Substation Engineering: Isolators (Part 2 of 2)

Milav Dabgar

Isolators (Part 2 of 2)

- Course: Substation Engineering
- Lecture 10: Isolators (Part 2 of 2)
- Unit 4: Switchgear Equipment

Agenda

- Electrical Ratings of Isolators
- Arcing Horns
- Interlocking Logic (CB, Isolator, Earth Switch)
- Installation and Alignment
- Testing Procedures (CRM, IR)
- Maintenance and Troubleshooting

Electrical Ratings of Isolators

- Rated Voltage (kV): Maximum system voltage it can withstand (e.g., 145kV for a 132kV system).
- Rated Normal Current (A): Continuous current the contacts can carry without overheating (e.g., 1250A, 2000A).
- Rated Short-Time Withstand Current (kA): Ability to withstand mechanical and thermal stress of a short circuit for 1 to 3 seconds.
- Lightning Impulse Withstand Voltage (kVp): Ability to withstand transient overvoltages.

Short Time Withstand Current

- During a short circuit, immense electro-dynamic forces try to push the isolator contacts apart.
- Contacts are designed with 'reverse loop' designs to use electromagnetic forces to grip tighter during a fault.
- Rated in kA for 1 or 3 seconds (e.g., 40kA for 3s).
- Failing this rating leads to contact separation, severe arcing, and destruction of the switch.

Arcing Horns

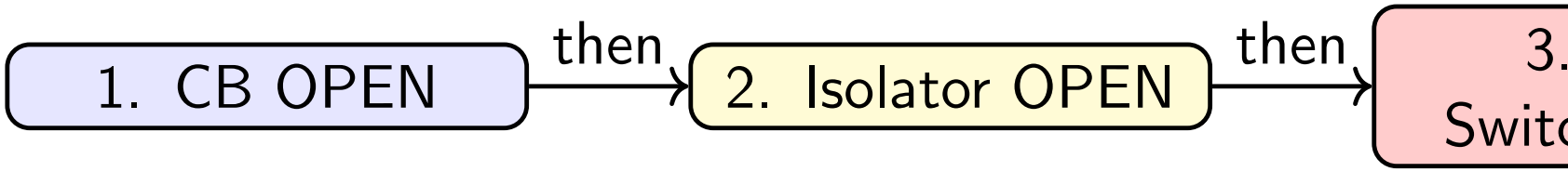
- Small metallic extensions attached to the main contacts of the isolator.
- Purpose: When the isolator opens, a small charging or magnetizing current may cause a minor arc.
- The arc is forced to strike on the arcing horns rather than the main silver-plated contacts.
- Protects the main contacts from pitting and erosion.
- Arcing horns make contact first while closing, and break contact last while opening.

Need for Interlocking

- Human error in substation switching can be fatal.
- Opening an isolator on load causes a massive explosion.
- Closing an earth switch on a live line causes a dead short circuit.
- Interlocking systems FORCE the operator to follow the correct switching sequence.
- Can be Mechanical (castell keys) or Electrical (relay logic).

Typical Interlocking Logic

To OPEN / Isolate:



Electrical vs. Mechanical Interlocking

- Electrical: Uses auxiliary contacts of the CB to cut power to the Isolator motor. Standard for modern remote operations.
- Mechanical: Uses captive keys. To operate the isolator manually, a key must be retrieved from the CB panel (only releasable when CB is open).
- Mechanical interlocking is fail-safe, even if DC power is lost.

Installation and Alignment

- Isolators require precise civil foundations to ensure they are perfectly level.
- Misalignment causes the male/female contacts to clash or fail to fully engage.
- Operating pipes must be plumb; torque must be evenly distributed.
- Frequent cause of failure is poor initial alignment causing mechanical binding.

Testing of Isolators

Test	**Check for**
Contact Resistance (CRM)	High resistance causing overheating
Insulation Resistance (IR)	Degraded porcelain insulators
Timing and Travel	Smooth operation, alignment issues
High Voltage (Dielectric)	Ability to withstand rated voltage

Contact Resistance Measurement (CRM)

- Also known as the 'Ductor Test'.
- Injects a high DC current (usually 100A) across the closed contacts.
- Measures the millivolt drop to calculate resistance in micro-ohms.
- High micro-ohm readings indicate loose contacts, loss of spring pressure, or oxidation.
- Prevents thermal runaway and melting of contacts.

Routine Maintenance

- Cleaning of male and female contacts with solvent.
- Application of conductive grease to prevent oxidation and ensure smooth sliding.
- Inspection of springs for loss of tension.
- Checking tightness of terminal connectors using thermo-vision cameras.
- Lubrication of bearings and gears in the MOM box.

Key Takeaways

- Isolators must withstand short-circuit forces without opening.
- Strict interlocking logic (CB -¿ Isolator -¿ Earth Switch) prevents fatal errors.
- Arcing horns protect main contacts from pitting.
- CRM testing is vital to prevent contact overheating.

Next Lecture Preview

- Introduction to Circuit Breakers
- Arc Interruption Principles
- SF6 and Vacuum Circuit Breakers