

Substation Engineering

Routine Substation Operations (Part 3 of 3)

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- Course: Substation Engineering (DI04009011)
- Unit 5: Auxiliary Systems and Routine Operations
- Lecture 25: Grounding, PTW, and Administration

Agenda

- Substation Grounding Procedures
- Earth Switches vs. Temporary Protective Grounds
- Applying and Removing Portable Grounds
- Step and Touch Potential Risks
- Permit to Work (PTW) System
- Logbooks and Shift Handovers

Substation Grounding (Earthing) Procedures

- De-energizing and isolating equipment is NOT enough to make it safe to touch
- Adjacent energized lines induce dangerous voltages (capacitive and inductive coupling) on isolated equipment
- Lightning strikes or accidental re-energization can occur
- All isolated equipment must be solidly grounded (earthed) before work begins
- Grounding creates an equipotential zone, keeping the worker at the same potential as the equipment

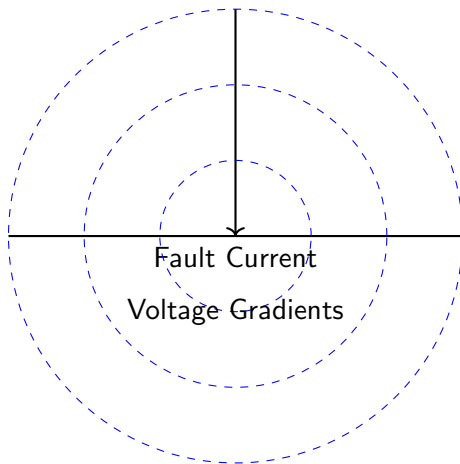
Earth Switches vs. Temporary Protective Grounds

Feature	Fixed Earth Switches	Temporary Protective Grounds (Portable)
Location	Permanently installed on isolators	Portable, carried by maintenance crews
Operation	Motorized or manual crank	Applied manually with hot sticks
Fault Rating	Rated for full system short circuit current	Rated based on cable size, subject to mechanical forces
Primary Use	Primary grounding of lines/buses	Working grounds applied directly at the work location

Applying Temporary Protective Grounds

- Rule 1: Always test for absence of voltage using a verified voltage detector before applying grounds
- Rule 2: ALWAYS connect the ground-end (earth grid) clamp FIRST
- Rule 3: Connect the phase-end (conductor) clamp LAST using an insulated hot stick
- Removal is the exact reverse: Remove phase-end first, ground-end last
- This ensures the operator is never in the path to ground if the line is accidentally live

Step and Touch Potential Risks



- During a fault, massive current flows into the substation earth grid
- This raises the ground potential locally (Ground Potential Rise - GPR)

Permit To Work (PTW) System

Role	Responsibilities
Control Center (Dispatcher)	Authorizes the outage, oversees the grid
Authorized Person (Issuer)	Substation operator who executes switching, applies LOTO and fixed grounds, issues the PTW
Competent Person (Executor)	Maintenance supervisor who receives the PTW, applies portable grounds, and oversees the work party
Work Party	Technicians working under the Executor's supervision

Permit To Work Lifecycle

- 1. Request and Approval (days/weeks in advance)
- 2. Isolation and Earthing (performed by Operator)
- 3. Issue of Permit (Issuer explains hazards to Executor, both sign)
- 4. Execution of Work (Executor controls the work zone)
- 5. Clearance and Cancellation (Tools removed, personnel clear, Executor signs off)
- 6. Restoration (Operator removes LOTO and re-energizes)

Sanction for Test (SFT)

- A special type of permit used for testing equipment (e.g., relays, breaker timing, high voltage testing)
- Unlike a standard PTW, an SFT allows the temporary removal of grounds for testing purposes
- Requires stricter supervision because the equipment may become temporarily energized (e.g., via test sets)
- Work party must step out of the hazard zone during test injections
- Once testing is complete, grounds are reapplied or the equipment is returned to service

Substation Logbooks

- The official, legal record of all events in the substation
- Must record: Switching operations, alarms received, visitors entering/exiting, PTWs issued
- Written in indelible ink; mistakes are struck through with a single line and initialed (no white-out)
- Chronological order with exact time stamps
- Crucial for incident investigations and audits

Shift Handover Procedures

- The most critical time for operational errors is during shift changes
- Outgoing operator must brief the incoming operator on:
 - 1. Current system configuration (abnormal alignments)
 - 2. Active Permits to Work and grounded equipment
 - 3. Active alarms or equipment defects
- Both operators must sign the logbook to formalize the transfer of responsibility

Emergency Operating Procedures

- In the event of a fire, explosion, or severe safety threat, operators have the authority to act without waiting for dispatcher orders
- Emergency trips can be initiated to de-energize the entire station
- Clearance distances must be maintained even during rescues
- Post-emergency: Secure the site, treat injured personnel, and preserve evidence
- Detailed incident reports follow immediately

Use of Personal Protective Equipment (PPE)

- Standard PPE: Hard hat, safety glasses, steel-toed boots, high-visibility clothing
- Arc Flash PPE: Flame-resistant (FR) clothing rated for the specific calorie/cm² exposure level
- Electrical PPE: Insulated rubber gloves with leather protectors (tested daily)
- PPE is the last line of defense in the safety hierarchy (after elimination and engineering controls)

Review of Routine Substation Operations

- Always prioritize safety: use breakers for load, isolators for isolation
- Respect interlocks and verify switchyard contacts visually
- Grounding (Earthing) is non-negotiable for working on isolated equipment
- The PTW system rigidly controls the transfer of equipment from operations to maintenance
- Accurate logbooks and shift handovers are essential for operational continuity

- End of Module 5: Auxiliary Systems and Routine Operations
- Review all material for the final examination
- Focus on: Single Line Diagrams, Protection Schemes, Battery Sizing, and Switching Procedures
- Practical lab sessions will cover physical LOTO and Relay testing