NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Field Tested Version of PRC-024 Mapped to Proposed PRC-024-1, Generator Frequency and Voltage Protective Relay Settings

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
2. Number: PRC-024-0	Proposed standard will only cover PRC-024-0 content and will not be merged with any other standard	**2. Number:** PRC-024-1
1. Title: Generator Performance During Frequency and Voltage Excursions	Protective System has been added to reflect the scope of the related requirements in the proposed Standard	**1. Title:** Generator Frequency and Voltage Protective Relay Settings
3. Purpose: To ensure that generators remain connected to the electrical grid during voltage and frequency excursions and are not normally tripped manually or by preset protection schemes during frequency and voltage excursions.	The Purpose has been modified to specifically focus on the coordination of protection schemes.	**3. Purpose:** Ensure that generator frequency and voltage protective relays[1] are set to support transmission system stability during voltage and frequency excursions. [1] Includes voltage and frequency protective functions for discrete relays, multi-function protective devices, voltage regulators, etc.
4. Applicability: **4.1.** Regional Reliability Organizations. **4.2.** Generation Owners. **4.3.** Transmission Owners	Regional Reliability Organization and Transmission Owner applicability is eliminated. The Standard further specifies which facilities must comply.	**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, **4.2.2** Each unit (with installed voltage or frequency protective relays) at generating plants/facilities consisting of

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
		multiple units with total generation > 75 MVA (gross aggregate nameplate rating) at the point of interconnection to the Bulk Electric System
R1. The Regional Reliability Organization shall establish requirements for generators to remain connected during system frequency and voltage excursions expressed as a function of:	Regional applicability is eliminated and direct entity responsibility is defined	Requirements R1, & R2 define the verification and data reporting previously addressed by regional procedures. These requirements are detailed in the following mapping.
R1.1. Time duration in seconds or cycles **R1.2.** Amplitude or magnitude of the excursion **R1.3.** Relationship between time and amplitude or magnitude	The details of the frequency excursions are defined in **R1.1, R1.2, R1.3, R1.4,** and **Attachment 1-PRC-024-1**. The details of the voltage excursions are defined in **R2.1, R2.2, R2.2.1, R2.2.2, R2.2.3, R2.2.4,** and **Attachment 2-PRC-024-1**.	**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. **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: (Violation Risk Factors: High - Units ≥500 MVA; Medium - Units >100 MVA and <500 MVA; Lower - Units ≤100 MVA)

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
		(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 Scheme (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.
R2. The Regional Reliability Organization shall establish and maintain requirements for generators to remain connected during frequency and voltage excursions. These requirements shall include:	Regional applicability is eliminated and direct entity responsibility is defined. Requirements **R1.2, R1.3,** and **R1.4** define the requirements for generator off-nominal frequency protective relay settings so that generating units remain connected during frequency excursions. Requirements **R2.2, R2.21, R2.2.2, R2.2.3** and **R2.2.4** define the requirements for	**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. **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.

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
	generator under and over voltage protective relay settings so that generating units remain connected during voltage excursions.	**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 Scheme (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.
R2.1. Coordination between the generator under frequency protection and the regional Under Frequency Load Shedding (UFLS) program.	During the drafting of this Standard, the Generator Verification Standard Drafting Team (GV SDT) maintained contact with the Under Frequency Load Shedding Standard Drafting Team (UFLS SDT) to ensure that the requirements of this Standard coordinated with the requirements being developed by the UFLS SDT. Requirements **R1, R1.1, R1.2, R1.3, R1.4, and Attachment 1-PRC-024-1** coordinate with the UFLS SDT effort.	**R1**. Each Generator Owner shall set 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.
R2.2. Coordination of generator protection, including back-up protection, with transmission Protection Systems.	The GV SDT created requirements for generator over and under voltage protective relay settings based on a voltage excursion defined by FERC Order 693 and low voltage excursion studies performed in WECC and SERC. Requirements **R2, R2.1, R2.2,**	**R2.** Each Generator Owner shall set 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: (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

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
	R2.2.1, R2.2.2, R2.2.3, R2.2.4, and Attachment 2-PRC-024-2 define these requirements. The GV SDT feels that coordination between the generator protection system and transmission protection system beyond that defined in this Standard is covered under **PRC-001 R3.**	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 Scheme (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.
	New	**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)*
R3. The Regional Reliability Organization shall establish and maintain criteria for exemptions to any of the regional requirements established in accordance with R1 and R2.	Regional Reliability Organization applicability is eliminated and direct entity responsibility is defined	**R5**. If an existing generator unit[2] cannot meet either Requirement R1 or Requirement R2 due to equipment limitations, such as manufacturer warranty requirements or limitations that endangers 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

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
	R5 defines the criteria for exceptions from the frequency and voltage requirements and the process to use for reporting this to the Reliability Coordinators, Planning Coordinators, Transmission Operators, and Transmission Planners. **R6** defines the process for the Generator Owner to respond to comments on the notification of exception.	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)* 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 nameplate capacity rating greater than 10%. [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. **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)*
R4. The Regional Reliability Organization shall establish and maintain a procedure for handling variances (i.e., different criteria or methods) from the Regional Reliability Organization's requirements established in R1 and R2, including steps for requesting and approving such variances.	Regional Reliability Organization applicability is eliminated and direct entity responsibility is defined. For the low voltage portion of the **Attachment 2-PRC-024-1**, **R2.2.2** allows the Transmission	**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.

Field Tested Version of PRC-024	Comment	Proposed PRC-024-1
	Planner to modify the shape of the curve based on location-specific breaker clearing time and voltage recovery characteristics.	
R5. The Regional Reliability Organization shall provide documentation of its excursion requirements, exemptions, and variance procedure to the Transmission Owners and Generator Owners within its Region within 30 calendar days of approval.	Regional Reliability Organization applicability is eliminated. Since the excursion requirements, exemptions and variance procedures are defined in the Standard, there are no requirements for communication to applicable entities.	This is not addressed by any requirement of the proposed Standard because it is no longer applicable.
R6. The Regional Reliability Organization shall, at least every five years, review and, as necessary, update its requirements, exemption criteria, and variance procedure.	Regional Reliability Organization applicability is eliminated. Since the excursion requirements, exemptions and variance procedures are defined in the Standard, the method for making modifications involves implementing the NERC SAR process.	This is not addressed by any requirement of the proposed Standard because it is no longer applicable.
R7. Generator Owners and Transmission Owners shall comply with the regional requirements for coordination of generator protection defined in R2 and any approved variances	Transmission Owner applicability is eliminated. The requirement for a Generator Owner to comply with the requirements in this Standard is implicit in being an applicable entity.	This is addressed by the Applicability section of the proposed Standard.