

PIP

Process Industry Practices
Electrical Team

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ELSGSO1

Design and Fabrication of High Resistance Grounding System (Wye System, 600 Volts or Below)

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1. Scope

This Practice covers requirements for design, fabrication, and inspection and testing of 600V class, three-phase, wye-connected, high-resistance grounding systems for use on 600V, or lower, power systems with neutral available.

2. References

Applicable requirements in the latest edition (or the edition indicated) of the following industry standards and Process Industry Practices shall be considered an integral part of this Practice:

2.1 Process Industry Practices

- PIP data sheet ELSGS01D (completed for application)

2.2 Industry Codes and Standards

- Institute of Electrical and Electronic Engineers (IEEE/ANSI) C37.20.1. - *IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*
- Institute of Electrical and Electronic Engineers (IEEE/ANSI) C37.20.2. - *IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear*
- American Society of Mechanical Engineers (ASME) D 1535. - *Method for Specifying Color by the Munsell System*

3. General

1. Grounding system shall be contained within a dedicated enclosure or within a switchgear or a motor control center enclosure.

2. Any conflicts between the referenced documents shall be identified to the Buyer in writing for resolution. In general, when resolving conflicts, the following order of precedence shall apply:

- ❑ One-Line diagram
- ❑ Data Sheet(s) ELSGS01D
- ❑ This Specification ELSGS01

- Referenced Standards

4. Design

4.1 General

The grounding system shall:

1. Ground the power system neutral utilizing high-resistance grounding principles such that the ground fault current is limited to a value between 0.9 and 3.6 amperes during a phase to ground fault condition.
2. Be capable of producing a pulsing current into the ground fault that can be traced to the fault with a multi-range portable clamp-on ammeter. Pulsing current shall be two to three amperes more than the setting of the ground fault current.
3. Have an adjustable time delay of the activation of ground fault alarm of 0.2 to 2.0 seconds to allow override of momentary ground fault alarm condition.
4. Continuously monitor the ground current in the electrical system neutral and shall indicate ground fault by means of an overcurrent relay (mechanically held) with normally open contact (close to alarm). Relay shall not drop out on loss of control power.
5. Have a fixed resistor to initiate a controlled fault on one phase when the system test push button is pressed.
6. Contact to provide remote indication of ground fault and loss of control voltage conditions.
7. The control power source for powering the high resistance system control circuitry and space heaters (when space heaters are specified) shall be as specified on the DATA SHEET.

4.2 Ambient Conditions

1. Grounding system shall be designed to perform satisfactorily under the following ambient conditions unless otherwise specified on the data sheet:
 - a) Atmosphere typical of petrochemical plants
 - b) Maximum temperature of 40°C (104°F) and minimum temperature of -20°C (-4°F).
 - c) Maximum altitude of 3,300 ft.
2. Unless otherwise specified on the DATA SHEET, the grounding system shall be designed for an indoor, nonclassified location.

4.3 Enclosure

1. Unless otherwise specified, grounding system enclosure shall be a freestanding, vertical structure made of steel. If indicated on the DATA SHEET, grounding system shall be integrated into the switchgear or motor control center enclosure.
2. Energized parts operated at or above 50 volts, shall be guarded.
3. Each enclosure compartment shall have a hinged access door in the front. Enclosure shall also have hinged access doors in the rear if rear access to the grounding system is required.
4. All grounding system components and connection points shall be visible and easily and safely accessible from the front of the enclosure.
5. Front doors on outdoor enclosures shall have hinged and gasketed clear polycarbonate plastic windows for viewing and access to monitoring and test functions.
6. Grounding system components shall be monitored on suitable back plates on the inside of the enclosure.
7. Enclosure ventilation openings shall have 1/3 in. mesh vermin-proof screens made of 304 stainless steel. Screens shall be located on the inside of the openings.
8. Bolts and nuts shall be captive type.
9. Bolting and hardware shall be seller's standard corrosion resistant type.
10. Disconnect devices shall have a means for padlocking in the "off" position.

4.4 Control System

- 1) Control system shall include the following:
 - a) One (1) ammeter (0 to 5 A scale) to indicate ground current when a ground occurs on the system.
 - b) Grounding system shall have a 5/5 A neutral current transformer.
 - c) Test push-button to simulate a ground-fault condition.
 - d) Reset push-button to reset the system.
 - e) A flashing red indicating light (transformer type with flashing bulb) to indicate "ground fault."
 - f) A green indicating light to indicate normal condition.
 - g) An amber indicating light to indicate "control power available."
 - h) A "normal-pulse" two-position selector switch.
 - i) A holding relay with two additional normally-open and two normally-closed contacts for use by the buyer. Relay contacts shall be connected to terminal blocks for buyer connections.
 - j) An overcurrent relay. Relay shall be mechanically held and shall have a normally-open contact (close to alarm). Relay shall have a polarized plug and receptacle attachment to allow removal of the relay for testing and calibration purposes.

- k) An undervoltage relay with two additional normally-closed and two normally-open contacts for remote indication of loss of control power. Relay contacts shall be connected to terminal blocks for buyer connections.
 - l) A pulsing contactor set to produce approximately 40 current pulsations per minute.
 - m) A timing relay for the pulsing contactor.
- 2) Non-flashing indicating lights shall have replaceable, cluster-type, LED lamps and colored lens.
 - 3) Push-buttons shall have flush heads to prevent accidental operation.

4.5 Disconnect Switch

- 1. Grounding system shall have one three pole load break disconnect device for isolation of control power and neutral.
- 2. Disconnect device shall have suitable terminals to connect incoming system supply and neutral.

4.6 Resistors

- 1. Grounding system shall have continuous rated, wire wound, stainless steel resistors. Resistors shall be rated to operate at 277V AC minimum (350V AC for systems operating at 550 and 600 volts).
- 2. Resistor assembly shall have a minimum of four adjustable taps to limit ground fault current between 0.9 A to 3.6 A.
- 3. Resistors shall be mounted on stand-off plates designed so that the surface temperature of the surrounding enclosure does not increase more than 20°C above ambient temperature during fault conditions.

4.7 Portable Ground Current Detector

- 1) Grounding system shall be designed to function in conjunction with a portable, clamp-on ground current detector.
- 2) System shall be furnished with one portable detector, unless otherwise specified on the DATA SHEET.
- 3) Portable ground current detector shall have:
 - a) A multi-range switch for accurate measurement of pulsing current at various taps.
 - b) A large window that is suitable for conduits with a nominal diameter of up

- to 5 in.
 - c) A removable arm to facilitate use of the detector in limited spaces in which conduits/cables are close together.
 - d) A shorting switch to provide transient protection while detector is being positioned around conductors.
 - e) Closed magnetic field to minimize effects of stray fields.
 - f) An insulated handle for use on systems rated up to 4160V nominal.
 - g) A carrying case
- 4) Ground current detector shall be dielectric tested at 12,000V between case and handle.

4.8 Wiring

4.8.1 General

1. All wiring shall be stranded copper conductors. Control wiring shall be #14 AWG, minimum, conductor, wiring from transformer neutral to switchgear shall be #8 AWG, minimum, conductor, and power wiring shall be #12 AWG, minimum, conductor.
2. Wiring insulation shall be rated for 600V and a conductor temperature of 90°C minimum.
3. A separate properly labeled terminal strip shall be provided for connection for remote devices.
4. Spare current or alarm relay contacts shall be wired to terminal block.
5. Exposed wiring shall be neatly bundled, protected against contact with sharp edges, and secured with wire ties. Adhesive-back wire supporters shall not be used on the enclosure to support control wiring.
6. Unless otherwise specified, wiring shall be terminated with seamless, insulated, locking-fork type lugs.
7. CT circuit wiring shall be terminated with uninsulated, ring-type lugs.
8. Wiring to the resistors shall be rated for high temperature or shall be protected with high-temperature, heat-shrink tape within 12 in. of the resistor terminals.

4.8.2 Terminal Blocks

1. Terminal blocks shall be rated for 600V and shall be suitable for holding spade and ring-type lugs.
2. A maximum of two wires shall be connected at each side of each terminal.
3. All external buyer connected wiring shall be connected on one side of the terminal block provided for external connections.

4. A terminal block shall be provided for terminating the incoming neutral connection, the outgoing connection to ground, and the connection to an external source of 120 VAC control power when required.
5. Each CT circuit shall be terminated in a properly identified shorting-type terminal block.

4.8.3 Labeling

1. Each wire shall have permanent wire labels at both ends. Labels shall be consistent with wiring diagrams. Adhesive-type wire labels are not acceptable.
2. Relays, fuse blocks, terminal blocks, and other auxiliary devices shall be labeled with engraved nameplates. Dymo type labels are not acceptable.

4.9 Space Heaters

1. All outdoor enclosures shall have space heaters as specified below. When indicated on the DATA SHEET, indoor enclosures shall have space heaters as specified below.
2. Space heaters shall be rated for 240V and operated as 120V AC.
3. Space heaters shall be mounted on standoff insulators to protect the enclosure.
4. Space heaters shall be controlled with adjustable thermostat to operate when the enclosure ambient temperature is below the setpoint. Thermostat shall be adjustable between 15°C (59°F) and 85°C (185°F).
5. Space heaters shall be completely wired for connection to an external power source.
6. Space heaters shall have expanded metal cages to protect personnel from contact with the box surface.
7. Wiring to the space heater terminal shall be protected with high temperature heat shrink tape. Tape shall be provided up to a minimum of 6 in. from the heater terminals.
8. Maximum sheath temperature shall be 200°C.

5. Fabrication

5.1 Painting

1. External and internal steel surfaces of grounding system enclosure shall be painted.
2. Paint system shall conform to ANSI C37.20.2 - 1987 section 5.2.8. Finish color shall be light gray No. 61 in accordance with ASTM D 1535-80 (Munsell Notation

- 8.3 G6 10/0.54).
3. Surface preparation and painting application shall conform to paint seller's written instructions.
 4. Paint system topcoat shall:
 - a) Be suitable for applications as specified on the DATA SHEET.
 - b) Be free from craters, pinholes, holidays, embedded foreign matter, and other visual defects.
 - c) Provide complete hiding, consistent coverage and thickness, and uniform color.
 5. Grounding system seller shall provide certification that the paint system conforms with this Practice.
 6. Seller shall supply one 1-pint can of paint for field touch-up.

5.2 Nameplates

1. Unless otherwise specified, nameplates shall be made of laminated plastic with black engraving on white background. Lettering shall be 1/4 in. high, minimum.
2. Nameplates shall be attached with stainless steel screws.
3. There shall be an instruction nameplate on the front of the enclosure with complete step-by-step instructions for normal operation, ground fault detection, and test procedures. Instruction nameplate shall have white engraved lettering on green background.
4. Each main component on the front of the enclosure of the grounding system shall have a nameplate that indicates the name or function of the component.
5. Auxiliary equipment on the back or on the inside of the enclosure shall also have a nameplate indicating the name of the device as indicated on the control schematic drawing.
6. When the unit has more than one source of external power, there shall be warning labels indicating multiple sources of power.

5.3 ID Tag

Provide an ID Tag made of laminated plastic with black figures on a white background. The tag shall list the "Equipment No.", "P.O. No.", and "Project No." as specified on the DATA SHEET.

6. Testing

1. A complete functional, operational, and point-to-point check on the wiring shall be performed.
2. Buyer reserves the right to witness tests if indicated on the DATA SHEET.
3. A certified test report shall be provided prior to shipment of the grounding system.
4. Dielectric tests shall be performed in accordance with ANSI/IEEE C37.20.1 [IEEE 32-1972,10.3.2]

7. Documentation

7.1 Documentation Content

1. Drawings shall have a space on the right hand bottom corner for buyer's title block.
2. Schematic drawings shall include the following information as a minimum:
 - a. Complete schematic diagram with item numbers corresponding to bill of materials.
 - b. Operation and contact arrangement of overcurrent and control relays.
 - c. All resistor taps for various ground fault currents and pulsating current arrangement.
 - d. Cross-reference to bill of materials and other drawings.
3. Documentation shall include instructions for method of testing the power system to determine its normal capacitive charging current. Drawings submitted for approval shall include setting of taps.

7.2 Seller Drawing and Data Requirements

Description	A	B	C	D
Detailed Bill of Material		X	X	X
General layout of equipment, showing all dimensions, weights, location and outline drawings showing the final assembled configuration	X	X	X	X
Connection wiring diagrams for all electrical equipment		X	X	X
Single-line, 3-line, and control schematic diagrams		X	X	X
Certified test reports			X	
Installation, Operation and Maintenance Manual			X ¹	
Final As-Built Drawings				X
Recommended priced spare parts list	X		X	

- A. Bidder shall furnish these documents with proposal.
- B. Seller shall furnish these documents for Buyer's review and authorization to proceed before fabrication.
- C. Seller shall furnish these documents as part of the final, certified document submittal

¹ Equipment should be shipped with one set of installation, operation and maintenance manuals.

D. Final as-built within 2 weeks following shipment.

COMMENTS: Seller to provide 1 reproducible set of drawings plus the specified number of copies of all documentation and operating manuals as indicated on the DATA SHEET. Format for reproducible shall be CAD convertible .DXF electronic format, unless the seller specifies otherwise in the proposal.