

## A. Introduction

1. **Title:** Disturbance Monitoring and Reporting Requirements for Inverter-Based Resources
2. **Number:** PRC-028-1
3. **Purpose:** To have adequate data available from Inverter-Based Resources to evaluate Inverter-Based Resource ride-through performance during System Disturbances and to provide data for Inverter-Based Resource model validation.
4. **Applicability:**
  - 4.1. **Functional Entities:**
    - 4.1.1. Generator Owner
  - 4.2. **Facilities:**
    - 4.2.1 BES Inverter-Based Resources
    - 4.2.2 Non-BES Inverter-Based Resources that either have or contribute to an aggregate nameplate capacity of greater than or equal to 20 MVA, connected through a system designed primarily for delivering such capacity to a common point of connection at a voltage greater than or equal to 60 kV
5. **Effective Date:** See Implementation Plan

## B. Requirements and Measures

- R1. Each Generator Owner shall have sequence of event recording (SER) data for the following Elements that it owns: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
  - 1.1. Circuit breaker position (open/close) for circuit breakers associated with the main power transformer(s)<sup>1</sup>, collector bus(es), shunt static and dynamic reactive device(s), and AC-DC and DC-AC converters, if any, in case of VSC HVDC system with a dedicated connection to Inverter-Based Resource.
  - 1.2. For IBR units<sup>2</sup> in commercial operation<sup>3</sup> after the effective date of this standard, the following data shall be recorded when triggered by ride-through operation or tripping of an IBR unit.

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<sup>1</sup> For the purpose of this standard, the main power transformer is the power transformer that steps up voltage from the collection system voltage to the nominal transmission/interconnecting system voltage for Inverter-Based Resources. In case of dedicated VSC HVDC system connecting to an Inverter-Based Resource, a transformer isolating the DC-AC converter from the transmission system is also considered a main power transformer.

<sup>2</sup> IBR unit includes the inverter, converter, wind turbine generator, or high voltage direct current converter connecting generating resource to alternating current Transmission network.

<sup>3</sup> Commercial operation means achievement of this designation indicating that the facility has received all approvals necessary for operation after completion of initial start-up testing.

- 1.2.1. All fault codes.
  - 1.2.2. All fault alarms.
  - 1.2.3. High and low voltage ride-through mode status.
  - 1.2.4. High and low frequency ride-through mode status.
- 1.3. For IBR units in commercial operation before the effective date of this standard, if capable, the following data shall be recorded when triggered by ride-through operation or tripping of an IBR unit.
  - 1.3.1. All fault codes.
  - 1.3.2. All fault alarms.
  - 1.3.3. High and low voltage ride-through mode status.
  - 1.3.4. High and low frequency ride-through mode status.
- M1. The Generator Owner has evidence (electronic or hard copy) of data, as applicable, as specified in Requirement R1. Evidence may include, but is not limited to: (1) actual data recordings; or (2) documents describing the device interconnections and configurations which may include a single design standard as representative for common installations; or (3) station or equipment drawings. The evidence to show IBR unit capability to record fault codes, alarms, or ride-through mode status may include, but is not limited to: (1) equipment specification, (2) letter from equipment manufacturer, or (3) documents describing lack of recording capability.
- R2. Each Generator Owner shall have triggered fault recording (FR) data to determine the following electrical quantities for Elements that it owns: *[Violation Risk Factor: Lower]*  
*[Time Horizon: Long-term Planning]*
  - 2.1. High-side of the main power transformer FR data:
    - 2.1.1. Phase-to-neutral voltage for each phase.
    - 2.1.2. Each phase current and the residual or neutral current.
    - 2.1.3. Real and Reactive Power expressed on a three-phase basis.
  - 2.2. Collector feeder breaker FR data:
    - 2.2.1. Phase-to-neutral voltage for each phase.
    - 2.2.2. Each phase current and the residual or neutral current.
    - 2.2.3. Real and Reactive Power expressed on a three-phase basis.
  - 2.3. Shunt dynamic reactive device FR data:
    - 2.3.1. Phase-to-neutral voltage for each phase.
    - 2.3.2. Each phase current and the residual or neutral current.
    - 2.3.3. Reactive Power output expressed on a three-phase basis.

- M2.** The Generator Owner has evidence (electronic or hard copy) of FR data that is sufficient to determine electrical quantities as specified in Requirement R2. Evidence may include, but is not limited to: (1) actual data recordings or derivations; or (2) documents describing the device specifications and configurations which may include a single design standard as representative for common installations; or (3) station or equipment drawings.
- R3.** Each Generator Owner shall have FR data as specified in Requirement R2 that meets the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 3.1.** High-side of the main power transformer FR data:
- 3.1.1.** A single record or multiple records that include a pre-trigger record length of at least two cycles and a total record length of at least 2.0 seconds for the same trigger point.
  - 3.1.2.** A minimum recording rate of 64 samples per cycle.
  - 3.1.3.** Trigger settings for at least the following:
    - 3.1.3.1.** Neutral (residual) overcurrent.
    - 3.1.3.2.** AC phase overvoltage and undervoltage.
    - 3.1.3.3.** Overfrequency and underfrequency
- 3.2.** Collector feeder breaker FR data:
- 3.2.1.** A single record or multiple records that include a pre-trigger record length of at least two cycles and a total record length of at least 2.0 seconds for the same trigger point.
  - 3.2.2.** A minimum recording rate of 64 samples per cycle.
  - 3.2.3.** Trigger settings for at least the following:
    - 3.2.3.1.** Neutral (residual) overcurrent, if applicable.
    - 3.2.3.2.** AC phase overvoltage and undervoltage.
    - 3.2.3.3.** Overfrequency and underfrequency.
- 3.3.** Shunt dynamic reactive device FR data:
- 3.3.1.** A single record or multiple records that include a pre-trigger record length of at least two cycles and a total record length of at least 2.0 seconds for the same trigger point.
  - 3.3.2.** A minimum recording rate of 64 samples per cycle.
  - 3.3.3.** Trigger settings for at least the following:
    - 3.3.3.1.** Neutral (residual) overcurrent.
    - 3.3.3.2.** AC phase overvoltage and undervoltage.

- M3.** The Generator Owner has evidence (electronic or hard copy) that FR data meets Requirement R3. Evidence may include, but is not limited to: (1) actual data recordings or derivations, or (2) documents describing the device specification and device configuration or settings.
- R4.** Each Generator Owner shall have continuous dynamic disturbance recording (DDR) data and storage to determine the following electrical quantities for each main power transformer(s) it owns: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 4.1.** One phase-to-neutral or positive sequence voltage on high-side of the main power transformer(s).
  - 4.2.** The phase current for the same phase at the same voltage corresponding to the voltage in Requirement R4, Part 4.1, or the positive sequence current.
  - 4.3.** Real Power and Reactive Power flows expressed on a three-phase basis corresponding to each main power transformer(s) where current measurements are required.
  - 4.4.** Frequency of any one of the voltage(s) in Requirement R4, Part 4.1.
- M4.** The Generator Owner has evidence (electronic or hard copy) of continuous DDR data recording and storage to determine electrical quantities as specified in Requirement R4. Evidence may include, but is not limited to: (1) actual data recordings or derivations; or (2) documents describing the device specifications and configurations, which may include a single design standard as representative for common installations; or (3) station drawings.
- R5.** Each Generator Owner responsible for DDR data for the electrical quantities identified in Requirement R4 shall have DDR data that meet the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 5.1.** Input sampling rate of at least 960 samples per second.
  - 5.2.** Output recording rate of electrical quantities of at least 60 times per second.
- M5.** The Generator Owner has evidence (electronic or hard copy) that DDR data meets Requirement R5. Evidence may include, but is not limited to: (1) documents describing the device specification, device configuration, or settings (R5, Part 5.1; R5, Part 5.2); or (2) actual data recordings (R5, Part 5.2).
- R6.** Each Generator Owner shall time synchronize all SER, FR, and DDR data to meet the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 6.1.** Synchronization to Coordinated Universal Time (UTC) with or without a local time offset.
  - 6.2.** The IBR unit synchronized device clock accuracy within  $\pm 100$  milliseconds of UTC. For all other devices, synchronized device clock accuracy within  $\pm 1$  milliseconds of UTC.

- M6.** The Generator Owner has evidence (electronic or hard copy) of time synchronization described in Requirement R6. Evidence may include, but is not limited to: (1) documents describing the device specification, configuration, or setting; (2) time synchronization indication or status; or (3) station drawings.
- R7.** Each Generator Owner shall provide all requested SER, FR, and DDR data to its Transmission Planner, Planning Coordinator, Transmission Operator, Balancing Authority, Reliability Coordinator, Regional Entity, or NERC in accordance with the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- 7.1.** Data shall be retrievable for the period of 20 calendar days, inclusive of the day the data was recorded.
- 7.2.** Data subject to Part 7.1 shall be provided within 15 calendar days of a request unless an extension is granted by the requestor.
- 7.3.** SER data shall be provided in ASCII<sup>4</sup> Comma Separated Value (CSV) format following Attachment 1.
- 7.4.** FR data shall be provided either in CSV format with appropriate headers or in electronic files that are formatted in conformance with C37.111, IEEE Standard Common Format for Transient Data Exchange (COMTRADE), revision C37.111-1999 or later.
- 7.5.** DDR data shall be provided either in CSV format with appropriate headers or in electronic files that are formatted in conformance with C37.111, IEEE Standard Common Format for Transient Data Exchange (COMTRADE), revision C37.111-1999 or later.
- 7.6.** Data files shall be named in conformance with C37.232, IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME), revision C37.232-2011 or later.
- M7.** The Generator Owner has evidence (electronic or hard copy) that data was submitted upon request in accordance with Requirement R7. Evidence may include, but is not limited to: (1) actual data recordings; (2) dated transmittals to the requesting entity with formatted records; or (3) documents describing data storage capability, device specification, configuration, or settings.
- R8.** Each Generator Owner shall, upon the discovery of a failure of the recording capability for the SER, FR, or DDR data: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- Restore the recording capability within 90 calendar days, or
  - Submit a Corrective Action Plan (CAP) to the Regional Entity within 90 calendar days and then implement it according to CAP timeline.

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<sup>4</sup> American Standard Code for Information Interchange

- M8.** The Generator Owner has dated evidence (electronic or hard copy) that meets Requirement R8. Evidence may include, but is not limited to: (1) dated reports of the discovery of a failure, (2) documentation noting the date the data recording was restored, (3) SCADA records, or (4) dated Corrective Action Plan transmittals to the Regional Entity and evidence of Corrective Action Plan implementation.

## C. Compliance

### 1. Compliance Monitoring Process

**1.1. Compliance Enforcement Authority:** “Compliance Enforcement Authority” means NERC or the Regional Entity, or any entity as otherwise designated by an Applicable Governmental Authority, in their respective roles of monitoring and/or enforcing compliance with mandatory and enforceable Reliability Standards in their respective jurisdictions.

**1.2. Evidence Retention:**

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

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 evidence, as per Requirements R1 through R8, for three calendar years.

If a Generator Owner is found non-compliant, it shall keep information related to the non-compliance until mitigation is completed and approved or for the time 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 Enforcement Program:** As defined in the NERC Rules of Procedure, “Compliance Monitoring and Enforcement Program” refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with associated Reliability Standard.

## Violation Severity Levels

R #	Violation Severity Levels			
	Lower VSL	Moderate VSL	High VSL	Severe VSL
<b>R1</b>	Each Generator Owner as directed by Requirement R1 to have the required SER data had more than 80 percent, but less than 100 percent of the circuit breaker(s) identified in Requirement R1.	Each Generator Owner as directed by Requirement R1 to have the required SER data had more than 70 percent, but less than or equal to 80 percent of the circuit breaker(s) identified in Requirement R1.	Each Generator Owner as directed by Requirement R1 to have the required SER data had more than 60 percent, but less than or equal to 70 percent of the circuit breaker(s) identified in Requirement R1.	Each Generator Owner as directed by Requirement R1 to have the required SER data had less than or equal to 60 percent of the circuit breaker(s) identified in Requirement R1.
<b>R2</b>	The Generator Owner had FR data as directed by Requirement R2, Parts 2.1, 2.2, and 2.3 that covers more than 80 percent, but less than 100 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had FR data as directed by Requirement R2, Parts 2.1, 2.2, and 2.3 that covers more than 70 percent, but less than or equal to 80 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had FR data as directed by Requirement R2, Parts 2.1, 2.2, and 2.3 that covers more than 60 percent, but less than or equal to 70 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had FR data as directed by Requirement R2, Parts 2.1, 2.2, and 2.3 that covers less than or equal to 60 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.
<b>R3</b>	The Generator Owner had FR data that meets more	The Generator Owner had FR data that meets more	The Generator Owner had FR data that meets more	The Generator Owner had FR data that meets less

	than 80 percent, but less than 100 percent of the total recording parameters as specified in Requirement R3.	than 70 percent, but less than or equal to 80 percent of the total recording parameters as specified in Requirement R3.	than 60 percent, but less than or equal to 70 percent of the total recording parameters as specified in Requirement R3.	than or equal to 60 percent of the total recording parameters as specified in Requirement R3.
<b>R4</b>	The Generator Owner had DDR data as directed by Requirement R4, Parts 4.1 through 4.4 that covered more than 80 percent, but less than 100 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had DDR data as directed by Requirement R4, Parts 4.1 through 4.4 for more than 70 percent, but less than or equal to 80 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had DDR data as directed by Requirement R4, Parts 4.1 through 4.4 for more than 60 percent, but less than or equal to 70 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.	The Generator Owner had DDR data as directed by Requirement R4, Parts 4.1 through 4.4 for less than or equal to 60 percent of the total required electrical quantities, which is the product of the total number of monitored Elements and the number of specified electrical quantities for each Element.
<b>R5</b>	The Generator Owner had DDR data that meets more than 80 percent, but less than 100 percent of the total recording parameters as specified in Requirement R5.	The Generator Owner had DDR data that meets more than 70 percent, but less than or equal to 80 percent of the total recording properties as specified in Requirement R5.	The Generator Owner had DDR data that meets more than 60 percent, but less than or equal to 70 percent of the total recording properties as specified in Requirement R5.	The Generator Owner had DDR data that meets less than or equal to 60 percent of the total recording properties as specified in Requirement R5.



<b>R6</b>	The Generator Owner had time synchronized SER, FR, or DDR data per Requirement R6, Parts 6.1 and 6.2 for more than 90 percent, but less than 100 percent of the Elements.	The Generator Owner had time synchronized SER, FR, or DDR data per Requirement R6, Parts 6.1 and 6.2 for more than 80 percent, but less than or equal to 90 percent of the Elements.	The Generator Owner had time synchronized SER, FR, or DDR data per Requirement R6, Parts 6.1 and 6.2 for more than 70 percent, but less than or equal to 80 percent of the Elements.	The Generator Owner failed to have time synchronized SER, FR, or DDR data per Requirement R6, Parts 6.1 and 6.2 for less than or equal to 70 percent of the Elements.
<b>R7</b>	<p>The Generator Owner as directed by Requirement R7 provided more than 90 percent, but less than 100 percent of the requested data.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Part 7.2 provided the requested data one to 10 calendar days late.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Parts 7.3 through 7.6 provided more than 90 percent of the data, but less than 100 percent of</p>	<p>The Generator Owner as directed by Requirement R7 provided more than 80 percent, but less than or equal to 90 percent of the requested data.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Part 7.2 provided the requested data 11 to 20 calendar days late.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Parts 7.3 through 7.6 provided more than 80 percent of the data, but less than or equal to 90 percent</p>	<p>The Generator Owner as directed by Requirement R7 provided more than 70 percent, but less than or equal to 80 percent of the requested data.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Part 7.2 provided the requested data 21 to 30 calendar days late.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Parts 7.3 through 7.6 provided more than 70 percent of the data, but less than or equal to 80</p>	<p>The Generator Owner as directed by Requirement R7 failed to provide less than or equal to 70 percent of the requested data.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Part 7.2 provided the requested data more than 30 calendar days late.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R7, Parts 7.3 through 7.6 provided less than or equal to 70 percent of the data in the proper data format.</p>

	the data in the proper data format.	of the data in the proper data format.	percent of the data in the proper data format.	
<b>R8</b>	The Generator Owner as directed by Requirement R8 was unable to restore recording capability within 90 calendar days and provided a Corrective Action Plan to the Regional Entity more than 90 calendar days, but less than or equal to 100 calendar days after discovery of the failure.	The Generator Owner as directed by Requirement R8 was unable to restore recording capability within 90 calendar days and provided a Corrective Action Plan to the Regional Entity more than 100 calendar days, but less than or equal to 110 calendar days after discovery of the failure.	<p>The Generator Owner as directed by Requirement R8 was unable to restore recording capability within 90 calendar days and provided a Corrective Action Plan to the Regional Entity more than 110 calendar days, but less than or equal to 120 calendar days after discovery of the failure.</p> <p>OR</p> <p>The Generator Owner as directed by Requirement R8 submitted a Corrective Action Plan to the Regional Entity but failed to implement it.</p>	<p>The Generator Owner as directed by Requirement R8 was unable to restore recording capability within 90 calendar days and provided a Corrective Action Plan to the Regional Entity more than 120 calendar days after discovery of the failure.</p> <p>OR</p> <p>Generator Owner as directed by Requirement R8 failed to restore the recording capability within 90 calendar days and failed to submit a Corrective Action Plan to the Regional Entity.</p>

## **D. Regional Variances**

None.

## **E. Interpretations**

None.

## **F. Associated Documents**

NERC Reliability Standard PRC-028-1: Implementation Plan.

NERC Reliability Standard PRC-028-1: Technical Rationale.

## **G. References**

IEEE C37.111: Common format for transient data exchange (COMTRADE) for power Systems.

IEEE C37.232-2011: IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME). Standard published 11/09/2011 by IEEE.

IEEE Std 2800-2022: IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems.

Multiple Solar PV Disturbances in CAISO, Joint NERC and WECC Staff Report, April 2022.

NERC Reliability Standard PRC-002-5.

Odessa Disturbance, Texas Events: May 9, 2021 and June 26, 2021, Joint NERC and Texas RE Event Report, September 2021.

Odessa Disturbance, Texas Event: June 4, 2022, Joint NERC and Texas RE Event Report, December 2022.

## Version History

Version	Date	Action	Change Tracking
1	October 8, 2024	Adopted by NERC Board of Trustees	

## **Attachment 1**

### **Sequence of Events Recording (SER) Data Format (Requirement R7, Part 7.3)**

Date, Time, Local Time Code, Plant Name, Device<sup>5</sup>, State<sup>6</sup>

08/27/23, 23:58:57.110, -5, Plant name 1, Breaker 1, Close

08/27/23, 23:58:57.082, -5, Plant name 2, Breaker 2, Close

08/27/23, 23:58:57.217, -5, Plant name 1, IBR unit 1, undervoltage ride-through mode

08/27/23, 23:58:57.214, -5, Plant name 2, IBR unit 2, dc overcurrent trip

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<sup>5</sup> Device name may include specific names of breakers or IBR units as appropriate.

<sup>6</sup> Breaker status and any other terminology such as TRIP, TRIP TO LOCKOUT, RECLOSE, etc. is acceptable. For IBR unit level data, fault codes, alarms, change in operating mode etc., are also acceptable.