Medium Voltage Safety-Interlocked ERTG Design Basics

NEC Article 250-188

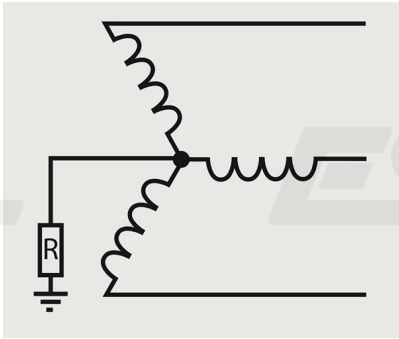
Grounding of Systems Supplying Portable or Mobile Equipment

Systems supplying portable or mobile equipment over 1000 volts, other than substations installed on a temporary basis, shall comply with 250.188(A) through (F)

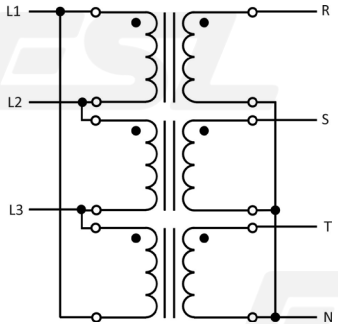
Let’s look briefly at these……

NEC Article 250-188 (A)
Portable or Mobile Equipment

Systems supplying portable or mobile equipment over 1000 volts **shall** be supplied from a system having its neutral current conductor grounded through an impedance.



Where a delta-connected system over 1000 volts is used to supply portable or mobile equipment, a system neutral point and associated neutral conductor shall be derived.



NEC Article 250-188 (B)
Exposed Non-Current-Carrying Metal Parts

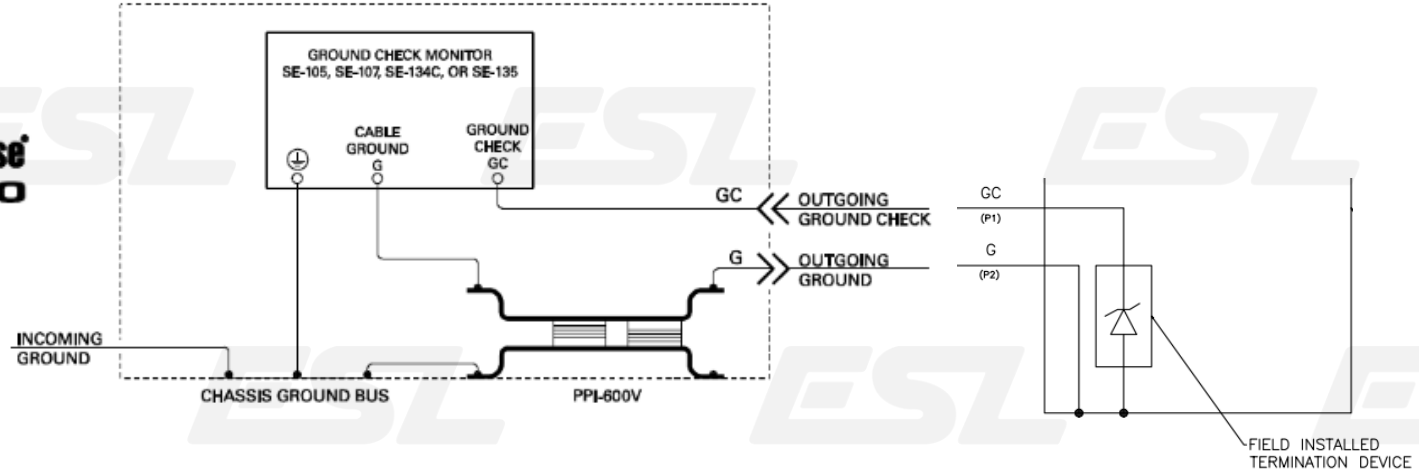
Exposed non-current-carrying metal parts of portable or mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

NEC Article 250-188 (C)
Ground Fault Current

The voltage developed between the portable or mobile equipment frame and ground by the flow of maximum ground fault current shall not exceed 100 volts

NEC Article 250-188 (D)
Ground Fault Detection and Relaying

Ground fault detection and relaying shall be provided to automatically de-energize any component of a system over 1000 volts that has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to automatically de-energize the circuit of the system of 1000 volts to the portable or mobile equipment upon loss of continuity of the equipment grounding conductor.



NEC Article 250-188 (E)
Isolation

The grounding electrode conductor to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 6.0m (20 ft.) from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as a buried pipe and fence, and so forth.

NEC Article 250-188 (F)
Trailing Cable and Couplers

Trailing cable and couplers of systems over 1000 volts for interconnection of portable or mobile equipment shall meet the requirements of Part III of Article 400 for cables and 490.55 for couplers

Let’s take a quick look…

NEC Article 400 Part III

- Copper, 12AWG or larger, flexible stranding.
- Provide an equipment grounding conductor for cable with (3) or more conductors.
- Shields to be connected to the equipment grounding conductor.
- Equipment grounding conductors to be in accordance with Article 250 Parts VI and VII.
- Bending radii to be adequate to prevent damage to the cable.
- Fittings are to lock firmly together, prevent opening and closing while energized, eliminate tension.
- Cable splices not allowed unless the vulcanized type.
- Terminations to be accessible only to authorized personnel.

NEC Article 490.55
Power Cable Connections to Mobile Machines

- Provide a metallic enclosure for the termination of the power cables.
- Enclosure to include termination points for the machine frame equipment grounding conductor.
- Ungrounded conductors to be attached to insulators or approved cable. couplers for the proper voltage and ampere rating.
- Termination method to prevent strain on the conductors.
- Lockable so that only authorized personnel have access.
- Danger marking “DANGER – HIGH VOLTAGE – KEEP OUT” to be in compliance with Article 110.21(B).

Medium Voltage Electrified ERTGs

- Common voltages: 4,160V 60Hz or 3,300 50Hz
- Voltage is stepped down at the RTG to typically 480VAC
- MV allows for lighter cable and longer run.

- Compact footprint minimizes obstructions in the yard
- Daisy-chaining several MV Disconnect Cabinets minimizes the number of MV circuit breakers needed at the switchgear reducing the space required & electrical equipment cost .

Environmental Considerations

- ERTGs are typically near seawater - Enclosures made from 304 or 316 stainless steel.
- Humidity/condensation – Use of a de-humidistat with a heater might be needed.
- Heat and sun loading – sunshields or fans might be a consideration.

- Colder climates – thermostats with heaters.

DESIGN CONSIDERATIONS

- Protect the cable connection from undue stress. This can usually be accomplished through the uses of “drums” and “funnels”

What about residual energy ?

- Once power is turned OFF to the ERTG, residual energy resides in the transformers and motors. This residual energy can be deadly.
- Two approaches:
  - Let dissipate over time, but for how long?
  - Install a grounding switch to ground the de-energized phase cables.
- ESL's interlocked eRTG cabinet is designed such that the plug cannot be removed unless the switch is open, AND the ground switch is closed.

Overcurrent Protection

- Upstream – MV circuit breaker.
- If there are single runs to each cabinet, no need for further overcurrent protection.
- If daisy chaining, each cabinet needs overcurrent protection – usually fuses, then a trip mechanism should be included to ensure that all three phases are disconnected when any fuse blows.

Safety Concerns

- An Interlocked receptacle and air-insulated load break switch to prevent connecting or disconnecting while energized.
- Interlocked Grounding Switch ensures no residual voltage at the cable prior to disconnecting the ERTG plug.
- A door switch that will trip the upstream breaker if a cabinet door is opened.
- Emergency trip button

Other Design Considerations

- Are fiber optic connections needed?
- A window to allow for safe observation of the switch's position?
- A large blinking light to indicate the receptacle is energized?
- Indicator lights for power available and tripped fuse?
- Interior lamp to allow viewing the switch status at night through a window?
- Fan-heater to prevent condensation?
- Termination of incoming MV cables – sufficient space?
- Step-down transformer for controls?

ESL's eRTG Cabinet

ERTG Safety-interlocked MV Disconnect Video

Check out a short demonstration video on the simplicity of operation and safety features of ESL's Safety-interlocked Disconnect Cabinet (eRTG):

Thank you for your time.

Questions ?

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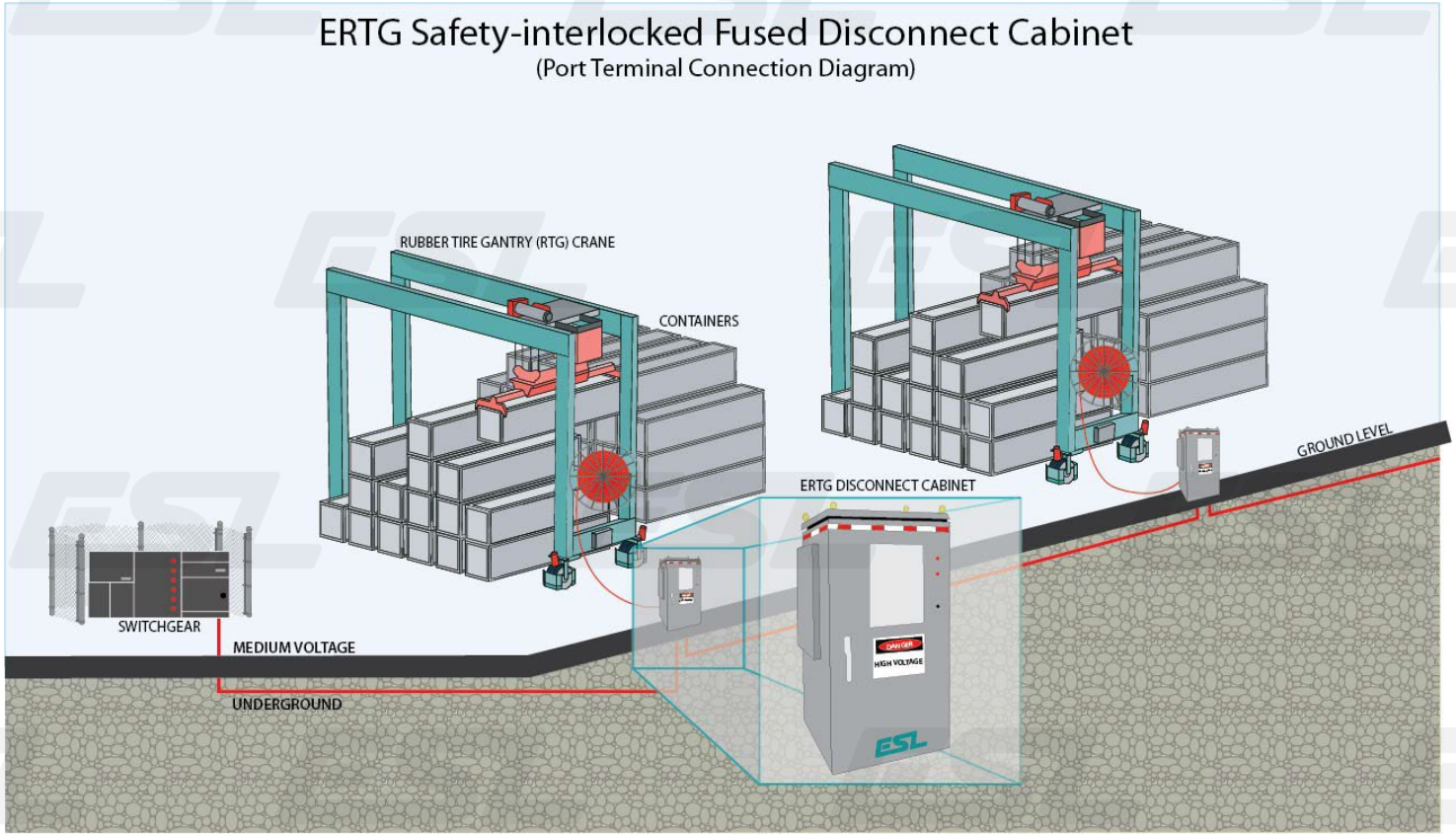
Daisy Chain Diagram

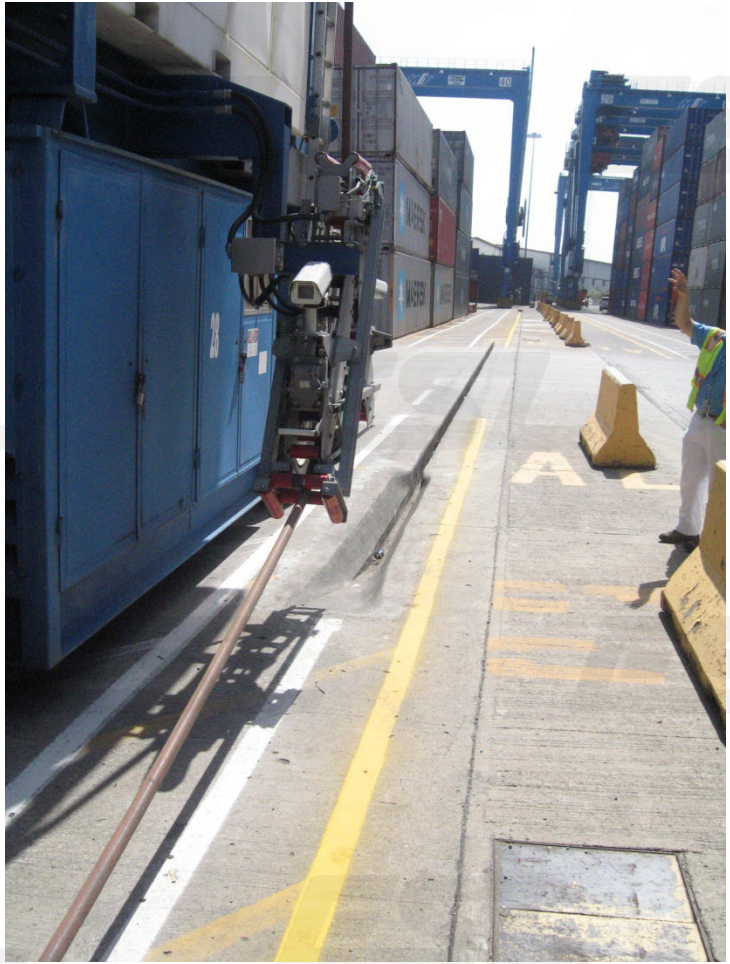


ERTG MV Safety-interlocked Disconnect Cabinet

Cluster of 4 ESL Safety-Interlocked Disconnect Cabinets with Tension Relief Drums & Funnels

ESL Safety-Interlocked Cabinets Back View

ERTG Arm Lays Cable into Road Channel



ERTG Arm

ERTG Cable Reel & Switchgear Room

Stainless Steel Cable Tension Relief Funnels & Drums