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**Generation Interconnection/Transmission Relay Loadability PRC-023-2**

This article primarily relates to the applicability of NERC standard PRC-023-2, Transmission Relay Loadability, to the Generator Owner (GO) function.

During analysis of major power outage events in the last 25 years, generators have been found to have tripped for conditions that did not pose a direct risk to those generators. Unnecessary generator tripping can extend the scope and/or duration of power outages. Premature or unnecessary tripping of generators during events can deepen the severity of a voltage disturbance due to removal of dynamic Reactive Power, and change the character of the disturbance such that it is less recoverable. This was noted, in detail, to be a serious issue in the Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations.  


As noted in the Report, when the electric grid is breaking apart into islands, if generators stay on-line longer, this improves the chances to keep the lights on within each island and to restore service following a blackout; so - - automatic transmission relay and generator protection must avoid premature tripping.  


FERC Order 785 allowed risk-based registration for determining if Generation Interconnection Facilities required separate registration as a Transmission Owner. Some of these Generation Interconnection Facilities do include transmission lines operated at above 200kV or otherwise designated by the Planning Coordinator.

Now while PRC-023-2 is titled “Transmission Relay Loadability”, **PRC-023-2 is currently in effect and enforceable for the GO function**. PRC-023-2 excludes the generator protection relays that are susceptible to load (PRC-023-2 Attachment A, ¶ 2.4); however, **PRC-023-2 still applies to certain transmission elements of the Generation Interconnection Facility**. The underlying goal of applicability ¶ 4.1.2 of the standard is to prevent unnecessary or premature tripping of the generator interconnect, thereby preventing unnecessary or premature generator tripping during power system disturbances.

PRC-023-2 applies to a registered Generator Owner (GO) with a Bulk Electric System (BES) generator when two conditions are met. The first condition is based on voltage, mainly a Generation Interconnection Facility with a voltage of 200 kV and above (¶ 4.2.1.1; see applicability...
4.2.1 for other circuits subject to Requirements R1 – R5). To clarify, if the Generation Interconnection Facility has a primary voltage of 200 kV or above, the standard applies to the GO, even if the GO is not a registered Transmission Owner (TO). The second qualifier is a load-responsive phase protection system as described in Attachment A of PRC-023-2. Attachment A includes phase distance relays, switch-on-to-fault relays, overcurrent relays, and communications aided protection schemes such as directional comparison blocking (DCB). In essence, nearly all protection schemes for Generator Step Up (GSU) transformers, and the associated high voltage Generation Interconnection Facility, fall under the criteria of Attachment A.

So if your generator falls under PRC-023-2, how do you go about meeting compliance with the standard? Requirement R1 lists thirteen (13) criteria that may be used to prevent phase protective relay settings from limiting system loadability while maintaining reliable protection of the BES for all fault conditions. Note that a GO is not required to meet all 13 criteria; the GO is only required to meet one of the criteria, and the GO may choose which one. The GO may even choose different criteria for different terminals. The typical approach is to target 150% relay loadability using criterion 1. [Other approaches may be used, for example, criterion 2 allows for 115% relay loadability of the 15-minute Facility Rating, but be careful, criterion 2 triggers an annual submittal to the Reliability Coordinator (RC) which would not otherwise be required when using criterion 1.]

Using criterion 1, a simplistic approach is to divide the minimum relay phase pickup trip setting by the highest 4-hour seasonal Generator Facility Rating, expressed in relay/secondary amps, verifying that the ratio is 150% or above. Now if at first glance you think your distance relay settings do not allow for 150% relay loadability, recognize that the standard only requires the analysis of the loading at 0.85 per unit voltage and a power factor angle of 30 degrees [see the bold line in the diagram below].

Without getting into the specifics of setting distance relays, as illustrated in the diagram, the power factor angle for a fault generally “migrates” to a higher power factor angle more closely approximating the transmission line conductor impedance. The trip settings for most distance relays generally have an offset “mho” circle or “prismatic” shape that primarily targets the fault region to improve relay loadability. Microprocessor distance relays also typically have a “load
encroachment” setting to aid with relay loadability. To restate, if a simple ratio of “minimum pickup current” to “facility rating current” does not meet the 150% base rule, for distance relays, check to see if the relay trips at the specified 30 degree power factor angle, typically shown in a relay impedance diagram. If options for use of criterion 1 fail, the next approach is to explore the other twelve criteria for compliance - - or - - adjust relay settings to meet criterion 1 or one of the other criteria.

Attachment A, paragraph 2 lists protection systems that are excluded from the requirements of PRC-023-2. For example, protections systems (or settings) intended for the detection of ground faults are excluded from the requirements.

Evidence of compliance could include, but not be limited to, spreadsheets or summaries of calculations, coordination curves, or “mho” graphs, to show that each of its transmission relays is set according to one of the criteria in Requirement R1, criteria 1 through 13. Similarly, for transformer fault protection, evidence of compliance should show that relays set per criterion 10 do not expose the transformer to fault levels and durations beyond those indicated in the standard (R1). A recommended internal control practice is to have an internal review and check (verification) of evidence for the standard. For criteria requiring an annual submittal, use an annual calendar reminder and maintain a spreadsheet showing previous submittal and the next scheduled submittal. Also, save email submittals in a PRC-023-2 compliance folder for future audits.

On a related note, while PRC-023-2 currently exempts “generator protection relays that are susceptible to load”, PRC-025-1 for Generator Relay Loadability will eventually specifically address generator relays. PRC-025-1 has been approved by NERC, and has been filed at FERC, but is not yet in effect.


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