

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:

1. SAR posted for comment (April 20–May 21, 2007).
2. Revised SAR and response to comments posted.
3. Revised SAR and response to comments approved by SC (June 14, 2007).
4. SDT appointed on (August 18, 2007).
5. Initial draft of PRC-024-1 was posted for a 45 day formal comment period (February 17 – April 2, 2009).

Proposed Action Plan and Description of Current Draft:

This is the second draft of the proposed standard including Time Horizons, Data Retention, Violation Risk Factors, and Violation Severity Levels. This second posting of the standard is for a 30-day formal comment period.

Future Development Plan:

Anticipated Actions	Anticipated Date
1. Post first draft revision of standard.	April-May 2011
2. Post response to comments and third version draft revision of standard.	July – August 2011
3. Post response to comments and request authorization to ballot the revised standard.	September - October 2011
4. Conduct initial ballot.	November 2011
5. Post response to comments.	December 2011
6. Conduct recirculation ballot.	January 2012
7. BOT adoption.	February 2012
8. File with regulatory authorities.	March 2012

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.

Frequency Excursion – an exceedance of system frequency beyond a continuous operating band; 60 ± 0.5 Hertz.

Voltage Excursion – an exceedance of system voltage beyond a continuous operating band; $\pm 5\%$ of scheduled voltage.

A. Introduction

1. **Title:** Generator Performance During Frequency and Voltage Excursions
2. **Number:** PRC-024-1
3. **Purpose:** Ensure generating units remain connected during frequency and voltage excursions and ensure expected generating unit performance during frequency and voltage excursions is communicated to Reliability Coordinators, Planning Coordinators, Transmission Operators and Transmission Planners for accurate system modeling.
4. **Applicability:**
 - 4.1. Generator Owner
5. **Effective Date:**
 - 5.1. The first day of the first calendar quarter one year following applicable regulatory approval; or, in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter one year following Board of Trustees adoption:
 - 5.1.1 Each Generator Owner shall verify that at least 33% of its applicable units are fully compliant with this standard.
 - 5.2. The first day of the first calendar quarter two years following applicable regulatory approval; or, in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter two years following Board of Trustees adoption:
 - 5.2.1 Each Generator Owner shall verify that at least 66% of its applicable units are fully compliant with this standard.
 - 5.3. The first day of the first calendar quarter three years following applicable regulatory approval; or, in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter three years following Board of Trustees adoption:
 - 5.3.1 Each Generator Owner shall verify that 100% of its applicable units are fully compliant with this standard.

B. Requirements

- R1. Each Generator Owner that has frequency protective relaying¹ activated to trip its new or existing generating unit shall set such protective relaying not to trip per the following operating conditions and relay settings unless the Generator Owner has documented and communicated a non-protection system equipment limitation in accordance with

¹ Each Generator Owner is not required to have frequency or voltage protective relaying (includes frequency and voltage protective functions for discrete relays, volts per hertz relays evaluated at nominal frequency, multi-function protective devices or protective functions within excitation controls that directly trip or provide tripping signals to the generator based on frequency or voltage inputs) installed or activated on its unit.

Requirement R3 for an existing generating unit.² [*Violation Risk Factor: High*] [*Time Horizon: Long-term Planning*]

- 1.1. When operating within a frequency range of 59.5 Hz to 60.5 Hz, inclusive.
 - 1.2. During the off-nominal frequency excursions specified in PRC-024 Attachment 1.
 - 1.3. By instantaneous under frequency relays set at a frequency higher than 57.8 Hz.
 - 1.4. By instantaneous over frequency relays set at a frequency lower than 62.2 Hz.
 - 1.5. When the transmission system frequency rate of change is less than 2.5 Hz/second.
- R2.** Each Generator Owner that has voltage protective relaying activated to trip its new or existing unit or generating plant or Facility shall set its protective relaying not to trip as a result of a voltage excursion (at the point of interconnection) caused by an event external to the plant per the following operating conditions and relay settings unless the Generator Owner has documented and communicated a non-protection system equipment limitation in accordance with Requirement R3 for an existing unit or generating plant or generating Facility: [*Violation Risk Factor: High*] [*Time Horizon: Long-term Planning*]
- 2.1. When operating within 95% to 105% of rated generator terminal voltage and during the transmission system operating conditions defined in PRC-024 Attachment 2, with the following clarifications:
 - 2.1.1. For three-phase transmission system zone 1 faults with Normal Clearing, set voltage relays based on actual fault clearing times, not to exceed 9 cycles.
 - 2.1.2. If a Transmission Planner’s study (based on the location specific voltage recovery characteristics) recommends less stringent voltage relay settings than those in PRC-024 Attachment 2, set voltage relays either to the Transmission Planner’s settings or the settings in PRC-024 Attachment 2.
 - 2.1.3. If a Special Protection System (SPS) or Remedial Action Scheme (RAS) includes tripping a generator after fault initiation, then setting the SPS or RAS relays to trip the generator even if in the “no trip zone” in PRC-024 Attachment 2 is acceptable.
 - 2.1.4. If clearing a system fault necessitates disconnecting a generator, then setting relays to trip the generator even if operating within the “no trip zone” specified in PRC-024 Attachment 2 is acceptable.
- R3.** Each Generator Owner of an existing generating unit or generating plant or Facility shall document each non-protection system equipment limitation that prevents a generating unit, generating plant, or Facility from meeting the criteria in Requirement R1 or R2 and communicate the documented limitation to its Reliability Coordinator, Planning

² To include generators under construction, generators with an executed interconnection agreement or Power Purchase Agreement by the effective date of this standard, or generators with an executed equipment purchase contract and scheduled delivery of major components within 2 years of the effective date of version 1 of this standard.

Coordinator, Transmission Operator and Transmission Planner within 30 calendar days of identifying the limitation to ensure the accuracy of planning studies and system modeling studies. The equipment limitation expires coincident with either of the following conditions:

- The equipment causing the limitation is repaired or replaced with equipment that removes the limitation.
- The generating unit continuous capacity rating increases $\geq 10\%$.

[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]

- R4.** Within 90 calendar days of receipt of a written inquiry from the Reliability Coordinator, Planning Coordinator, Transmission Operator, or Transmission Planner regarding an equipment limitation identified in accordance with Requirement R3, the Generator Owner shall provide a written response to the entity that submitted the inquiry.
- R5.** Each Generator Owner of an existing unit or generating plant or generating Facility shall provide an estimate of that unit's performance during Frequency/Voltage Excursions to the requesting entity (Reliability Coordinator, Planning Coordinator, Transmission Operator or Transmission Planner that monitors or models the associated unit) within 30 calendar days of a written request to ensure the accuracy of planning studies and system modeling studies. The documentation shall include: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 5.1.** An estimate of the time duration the existing unit or generating plant or Facility will remain connected as a result of a Frequency Excursion defined by the curves in PRC-024 Attachment 1 and a Voltage Excursion defined by the curves in PRC-024 Attachment 2 or the voltage profile at the Point of Interconnection for the generating unit or generating plant or Facility of the most severe normally-cleared Zone 1 fault described by dynamic simulation provided by the Transmission Planner if this profile is less stringent than the curves in Attachment 2.
- 5.2.** An estimated probability in 25% increments that the existing unit or generating plant or generating Facility will remain connected during a Frequency Excursion defined by the curves in PRC-024 Attachment 1 and a Voltage Excursion defined by the curves in PRC-024 Attachment 2 or the voltage profile at the Point of Interconnection for the generating unit or generating plant or Facility of the most severe normally-cleared Zone 1 fault described by dynamic simulation provided by the Transmission Planner if this profile is less stringent than the curves in Attachment 2.
- 5.3.** Identification of the basis for the estimates developed for 5.1 and 5.2 which may include, but is not limited to: experience, actual event histories, or sound engineering judgment.

- R6.** Each Generator Owner shall design, build, and maintain its new³ unit or new generating plant or generating Facility so that it will not trip due to a Frequency Excursion or Voltage Excursion at the Point of Interconnection, caused by an event external to the plant, within the parameters set forth in PRC-024 Attachments 1 and 2 and in accordance with the following conditions and exceptions: [*Violation Risk Factor: High*] [*Time Horizon: Real-time Operations*]
- 6.1.** (condition) When the unit or generating plant or generating Facility is operating at or above the minimum sustainable generation threshold.
- 6.1.1.** For a generating plant or generating Facility consisting of multiple units with total generation > 75 MVA (gross aggregate rating), when the Facility is producing at least 20% of the Facility's rated capacity and the voltage support equipment is in service.
- 6.2.** (condition) For a new generating plant or generating Facility consisting of multiple units less than 20 MVA each with total Facility generation > 75 MVA (gross aggregate rating), at least 90% of the individual generating units shall remain connected.
- 6.3.** (exception) A unit or generating plant or generating Facility may operate to a less stringent voltage ride-through performance criterion than the duration curve identified in PRC-024 Attachment 2 based on the location specific voltage recovery characteristics as specified by the Transmission Planner.
- 6.4.** (exception) A unit or generating plant or generating Facility may trip if this action is designed as part of a Special Protection System (SPS) or Remedial Action Scheme (RAS).
- 6.5.** (exception) A unit or generating plant or generating Facility may trip if clearing a system fault necessitates disconnecting the unit or generating plant or generating Facility.
- 6.6.** (exception) A unit or generating plant or generating Facility may trip if the Generator Owner has a temporary exemption granted by its Reliability Coordinator based on a documented equipment limitation.
- 6.7.** (exception) A unit or generating plant or generating Facility may trip if the protective functions (such as out of step or loss of field functions) operate due to an impending or actual loss of synchronism or due to instability in power conversion control equipment.
- R7.** Each Generator Owner shall provide to the Reliability Coordinator, Planning Coordinator, Transmission Operator and Transmission Planner (that monitors or models the associated unit) its generator protection trip settings as specified by Requirements R1

³ Excluding generators in service prior to the effective date of version 1 of this standard and excluding generators referenced in Footnote 2.

and R2, and documented equipment limitations as specified by Requirement R3 within 30 calendar days of any change to those trip settings or limitations and within 30 calendar days of a written request for the data to ensure the accuracy of planning studies and system modeling. [*Violation Risk Factor: Lower*] [*Time Horizon: Operations Planning*]

C. Measures

- M1.** Each Generator Owner has evidence such as dated setting sheets, calibration sheets, or other documentation, that generator frequency protective relays have been set in accordance with Requirement R1.
- M2.** Each Generator Owner has evidence such as dated 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 has evidence that it has documented and communicated any equipment limitations (Protection System excluded) that resulted in an exception to Requirements R1 or R2 in accordance with Requirement R3 such as a dated email or letter that contains such documentation as study results, experience from an actual event, or manufacturer's advisory.
- M4.** Each Generator Owner has evidence such as dated e-mails, mail receipts or other evidence that it provided a written response to an inquiry regarding equipment limitations to a requesting entity within 90 calendar days of a request in accordance with Requirement R4.
- M5.** Each Generator Owner has evidence such as a copy of the performance report and dated e-mails, mail receipts or other documentation that an estimate of the performance of its existing generating unit(s) as a result of a Frequency Excursion or Voltage Excursion has been communicated in accordance with Requirement R5.
- M6.** Each Generator Owner has evidence such as dated unit output records, trip investigation reports or disturbance monitoring records or a trip report indicating each unit trip did not result from a Frequency Excursion or Voltage Excursion as specified in Requirement R6 or provide an attestation that the generating unit, generating plant or Facility did not trip.
- M7.** Each Generator Owner has evidence such as dated e-mails, mail receipts or other evidence that it communicated generator protective relay settings or equipment limitations to a requesting entity within 30 calendar days of a request or change in setting(s) in accordance with Requirement R7.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Regional Entity

1.2. Data Retention

The Generator Owner shall keep data or evidence to show compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation:

- The Generator Owner shall retain the latest evidence of Requirement R1 through R7, Measure M1 through M7; and shall retain prior evidence for 3 calendar years or until the next audit, whichever is longer.

If a Generator Owner is found non-compliant, it shall keep information related to the non-compliance until found compliant or for the time period specified above, whichever is longer.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

1.3. Compliance Monitoring and Assessment Processes

Compliance Audit

Self-Certification

Spot Checking

Compliance Violation Investigation

Self-Reporting

Complaint

1.4. Additional Compliance Information

None

2. Violation Severity Levels

R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	N/A	N/A	N/A	The Generator Owner failed to set frequency protective relaying so that it does not trip within the criteria listed in Requirement R1, Parts 1.1 through 1.5.
R2	N/A	N/A	N/A	The Generator Owner with voltage protective relaying failed to set its protective relaying not to trip as a result of a voltage excursion at the point of interconnection, caused by an event external to the plant per the operating conditions and relay settings specified in Requirement R2
R3	The Generator Owner documented the non-protection system equipment limitation that prevents compliance with Requirement R1 or R2 and communicated the documented limitation to its Reliability Coordinator, Planning Coordinator, Transmission Operator and Transmission Planner more than 30 calendar days but less than or equal to 40 calendar days of identifying the limitation.	The Generator Owner documented the non-protection system equipment limitation that prevents compliance with Requirement R1 or R2 and communicated the documented limitation to its Reliability Coordinator, Planning Coordinator, Transmission Operator and Transmission Planner more than 40 calendar days but less than or equal to 50 calendar days of identifying the limitation.	The Generator Owner documented the non-protection system equipment limitation that prevents compliance with Requirement R1 or R2 and communicated the documented limitation to its Reliability Coordinator, Planning Coordinator, Transmission Operator and Transmission Planner more than 50 calendar days but less than or equal to 60 calendar days of identifying the limitation.	The Generator Owner failed to document any non-protection system equipment limitation that prevents compliance with Requirement R1 or R2. OR The Generator Owner failed to communicate the documented limitation to its Reliability Coordinator, Planning Coordinator, Transmission Operator and Transmission

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R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
				Planner within 61 calendar days of identifying the limitation.
R4	The Generator Owner provided a written response to an equipment limitation inquiry more than 90 calendar days but less than or equal to 100 calendar days of a written request.	The Generator Owner provided a written response to an equipment limitation inquiry more than 100 calendar days but less than or equal to 110 calendar days of a written request.	The Generator Owner provided a written response to an equipment limitation inquiry more than 110 calendar days but less than or equal to 120 calendar days of a written request.	The Generator Owner failed to provide a written response to an equipment limitation inquiry within 121 calendar days of a written request.
R5	The Generator Owner provided an estimate of a unit's performance more than 30 calendar days but less than or equal to 40 calendar days of a written request.	<p>The Generator Owner provided an estimate of a unit's performance more than 40 calendar days but less than or equal to 50 calendar days of a written request.</p> <p>OR</p> <p>The Generator Owner failed to include documentation for one of the Parts specified in Requirement R5, Parts 5.1 through 5.3.</p>	<p>The Generator Owner provided an estimate of a unit's performance more than 50 calendar days but less than or equal to 60 calendar days of a written request.</p> <p>OR</p> <p>The Generator Owner failed to include documentation for two of the Parts specified in Requirement R5, Parts 5.1 through 5.3.</p>	<p>The Generator Owner failed to provide an estimate of a unit's performance within 61 calendar days of a written request.</p> <p>OR</p> <p>The Generator Owner failed to include any of the documentation specified in Requirement R55, Parts 5.1 through 5.3.</p>
R6	N/A	N/A	N/A	The Generator Owner failed to demonstrate its new unit or new generating plant or generating Facility did not trip due to a Frequency Excursion within the parameters set forth in

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R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
				<p>Requirement 6.</p> <p>OR</p> <p>The Generator Owner failed to demonstrate its new unit or new generating plant or generating Facility did not trip due to a Voltage Excursion within the parameters set forth in Attachment 2.</p>
R7	<p>The Generator Owner provided its generator protection trip settings as specified by Requirements R1 and R2, and documented equipment limitations as specified by Requirement R3 more than 30 calendar days but less than or equal to 40 calendar days of any change to those trip settings or limitations.</p> <p>OR</p> <p>The Generator Owner provided trip settings or equipment limitations more than 30 calendar days but less than or equal to 40 calendar days of a</p>	<p>The Generator Owner provide its generator protection trip settings as specified by Requirements R1 and R2, and documented equipment limitations as specified by Requirement R3 more than 40 calendar days but less than or equal to 50 calendar days of any change to those trip settings or limitations.</p> <p>OR</p> <p>The Generator Owner provided trip settings or equipment limitations more than 40 calendar days but less than or equal to 50 calendar days of a</p>	<p>The Generator Owner provide its generator protection trip settings as specified by Requirements R1 and R2, and documented equipment limitations as specified by Requirement R3 more than 50 calendar days but less than or equal to 60 calendar days of any change to those trip settings or limitations.</p> <p>OR</p> <p>The Generator Owner provided trip settings or equipment limitations more than 50 calendar days but less than or equal to 60 calendar days of a</p>	<p>The Generator Owner failed to provide its generator protection trip settings as specified by Requirements R1 and R2, and documented equipment limitations as specified by Requirement R3 within 61 calendar days of any change to those trip settings or limitations.</p> <p>OR</p> <p>The Generator Owner failed to provide trip settings or equipment limitations within 61 calendar days of a written request for the data.</p>

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R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
	written request.	written request.	written request.	

E. Regional Variances

None

F. Associated Documents

None

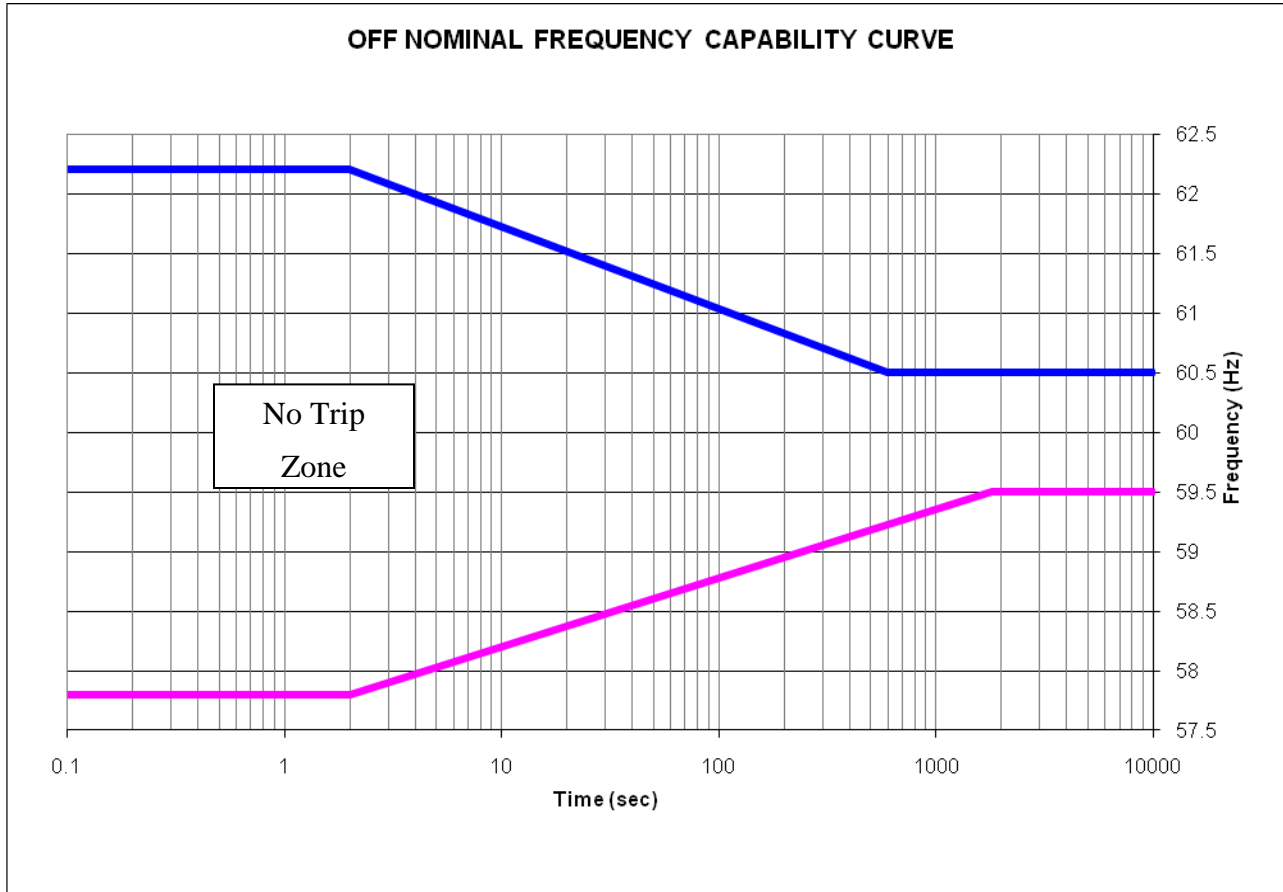
Version History

Version	Date	Action	Change Tracking

G. References

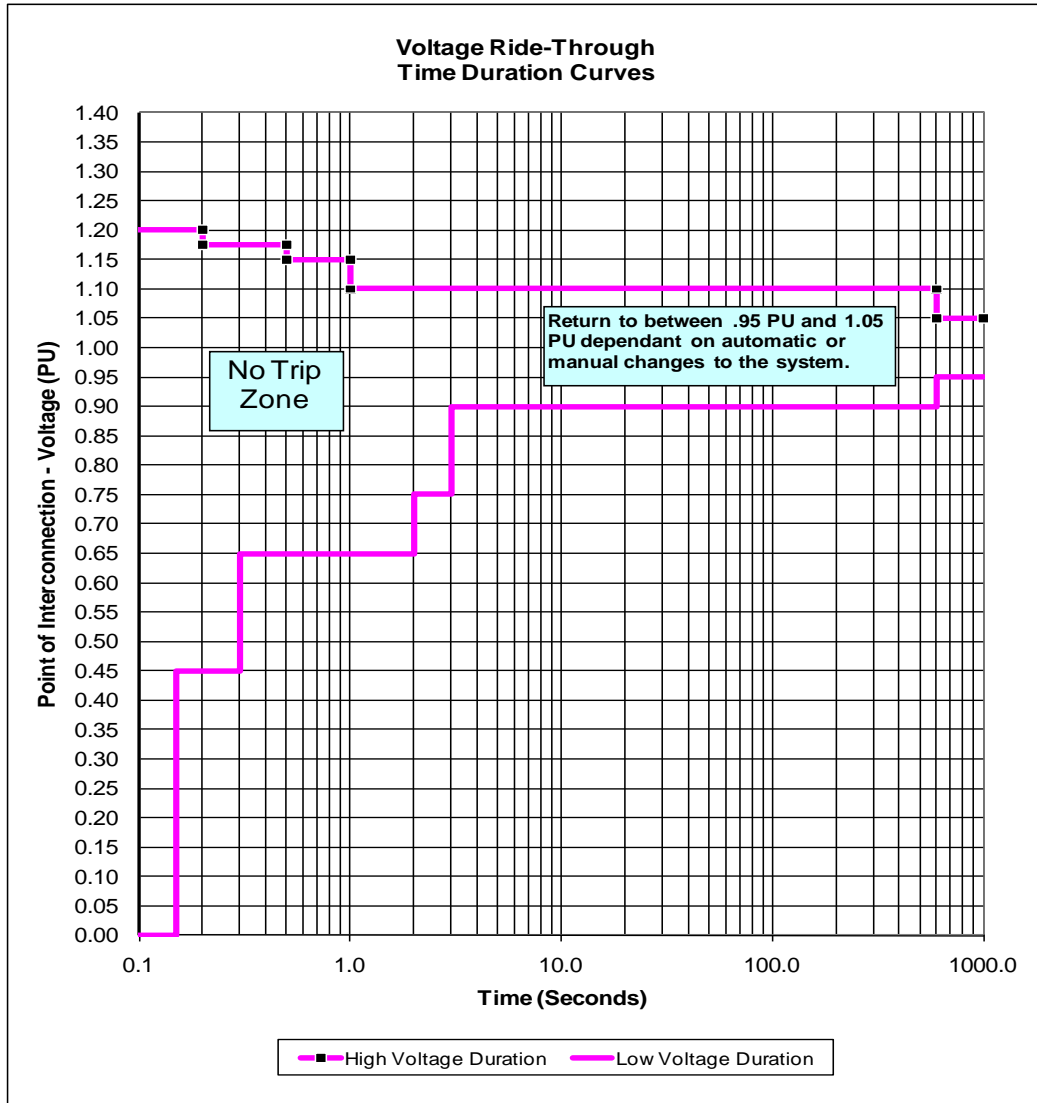
1. “The Technical Justification for the New WECC Voltage Ride-Through (VRT) Standard, A White Paper Developed by the Wind Generation Task Force (WGTF),” dated June 13, 2007, a guideline approved by WECC Technical Studies Subcommittee.

PRC-024 — Attachment 1



Frequency (hertz)	57.8	59.5	62.2	60.5
Time (seconds)	0 to 2	Over 1800	0 to 2	Over 600

PRC-024— Attachment 2



Curve Data Points:

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HVRT DURATION	
Time (Sec)	Voltage (p.u.)
0.20	1.200
0.50	1.175
1.00	1.150
600	1.100

LVRT DURATION	
Time (Sec)	Voltage (p.u.)
0.15	0.000
0.30	0.450
2.00	0.650
3.00	0.750
600	0.900

Voltage Ride-Through Curve Clarifications

1. The per unit voltage base for these curves is the scheduled operating voltage as measured at the point of interconnection to the Bulk Electric System (BES).
2. The curves depicted apply to a three-phase transmission system zone 1 fault with Normal Clearing.
3. When the cumulative voltage duration at the point of interconnection with the BES is within the voltage boundaries of these curves, the generator voltage protective relaying will not trip the generator.
4. The curves depicted assume system frequency is 60 Hertz.
5. Use the following assumptions if basing voltage protection relay setting calculations on the static case for steady state initial conditions:
 - a. All of the units connected to the same transformer are online and operating,
 - b. All of the units are at full nameplate real-power output.
 - c. Power factor is 0.95 lagging.
 - d. Scheduled voltage is measured at the point of interconnection.
6. Calculate voltage protection relay settings to comply with these curves assuming that any additional installed generating plant reactive support equipment (such as static VAR compensators, synchronous condensers, or capacitors) is available and operating normally.
7. Calculate voltage protection relay settings to comply with these curves, accounting for the actual tap settings of transformers between the generator terminals and the point of interconnection.