Manual 07 Update – Revision 5
PJM Protection Standards

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Communication Channels: Section 2

- Changed dual pilot reference to dual communication channels to update & generalize references
- Removed “and/or relay coordination” since 1st read based on stakeholder feedback

2.1.3 Communication Channels

Dual ~~pilot~~ communication (pilot) channels must be utilized if high speed primary and backup clearing~~dual pilot~~ is required for stability ~~and/or relay coordination~~ for BES circuits based on studies conducted by PJM as specified in NERC Reliability Standard TPL-001.

Dual communication (pilot) channels are defined as two separate, independent communications channels that~~which~~ are applied to provide high speed clearing for transmission line faults via both the primary and backup relay schemes (see Appendix C: Dual Communication (Pilot) Channels for Protective Relaying).

As noted in Section 15.2, all relay communication channels must be monitored to detect any channel problems and initiate an alarm. Channels that cannot be monitored due to the use of a

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The ~~pilot~~ communication (pilot) channel for the primary and backup systems shall be designed to minimize the risk of both systems being disabled simultaneously by a single event or condition. For all requirements and recommendations see Appendix C.

Communication Channels: Appendix C

- Clarified leased communication channels in Part 2.3
- Added requirements for independent fiber optic wires physically located on the same structure in Part 2.4

2.3 Leased Communication Channels ~~Telephone Circuits~~

For legacy applications, ~~i~~If dual communication (pilot) channels are required, they may not both utilize leased telephone circuits. For new or rebuilt transmission lines, leased telephone circuits shall not be used if dual communication (pilot) channels are required. For new or rebuilt transmission lines, leased communication (pilot) channels from a telecommunication company using direct relay to relay connection for the operation of transmission line protection schemes shall require approval by the PJM Relay Subcommittee if dual communication (pilot) channels are required.

The justification for prohibiting the use of leased communication (pilot) channels for lines requiring dual communication channels is that with growing penetration of inverter-based resources, the need for reliable communication (pilot) channels between line terminals for protection has grown in importance. For new or rebuilt transmission lines, the installation of utility owned communication (pilot) channels (typically fiber optic) prevents future complications with protection on lines that require dual communication (pilot) channels. Additionally, the use of infrastructure owned by a third party will inevitably complicate commissioning, maintenance, and modifications to transmission lines that require dual communication channels. Lastly, concerns about the viability of these channels during blackstart situations, makes them an unacceptable risk.~~-~~

2.4 Fiber Optic Communication (Pilot) Channels

Two independent fiber optic shield wires (two separate fiber optic wires but physically located on the same structure):

- One permissive tripping scheme and one blocking tripping scheme is acceptable
- Two permissive tripping schemes: Acceptable for dual communication-aided (pilot) protection schemes, but not recommended.
- Although this scheme offers some improvement over one fiber optic shield wire utilization, outside interference such as an aircraft could cause the loss of both shield wires during a fault.
- Two unblocking schemes: Acceptable for dual communication-aided (pilot) protection, but not recommended.
- This arrangement is similar to the Two permissive tripping schemes, but with the repair problem of one fiber optic shield wire utilization alleviated.

Station Batteries

- Revised monitoring requirements for use of a single station battery
- Align requirements with TPL-001-5

2.1.4 Station Batteries

Primary and Backup protection schemes must employ independently protected DC control circuits. Each station battery is required to have its own charger. Physical separation shall be maintained between the two station batteries, if utilized.

For BES substations above 300 kV, dual station batteries are preferred; however, if a single battery is utilized, dual battery chargers are required.

The battery charger(s) and DC control circuits shall be protected against short circuits. The protective devices utilized shall be designed to minimize the number of control circuits interrupted.

DC control systems shall be continuously monitored and alarmed to detect abnormal voltage levels. At a minimum, a low battery voltage condition and an open circuit battery condition shall be reported remotely, as per Section 15.1. In addition, it is recommended that high battery voltage and DC ground conditions be also reported remotely.

Battery chargers are recommended to be continuously monitored and alarmed. If a single battery with a single charger is utilized, charger failure and loss of AC source shall be reported remotely.

15.1 Design Standards

The following conditions shall be reported remotely from unattended stations. Some functions can be grouped together when reporting the alarm condition to the remote site based on common operator response and the availability of alarm points. Facilities shall be provided to indicate the specific trouble at the local site.

- Battery low voltage condition
- Battery open circuit condition (In instances where a single battery is installed, open-circuit monitoring and reporting is required.)
- Blown fuse on protective relaying DC control circuit
- Loss of AC relaying potential
- Alarm condition of protective relay pilot channels as described in Section 15.2
- Relay trouble alarms where internal alarm features are provided

- Enhanced section 4.2 on transformer high-side lead protection with more details and added reference diagrams

4.2 Transformer High-Side Lead Protection

Transformer high side leads are defined as the phase conductors between the unit power transformer high side and the transmission substation, irrespective of the conductor length.

The transformer high-side leads are required to be protected by two independent current differential schemes ~~or equivalent high-speed schemes~~. The schemes must utilize independent current sources and independently protected DC control circuits.

Transformer high-side leads shall not have infeed within the protection zone as experienced by the two independent current differential schemes. Transformer high-side leads shall not have more than two terminals as experienced by the two independent current differential schemes.

In Section 4.2.1 several examples of acceptable configurations are provided; this is not an exhaustive list. Other configurations of both the protection and phase conductor are possible while satisfying the requirements. Additionally, Section 4.2.1 provides a possible system configuration that is prohibited.

Transformer High-Side Lead Protection Examples

4.2.1 Acceptable and Prohibited System Configurations

Figure 1. Acceptable Configuration

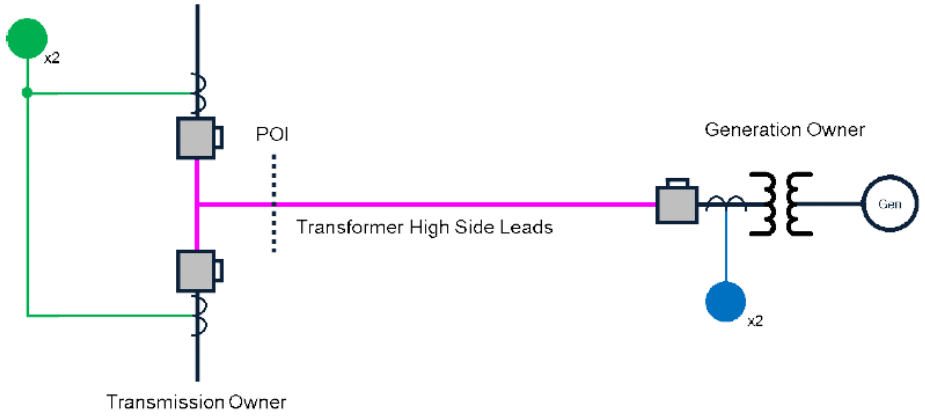


Figure 2. Acceptable Configuration

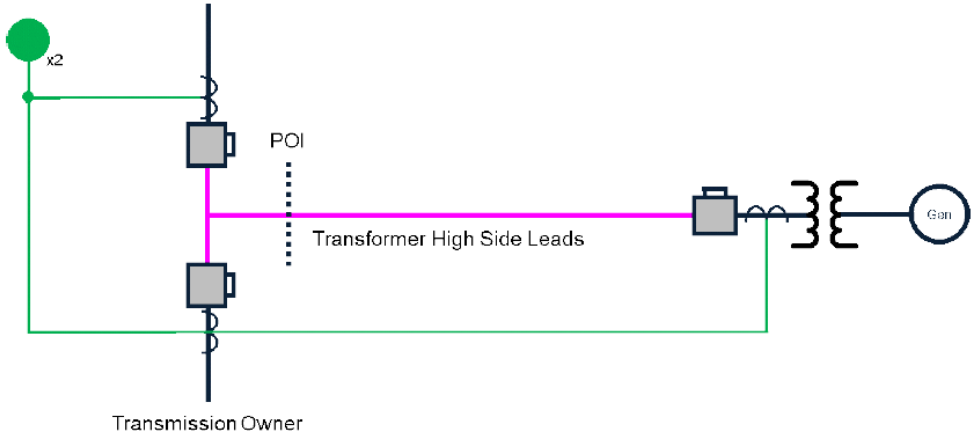


Figure 3. Acceptable Configuration

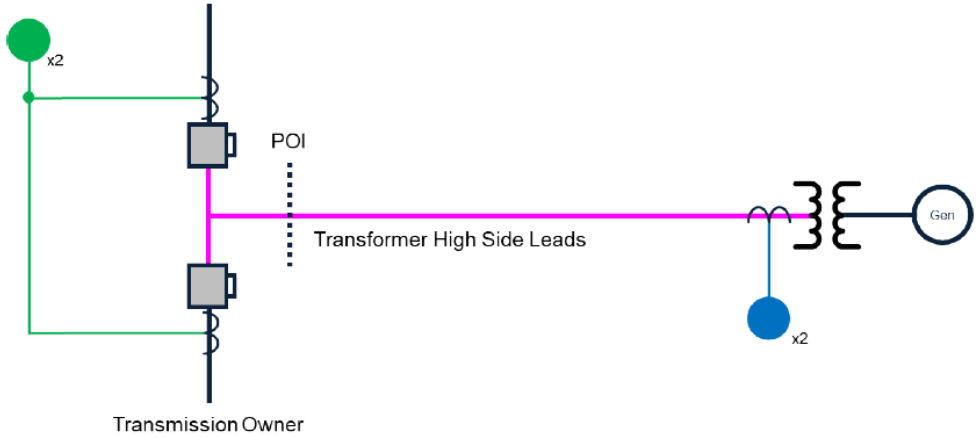
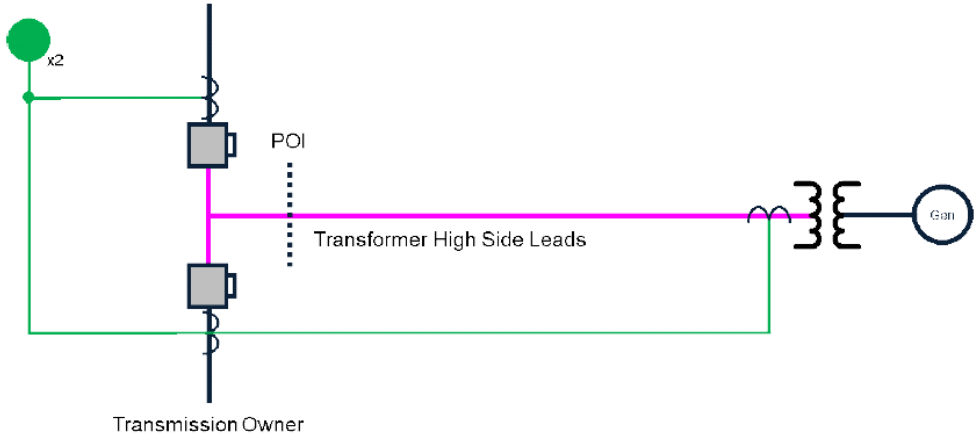


Figure 4. Acceptable Configuration



Transformer High-Side Lead Protection Examples

Figure 5. Acceptable Configuration

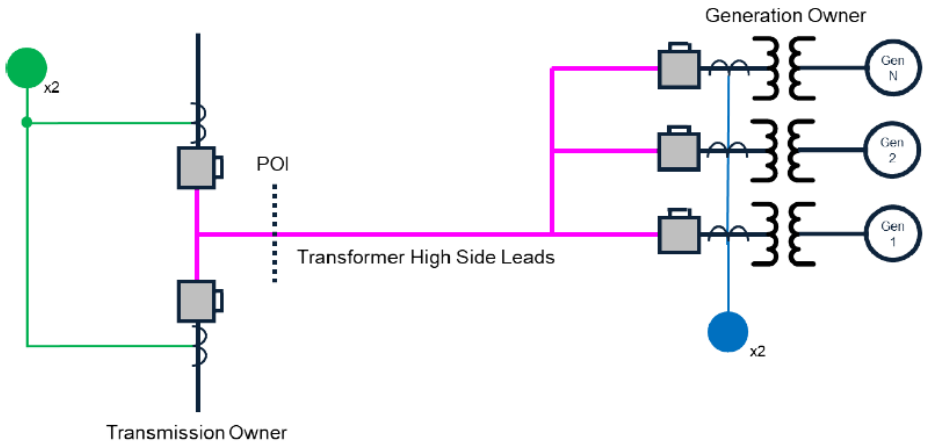


Figure 6. Acceptable Configuration

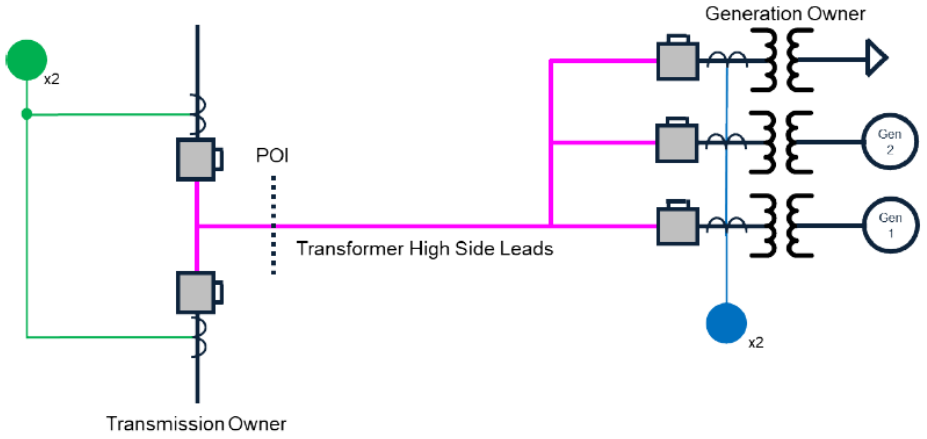
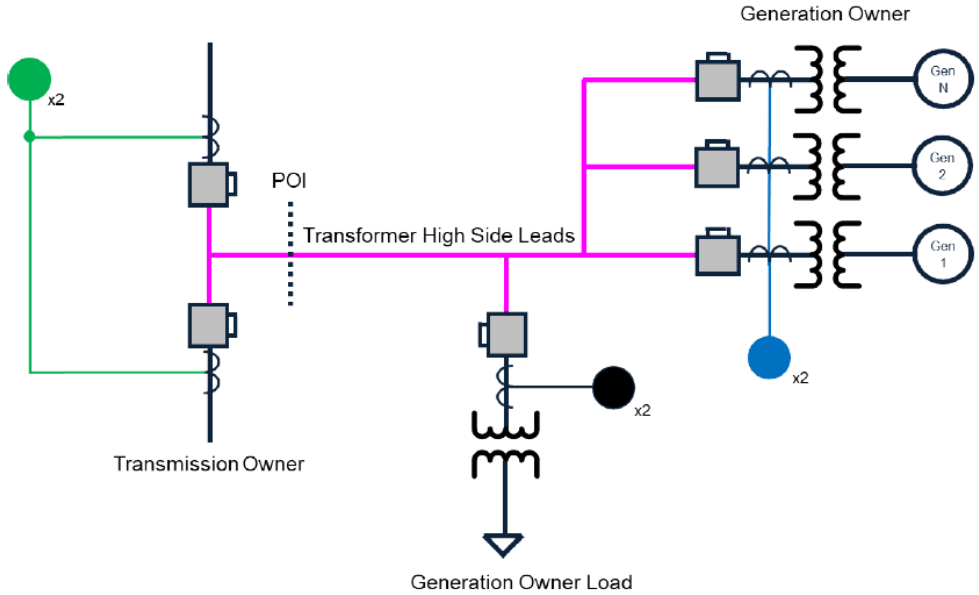


Figure 7. Prohibited Configuration



- Enhanced Section 7.4 on Restricted Ground Fault Protection to add clarity on relay pickup and sensitivity.

7.4 Restricted Ground Fault Protection

A scheme must be provided to detect ground faults with high fault resistance. The relay(s) selected for this application must be set ~~at 600 primary amperes~~ such that the pickup has sufficient sensitivity to detect all plausible high resistance faults within the transmission line zone ~~or less~~, provided that this setting is greater than the maximum line zero-sequence load unbalance. These relays may serve as the overreaching non-communications-assisted ground tripping function.

- Clarified Section 8.2.1 Transformer HV Isolation Device Requirements

8.2 Isolation of a Faulted Transformer Tapped to a Line

This section addresses the requirements for isolating a fault on a transformer tapped on a line. Bulk power lines operated at greater than 300 kV shall not be tapped. Lines operated at less than 300 kV lines may be tapped with the concurrence of the transmission line owner(s).

8.2.1 Transformer HV Isolation Device Requirements

This section is concerned with the isolation of power transformers tapped a line.

All transformers connected~~tagged~~ to a line shall have~~require~~ a device (e.g. circuit breaker, circuit switcher, disconnect switch, etc.) which will automatically isolate the transformer from the line following transformer fault clearing.

Local Breaker Failure Protection Requirements

- Clarified Section 12.1 Local Breaker Failure protection requirements for resultant clearing of the faulted breaker.

12.1 Local breaker failure protection requirements

A dedicated[2] breaker failure scheme shall be used for each fault-interrupting device and shall initiate tripping of all local sources of fault current.

The breaker failure output tripping relay shall block both manual and automatic closing of all local breakers that isolate the failed breaker~~required to trip~~ until the failed breaker has been electrically isolated.

NERC PRC-027 & Other PRC Standards

- Added Section 18 on NERC PRC-027 and other Protection and Control (PRC) Standards
- Added PJM Short Circuit case usage recommendations

Section 18: NERC PRC-027 and other Protection and Control Series

NERC Protection and Control Standards: The purpose of this section is to clarify the role of PJM Planning short circuit cases.

18.1Background

Coordination is necessary of neighboring Protection Systems installed to detect and isolate Faults on Bulk Electric System (BES) Elements, such that those Protection Systems operate in the intended sequence during Faults. Some Generator Owners and Transmission Owners have sought PJM's short circuit cases in an attempt to meet their coordination efforts associated with PRC-027 among other standards. PJM's short circuit cases are developed based on future year assumptions and include transmission and generation expansions and retirements for future time periods.

18.2PJM Short-Circuit Cases Uses

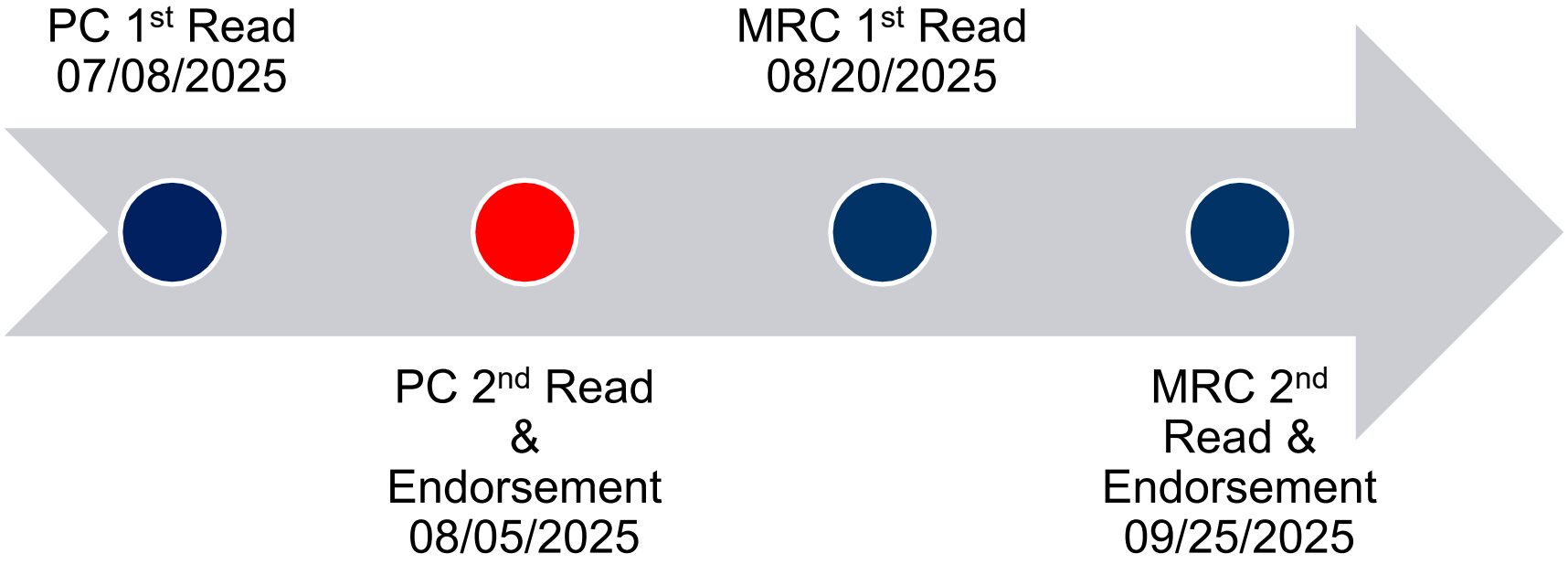
PJM strongly recommends against using the future years' planning short circuit cases solely to establish protection system settings. If PJM's future year short circuit cases are used to model the external system, PJM highly recommends coordination for protection setting across tie lines. PJM recommendations:

- Generator Owners should coordinate directly with their interconnected Transmission Owner.
- Transmission Owners should coordinate with neighboring Transmission Owners.

Manual 07 Miscellaneous Administrative Updates

- Removed references to NERC Standard PRC-001 which was retired
- Updated web links
- Fixed various typos and added consistency in terminology usage
- Grammatical updates/corrections

Review and Approval Timeline



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Revision History

Version No.	Date	Description
1	07/29/2025	• Original slides posted

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