RELAYS IN POWER PLANT

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TYPES OF RELAY PANEL

- ## CONTROL RELAY PANEL

  The control relay panel is used to control and protect switchyard equipment. It plays a vital role in the safe operation of various electrical components such as transformers, feeders, transmission lines, and busbars. These panels are typically located in the **Switchyard Control Room**. Their primary function includes the **tripping and closing of circuit breakers** within the grid system to ensure reliable power flow and system protection.

- ## GENERATOR RELAY PANEL

  The generator relay panel is designed to control and protect generator units. It is commonly used in various types of power generation setups, including **thermal, gas, and hydroelectric plants**. These panels are usually installed in the **Generator Control Room**. Their core functions involve **tripping and closing generator circuit breakers**, as well as handling **synchronizing operations** to match the generator output with the grid.

CONTROL RELAY PANEL

- The Control Relay Panel is a vital component of a Combined Cycle Power Plant's electrical substation.
- It facilitates **protection, monitoring, control**, and **fault isolation** of various elements like transformers, generators, feeders, and busbars.
- CRP is a key interface between the **field equipment** (like circuit breakers and CT/PTs) and the **control room** (SCADA).
- In Combined Cycle Gas Substations (CCGS), the CRP must handle **both gas and steam cycle protection** with high-speed relay coordination.
- It ensures plant safety, minimizes downtime, and complies with grid and operational norms (CEA guidelines in India).

COMPONENTS OF CRP

- **Protection Relays:** Overcurrent, earth fault, differential, REF (Restricted Earth Fault), and distance protection (e.g., Siemens, ABB make).
- **Control Relays & Timers:** Operate CBs, isolators, interlocking schemes, auto reclose and sync-check functions.
- **Annunciators:** Visual + audible alarms for fault indication and system abnormality alerts.
- **Meters & Indications:** Digital meters (volt, amp, power factor, energy), status LEDs.
- **SCADA/RTU Interface:** Communicates with SCADA for remote operations.
- **Terminal Blocks & Wiring:** High-quality wiring and terminations for CTs, PTs, trip/alarm circuits.
- **Auxiliary Relays:** For interlocks, signaling, breaker fail backup, or hand-reset functions.

WORKING OF CRP

- CRP constantly receives input signals from **CTs, PTs, and breaker status contacts** in the switchyard.
- It processes data through protection relays and sends **trip/close commands** to breakers during faults.
- Supports both **manual control (from switchyard)** and **remote control (from CCR/SCADA)**.
- In combined cycle plants, the CRP coordinates between:
  - Gas turbine generator (GTG) breaker panel
  - Steam turbine generator (STG) relay panel
  - Bus-coupler and transformer protection panels
- Ensures **coordinated tripping** in case of turbine faults, grid disturbance, or transformer issues.

PROTECTION SCHEMES

- **Transformer Protection:**
  - **Differential Protection :** Detects internal phase faults by comparing current on both sides of the transformer.
  - **Restricted Earth Fault (REF):** Sensitive detection of earth faults within the transformer zone.
  - **Buchholz Relay:** Gas-actuated protection device placed between transformer main tank and conservator; detects internal faults and slow oil flow.
  - **PRV (Pressure Relief Valve):** Protects transformer by releasing pressure during internal faults; integrated with alarm circuits.

- **Generator Protection (GT & ST):**
  - **Overvoltage & Overcurrent Protection:** Ensures generators are isolated during abnormal voltage/current surges.
  - **Rotor Earth Fault Protection:** Detects insulation failure in the rotor winding.
  - **Loss of Excitation:** Protects the generator against reverse power flow and system instability.
  - **Stator Earth Fault:** Detects insulation breakdown in stator windings, typically through protection schemes.

PROTECTION SCHEMES

- **GRP (Generator Relay Panel):**
  - Always equipped with **two independent relays** for redundancy — one **ABB** make and one **Siemens** make.
  - Enhances reliability of protection in critical generation assets.

- **Busbar Protection:**
  - Zone-wise **high-speed differential relays** isolate faulted section without affecting the healthy zones.
  - Ensures minimum interruption in supply.

- **Feeder Protection:**
  - **Distance Protection :** Measures impedance and trips based on fault location distance.
  - **Overcurrent :** Protects against excessive currents; includes both instantaneous and time-delayed tripping.
  - **Earth Fault :** Detects phase-to-ground faults in feeders using residual current measurement.

CRP OPERATION & MONITORING

- **Central Control Room (CCR):**
  - Operator controls field equipment via SCADA linked to CRP.
  - Mimics panel in CCR replicates real-time breaker/relay status.
- **Gas Relay Panel (GRP):**
  - GRP is dedicated for generator protection and trip interlock.
  - Always equipped with dual relays (Redundancy): e.g., Siemens + ABB
  - GRP includes REF protection, thermal overload relays, and AVR trip signals.

❖ **PMU (PHASOR MEASUREMENT UNIT) INTEGRATION:**

- Installed for **wide-area monitoring** using Synchrophasors.
- **P444 (Distance Relay)** installed on **Palla Line 1** for line impedance and angle fault detection.
- **P437 (Overload Relay)** monitors overload conditions for grid-connected feeders.
- Measures frequency deviation, voltage angle difference — crucial for maintaining synchronism with the grid.

RELAY PANEL SYSTEMS AND KEY DEVICES AT NTPC

- **RTU (Remote Terminal Unit)**
  - Acts as an interface between field equipment and the SCADA system. It gathers real-time operational data such as current, voltage, and breaker status from the substation and sends it to control centers.
- **Event Logger**
  - Records time-stamped digital events like breaker operations, system alarms, and control actions. Essential for post-event diagnostics and sequence-of-events analysis.
- **CMS (Condition Monitoring System)**
  - Monitors the health of major substation assets such as transformers and circuit breakers by tracking parameters like temperature, vibration, and gas content. Enables predictive maintenance and reduces downtime.
- **HMI (Human Machine Interface)**
  - Provides a graphical interface for operators to monitor and control substation equipment. Displays real-time data, alarm indications, control switches, and historical trends.

RELAY PANEL SYSTEMS AND KEY DEVICES AT NTPC

- **ABT Meter (Availability-Based Tariff Meter)**
  - Used for energy accounting and tariff calculation as per the ABT mechanism. Measures parameters like active/reactive energy, frequency, and demand for grid discipline and billing.
- **SCADA Server**
  - Acts as the central node of the SCADA system. It collects data from RTUs and other devices, processes it, and displays it through the HMI for real-time monitoring and control.
- **GPS Clock**
  - Provides a precise and synchronized time source to all connected substation devices. Ensures accurate time-stamping of data and events across systems for coordinated analysis.

VISIT INSIGHTS :

THANK YOU

Sincere thanks to :

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&

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