

## SECTION 34 21 18

### AC SWITCHGEAR

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. General
- B. Operating requirements
- C. Ratings
- D. Switchgear enclosure
- E. Circuit breakers
- F. Buses and bus connections
- G. Grounding
- H. 125 Volt DC control power
- I. 120 Volt AC power
- J. Terminations
- K. Equipment protection
- L. Instrument transformers
- M. Appurtenances and auxiliary devices
- N. Maintenance accessories
- O. Testing

##### 1.02 MEASUREMENT AND PAYMENT

Not used.

##### 1.03 REFERENCES

- A. American National Standards Institute (ANSI):
  - 1. ANSI C37.04 Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

#### AC SWITCHGEAR

2. ANSI C37.06 Preferred Ratings and Related Required Capabilities for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
  3. ANSI C37.09 Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
  4. ANSI C37.20.2 Metal-Clad and Station-Type Cubicle Switchgear (above 1000V)
  5. ANSI C37.55 Conformance Testing of Metalclad Switchgear
  6. ANSI C57.13 Requirements for Instrument Transformers
- B. American Society for Testing and Materials (ASTM):
1. ASTM F855 Temporary Grounding Systems to be used on De-Energized Electric Power Lines and Equipment
- C. National Electrical Manufacturers Association (NEMA):
1. NEMA SG4 AC High-Voltage Circuit Breaker
  2. NEMA SG 5 Power Switchgear Assemblies

### 1.04 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.

### 1.05 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 5 years of successful and proven transit, industrial or utility experience of providing equipment similar to 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 5 years.

### 1.06 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.

## 1.07 WARRANTY

- A. A warranty for the 34.5 kV circuit breakers and ac switchgear components shall be provided and signed by the manufacturer and installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship. The warranty shall be for the period between installation and the start of revenue service, plus 2 years from the date of system in revenue service.

## PART 2 – PRODUCTS

### 2.01 GENERAL

- A. The functions of the ac switchgear assembly in each traction power facility are as described below. 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 subtransmission 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 subtransmission 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 circuit breaker, whose load side is connected to a rectifier transformer. A normally closed bus-tie circuit breaker is provided, also connected between the load sides of the two feeder circuit breakers. The feeder circuit breakers are interlocked to allow only one breaker to be closed at any one time, and the bus-tie circuit breaker is provided to allow isolation of one transformer/rectifier unit, if needed.
  3. In sectionalizing stations, the ac switchgear divides the 34.5 kV subtransmission 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 form a lineup of dead-front, free standing metal cubicles. The ac switchgear and associated auxiliary cubicles shall be of the metal-clad construction, and designed and fabricated in accordance with ANSI C37.20.2 and NEMA SG 5.
- C. 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 ac switchgear shall include drawout circuit breakers, three-phase bus and bus connections, 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.
- B. At the switching stations, the 34.5 kV circuit breakers shall be normally closed to keep both subtransmission 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. One of the two 34.5 kV circuit breakers shall be normally open and connected to one of the incoming 34.5 kV feeders, while the other circuit breaker shall be normally closed and connected to the other 34.5 kV feeder, as indicated.
  - 2. Upon loss of power to the traction power substation, the circuit breakers shall automatically change status provided fault conditions do not exist, and the 34.5 kV feeder circuit to which the normally-open breaker is connected, is energized.
  - 3. The 34.5 kV bus tie circuit breaker shall be normally closed.

**2.03 RATINGS**

- A. The ac switchgear ratings shall be in accordance with ANSI C37.20 and NEMA SG5, 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. AC circuit breakers shall be rated in accordance with ANSI C37.06 and NEMA SG4 and shall have the following minimum ratings:
 

1.	Rated Short-Circuit Current at Rated Max kV	21 kA,	rms
2.	Breaker Rated Voltage Range Factor, K	1.65	
3.	Breaker Rated Interrupting Time	5 cycles	

## AC SWITCHGEAR

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| 4. | Breaker Rated 3-Sec Short-Time Current Carrying Capability | 35 kA, rms |
| 5. | Breaker Rated Closing and Latching Capability              | 95 kA, rms |
| 6. | Rated Max Voltage  | 38 kV      |

### 2.04 SWITCHGEAR ENCLOSURE

- A. Switchgear assemblies for circuit breakers and associated instrument transformers and relaying shall be of the metal-clad type and shall form a line-up of deadfront, freestanding cubicles. Each cubicle shall consist of several compartments to house the circuit breaker, bus bars, cables, relays and devices as indicated. Circuit breakers shall be installed in the bottom compartments of the respective cubicles.
- B. Each cubicle shall be a rigid, self-supporting and self-contained electrically welded or bolted steel structure enclosing all sides and top except openings for specific purposes. The structure shall support equipment under normal and short-circuit conditions.
- C. All panels comprising the switchgear enclosure, including the doors, shall be constructed of sheet steel, of thickness not less than No. 11 gauge.
- D. Compartments shall be isolated from one another by grounded barriers of not less than No. 11 gauge sheet steel.
- E. Each cubicle shall have front and rear hinged doors. Rear doors shall be weatherproof type. 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 cubicle front hinged door shall have a handle and a mechanical three-point vibration-proof latch for holding it in a closed position.
  3. Each cubicle 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. Doors of the circuit breakers compartments shall be designed to be closed and locked when the breaker is in the CONNECTED, TEST or DISCONNECTED position.
  5. Both the front and rear doors shall have provisions for padlocking.
- F. Each circuit breaker cubicle shall be provided with protective shutters, which automatically close and cover the live high-voltage terminals as the removable breaker element is racked out.
- G. Breaker compartments shall be constructed so that the circuit breakers may be drawn in and out of their housing on wheels along guide ways and make connections to the buses and auxiliary circuits by means of self-aligning, self-coupling primary and secondary disconnecting devices.

- H. Bus compartments shall be rigid framework and shall include, but not be limited to, bus work, connection bars, cable terminal connectors, and bus and cable supports.
- I. To facilitate cleaning and inspection, removable cover plates with lifting handles shall be furnished for all bus compartments to allow access to the bus and cable connections with cables in place. Plates shall be less than 18 by 24 inches in size, shall have no sharp edges, and shall weigh less than 20 lbs each.
- J. Bottom cable entrance shall be provided for external power and control terminations, unless top entries are shown on the Contract Drawings. At indoor traction power substations, cable entrance shall be top entry. 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.
- K. 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 and the rear.
- L. The switchgear cubicle shall contain louvers to provide adequate ventilation and air cooling of the components inside. Louver design shall be coordinated with the specified ventilation system for the prefabricated switchgear house. Ventilation intake openings shall not be located less than six inches above the floor, nor where they would allow entry of debris and dirt.

## 2.05 CIRCUIT BREAKERS

### A. General

1. The circuit breakers shall be sealed vacuum type, and shall be rated in accordance with ANSI C37.04 and ANSI C37.06. Circuit breaker design shall incorporate the following features:
  - a. The circuit breakers shall be 3-pole, single-throw, stored-energy operating type, rated for service on a 3-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. Removable breaker elements of the same type and rating shall be completely physically and electrically interchangeable. Removable elements of different type or ratings shall not be interchangeable.
  - d. The circuit breakers shall successfully close over a voltage range from 100 V dc to 150 V dc, and trip over a voltage range from 75V dc to 150 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 Breaker Positions:

## AC SWITCHGEAR

1. Provisions shall be made for moving the circuit breaker to and from a CONNECTED, TEST and DISCONNECTED position. The three positions shall be clearly marked.
2. In the CONNECTED position, both the primary and secondary disconnecting devices shall be in full contact and the breaker shall be in position for normal operation.
3. In the TEST position, the primary disconnecting devices shall be open and separated by a safe distance to prevent arcing, while the secondary disconnecting devices shall be in full contact. Automatically operated shutters shall cover the exposed part of the bus and main stationary contacts.
4. In the DISCONNECTED position, both the primary and secondary disconnecting devices shall be open and separated by a safe distance.

### C. 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. The operating springs shall be discharged automatically when the breaker is rolled out fully from the compartment or is moved into the DISCONNECT position.
3. A closing spring CHARGE/DISCHARGE indicator shall be provided on the front of the removable element, showing the status of the closing spring. In addition, a white indicating light shall be provided on the front door, with the light being lit on when the closing spring is fully charged.
4. The closing spring shall be re-charged automatically once the circuit breaker has been closed.

### D. Withdrawal Mechanism:

1. Each switchgear cubicle shall have a cranking or ratcheting device for moving the circuit breaker to and from the CONNECTED, TEST and DISCONNECTED positions.
2. A switch shall be included to disconnect automatically the charging motor circuit during cranking.
3. Guide rails shall ensure alignment of the circuit breaker during insertion and removal. Breaker insertion and withdrawal shall be free of jamming and shall only require an average person to operate.

### E. Mechanical Interlocks:

1. Mechanical interlocks shall be provided on each circuit breaker unit to:
  - a. Prevent inserting or disconnecting a closed circuit breaker
  - b. Discharge the stored energy springs prior to circuit breaker removal, and

- c. Prevent the circuit breaker from closing, if the closing spring is not fully charged.
2. Positive stop shall be provided to prevent overtravel of the circuit breaker when moving into the CONNECTED position and the TEST positions.
3. A flag indicator, visible when the cubicle door is closed, shall be provided to indicate when the breaker is in TEST or CONNECTED positions.

F. Disconnecting Devices:

1. Each circuit breaker shall be equipped with primary and secondary disconnecting devices.
2. Stationary and potentially energized parts of the primary disconnecting devices shall be covered automatically by safety shutters, when the circuit breaker is racked away from the CONNECTED position to the TEST or DISCONNECTED position. The shutters shall be operated by direct mechanical linkage to the floor-mounted racking mechanism, and shall be capable of withstanding the force of the circuit breaker in case of failure of the shutters to open when the breaker is racked into position. The shutters shall be designed to remain closed until they are opened by the presence of the circuit breaker.
3. All disconnecting devices shall:
  - a. Have silver-plated contact surfaces,
  - b. Be located and mounted to maintain alignment during breaker insertion or withdrawal, and
  - c. Provide electrical continuity between the stationary contacts in the housing and the corresponding circuit breaker terminals.

G. Circuit Breaker Controls:

1. A control switch shall be provided on the front door of each breaker unit for electrical tripping of the breaker in any position, and closing it only in the TEST position.
2. Local control of the breaker while in the CONNECTED position shall be from the control switch provided on the control and annunciator panel as specified in Section 34 21 33, Control, Monitoring and Display Panel.
3. Each circuit breaker shall be provided with a manually-operated mechanical means for tripping the circuit breaker when in the TEST and CONNECTED positions, and closing the breaker when in the TEST position only.
4. All 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, but shall be able to close it only when the LOCAL-REMOTE selector switch is in the REMOTE position.
5. Controls for the 34.5 kV breakers shall be interlocked with the rectifier doors in the traction power substation, such that any door opening shall trip the breakers.

6. A minimum of ten electrically separate reversible auxiliary spare contacts shall be provided, in addition to those required for the circuit breaker control circuit.
7. All auxiliary contacts shall be operated by the breaker mechanism in both the CONNECTED and the TEST positions.
8. All auxiliary contacts including spares shall be wired to the terminal blocks and properly labeled.
9. Four-digit operation counter shall be provided to record tripping operations with provisions for resetting the counter to zero.
10. Circuit breakers shall be equipped with padlocking provisions in the DISCONNECTED position.

H. 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 (i.e. CONNECTED, TEST or DISCONNECTED).
3. Dry auxiliary contacts wired to terminal blocks shall be provided for remote breaker status and position indications.

## 2.06 BUSES AND BUS CONNECTIONS

- A. The 34.5 kV buses shall be made of rigid copper bars and shall be of sufficient size to carry the continuous rated current, without exceeding the temperature limits indicated in ANSI C37.20.2. 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-B-C 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. The method of bus insulation and materials shall conform to ANSI C37.20.2.

- 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 all bolted connections after installation of the bus enclosure.

## 2.07 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  $\frac{1}{4}$  x 2 inches in size.
- B. At least two 9/16-inch diameter holes at 1-3/4 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 34.5 kV cables and phase buses. The grounding knobs shall be provided with removable insulated caps for the grounding device.
- D. The frame of each circuit breaker shall be grounded directly through a high-current ground contact shoe at all times, when the circuit breaker is in the CONNECTED or TEST positions.
- E. 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.
- F. All grounding connections shall be metal-to-metal, with any nonconductive coatings such as paint or lacquers removed to ensure solid electrical contact.
- G. The ground bus shall have provisions for connecting ground cables in each cubicle and at the ends of the switchgear lineup.

## 2.08 125 VOLT DC CONTROL POWER

- A. Control power for all 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 XX, Traction Power DC Battery 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:

## AC SWITCHGEAR

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.

### **2.09 120 VOLT AC POWER**

- A. A 120 V ac, 60 Hz, No. 2 AWG or larger 2-wire bus shall be furnished 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.

### **2.10 TERMINATIONS**

- A. The bus connections for the 34.5 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.
- 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. 34.5 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 20 70 26, Common Materials and Methods for Electrical Systems.

### **2.11 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. Switching Station Protection:

#### AC SWITCHGEAR

1. Phase-directional and ground-directional relays (Dev. 267, 267N) shall be provided and set to operate for faults on the incoming 34.5 kV cables from the high-voltage substation.
2. Phase and ground time overcurrent primary and backup relays (Dev. 251, 251N, 251-B, 251N-B) shall be provided for each circuit breaker, set to operate for faults on the 34.5 kV subtransmission feeder cables.
3. Undervoltage relays (Dev. 227) shall be furnished to provide permissive closing of the circuit breakers in adjacent sectionalizing stations and tripping of the main breakers in the out-of-service switching station.

#### C. Sectionalizing Station Protection:

1. Phase and ground time-overcurrent relays (251, 251N) set to operate for short-circuit faults on the 34.5 kV subtransmission feeder cables on either side of the circuit breakers
2. Undervoltage relays (227) with adjustable time delay to initiate automatic transfer, and provide selective blocking on manual closing, as indicated on the Contract Drawings.

#### D. Traction Power Substation Protection:

1. Phase and ground instantaneous and time overcurrent relays (250/251, 250/251N) shall be provided for the 34.5 kV breakers and shall be set to operate for short-circuit faults in the transformer/rectifier units and the dc switchgear bus.
2. Phase and ground time overcurrent relays (251-B & 251N-B) shall be provided for the main 34.5 kV breakers, and shall be set to operate on overload considering the duty cycle of the transformer rectifier units. A backup set of phase and ground overcurrent relays (251-B and 251N-B relays shall provided.
3. Undervoltage relays (227) with adjustable time delay shall be provided to initiate automatic transfer upon loss of power on the 34.5 kV feeder circuit supplying the substation under normal conditions.

## 2.12 INSTRUMENT TRANSFORMERS

- A. Instrument transformers shall conform to ANSI C57.13 and NEMA EL 2. The current and potential transformers shall comply with the ANSI/IEEE relays and metering accuracy standards, and shall have 0.6 accuracy class or better, under the burdens imposed by the connected services.
- 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 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. Current transformers 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 current transformers per phase and shall have provisions for mounting two more. In sectionalizing stations each breaker cubicle shall be provided with one current transformer per phase and shall have provisions for mounting one more.
  4. Current transformers (CT's) and their secondary wiring shall be protected from induced voltages by metallic shielding. Secondary wiring shall utilize No. 12 AWG copper wire, and shall be run to readily identifiable terminal blocks in the breaker control compartment. The terminal blocks for the CT's shall be suitable for ring type wire connections, shall have covers, and shall feature integral shorting bars for the CT leads.
  5. Current transformers 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.
- D. Potential Transformers: Potential transformers (PT's) shall be of the molded rubber or epoxy-encapsulated construction, with primary current-limiting fuses mounted on integral drawout carriage:
1. Potential transformers shall be mounted in a dedicated compartment and shall be easily accessible for inspection and maintenance, either from the front or rear of the cubicle. Upon opening of the dead-front door, the primary fuses and potential transformers shall be automatically disconnected and shall be visibly grounded.
  2. Primary and secondary circuits of all PT's shall be protected by means of non-renewable cartridge type fuses. Secondary circuit fuses shall be installed in the low voltage circuits of the PT's, and shall be located so as to permit replacement when the switchgear is in service.
  3. Potential transformers shall have voltage ratio of 20125 V primary to 115 V secondary, and shall be connected between phase A and neutral.

## 2.13 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.

## 2.14 MAINTENANCE ACCESSORIES. Provide at least the following accessories for each ac switchgear assembly:

- A. Wall mounted test cabinet with all necessary equipment for testing a 34.5 kV ac circuit breaker after it has been removed from the cubicle.
- B. All necessary equipment needed for the normal operation and preventive maintenance of the circuit breaker, such as manual charging handle and manual racking crank handle. One set of fuse tongs or hooksticks for replacement of high-voltage fuses, depending on the requirements.
- C. All necessary equipment needed for the normal operation and preventive maintenance of the circuit breakers, such as manual charging handle and manual racking crank handle.

- D. Test cable for each switchgear assembly to permit operating a circuit breaker when completely removed from its compartment. This cable will be required to connect the control circuits of the compartment to the control circuits of the withdrawn breaker and to operate the breaker without the use of the test cabinet.
- E. One set of wrenches for the primary disconnecting devices of the circuit breaker, two sets of screwdrivers and any other hand tools required for obtaining access to and replacement of any equipment or device in the ac switchgear.
- F. A cable-type grounding device for grounding dead bus of the switchgear. The device shall be operated by a hot-stick and shall meet ASTM F855 requirements. A wall-mounted storage panel shall be provided for the grounding device and hot-stick.

### **PART 3 – EXECUTION**

#### **3.01 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. All applicable tests identified as design tests in ANSI C37.09 for the circuit breaker.
    - b. All applicable tests identified as design tests in ANSI C37.20.2 and ANSI C37.55 for the switchgear assembly.
    - c. Performance verification tests on all switchgear control circuits including automatic transfer.
  - 2. The following production tests shall be performed on all ac switchgear assemblies, complete with their associated 34.5 kV ac circuit breakers:
    - a. All applicable tests identified as Production Tests in ANSI C37.09 for the circuit breakers.
    - b. All applicable tests identified as Production Tests in ANSI C37.20.2 and ANSI C37.55 for the switchgear assemblies.
    - c. Functional tests on all switchgear control circuits including automatic transfer between the substation main 34.5 kV circuit breakers.

**END OF SECTION 34 21 18**