 - b. The operation then issues a command to "Close Breaker B."
 - c. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.
 4. Local Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Local" position.
 - b. Confirm proper voltage at both incoming sources.
 - c. Turn breaker B control switch handle to "Close" to initiate manual retransfer.
 - d. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.

- D. Local Manual Transfer to Bus B (Live Bus Transfer):
1. Initial Conditions: See initial conditions above.
 2. Local Manual Transfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Local" position.
 - b. Move device 10 handle to "Trip A" position.
 - c. The transfer control shall check for permissive interlocks. If they are all satisfied, it shall close breaker T and after a time delay of 0.1 second open breaker A.
 3. Remote Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.3 for description.
 4. Local Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.4 for description.
- E. Local Manual Transfer to Bus A (Live Bus Transfer):
1. Initial Conditions: See initial conditions above.
 2. Local Manual Transfer (Make-Before-Break):
 - a. Move breaker A, B, T and M "Local-Remote" switches to "Local" position.
 - b. Move device 10 handle to "Trip B" position.
 - c. The transfer control shall check for permissive interlocks. If they are all satisfied, it shall close breaker T and after a time delay of 0.1 second open breaker B.
 3. Remote Manual Retransfer (Make-Before Break): See paragraph 2.20.B.3 for description.
 4. Local Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.4 for description.
- F. Remote Manual Transfer to Bus B (Live Bus Transfer):
1. Initial Conditions: See initial conditions above.
 2. Remote Manual Transfer (Make-Before-Break):
 - a. Control room operator confirms, via SCADA, that the system is normal and issues a command to "Transfer to Bus B." (Note: The control room operator can also trip breaker A by issuing a "Trip Breaker A" command without initiating bus transfer when voltage is available at incoming source A.)
 - b. The transfer control shall check for permissive interlocks. If all interlocks are satisfied, it shall close breaker T and after a time delay of 0.1 second open breaker A.

3. Remote Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.3 for description.
 4. Local Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.4 for description.
- G. Remote Manual Transfer to Bus A (Live Bus Transfer):
1. Initial Conditions: See initial conditions above.
 2. Remote Manual Transfer (Make-Before-Break):
 - a. Control room operator confirms, via SCADA, that the system is normal and issues a command to "Transfer to Bus A." (Note: The control room operation can also trip breaker B by issuing a "Trip Breaker B" command without initiating bus transfer when voltage is available at incoming source B.)
 - b. The transfer control shall check for permissive interlocks. If all interlocks are satisfied, it shall close breaker T and after a time delay of 0.1 second open breaker B.
 3. Remote Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.3 for description.
 4. Local Manual Retransfer (Make-Before-Break): See paragraph 2.20.B.4 for description.
- H. Local Test of Automatic Transfer (Remote Test Not Available):
1. Initial Conditions: See initial conditions above.
 2. Local Test of Transfer to Bus B (Break-Before-Make):
 - a. Move breaker A, B and T "Local-Remote" switches to "Local" position.
 - b. Switch bus A voltage transformer test switches to "Off" position to simulate loss of power to incoming source A.
 - c. The transfer control shall open breaker A after a time delay of 3 seconds and close breaker T.
 - d. Transfer shall not occur if incoming source B voltage is lost during the time delay and operation of any lockout relay.
 3. Local Retransfer to Normal After Test (Make-Before-Break)
 - a. Confirm proper voltage at both incoming sources.
 - b. Switch bus B voltage transformer test switches to "On" position.
 - c. Move breaker B control switch handle to "Close" position to initiate manual retransfer.

- d. The transfer control shall check for permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.
- I. Local Manual Transfer to Bus B (Dead Bus Transfer):
- 1. Initial Conditions:
 - a. Breakers A, B and T are open, breaker M is closed.
 - b. Breakers A, B, T and M are racked into the "Connected" position.
 - c. Breakers A, B and T "Local-Remote" switches are at the "Local" position.
 - d. Device 10 is at the "Trip T" position.
 - e. Both VT secondary test switches upstream of the under-voltage relays are switched on.
 - f. Both incoming sources are available or only incoming source B is available.
 - g. All lockout relays are reset.
 - 2. Local Manual Transfer:
 - a. Close breaker B with breaker control switch to energize bus B.
 - b. The control shall allow breaker B to close with breakers A and T open.
 - c. Move device 10 handle to "Trip A" position.
 - d. Close breaker T with breaker control switch.
 - e. The transfer control shall check that breaker A is open, breaker B and M are closed, all breakers are racked in the connected position and all lockout relays are reset. If all conditions are satisfied, it shall close breaker T to energize bus A.
 - 3. Local Manual Retransfer (Make-Before-Break):
 - a. Incoming source A is available.
 - b. Confirm proper voltage at both incoming sources.
 - c. Turn breaker A control switch handle to "Close" position to initiate manual retransfer.
 - d. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.

4. Remote Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Remote" position.
 - b. The control room operator confirms, via SCADA, incoming source A is available and the system is normal.
 - c. The operator then issues a "Close Breaker A" command, via SCADA.
 - d. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.

- J. Local Manual Transfer to Bus A (Dead Bus Transfer):
 1. Initial Conditions:
 - a. Breakers A, B and T are open, breaker M is closed.
 - b. Breakers A, B, T and M are racked into the "Connected" position.
 - c. Breakers A, B and T "Local-Remote" switches are at the "Local" position.
 - d. Device 10 is at the "Trip T" position.
 - e. Both VT secondary test switches upstream of the under-voltage relays are switched on.
 - f. Both incoming sources are available or only source A is available.
 - g. All lockout relays are reset.
 2. Local Manual Transfer:
 - a. Close breaker A with breaker control switch to energize bus A.
 - b. The control shall allow breaker A to close with breakers B and T open.
 - c. Move device 10 handle to "Trip B" position.
 - d. Close breaker T with breaker control switch.
 - e. The transfer control shall check that breaker B is open, breaker A and M are closed, all breakers are racked in the connected position and all lockout relays are reset. If all conditions are satisfied, it shall close breaker T to energize bus B.
 3. Local Manual Retransfer (Make-Before-Break)
 - a. Confirm proper voltage at both incoming sources.
 - b. Turn breaker B control switch handle to "Close" position to initiate manual retransfer.

- c. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.
 - 4. Remote Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Remote" position.
 - b. The control room operator confirms, via SCADA, incoming source B is available and the system is normal.
 - c. The operator then issues a "Close Breaker B" command, via SCADA.
 - d. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.
- K. Remote Manual Transfer to Bus B (Dead Bus Transfer):
- 1. Initial Conditions:
 - a. Breakers, A, B and T are open, breaker M is closed.
 - b. Breakers A, B, T and M are racked into the "Connected" position.
 - c. Breakers A, B and T "Local-Remote" switches are at the "Remote" position.
 - d. Device 10 is at the "Trip T" position.
 - e. Both VT secondary test switches upstream of the under-voltage relays are switched on.
 - f. Both incoming sources are available or only source B is available.
 - g. All lockout relays are reset.
 - 2. Remote Manual Transfer:
 - a. Control room operator confirms that incoming source B is available and issues a command to "Close Breaker B," via SCADA.
 - b. The control shall allow breaker B to close with breakers A and T open.
 - c. The operator then issues a command to "Close Breaker T," via SCADA, to initiate transfer.
 - d. The transfer control shall check that breaker A is open, breakers B and M are closed, all breakers are racked in the connected position and all lockout relays are reset. If all conditions are satisfied, it shall close breaker T to energize bus A.

3. Remote Manual Retransfer (Make-Before-Break):
 - a. Control room operator confirms that incoming source A is available and all systems are normal.
 - b. The operator issues a command to "Close Breaker A" to initiate retransfer.
 - c. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.
4. Local Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Local" position.
 - b. Confirm proper voltage at both incoming sources.
 - c. Turn breaker A control switch to "Close" position to initiate manual retransfer.
 - d. The transfer control shall check for all permissive interlocks (proper synchronism, proper voltage level of both incoming sources, breakers A, B, T and M are racked into the connected position, breaker M is closed and all lockout relays are reset). If all interlocks are satisfied, it shall close breaker A and after a time delay of 0.1 second open breaker T.
- L. Remote Manual Transfer to Bus A (Dead Bus Transfer):
 1. Initial Conditions:
 - a. Breakers A, B and T are open, breaker M is closed.
 - b. Breakers A, B, T and M are racked into the "Connected" position.
 - c. Breakers A, B and T "Local-Remote" switches are at the "Remote" position.
 - d. Device 10 is at the "Trip T" position.
 - e. Both VT secondary test switches upstream of the under-voltage relays are switched on.
 - f. Both incoming sources are available or only source A is available.
 - g. All lockout relays are reset.
 2. Remote Manual Transfer:
 - a. Control room operator confirms that incoming source A is available and issues a command to "Close Breaker A," via SCADA.
 - b. The control shall allow breaker A to close with breakers B and T open.
 - c. The operator then issues a command to "Close Breaker T," via SCADA, to initiate transfer.

- d. The transfer control shall check that breaker B is open, breaker A and M are closed, all breakers are racked in the connected position and all lockout relays are rest. If all conditions are satisfied, it shall close breaker T to energize bus B.
3. Remote Manual Retransfer (Make-Before-Break):
 - a. Control room operator confirms that incoming source B is available and all systems are normal.
 - b. The operator issues a command to "Close Breaker B" to initiate retransfer.
 - c. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.
 4. Local Manual Retransfer (Make-Before-Break):
 - a. Move breakers A, B and T "Local-Remote" switch handles to "Local" position.
 - b. Confirm proper voltage at both incoming sources.
 - c. Turn breaker B control switch to "Close" position to initiate manual retransfer.
 - d. The transfer control shall check for all permissive interlocks. If all interlocks are satisfied, it shall close breaker B and after a time delay of 0.1 second open breaker T.

2.21 SPACE HEATERS

- A. Space heaters shall be provided by the manufacturer in each vertical section of switchgear to prevent condensation during storage. Space heaters shall be 120 VAC and shall be supplied from an external source by CONTRACTOR. Heaters shall be thermostatically controlled. The space heater circuit(s) shall be protected by a circuit breaker located in the switchgear.

2.22 TOOL AND ACCESSORIES

- A. A set of standard and special tools shall be furnished which are required for installation, alignment, operation and maintenance of all equipment and devices covered under this Specification. The following shall be included:
 1. One test cabinet with pushbuttons and lights, and with all necessary equipment and test cables for testing the circuit breakers after they have been removed from the cubicles
 2. Two pairs of fuse tongs
 3. Operating lever for manual closing of the circuit breakers during maintenance
 4. Removable hand crank or lever for moving the circuit breakers into the OPERATING position
 5. Breaker lifting truck for removing breakers from the switchgear

6. Two secondary test coupler, if required
7. Set of test plugs for meters and relays
8. Drawout-type manually operated ground and test devices suitable for insertion in the metal-clad switchgear in place of each different size and voltage circuit breaker shall be furnished to provide means for grounding lines or buses for maintenance work.
9. Special tools, such as wrenches or spanners, or any other devices which are required for installation and maintenance of the mechanism, contacts, interrupters, or other parts shall be furnished.

2.23 SURFACE PREPARATION, PAINTING, CLEANLINESS & SHIPMENT

- A. Surface preparation, painting, cleanliness and shipment shall be in accordance with manufacturer's standard.
- B. The final exterior color shall be Light Gray ANSI NO. 61. The manufacturer's standard finish is acceptable for the interior of the switchgear.
- C. The equipment shall be shipped in assembled units, insofar as is consistent with good shipping practice. When items must be disassembled for shipment, they shall be match-marked. All units and their containers shall be piece-marked and show the Purchase Order number. Machined and other unpainted surfaces shall be fully protected from impact and weather damage with all openings, etc., plugged or covered.
- D. The manufacturer shall furnish all material required to prepare the assembled sections of switchgear for shipping, including structural steel lifting beams or other suitable means for handling these assemblies. These beams shall be sufficiently rigid to distribute evenly all forces and strains, which may be imposed in handling.

2.24 RETROFIT OF EXISTING SWITCHGEAR "ESC"

- A. The design and construction of the modifications to the existing switchgear vertical sections and individual units shall match the existing equipment it modifies. This shall also include to the equipment enclosure color. The retrofit equipment shall be UL labeled.
- B. Unless otherwise specified on the Drawings, the short-circuit and other electrical ratings of the equipment used for the retrofit shall match that of the existing equipment, vertical sections and individual units as applicable.
- C. Unless otherwise specified on the Drawings, the retrofit equipment and its individual components shall be manufactured by Cutler-Hammer, **or equal**. The individual retrofit components shall be UL-listed. All the retrofit equipment and components shall be new. No refurbished equipment and components shall be acceptable.
- D. Individual retrofit units design (e.g., internal layout) shall be acceptable to the ENGINEER.
- E. Power monitors of the new feeder breaker sections shall be networked with the power monitors of the existing lineup.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The switchgear shall be installed completely in accordance with the requirements of the National Electrical Code, applicable NEMA, ANSI and IEEE standards, the manufacturer's recommendations and practice, and in accordance with the requirements of the Contract Documents.
- B. The CONTRACTOR shall receive, store, set, and assemble individually shipped sections of switchgear to form complete units, and install and attach to the main switchgear units any breakers, relays, meters, or other miscellaneous devices shipped separately. CONTRACTOR shall make all internal wiring interconnections necessary for a complete assembly of each switchgear unit.
- C. Bus joints at shipping splits shall be made by the CONTRACTOR. All bus conductor joints and taps shall be carefully made and insulated by qualified personnel in strict accordance with manufacturer's instructions. All bolted connections between sections of current-carrying bus shall be tightened down to torque values recommended by the manufacturer.
- D. The CONTRACTOR shall take all necessary precautions to exclude moisture and foreign material from the equipment at all times during storage and installation. Special care shall be taken to prevent corrosion of silver-plated contact surfaces and damage to relays and control devices.
- E. Each switchgear unit shall be set level and plumb on embedded steel floor channels with foundation bolts furnished, installed, and grouted by this CONTRACTOR as shown on the Plans. The CONTRACTOR shall furnish all shims necessary to comply with these requirements. Before switchgear units are anchored in place, the location, elevation, and degree of plumpness shall be checked by the CONTRACTOR's surveyors and shall be accurate to within 1/8 inch in all directions. The switchgear shall be secured to the floor channels by welding or bolting at the front and rear. After the switchgear has been installed and secured to the floor, the CONTRACTOR shall touch up all spots where original factory paint was scratched or burned off during welding.
- F. Upon completion of all installation work by the CONTRACTOR, as specified, each switchgear unit shall be cleaned with a vacuum cleaner to remove all dust and debris from the inside of the switchgear enclosure. The switchgear units shall remain tightly closed to keep out any additional dust or debris until turned over for installation of conduit, installation and termination of power and control cable, testing and energization. Cleaning equipment shall not be used in such a manner as to damage instruments, relays, or other parts. All openings in enclosures for drawout-type large circuit breakers or other separate devices to be installed later shall be temporarily closed with cardboard until such time when devices are installed.
- G. During temporary storage and after installation of the switchgear, the CONTRACTOR shall install and provide temporary 120-V power to space heaters furnished with the switchgear. CONTRACTOR shall secure and connect permanent power to the heaters before completion of the job.

3.2 MANUFACTURER'S REPRESENTATIVE

- A. The CONTRACTOR shall arrange to have the switchgear manufacturer provide the services of a competent and experienced engineer to supervise the erection of the equipment, the field tests, initial operation, and instruct and train the DISTRICT's operations personnel in the correct operation, service, and maintenance of the equipment. Training shall be provided in accordance with requirements and time durations specified in GENERAL REQUIREMENTS and in Section 01820, Training.

* * * * *

THIS PAGE LEFT INTENTIONALLY BLANK