

Standard PRC-024-1 — Generator Frequency and Voltage Protective Relay Settings

Standard Development Roadmap

This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.

Development Steps Completed:

SAR authorized by Standards Committee for development as a reliability standard July 12, 2007.

Standard Drafting Team appointed by Standards Committee September 11, 2007.

Proposed Action Plan and Description of Current Draft:

This is the first draft of the proposed standard and includes requirements with violation risk factors, time horizons and measures; additional compliance elements will be added later. This first posting of the standard is for a 45-day comment period from February 17 through April 2, 2009.

Future Development Plan:

Anticipated Actions	Anticipated Date
1. Post response to comments and second version of standard.	May 4, 2009
2. Post response to comments and request authorization to ballot the revised standard.	To be determined
3. Conduct initial ballot.	To be determined
4. Post response to comments.	To be determined
5. Conduct recirculation ballot.	To be determined
6. BOT adoption.	To be determined
7. File with regulatory authorities.	To be determined

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Definitions of Terms Used in Standard

This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.

None.

Standard PRC-024-1 — Generator Frequency and Voltage Protective Relay Settings

A. Introduction

1. **Title:** Generator Frequency and Voltage Protective Relay Settings
2. **Number:** PRC-024-1
3. **Purpose:** Ensure that generator frequency and voltage protective relays¹ are set to support transmission system stability during voltage and frequency excursions.
4. **Applicability**
 - 4.1. Functional entities:
 - 4.1.1 Generator Owners
 - 4.2. Facilities:
 - 4.2.1 Each generating unit (with installed voltage or frequency protective relays) greater than 20 MVA connected to the Bulk Electric System (BES).
 - 4.2.2 Each unit (with installed voltage or frequency protective relays) at generating plants/facilities consisting of multiple units with total generation > 75 MVA (gross aggregate nameplate rating) at the point of interconnection to the BES.
5. **Effective Dates:** The standard is effective the first day of the first calendar quarter after applicable regulatory approvals (or the standard otherwise becomes effective the first day of the first calendar quarter after NERC BOT adoption in those jurisdictions where regulatory approval is not required).

Each Generator Owner's unit with installed voltage or frequency protective relays shall be compliant with the standard based on the following phased implementation schedule:

- 5.1. No less than 33% of a Generator Owner's units shall be fully compliant with the standard within 1 year of the effective date of the standard.
- 5.2. No less than 66% of a Generator Owner's units shall be fully compliant with the standard within 2 years of the effective date of the standard
- 5.3. No less than 100% of a Generator Owner's units shall be fully compliant with the standard within 3 years of the effective date of the standard

A. Requirements

- R1. Each Generator Owner shall set its installed generator frequency protective relaying not to trip during the following frequency-related operating conditions unless the Generator Owner has documented and reported the unit's limitation in accordance with Requirement R5: (*Violation Risk Factors: High - Units ≥ 500 MVA; Medium - Units > 100 MVA and < 500 MVA; Lower - Units ≤ 100 MVA*) (*Time Horizon – Operations Planning*)
 - R1.1. When operating within a frequency range of 59.5 Hz to 60.5 Hz, inclusive.
 - R1.2. During the off-normal frequency excursions specified in PRC-024-1 Attachment 1.
 - R1.3. Instantaneous underfrequency relay trip setting shall be set no higher than 57.8 Hz.
 - R1.4. Instantaneous overfrequency relay trip settings shall be set no lower than 62.2 Hz.

¹ Includes voltage and frequency protective functions for discrete relays, multi-function protective devices, voltage regulators, etc.

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- R2.** Each Generator Owner shall set its installed generator over and under voltage (including volts per hertz relays evaluated at nominal frequency) protective relays not to trip during the steady-state and voltage-related operating conditions as follows unless the Generator Owner has documented and reported the unit's limitation in accordance with Requirement R5 of this standard: (*Violation Risk Factors: High - Units ≥ 500 MVA; Medium - Units > 100 MVA and < 500 MVA; Lower - Units ≤ 100 MVA*) (*Time Horizons – Operations Planning*)
- R2.1.** When operating within 95% to 105% of rated generator terminal voltage.
- R2.2.** During the transient voltage excursions measured at the point of interconnection to the BES as specified in PRC-024-1 Attachment 2. The following generator protective relaying settings are acceptable:
- R2.2.1.** For three-phase transmission system zone one faults with Normal Clearing, relaying may be set based on actual fault clearing times, but not greater than nine cycles.
- R2.2.2.** Relaying may be set to meet a shorter voltage ride through duration curve as specified by the Transmission Planner based on the location specific voltage recovery characteristics.
- R2.2.3.** Relaying may be set to trip a generator after fault initiation if this action is intended as part of a Special Protection System (SPS) or Remedial Action Scheme (RAS).
- R2.2.4.** Relaying may be set to trip a generator if clearing a system fault necessitates disconnecting the generator.
- R3.** Each Generator Owner shall provide to the Reliability Coordinators, Planning Coordinators, Transmission Operators and Transmission Planners (that monitor or model the associated unit) its generator protection trip settings as specified by Requirement R1 and Requirement R2 within 30 calendar days of any change to those trip settings. (*Violation Risk Factor – Lower*) (*Time Horizon – Operations Planning*)
- R4.** Each Generator Owner shall provide to the Reliability Coordinators, Planning Coordinators, Transmission Operators and Transmission Planners (that monitor or model the associated unit), its generator protection trip settings as specified by Requirement R1 and Requirement R2 within 30 calendar days of a written request for the data. (*Violation Risk Factor – Lower*) (*Time Horizon – Operations Planning*)
- R5.** If an existing generator unit² cannot meet either Requirement R1 or Requirement R2 due to equipment limitations, such as manufacturer warranty requirements or limitations that endanger the equipment according to published manufacturer instructions, (Protection System excluded), the Generator Owner is granted an exception for that unit from meeting the portion of Requirement R1 or R2 for that limitation once it provides documentation of the equipment limitation(s) to the Reliability Coordinators, Planning Coordinators, Transmission Operators and Transmission Planners that monitor or model the associated unit, within 30 days of identifying the equipment limitation. (*Violation Risk Factors: Medium - Units > 100 MVA; Lower - Units ≤ 100 MVA*) (*Time Horizon – Operations Planning*)

² Including generators under construction, generators with an executed interconnection agreement or Power Purchase Agreement, or generators with an executed equipment purchase contract and scheduled delivery within 2 years of the effective date of the standard.

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The exception for the equipment limitation shall expire coincident with either of the following conditions:

- The equipment causing the limitation is replaced with equipment that removes the technical limitation.
 - The equipment causing the limitation is modified or upgraded resulting in an increase of generator nameplate capacity rating greater than 10%.
- R6.** The Generator Owner shall provide a written response within 90 calendar days of receipt of written comments from a Reliability Coordinator, Planning Coordinator, Transmission Operator or Transmission Planner (that monitors or models the associated unit) regarding the equipment limitation. The response shall indicate whether a change will be made to the equipment limitation or if no change will be made to the equipment limitation, the reason why. *(Violation Risk Factor – Lower) (Time Horizon – Operations Planning)*

B. Measures

- M1.** Each Generator Owner shall have evidence such as setting sheets, calibration sheets, or other documentation, that generator frequency protective relays have been set in accordance with Requirement R1.
- M2.** Each Generator Owner shall have evidence such as setting sheets, voltage-time curves, calibration sheets, coordination plots or dynamic simulation studies, that generator voltage protective relays have been set in accordance with Requirement R2.
- M3.** Each Generator Owner shall have evidence such as dated e-mails, mail receipts or other documentation that generator protective relay settings changes have been communicated to the entities listed in Requirement R3.
- M4.** Each Generator Owner shall have evidence such as dated e-mails, mail receipts, request received or other documentation that generator protective relay settings have been communicated to the entities listed in Requirement R4.
- M5.** Each Generator Owner of existing generators that are unable to comply with Requirements R1 or R2 due to equipment limitations (Protection System excluded) shall have evidence such as warranty agreements, insurance agreements, manufacturers documented limitations, engineering analysis or other documentation that explains the equipment limitation of the unit(s).
- M6.** Each Generator Owner shall have evidence such as dated copy, e-mail receipts or other evidence that it provided a written response to a commenting entity within 90 calendar days of receipt of comments.

C. Regional Variances

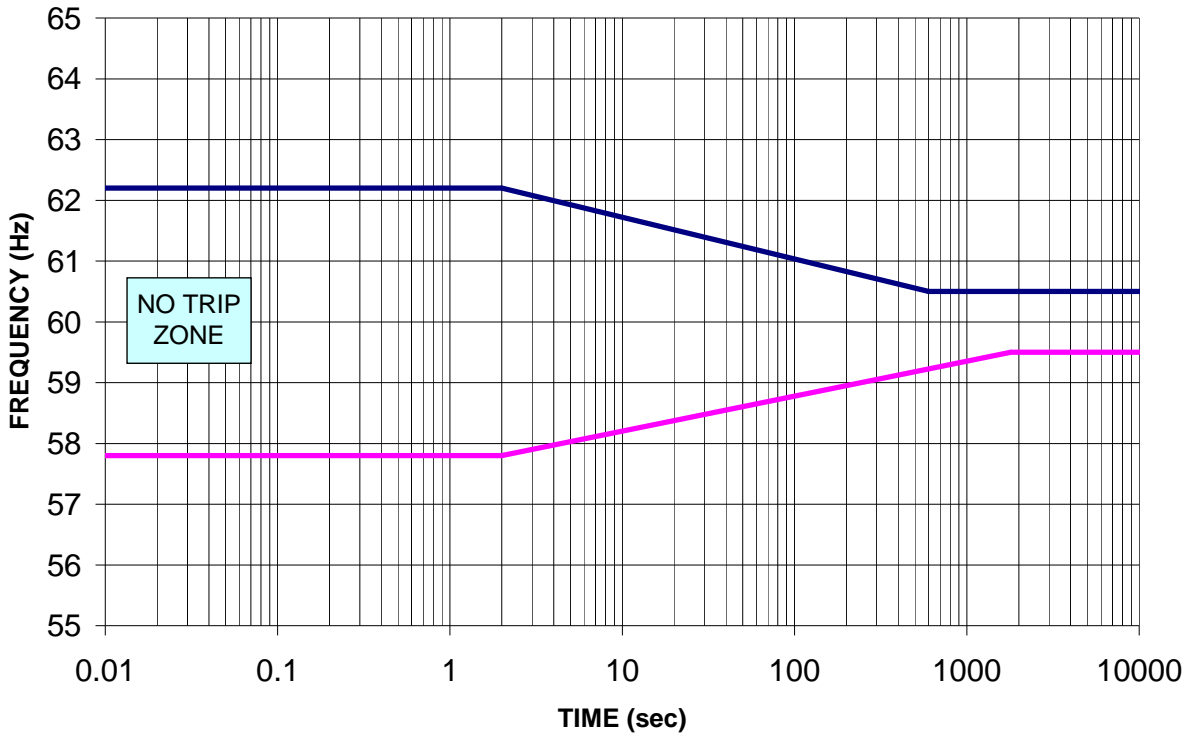
None

D. References

“The Technical Justification for the New WECC Voltage Ride-Through (VRT) Standard, A White Paper Developed by the Wind Generation Task Force (WGTF),” dated June 13, 2007, a guideline approved by WECC Technical Studies Subcommittee.

PRC-024-1 — Attachment 1

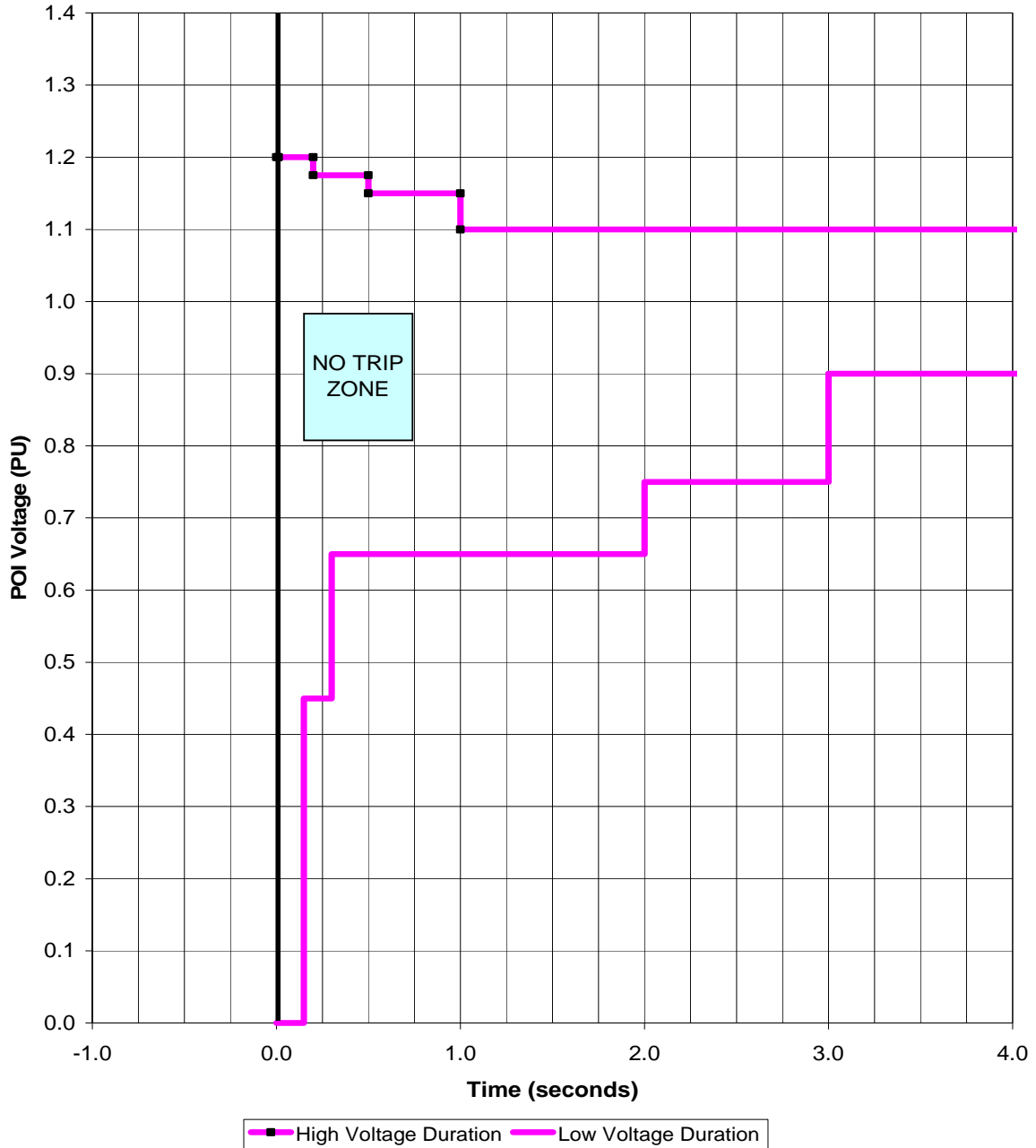
OFF NOMINAL FREQUENCY CAPABILITY CURVE



Frequency (hertz)	62.2	60.5	57.8	59.5
Time (seconds)	0 to 2	600 to 10,000	0 to 2	1,800 to 10,000

PRC-024-1 — Attachment 2

Voltage Ride-Through
Time Duration Curves



The following data points would apply to this curve:

HVRT DURATION		LVRT DURATION	
Time	Voltage	Time	Voltage
0.20	1.200	0.15	0.000
0.50	1.175	0.30	0.450
1.00	1.150	2.00	0.650
4.00	1.100	3.00	0.750
		4.00	0.900

Voltage Ride-Through Curve Clarifications

1. The per unit voltage base for this curve is the nominal operating voltage as measured at the point of interconnection to the BES.
2. As long as the cumulative voltage duration at the point of interconnection with the BES is within the voltage boundaries of the curve, the generator voltage protective relaying will not trip the generator.
3. The curve depicted in this Attachment 2 assumes system frequency of 60 Hertz and all of the units connected to the same transformer are on line.