PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General
B. Operating requirements
C. Ratings
D. Switchgear enclosure
E. Circuit breakers
F. Three position switches
G. Buses and bus connections
H. Grounding
I. 125 Volt DC control power
J. 120 Volt AC power
K. Terminiations
L. Equipment protection
M. Instrument transformers
N. Appurtenances and auxiliary devices
O. Maintenance accessories
P. Factory testing
Q. Field acceptance testing

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures
B. Section 01 33 23 Shop Drawings, Product Data, and Samples
C. Section 01 42 00 Quality Assurance
D. Section 01 45 00 Quality Control
E. Section 01 45 24 Testing Program Requirements
F. Section 01 78 23 Operation and Maintenance Data
G. Section 01 78 44 Spare Parts and Maintenance Manuals
H. Section 34 21 05 Prefabricated AC and DC Equipment Houses
I. Section 34 21 40 DC Control Power System
J. Section 34 22 23 Traction Power Cables
K. Section 34 21 50 Common Materials and Methods for Traction Power
L. Section 34 21 80 Traction Power System Field Acceptance Testing

1.03 MEASUREMENT AND PAYMENT

A. Measurement: AC switchgear will be measured for payment per individual unit that is fabricated, factory tested, delivered to site, installed and field functioning tested in accordance with the Contract Documents.

B. Payment: AC switchgear houses will be paid for at the Contract unit price per each individual switchgear cubicle as indicated in the Bid Schedule of the Bid Form.

1.04 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI C37.54 Indoor Alternating Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal Enclosed Switchgear – Conformance Test Procedures
2. ANSI C37.57 Switchgear – Metal Enclosed Interrupter Switchgear Assemblies – Conformance Testing
3. ANSI C37.58 Switchgear – Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear – Conformance Test Procedures

B. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE C37.010 Application Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis
2. IEEE C37.04 Standard Rating Structure for AC High-Voltage Circuit Breakers
3. IEEE C37.06 Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V
4. IEEE C37.09  Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on Symmetrical Current Basis

5. IEEE C37.016 Standard for AC High Voltage Circuit Switchers Rated 15.5 kV through 245 kV

6. IEEE C37.20.3 Standard for Metal Enclosed Interrupter Switchgear (1 kV – 38 kV)

7. IEEE C37.20.7 Guide for Testing Switchgear Rated Up to 52kV for Internal Arcing Faults

8. IEEE C37.122.2 Guide for the Application of Gas-Insulated Substations 1 kV to 52 kV.

9. IEEE C57.13 Standard Requirements for Instruments Transformers

C. National Electrical Code (NEC):
   1. NFPA 70 National Electrical Code

D. National Electrical Manufacturer’s Association (NEMA):
   1. NEMA EL 21.2 Instrument Transformers for Revenue Metering (125 kV BIL Through 350 kV BIL)

1.05 SUBMITTALS

A. General: Refer to Section 01 33 00, Submittal Procedures; and Section 01 33 23, Shop Drawings, Product Data, and Samples for submittal requirements and procedures.

B. Product Data: Submit product data for components specified herein.

C. Design Drawings: Provide design drawings for the 34.5 kV gas insulated switchgear and associated devices, including equipment layouts, and circuit breaker control schematics.

D. Protective relay settings and communications interfaces with C02 panel PLC.

E. Test plan and procedures for factory testing.

F. Test report for factory testing.

G. Operations and Maintenance Manuals: Provide the following operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
1.06 QUALITY ASSURANCE AND SUPPLIER QUALIFICATIONS

A. Electrical components, devices, and accessories shall be listed and labeled in conformance with NFPA 70, Article 100. Electrical components, devices, and accessories and their installation shall comply with NECA’s National Electrical Installation Standards (NEIS).

B. The manufacturer of the 34.5 kV AC switchgear and 34.5 kV circuit breakers shall have a minimum of five years of successful and proven transit, industrial or utility experience of providing equipment like the one specified herein.

C. Auxiliary equipment, devices, and components comprising the AC switchgear shall be proven standard products, or equivalent to the standard products of manufacturers engaged in the production of such equipment, devices, and components for at least the past five years.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be weatherproofed for shipment. Connection openings shall be closed to prevent entrance of foreign material during shipment and storage.

B. Equipment shall be handled and stored in conformance with manufacturer’s instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.08 SPARE PARTS, TEST EQUIPMENT, AND TOOLS

A. Mandatory Spare Parts: Furnish the following mandatory spare parts required to maintain and operate the 34.5 kV gas insulated switchgear in accordance with the requirements of Section 01 78 44, Spare Parts and Maintenance Materials.

1. Blocking coil ground or isolator switch: 2 each
2. Motor for ground or isolator switch: 2 each
3. Isolator or grounding switch auxiliary contacts: 2 each
4. Motor for spring charging of circuit breaker: 2 each
5. Varistor for circuit breaker motor: 2 each
6. Circuit breaker trip or close coil: 4 each
7. Circuit breaker control power under voltage trip coil: 1 each
8. Camera for isolator/ground Switch: 1 each
9. Circuit breaker auxiliary contacts: 1 each
10. Spring charging auxiliary contacts: 1 each
11. Intelligent Voltage Information System (IVIS-F) Display: 1 each

12. Intelligent Displays (IDIS): 1 each

13. Density switch for IDIS (with cable): 1 each

14. Dummy section for easy, quick and safe return to service after circuit breaker failure: 1 each

15. Lubrication kit (including cleaning agent, grease and lubricant): 1 each

B. Recommended Spare Parts: Provide a recommended list of spare parts, tools, and test equipment in accordance with the requirements of Section 01 78 44, Spare Parts and Maintenance Materials.

1.09 MAINTENANCE ACCESSORIES

A. Provide necessary equipment and accessories recommended by the equipment Supplier needed for the normal operation and preventive maintenance of the AC switchgear.

PART 2 – PRODUCTS

2.01 GENERAL

A. The functions of the 34.5 kV gas insulated switchgear assembly in each traction power facility are as described below. The gas insulated switchgear assembly shall be supplied as indicated. Where different 34.5 kV switchgear functions, such as power supply to transformer/rectifier units, sectionalizing stations, and switching stations are combined in one location, a common AC switchgear assembly shall be supplied, as indicated on the Contract Drawings:

1. In switching stations, the 34.5 kV switchgear receives 3-phase, 60 Hz, 34.5 kV power from the high-voltage 115/34.5 kV substation and distributes it by means of two 34.5 kV sub-transmission feeders to the traction power substations installed along the tracks, as indicated. In certain switching station locations, the AC switchgear is provided with an additional circuit breaker, which supplies power to auxiliary substations feeding the subway ventilation system.

2. In traction power substations, the 34.5 kV switchgear receives power from the two sub-transmission feeders and distributes it to two transformer/rectifier units via sectionalized bus. Each 34.5 kV feeder is terminated on the line side of a 34.5 kV feeder circuit breaker, whose load side is connected to a rectifier transformer. A normally open bus-tie circuit breaker is provided, also connected between the load sides of the two feeder circuit breakers. The two 34.5 kV feeder circuit breakers are normally closed.

3. In sectionalizing stations, the AC switchgear divides the 34.5 kV sub-transmission system between adjacent high-voltage substations into line sections.
and provides the capability to connect the two adjoining line sections during outage of either high-voltage substation.

B. The AC switchgear shall be housed in an outdoor, walk-in type, transportable prefabricated house, as specified in Section 34 21 05, Prefabricated AC and DC Equipment Houses. The 34.5 kV gas insulated switchgear shall include a SF-6 insulated, type tested single phase metal enclosed vacuum interrupters. Three-position disconnections and grounding switches power cable terminations, instrument transformers, indicating devices, protective and auxiliary relays, terminal blocks, control circuitry, interlocks, switches, and all other equipment, panels, and devices as indicated for a complete operating installation.

2.02 OPERATING REQUIREMENTS

A. The 34.5 kV circuit breakers shall be provided with both local and remote control and monitoring. Each 34.5 kV circuit breaker shall be provided with disconnector and grounding switches.

B. At the switching stations, the 34.5 kV circuit breakers shall be normally closed to keep both sub-transmission feeders energized under normal operating conditions.

C. At the sectionalizing stations, the 34.5 kV circuit breakers shall be normally open.

D. At each traction power substation, operation of the circuit breakers shall be as follows:

1. Under normal operating condition, the two 34.5 kV feeder circuit breakers shall be closed, and the 34.5 kV bus tie circuit breaker shall be open. The line side of each feeder circuit breaker shall be connected to the incoming 34.5 kV sub-transmission feeder and the load side connected to the rectifier transformer.

2. The two 34.5 kV feeder circuit breakers and the bus tie circuit breaker shall be equipped with automatic transfer scheme (ATS) such that upon loss of power on one of the incoming 34.5 kV sub-transmission feeder, after a short time delay, it will automatically trip the affected 34.5 kV feeder circuit breaker and automatically close the normally open 34.5 kV tie circuit breaker. Similarly, upon loss of power on the other incoming 34.5 kV sub-transmission feeder, the corresponding normally closed feeder circuit breaker will automatically trip after a short time delay and then close the normally open 34.5 kV tie circuit breaker. No paralleling of the two 34.5 kV feeder circuit breakers will be allowed and no automatic transfer will be permitted if there are any system faults (i.e., phase to phase or phase to ground or phase current unbalanced).

3. During manual operation, the 34.5 kV feeder and bus tie circuit breakers shall have the capability to operate with one feeder circuit breaker closed and the bus tie circuit breaker closed. Controls shall be designed to allow only two out of three circuit breakers to be closed at any one time.

4. The circuit breaker and the disconnector and grounding switches are electromechanically interlocked to only operate with the circuit breaker in the open position. The three-position switch shall be prevented from switching through the
CLOSED state in the “ready to earth” state. Closing of the circuit breaker shall be blocked if the three-position switch is in an intermediate position.

5. The 34.5 kV circuit breaker/disconnector switch operation and interlocking shall function as specified in IEEE C37.122.2.

6. The outdoor type 34.5 kV visible disconnect switch in the isolation disconnect switch (IDS) functions as a switching device between the 34.5 kV feeder circuit cables and the 34.5 kV AC switchgear circuit breaker. The 34.5 kV circuit breaker is equipped with disconnector/grounding switches on the line and load sides of the circuit breaker. The corresponding 34.5 kV disconnector/grounding switches shall be interlocked with the 34.5 kV visible disconnect switch so that the disconnector/grounding switches can only be operated when the visible disconnect switch is opened and no voltage present at the 34.5 kV feeder circuit to ensure ground is never applied to an energized cable.

2.03 RATINGS

A. The 34.5 kV gas insulated switchgear ratings shall be in accordance with IEEE C37.06, IEEE C37.20.3, and IEEE C37.016, and shall be as follows:

1. Nominal Voltage, Line-to-Line: 34.5 kV, rms
2. Rated Max Voltage: 38 kV, rms
3. Rated Low Frequency Withstand: 80 kV, rms
4. Rated Full Wave Impulse Withstand: 150 kV, rms
5. Rated Frequency: 60 Hz
6. Rated Continuous Current: 1200A, rms

B. The 34.5 kV Vacuum circuit breakers shall be rated in accordance with IEEE C37.06 and IEEE C37.016 and shall have the following minimum ratings:

1. Rated Short-Circuit Withstand Current: 25 kA, rms
2. Rated Peak Withstand Current: 65 kA
3. Breaker Rated Interrupting Time: 3 cycles
4. Rated Short Circuit Making Current (max.): 65 kA, rms
5. Rated Short Circuit Breaking Current: 25 kA, rms

2.04 SWITCHGEAR ENCLOSURE

A. Switchgear assemblies for vacuum circuit breakers, bus bars, disconnector and grounding switches, and associated instrument transformers and devices shall be of the metal enclosed type, Sulfur hexafluoride (SF-6) insulated and shall form a line-up
of dead front, freestanding cubicles. Each cubicle shall consist of three single pole vacuum circuit breakers, bus bars, disconnector and grounding switches, relays, devices and incoming cable entering from above or below as indicated in the Contract Drawings. The circuit breaker housings and bus bars housings shall be separated from each other with gas tight bushings.

B. Cubicle housing shall consist of a corrosion resistant high nickel content aluminum alloy assembled using O-rings for gas tightness or stainless steel or galvanized steel welded or bolted structure enclosing all sides and top except openings for specific purposes. The structure shall support equipment under normal and short-circuit conditions.

C. Each closed gas compartment shall have its own pressure relief which prevents rupture of the housing in case of an arc fault. The gas compartment shall be equipped with gas monitoring device complete with auxiliary contacts for local and remote alarm indications. Setting of the gas monitoring device shall be provided by the equipment Supplier to the District.

D. Each cubicle control panel and low voltage cabinet shall have front hinged doors. At a minimum, the doors shall meet the following requirements:

1. The doors shall support flush and semi-flush mounted devices and not distort from a plane surface in any position. The doors shall be supported by concealed hinges.

2. Each front hinged door shall have a handle and a mechanical three-point vibration proof latch for holding it in a closed position.

3. Each front door shall be provided with a stop to hold the door in the open position, so that door-mounted devices will not touch similar devices mounted on adjacent doors.

4. The front doors shall have provisions for padlocking.

E. Top cable entrance shall be provided for external power and control terminations as indicated on the Contract Drawings. Ample space shall be provided for cable pulling, cable termination, and performing high potential tests on cables without having to remove the terminations from the cubicle.

F. Switchgear assembly items requiring inspection, operation or maintenance shall be installed not higher than 72 inches off the floor and shall be accessible from the front.

2.05 CIRCUIT BREAKERS

A. General

1. The circuit breakers shall be sealed vacuum type and shall be rated in accordance with IEEE C37.04 and IEEE C37.06. Circuit breaker design shall incorporate the following features:
a. The circuit breakers shall be three single pole stored-energy operating mechanism type, rated for service on a three-phase, effectively grounded-neutral, 60 Hz system at a nominal operating voltage of 34.5 kV line-to-line.

b. The circuit breaker control circuits and stored-energy mechanism charging motor shall operate from a 125 V DC source.

c. The circuit breakers shall successfully close over a voltage range from 90 V DC to 140 V DC, and trip over a voltage range from 75 V DC to 140 V DC.

2. Circuit breakers shall be designed to interrupt the rated short-circuit current in a sealed vacuum with a separate vacuum chamber for each phase of the circuit breaker.

a. Contact erosion indication shall be provided on each interrupter pole assembly, for evaluation of wear on the main contacts over the life of the circuit breaker.

b. Circuit breakers shall have only one internal movable contact per phase in the vacuum interrupter.

B. Operating Mechanism

1. The circuit breaker shall be operated by a stored-energy mechanism of the motor-charged, and shall be spring type, mechanically and electrically trip-free, and non-pumping. Circuit breaker design shall include provisions for manual charging of the stored-energy mechanism. The use of hydraulic or pneumatic operating mechanisms is not acceptable.

2. A SPRING CHARGE indicator shall be provided on the front of the control panel showing the status of the closing spring. A white indicating light shall be provided on the front door, with the light being lit on when the closing spring is fully charged.

3. The closing spring shall be re-charged automatically once the circuit breaker has been closed.

C. Circuit Breaker Controls

1. A control switch shall be provided on the front door of the control panel of each breaker unit for electrical tripping of the breaker only.

2. A LOCAL-REMOTE selector switch (local cubicle) shall be provided on the front door of each breaker unit for electrical closing of the breaker in the connected position. When using this function, the close shall be actuated with a programmable time delay.

3. Manual local control of the breaker while in the CONNECTED position shall be from the control switch provided on the control and annunciator panel (C02) when the C02 main PLC or C04 Ethernet switch is inoperable. LOCAL-REMOTE selector switch shall be in the LOCAL position and AC breaker shall be in CONNECTED position. Input / output module shall be installed in the C02 panel
and the matching pair shall be installed with the AC switchgear lineup. IOMs can be wired directly to more than one AC circuit breaker IPR.

4. Each circuit breaker shall be provided with a manually-operated mechanical means for tripping the circuit breaker. Open and close mechanical position indications shall be provided on the front control panel. The mechanical grounding lever shall be lockable and taggable for a grounded feeder circuit.

5. Circuit breakers shall be designed for remote control operation as specified in Section 34 21 33, Control, Monitoring and Display Panel. Remote commands shall be able to trip the breaker at all times while in the connected position but shall be able to close it only when the LOCAL-REMOTE selector switch “Station” located at C02 panel and the LOCAL-REMOTE selector switch (local) on the front of each circuit breaker unit are in the REMOTE positions.

6. Controls for the 34.5 kV circuit breakers shall be interlocked with the rectifier doors in the traction power substation, such that any door opening shall trip the main and tie circuit breakers connected to their respective transformer-rectifier unit. The protective relay logic and interlocking shall permit operation of the substation with one transformer-rectifier unit only, while the other unit is out-of-service due to fault or maintenance.

7. Provide remote SCADA indications to the OCC for the open/close status, and CONNECTED position for each 34.5 kV circuit breaker.

8. Auxiliary contacts shall be operated by the breaker mechanism in both the TRIPPING and CLOSING operations.

9. Auxiliary contacts including spares shall be wired to the terminal blocks and properly labeled.

10. Four-digit operation counter shall be provided to record tripping operations.

D. Circuit Breaker Status Indications

1. The open and closed status of the breakers shall be indicated, respectively, by green and red lights mounted on the control panels and by mechanical flag indicators.
   a. The red BREAKER CLOSED indicating light and auxiliary relay for remote indication shall be connected to monitor the continuity of the trip circuit.
   b. The indicating lights and the mechanical flags shall be visible when the circuit breaker compartment door is closed.

2. A flag indicator, visible when the door is closed, shall be provided to indicate the position of the circuit breaker.

3. Dry auxiliary contacts wired to terminal blocks shall be provided for remote breaker status and position indications.
2.06 THREE POSITION SWITCHES

A. The disconnector and grounding switches rated at 1200A, shall be designed as single three-position switches. In combination with the circuit breaker, the no load break three position switch shall be used for fault close feeder grounding.

B. The disconnector/grounding stationary and movable contacts shall be mounted in the bus bar housing with mechanical coupling made through an external shaft.

C. The three-position switch operating mechanism shall be located on the front control panel with two operating functions (disconnecting and grounding), separate interlocked operating handles shall be provided.

D. The switching positions of the three position switches shall be visually monitored using a web-camera system and shall be displayed with a provided laptop computer. Alternatively, provide a visual monitoring capability.

E. A mechanical switch position indication for connected and grounding switch positions shall be provided.

F. To prevent the three-position switch from operating under load, the three-position switch shall be electro-mechanically interlocked to only operate with the circuit breaker in the open position as indicated on the Contract Drawings. The three-position switch can only be brought into the ready-to-earth position if the disconnector and circuit breaker are open. The three-position switch shall be prevented from switching through from the CLOSED state into the “ready-to-earth” state. Closing of the circuit breaker shall be blocked if the three-position switch is in an intermediate position.

G. If the control voltage fails, an interlocked emergency operation of the feeder shall be possible.

H. For the disconnector switch, a minimum of ten auxiliary contacts (4 NO + 4NC +2 CO) shall be provided for local and remote position indications.

I. For the grounding switch, a minimum of eight auxiliary contacts (2 NO + 2 NC + 4 CO) shall be provided for local and remote position indications.

2.07 BUSES AND BUS CONNECTIONS

A. The 34.5 kV single pole buses shall be made of insulated copper bars and shall be of sufficient size to carry the continuous rated current, without exceeding the temperature limit of 40 degrees Celsius. The continuous rating of bus and bus connections shall be 1200 amperes.

B. The phase sequence of three-phase assembled buses and primary conductors shall be A-C-B counting from front to back, top to bottom, or left to right as viewed from the front side of the switchgear assembly.

C. The buses shall be supported and braced between each other and to the enclosure with high strength anti-hygroscopic, flame retardant, non-tracking insulators, so that
the buses withstand the thermal and mechanical stresses due to maximum short-circuit currents equal to the maximum symmetrical interrupting and 3-second short time current ratings of the circuit breaker protecting the bus.

D. Bus bars including runbacks shall be insulated with track-resistant, flame-retardant epoxy coating. Bus joints shall be insulated with flexible or molded removable resin boots.

E. Bus joints and connections shall be of the bolted construction. They shall:
   1. Be acid etched and plated with electro-deposited silver after buses have been bent or formed. Bending after the plating process will not be allowed.
   2. Be made with Bellville-type washers and high-strength, rust resistant steel bolts, such as cadmium-plated or galvanized. Bolt shall be capable of being properly torqued and locked in place.

F. Bus joints shall have conductivity at least equal to that of the bus bars, and each joint shall be so clamped that no loss of conductivity will occur during the life of the equipment.

G. Access plates shall permit assembling joints and inspecting bolted connections after installation of the bus enclosure.

### 2.08 GROUNDING

A. A copper ground bus with a symmetrical withstand current rating equal to that of the circuit breaker shall extend throughout the entire length of the switchgear assembly. Ground bus shall not be less than one fourth inch by two inches in size.

B. At least two nine sixteenths inch diameter holes at one and three fourths inch centers shall be provided at each end of the bus.

C. Provide grounding knobs on the ground bus and on each phase bus for safety grounding of the incoming 35.5 kV cables and phase buses. The grounding knobs shall be provided with removable insulated caps for the grounding device.

D. Each cubicle shall be grounded directly to the ground bus. Cubicle doors and panels shall be provided with a flexible copper braid ground strap attached to the structure framing.

E. Grounding connections shall be metal-to-metal, with any nonconductive coatings such as paint or lacquers removed to ensure solid electrical contact.

F. The ground bus shall have provisions for connecting ground cables in each cubicle and at the ends of the switchgear lineup.
2.09 125 VOLTS DC CONTROL POWER

A. Control power for circuit breaker closing and tripping functions, and for energizing control, indication, monitoring, and protective devices shall be from the 125 V DC control power as specified in Section 34 21 40, DC Control Power System.

B. A two-conductor AWG No. 6 or larger, 125-volt DC control bus with a minimum 600-volt insulation shall be provided for the full length of each switchgear assembly.

C. The control bus shall:
   1. Run in a protective raceway;
   2. Be terminated on a terminal block for connection to the power supply source; and
   3. Be tapped at each cubicle served and extended to the associated circuit breaker control compartment.

D. Molded-case, thermal magnetic circuit breakers shall be provided for protection and isolation of each control circuit in each switchgear cubicle.

E. Control power voltage-monitoring relay shall be furnished and connected on the load side of the molded-case circuit breaker in each switchgear cubicle.

2.10 120 VOLTS AC POWER

A. A 120 V AC, 60 Hz, No. 2 AWG or larger 2-wire bus shall be provided for devices such as heaters, fans, lights, and receptacles.

B. The AC bus shall:
   1. Extend for the full length of each switchgear assembly;
   2. Be terminated on a terminal block for connection to an external power supply; and
   3. Be tapped in each switchgear cubicle for connections of space heaters, fans, lights, and receptacles. Lighting circuits shall be independent from other circuits.

2.11 TERMINATION

A. The bus connections for the 35 kV single-conductor power cables shall be coordinated with the size of the cable terminations and shall not be located lower than 24 inches above the switchgear floor if the power cables are entering from below.

B. Unless otherwise indicated, power cables shall enter and leave the switchgear at the bottom. Provisions shall be made to accommodate the number of cables indicated.
C. 35 kV power cable terminations shall be as specified in Section 34 22 23, Traction Power Cables. NEMA 2-hole cable connections shall be provided for the cable size indicated.

D. Low voltage terminations shall be as specified in Section 34 21 50, Common Materials and Methods for Traction Power.

E. Capacitive voltage detecting system or the low resistance modified (LRM) with the plug-in indicator for each 35 kV feeder cable shall be provided.

2.12 EQUIPMENT PROTECTION

A. Relaying, metering, and indicating devices shall be provided as shown on the Contract Drawings, and as specified herein. Refer to Section 34 21 50, Common Materials and Methods for Traction Power, for general requirements of protective relays and indicating devices.

B. Provide control and indication functions in accordance with Contract Specifications Section 34 21 33, Traction Power Control, Monitoring, and Display Panel and Related Equipment.

C. Equip each 34.5 kV feeder circuit breaker and bus tie circuit breaker with a microprocessor-based multi-function protection relay, referred to as integrated protection relay (IPR) as specified in Specifications Section 34 21 12, Integrated Protection Relay Equipment.

D. At traction power facilities using 34.5 kV switchgear IPR shall be used for protection, as well as circuit breaker control. Apply protection functions as indicated on the Contract Drawings.

E. Backup Control Systems

1. Provide backup controls described in item 2.05C.3 in addition to the primary control and protection devices. If a phase or ground fault occurs on a 34.5 kV transformer-rectifier circuit, the corresponding 34.5 kV feeder circuit breaker and 34.5 kV bus tie circuit breaker shall be tripped directly by its primary or back-up protection devices, or through its corresponding lockout relay, device 286 as indicated on the Contract Drawings. If there is any failure in the fiber optic cable associated with the protection relay, the feeder circuit breakers 252-1, 252-2 and bus tie circuit breaker, 252-8 shall be tripped through its back-up remote input/output module.

F. Control and Communication Functions

1. Coordinate the C02 panel to implement controls, indications, and data transfer between the IPR relays and the C02 panel for local and remote control, indication, and data transfer functions and processes. Communication between IPR relays and the C02 PLC shall use the DNP3 protocol.
2.13 INSTRUMENT TRANSFORMERS

A. Instrument transformers shall conform to IEEE C57.13 and NEMA EL 21.2. The current and potential transformers shall comply with the IEEE C57.13 relaying and metering accuracy standards, and shall have 0.6 accuracy class or better, under the burdens imposed by the connected services. This accuracy limit does not apply to revenue metering which is described in the following paragraph in this section.

B. Instrument transformers shall be insulated for 38 kV voltage class and shall have basic impulse insulation (BIL) level of 200 kV full-wave.

C. Current Transformers

The current transformers (CTs) shall be dry type, of molded rubber or epoxy construction, multi-ratio, bushing, toroidal or wound-type:

1. Ratio and phase-angle characteristics of current transformers shall be suitable for the relaying or metering, as indicated.

2. CTs shall be installed in a manner such that they are easily accessible for inspection and maintenance.

3. In traction power substations and switching stations, each breaker cubicle shall be provided with two CTs per phase rated 1200/5 and the bus tie circuit breaker cubicle shall be provided with one current transformer per phase rated 1200/5A as indicated. In sectionalizing stations each breaker cubicle shall be provided with one CT per phase as indicated.

4. CTs and their secondary wiring shall be protected from induced voltages by metallic shielding. Secondary wiring shall utilize No. 10 AWG copper wire and shall be run to readily identifiable terminal blocks in the low voltage control panel. The terminal blocks for the CTs shall be suitable for ring type wire connections, shall have covers, and shall feature integral shorting bars for the CT leads.

5. CTs shall be capable of withstanding thermal, magnetic and mechanical stresses from the flow of current equal to the interrupting and momentary routings of the circuit breakers.

6. CTs for revenue metering application shall be 0.15 percent across Burden Classes B1 thru B8 as defined by IEEE C 57.13.6.

D. Potential Transformers

1. Potential transformers (PTs) shall be of the molded rubber or epoxy-encapsulated construction, with primary current-limiting fuses outside the primary enclosure as indicated:

2. PTs shall be mounted and connected on the line side of the three-position switch via plug-in cable and shall be easily accessible for inspection and maintenance.
3. Primary and secondary circuits of PTs shall be protected by means of non-renewable cartridge type fuses. Secondary circuit fuses shall be installed in the low voltage control panel and shall be located to permit replacement when the switchgear is in service.

4. PTs shall have voltage ratio of 20125 V primary to 115 V secondary, and shall be connected between phase A and neutral, phase B and neutral and phase C and neutral.

5. PTs for revenue metering application shall be 0.15 percent across Burden Classes W to ZZ as defined by IEEE C 57.13.6.

2.14 APPURTENANCES AND AUXILIARY DEVICES

A. AC switchgear appurtenances and auxiliary devices, such as control switches, wiring devices, low voltage wires and cables, and indicating lights shall be as specified in Section 34 21 50, Common Materials and Methods for Traction Power.

2.15 FACTORY TESTING

A. General: Testing shall be performed in accordance with the requirements of Section 01 45 24, Testing Program Requirements.

B. Factory Tests:

1. The following design tests shall be performed on one AC switchgear assembly, complete with associated 34.5 kV AC circuit breakers:

   a. Applicable tests identified as design tests in IEEE C37.09 for the circuit breaker.

   b. Applicable tests identified as design tests in ANSI C37.54 and ANSI C37.58 for the switchgear assembly.

   c. Performance verification tests on switchgear control circuits including automatic transfer.

2. The following production tests shall be performed on AC switchgear assemblies, complete with their associated 34.5 kV AC circuit breakers:

   a. Applicable tests identified as Production Tests in IEEE C37.09 for the circuit breakers.

   b. Applicable tests identified as Production Tests in ANSI C37.54, ANSI C37.57 and ANSI C37.58 for the switchgear assemblies.

   c. Functional tests on switchgear control circuits including automatic transfer between the substation 34.5 kV feeder circuit breakers and bus tie circuit breaker.
PART 3 – EXECUTION

3.01 FIELD ACCEPTANCE TESTING

Refer to Section 34 21 80, Traction Power System Field Acceptance Testing for requirements.

END OF SECTION 34 21 17