What is a Protection Relay?

- A device designed to trip (open) a circuit breaker when a fault (problem) is detected.
- Critical to safe operation and protection of personnel and equipment.
Types of Protection Relays

Digital / Microprocessor / Multi-function

Solid State

Electro-Mechanical
Failures:

- Relay failures without a coordinated backup can result in fire and extensive facility damage and Personnel danger.

- Personnel danger (Arc Flash)
- Equipment failure/damage:
  - Damage to generator/turbine shafts
  - Damage to electrical equipment including transformers, switchgear (breakers), motors etc.
Prevention:

- Proper Engineered Settings
  - Coordination Studies
  - Short Circuit Studies
  - Arc Flash Studies

- Regular inspection, testing and maintenance.
Maintenance & Testing:

- Most modern digital relays have extensive self-testing features therefore most manufacturers will recommend to monitor the front panel for messages (such as a green “enabled” light).

- Many manufacturers do not require specific routine tests, but many companies and regulatory bodies do require some degree of periodic relay verification.

- If you need or want to perform periodic relay verification, some typical tests would be:
  - Relay status – lights and messages
  - Metering verification – verify relay is measuring current and/or voltages accurately.
  - **Input/output verification** – Confirm that as you change the state of inputs to the relay the relay recognizes the changes and as you change the state of outputs the outputs physically change state as well.
Metering Verification

- Use a relay test set to inject known voltage and current

- Utilize specialized test switches that accept the voltage and current from the test source and bypass the main source from the substation or switchgear

- Confirm the values that show up on the relay match what you are transmitting
**Input/Output Verification**

**INPUTS:**
- Use a relay test set to simulate a device status change (such as a breaker opening or closing)
- Confirm the change shows up on the relay.

**Outputs:**
- Use the relay to simulate an output contact status change.
- Confirm the output actually changes state and in some cases that the element it is controlling (like a circuit breaker) actually operates.
Maintenance & Testing:

- Acceptance testing and initial commissioning tests can be different than maintenance testing.

- If a new digital relay has an issue not only one element of function is affected – the entire relay is compromised.

- Unless you are concerned that the originally programmed settings and logic are incorrect (which is certainly a very valid concern) there is no need to go through and re-test each element and all logic at each maintenance interval.
### Requirements:

#### BCH requirements:

- “The PG has full responsibility for the inspection, testing, calibration, and maintenance of their equipment”

- “The PG shall have a preventive maintenance program and retain maintenance records for audit purposes in compliance with applicable standards imposed by NERC/WECC…”

- “Periodic maintenance of protection equipment shall include, but not limited to, the calibration and functional testing of all protective relays, the associated telecommunications equipment, and the trip testing of the corresponding circuit breakers.”

- “The interval between tests for protective relays and telecommunications equipment shall be in accordance with applicable WECC requirements…”

#### WECC requirements:

- References NERC

*Some facilities may have specific and additional testing requirements and intervals*
NERC Requirements:

• Relay testing intervals:

<table>
<thead>
<tr>
<th>Component Attributes</th>
<th>Maximum Maintenance Interval</th>
<th>Maintenance Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any unmonitored protective relay not having all the monitoring attributes of a category below.</td>
<td>6 Calendar Years</td>
<td>For all unmonitored relays:</td>
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<tr>
<td></td>
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<td>• Verify that settings are as specified</td>
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<td></td>
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<td>For non-microprocessor relays:</td>
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<td></td>
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<td>• Test and, if necessary calibrate</td>
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<td>For microprocessor relays:</td>
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<td>• Verify operation of the relay inputs and outputs that are essential to proper functioning of the Protection System.</td>
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<td>• Verify acceptable measurement of power system input values.</td>
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</table>

*Source: NERC PRC-005-01*
NERC Requirements Cont’d

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<tr>
<th>Component Attributes</th>
<th>Maximum Maintenance Interval</th>
<th>Maintenance Activities</th>
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<tbody>
<tr>
<td>Monitored microprocessor protective relay with the following:</td>
<td>12 Calendar Years</td>
<td>Verify:</td>
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<tr>
<td>• Internal self-diagnosis and alarming (see Table 2).</td>
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<td>• Settings are as specified.</td>
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<tr>
<td>• Voltage and/or current waveform sampling three or more times per power cycle, and conversion of samples to numeric values for measurement calculations by microprocessor electronics.</td>
<td></td>
<td>• Operation of the relay inputs and outputs that are essential to proper functioning of the Protection System.</td>
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<tr>
<td>• Alarming for power supply failure (see Table 2).</td>
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<td>• Acceptable measurement of power system input values.</td>
</tr>
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*Source: NERC PRC-005-01*
Batteries & Chargers:

• If the battery system is compromised the modern protection system may be as well

NERC may require battery maintenance as little as every 4 months
Retrofits/Upgrades:

**Purpose:** Upgrade Existing Electro-Mechanical and Solid State Relays or older digital relays to modern digital relays that:

1) Combine multiple protection functions in one
2) Add communication for remote access and data/metering
3) Contain self-diagnostic functionality
4) Are readily available for replacement in case of failure
5) Allow Better troubleshooting (GPS Timestamping / Event Reports)
PRIME ENGINEERING
HAS THE EXPERIENCE AND INFRASTRUCTURE TO MANAGE MULTIPLE SIMULTANEOUS PROJECTS AS WELL AS THE ABILITY TO STAGE EQUIPMENT FOR FACTORY ACCEPTANCE AND WITNESS TESTING.