Substation Engineering: Isolators (Part 1 of 2)

Milav Dabgar

Isolators (Part 1 of 2)

- Course: Substation Engineering
- Lecture 9: Isolators (Part 1 of 2)
- Unit 4: Switchgear Equipment

Agenda

- What is an Isolator?
- Isolator vs. Circuit Breaker
- Need for Isolation in Substations
- Types of Isolators (Construction based)
- Horizontal Break Isolators
- Pantograph Isolators
- Earth Switches

What is an Isolator?

- An isolator is a mechanical switching device.
- Primary function: To provide a VISIBLE break in an electrical circuit.
- Used to safely isolate a section of a substation for maintenance.
- Operates under 'No Load' conditions only.
- It is not designed to break fault currents or even normal load currents.

Isolator vs. Circuit Breaker

- Circuit Breaker (CB): Designed to make and break circuits under normal load AND fault conditions (short circuits). Contains an arc quenching medium.
- Isolator: Designed to open or close only when there is negligible current. Has no arc quenching medium.
- Sequence of operation: CB opens first, then Isolator opens. Isolator closes first, then CB closes.
- Operating an isolator on load will result in a massive, uncontrolled arc.

Difference Summary

Feature	**Circuit Breaker (CB)**	**Isolator**
Breaking Capacity	High (Fault currents)	Zero (No load only)
Arc Quenching	Yes (SF6, Vacuum, Oil)	No (Air)
Speed of operation	Milliseconds	Seconds (Motor/Manual)
Purpose	Protection and switching	Safety and isolation

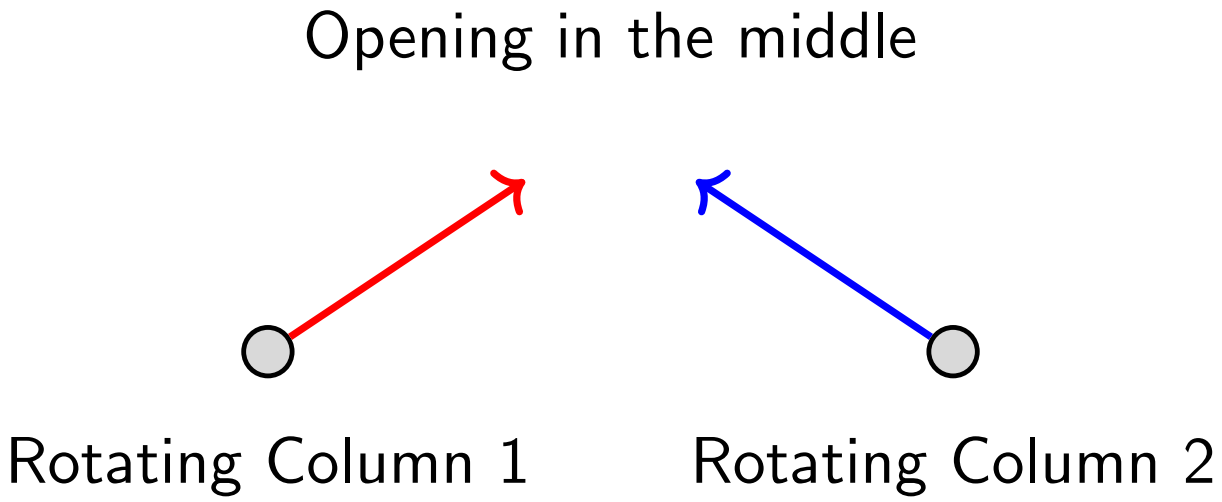
Types of Isolators (By Construction)

- Isolators are classified by how their moving contacts open.
- Horizontal Double Break (HDB)
- Horizontal Center Break (HCB)
- Vertical Break
- Pantograph / Semi-Pantograph
- Selection depends on voltage level, space availability, and busbar arrangement.

Horizontal Double Break (HDB) Isolator

- Features three insulator columns per phase.
- The middle insulator column rotates.
- A single contact blade is mounted on the rotating middle column.
- When it rotates 90 degrees, it breaks contact at both ends simultaneously.
- Very common in older layouts and up to 220kV.

Horizontal Center Break (HCB) Isolator



Vertical Break Isolator

- The contact arm swings upwards in a vertical plane.
- Used when horizontal phase-to-phase clearance is tight.
- Requires less ground footprint.
- Common in EHV (Extra High Voltage) yards where phase spacing is critical.
- The blade must be balanced with counterweights or springs.

Pantograph Type Isolator

- Operates vertically like a scissor lift.
- Connects a lower busbar to an upper busbar.
- Extremely space-efficient; minimizes substation footprint.
- Highly complex mechanical linkages.
- Used primarily in 400kV and 800kV substations.

Isolator Operating Mechanisms

- Manual Operation: Done via a mechanical handle and operating pipe. Common for lower voltages (up to 33kV) or as a backup.
- Motor Operated Mechanism (MOM): Uses an electric motor (usually DC) to drive the gear assembly.
- MOM box is mounted at the base of the isolator structure.
- Allows remote operation from the control room.

Earth Switches (Earthing Blades)

- Often integrated with the main isolator structure.
- Function: To ground the isolated section of the line.
- Discharges trapped charges and capacitive voltages to ground safely.
- Strict mechanical interlocking ensures the Earth Switch can ONLY close when the main Isolator is OPEN.
- Closing an earth switch on a live line causes a dead short circuit.

Key Takeaways

- Isolators provide a visible safety break for maintenance.
- They MUST NOT be operated on load.
- Different designs (Center break, Vertical, Pantograph) cater to different layout constraints.
- Earth switches discharge trapped capacitive currents.

Next Lecture Preview

- Ratings and Specifications of Isolators
- Interlocking Schemes (Breaker - Isolator - Earth Switch)
- Arcing Horns
- Testing and Maintenance of Isolators