

More about PRC-024

Generator Frequency and Voltage Protective Relay Settings

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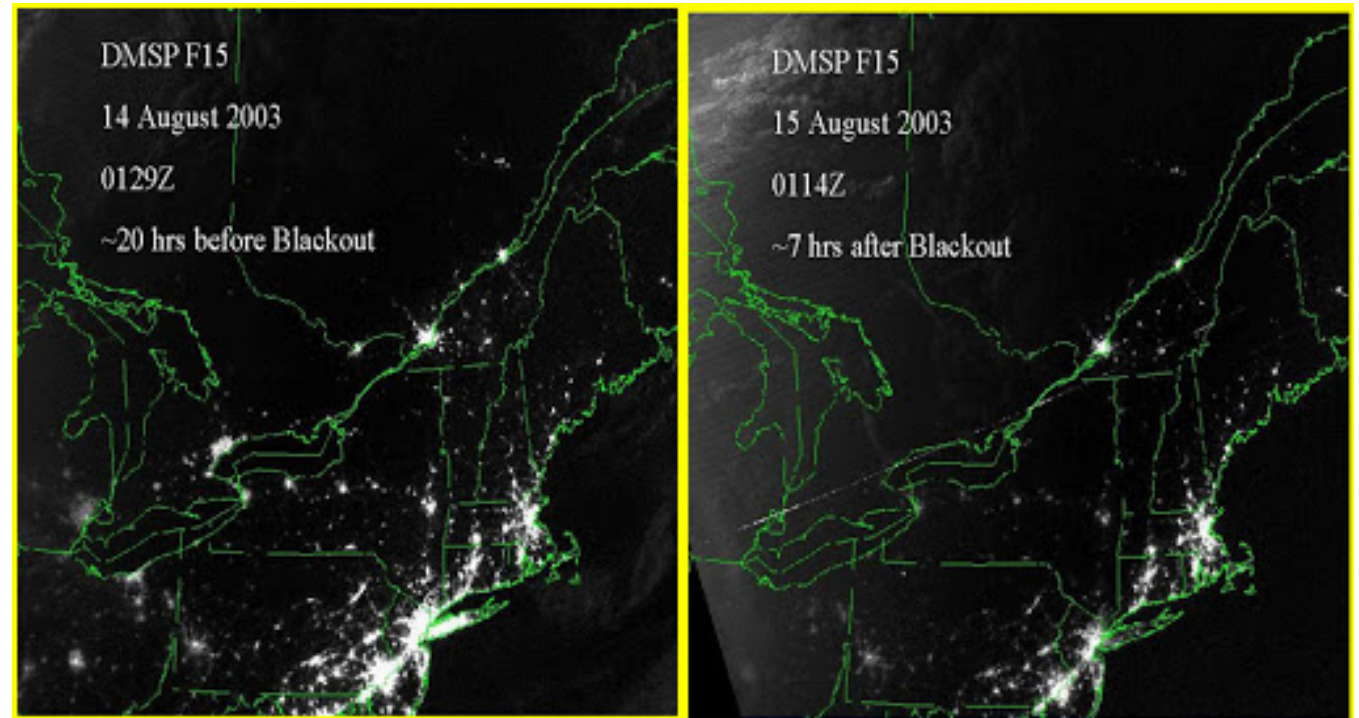
Agenda

- **Why is PRC-024 important and why do another PRC-024 presentation?**
- **Continuing Non-Compliance**
- **Voltage Measurements at Point of Interconnection (POI)**
- **Potential Gap Due to Inverters**
- **NERC's Preliminary Response**
- **Revised Standard PRC-024-3**



Why is PRC-024 Important?

➤ Contributing cause to the 2003 Blackout



Why another PRC-024 Presentation?

- **Violations and Areas of Concern still continue**
- **Inverter Potential Gaps**
 - Blue Cut Fire Disturbance
 - Canyon 2 Fire Disturbance



CONTINUING PRC-024 NON-COMPLIANCE



Summary of Findings

➤ **59 Self Reports since July 2016**

➤ **Audit Findings 2017 - Present**

- 1 Open Enforcement Action (OEA)
- 17 Potential Non-Compliance (PNC)
- 7 Areas of Concern (AoC)
- 7 Recommendations



Some Causes of Violations and AoCs

➤ **Contract planning**

- Limited number of contractors

➤ **Scheduling of compliance across fleets**

- Implementation is calculated based on an individual entity registration
- Sales and Acquisitions impact implementation

➤ **Misunderstanding of curves**

- Settings do not have to be on the curve
- Outside of the curves should be called the “May-Trip Zone”

➤ **Point of interconnection for R2**

- Settings must reflect the Point of Interconnection (POI)



VOLTAGE MEASUREMENTS AT THE POI



Inclusion I4 and the POI

- **Footnote 2 (R1)** and **Footnote 4 (R2)** -
- For **frequency/voltage** protective relays associated with dispersed power producing resources identified through Inclusion I4 of the Bulk Electric System definition, this requirement applies to **frequency/voltage** protective relays applied on the individual generating unit of the dispersed power producing resources, as well as **frequency/voltage** protective relays applied on equipment from the individual generating unit of the dispersed power producing resource up to the **point of interconnection**.



Inclusion I4 POI - Solar

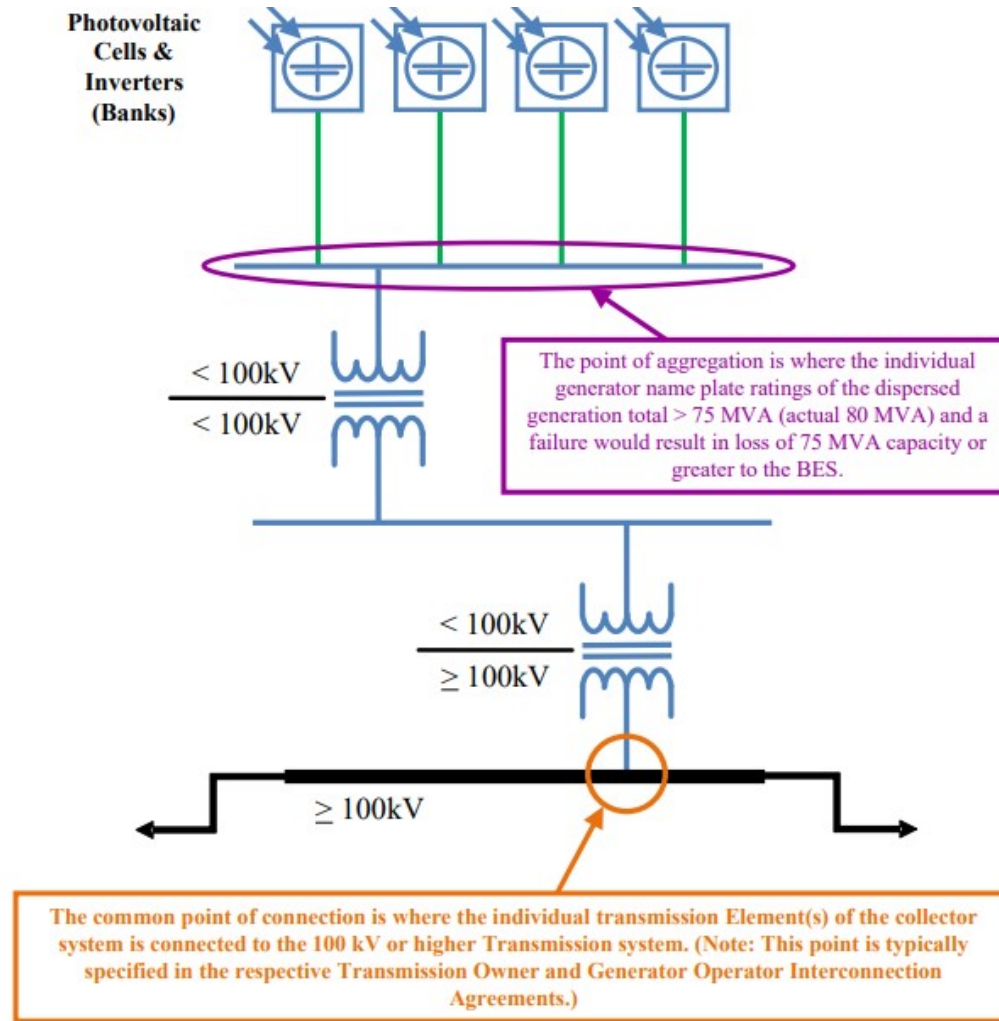


Figure I4-4: Dispersed Generation Site (Multiple Voltage Transformations) – Solar Array

Inclusion I4 POI - Wind

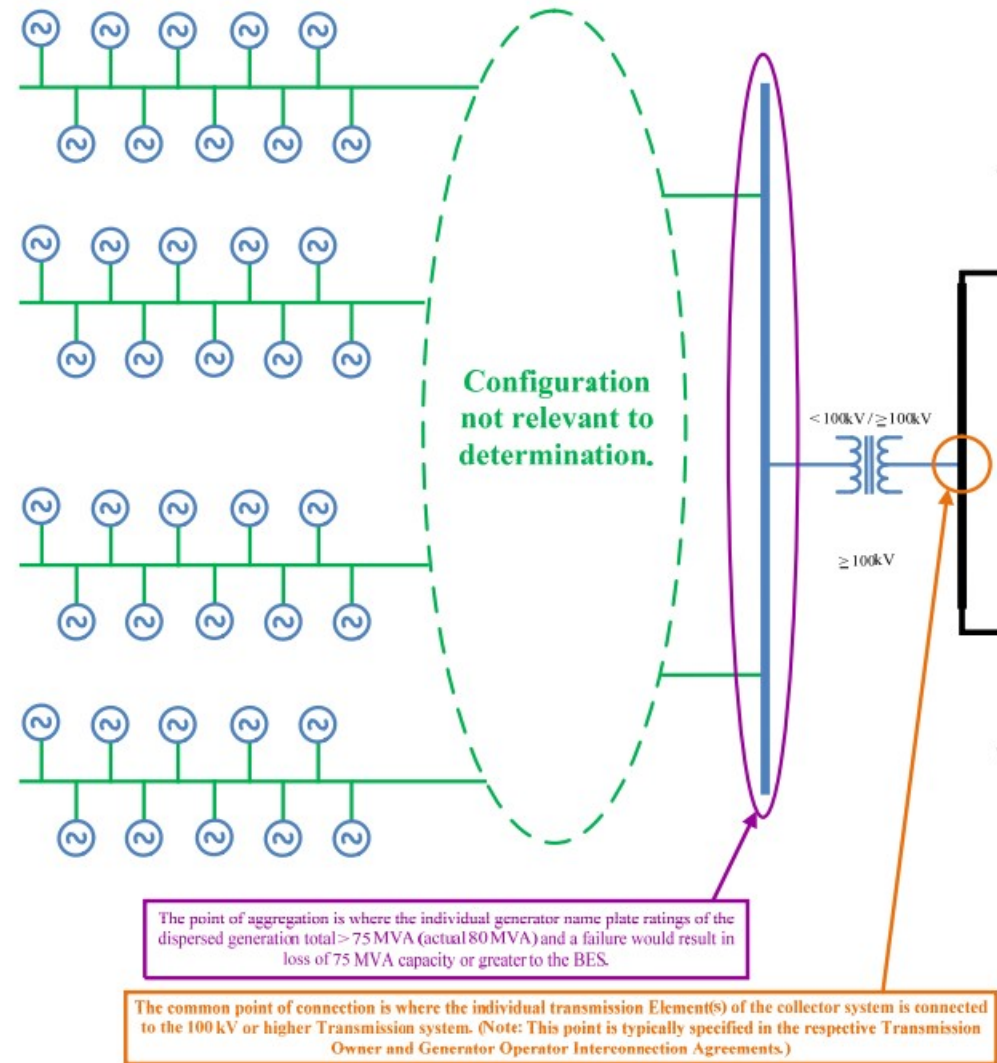


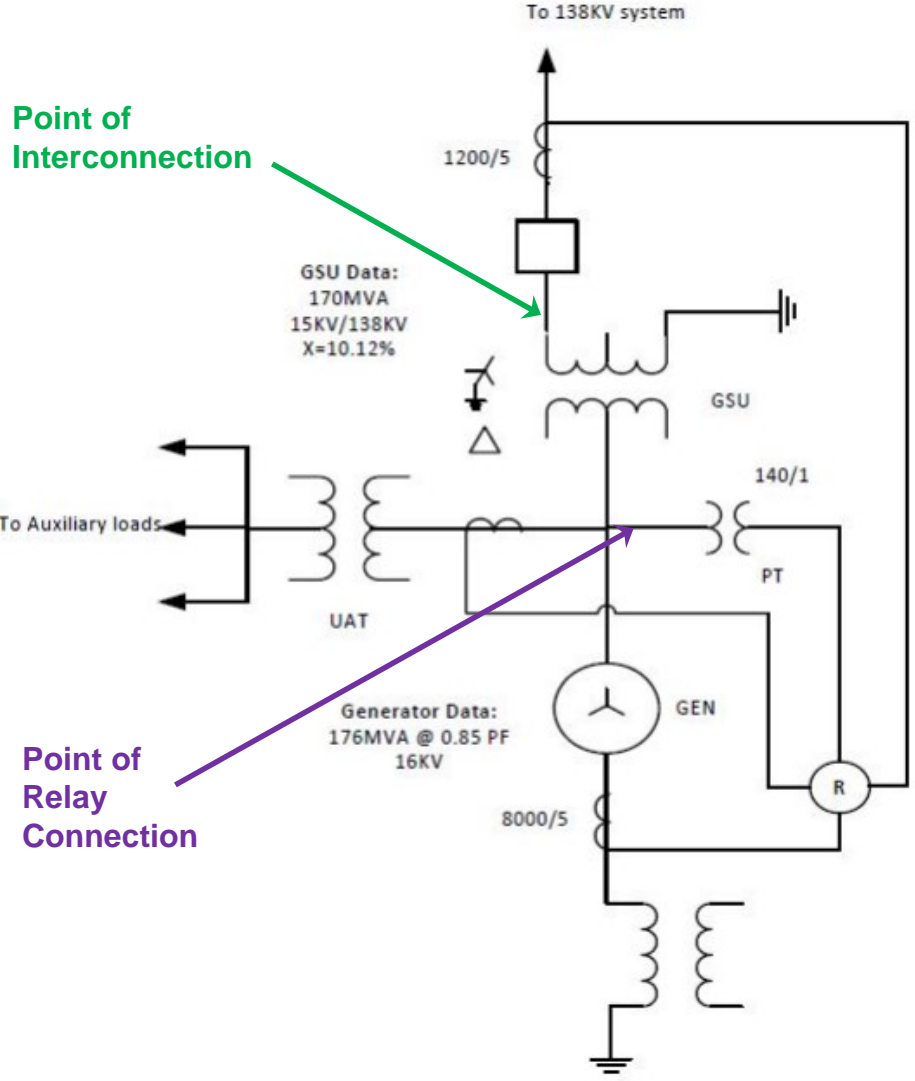
Figure I4-2: Dispersed Generation Site (Unknown Collector System Configuration) – Wind Farm

PRC-024 definition of POI

- **Footnote 3 (R2) - point of interconnection means the transmission (high voltage) side of the generator step-up or collector transformer.**
- **NERC Implementation Guidance (January 19, 2018) –**
 - [Generator Voltage Protective Relay Settings \(Implementation Guidance PRC-024-2 Requirement R2\)](#)
 - Includes examples of how to project generator voltage protective relay settings to a corresponding POI voltage, or conversely, project the POI voltages to the corresponding relay voltage.



Point of Interconnection Transposition



You can either do:

Relay Setting x f(POI) evaluated against "No-Trip Zone" curves

-or-

"No-Trip Zone" curves / f(POI) evaluated against Relay Setting



POTENTIAL GAPS DUE TO INVERTERS



Events Highlighting Gaps

- **Blue Cut Fire Disturbance - 8/16/2016**
- **Canyon 2 Fire Disturbance - 10/9/2017**
- **Nine additional events between August 2016 and May 2017**



NERC'S PRELIMINARY RESPONSE



First NERC Alert (6/20/2017)

- **Work with inverter manufacturer to ensure no erroneous frequency tripping during transients**
- **If momentary cessation is used, restore output as soon as practical but no greater than five seconds. Inverters may continue to produce real and reactive power outside of the ride through operation conditions**
- **If the resources above are unmitigated then the RCs and BAs should plan on the loss of these resources during transmission faults and develop mitigating measures**
- **Provide response to questions within the Alert and send to NERC**



Second NERC Alert (5/1/2018)

- Ensure dynamic model(s) accurately represent the dynamic performance of the solar facilities
- Work with inverter manufacturers to eliminate momentary cessation to the greatest extent possible or adjust momentary cessation thresholds as wide as possible, reduce recovery delay to smallest value possible, and increase power ramp rate to at least 100% per second
- Ensure inverter restoration from momentary cessation is not impeded by plant-level control ramp rates
- Voltage and frequency settings should not be set to the curves in the Standard but based on physical equipment limitations
- Set DC reverse power current protection settings based on equipment limitations to reduce unnecessary trips during high voltage transients
- Provide response to questions within the Alert and send to NERC
- Track, retain, and analyze the proposed dynamic model(s) to identify any potential reliability risk or approve or disapprove the potential changes based on reliability risk used to eliminate momentary cessation; report results to Regional Entity



PRC-024-2 Gaps Whitepaper

- **Inverter-Based Resource Performance Task Force developed a Whitepaper that details potential gaps and lists recommendations (2/7/2019)**
- **Eliminate the term “ride-through” to add clarity**
- **Region outside of the “No-Trip” zone should be marked as a “May-Trip” zone**
- **Inconsistency between table (instantaneous) and Frequency Capability Curves (start 100ms)**
- **Identified areas of Confusion**
 - Regarding voltage measurements
 - Crest vs. RMS voltage
 - Use of phase-to-phase for high voltage but phase-to-phase or phase-to-ground for low
 - Instantaneous tripping (inverter protection may be faster than conventional relaying which perform filtering on the incoming waveform)
 - Inclusion of the four second cumulative time functionality
 - Footnote 1 and the applicability of inverter protective functions within the inverter control systems
 - Use of momentary cessation within the “No-Trip” zone



REVISED STANDARD PRC-024-3



- **NERC filed with FERC on March 20, 2020**
- **FERC Approved July 9, 2020**
- **Effective date is October 1, 2022**
 - Allows at least 24 months for affected generators to schedule outages and make changes

General Changes

- Added more detail to the applicability section
- Addressed momentary cessation
- Clarified the inclusion of generator/inverter controls
- Allows Transmission Planner to approve exceptions within the voltage recovery characteristics
- Added a variance for the Quebec Interconnection



Changes to the Attachments

- Boundary Points Table defines the boundaries (not the figures)
- Instantaneous trip to include filtering
- Area outside the “No-Trip Zone” is **not** a “Must-Trip Zone”
- Eliminated the term “Voltage Ride-Through Curve”
- Voltages in the boundaries assume RMS fundamental frequency phase-to-ground or phase-to-phase per unit voltage
- Voltage “No-Trip Zone” ends at 4 seconds
- Clarified Voltage protection settings evaluation point



Questions & Answers

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