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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

# Joint Industry Webinar

NERC Standards Development
FERC Order No. 901 - Milestone 2 projects

2020-06, 2021-04, 2020-02, 2023-02
(ordered as presented)

March 28, 2024

**RELIABILITY | RESILIENCE | SECURITY**




# Administrative

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  - It is NERC's policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition
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# Webinar Agenda

- Welcome
  - Thank you to each drafting team coordinating and adjusting
  - Highlight approach to joint webinar and staggered ballots
- FERC Order No. 901 Summary Updates
  - Milestone 2 includes – Assuring Performance Requirements
  - Milestone 3 and 4 information to be shared over the year
- IBR Registration Criteria
  - Recent NERC filing with FERC in response to Order
  - Expands registration criteria and applies to current functional registrations

# Webinar Agenda

- Defining Inverter-based resource (IBR and IBR Unit)
  - Project 2020-06 proposed definitions
- Review each Milestone 2 Project
  - Introduce and thank Drafting Team members
  - High-level draft information
  - How each project fits together to address FERC Order No. 901 directives
  - Implementation Plans staggered throughout 2030, for **all** 901 milestones
  - Status of drafts/ballots/comments
  - Short Q&A following each project update

# Order 901 Summary

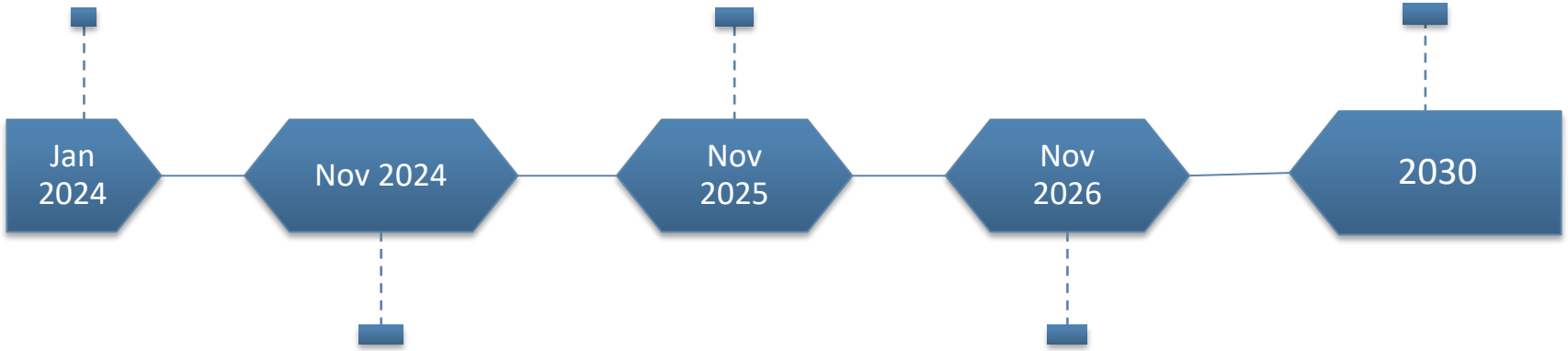
- FERC Order 901
  - Issued October 2023
  - Includes 4 Milestones dates through November 2026
  - Addresses a wide spectrum of IBR related performance issues and Reliability Standards
  - Brings forward RSTC guidance and expertise into standards projects

# General Milestone Summary

**Milestone 1**: Submit Information Work Plan

**Milestone 3**: Modeling Data Sharing and Validation based on Performance

Implementation of all 901 Directives




**Milestone 2**: IBR Performance based on disturbance monitoring data requirements and post-event analytics

**Milestone 4**: New Requirements for Operational and Planning Studies to Leverage Performance Data

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# Project 2020-06

## Verifications of Models and Data for Generators
## IBR Definitions
## March 28, 2024

Chris Larson (NERC Standards Developer)

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# Project 2020-06 Drafting Team (DT) Members

| Name | Company |
|---|---|
| Brad Marszalkowski (chair)* | ISO-New England |
| Katie Iversen (vice-chair)* | S Power (AES Corporation) |
| Andrew Arana | Florida Power & Light |
| Jonathan Rose | ERCOT |
| William Casey Harman | Puget Sound Energy |
| Ebrahim Rahimi | California ISO |
| Jason MacDowell* | GE Energy Consulting |
| Sam Li | BC Hydro |
| Wes Baker* | Southern Company |
| Michael (Bing) Xia | Powertech Labs |
| Jerry L Thompson | Kestrel Power Engineering |
| Robert J. O'Keefe* | American Electric Power |

# Project 2020-06 NERC Glossary of Terms

Reliability Standard(s) include both:

- Applicability
  - Functional Entity(s)
  - Facilities
- Requirement(s)

- Definitions found in the Glossary of Terms are available for use in Standards.
- This project and discussion are focused on defining the terms IBR and IBR Unit to be used in multiple standards.

# Project 2020-06 IBR Definitions (Draft 2)

- **Inverter-Based Resource (IBR):** A plant/facility that is connected to the electric system, consisting of one or more IBR Unit(s) operated as a single resource at a common point of interconnection. IBRs include, but are not limited to, solar photovoltaic (PV), Type 3 and Type 4 wind, battery energy storage system (BESS), and fuel cell.

- **Inverter-Based Resource Unit (IBR Unit):** An individual device that uses a power electronic interface, such as an inverter or converter, capable of exporting Real Power from a primary energy source or energy storage system, and that connects at a single point on the collector system; or a grouping of multiple devices that uses a power electronic interface(s), such as an inverter or converter, capable of exporting Real Power from a primary energy source or energy storage system, and that connect together at a single point on the collector system

# Project 2020-06 Examples of IBRs

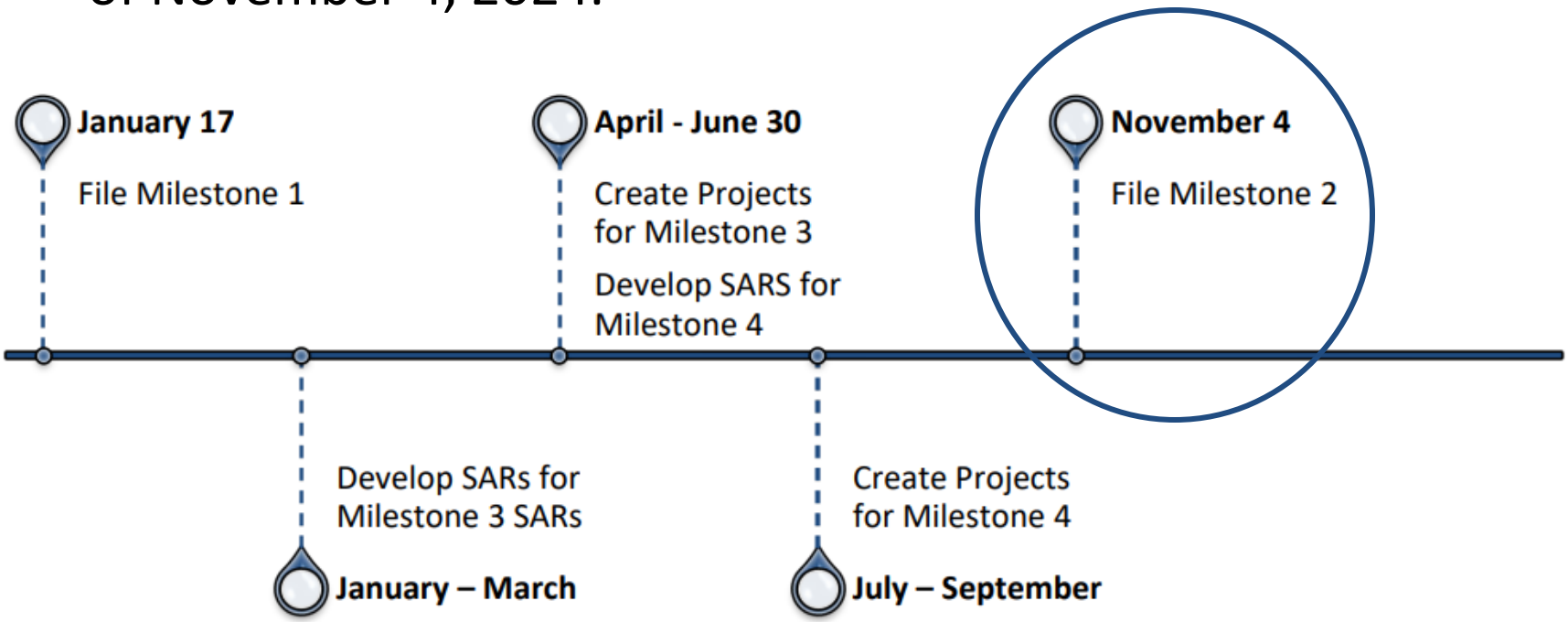
Examples of IBRs include:

| IBRs | Not an IBR |
|---|---|
| • Solar photovoltaic<br>• Type 3 wind<br>• Type 4 wind<br>• Battery energy storage system (BESS)<br>• Fuel cell(s)<br>• Hybrid combination of IBRs<br>• Portions of co-located facility that are IBR<br>• VSC HVDC with dedicated connection to IBR<br>• This is not an all-inclusive list. | • Stand-alone FACTS device (e.g., STATCOM or SVC)<br>• Flywheels<br>• Synchronous generator<br>• Synchronous condenser<br>• VSC HVDC<br>• LCC HVDC<br>• This is not an all-inclusive list. |

**Table 1: Inverter-Based Resource (IBR) examples**

# Project 2020-06 Relation to FERC Order No. 901

The IBR-related definitions are used in three (3) active projects associated with Milestone 2 of NERC's Work Plan to address FERC Order No. 901, which has a filing deadline of November 4, 2024.



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# Project 2021-04

Modifications to PRC-002-2
PRC-002-5 and PRC-028-1
March 28, 2024

Manish Patel (Southern Company Services)
Chris Milan (CrestCura)
Ben Wu (NERC Standards Developer)

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# Project 2021-04 Standard Drafting Team (SDT)

| Name | Organization/ Company |
|---|---|
| Manish Patel (Chair) | Southern Company Services |
| Chris Milan (Vice Chair) | CrestCura |
| Bret Garner Burford | American Electric Power |
| Tracy Kealy | Bonneville Power Administration |
| Jacob Magee | Transmission Asset Management |
| Don Burkart | Consolidated Edition of New York |
| Amy Key | MidAmerican Energy Company |
| Terry Volkmann | Volkmann Consulting |

# Project 2021-04 Project Status

- The SDT completed the first phase of work to address the Glencoe Light SAR in the Winter of 2022 with the development of Reliability Standard PRC-002-4.
- The SDT submitted a revised SAR to create a new Standard (PRC-028-1) for monitoring requirements for IBRs and the SC authorized drafting revisions of the SAR on April 19, 2023.
- At the SC's July 19, 2023 meeting, the SC authorized initial posting for the IRPTF SAR.
- The initial draft of phase II was posted from August 1 through September 14, 2023 with 61.44% approval for PRC-002-5 and 43.33% approval of PRC-028-1 from the industry.
- The second posting is currently posted from March 18 through April 11, 2024 with a waiver.

# Project 2021-04 Background

- Industry Need
  - Have adequate data available to facilitate the analysis of BES disturbances
- Purpose/Goal
  - Ensure adequate data is available and periodically assessed to facilitate the analysis of BES disturbances, including in areas of the Bulk Power System (BPS) that may not be covered by the existing requirements
- Project Scope
  - Consider ways to ensure that the identification and periodic assessment of BES and/or BPS buses for which SER and FR data / Elements for which DDR data is required provide adequate monitoring of BES Disturbances
  - Consider other manners in which to add to, modify or clarify the existing requirements to ensure adequate monitoring of BES disturbances
  - Consider proposed IEEE P2800 monitoring requirements and NERC Odessa Disturbance Report recommendations

# Project 2021-04 Industry Comments with Initial Ballot

- Industry agrees with the need of creating a new Standard PRC-028 to address disturbance monitoring requirements for IBRs.
  - Thank you.
- PRC-028 should not apply to Inverter-Based Portion of Facility meeting Inclusion I2, Part (b) criterion of the BES definition
  - SDT agrees, Facilities section is revised.
- PRC-002 includes criteria to identify BES Elements where DME is installed. PRC-028 should include criteria as well.
  - Purpose of PRC-002 is to have adequate data to facilitate analysis of BES Disturbances.
  - Purpose of PRC-028 is to have adequate data to facilitate analysis of IBR performance during BES Disturbances. Data to be used for model validation as well.

# Project 2021-04 Industry Comments with Initial Ballot

- Installing DME at IBR unit level is a challenge, especially for plants in commercial operation before the effective date of this standard.
  - SDT understands and relaxed the requirement. Instead of monitoring at least one IBR unit per collector feeder, the latest draft requires monitoring of one IBR unit per collector bus.
  - Per feedback from a couple of OEMs, removed requirement to record dc quantities at IBR unit level.
- Need more time to install DME at Facilities in commercial operation before the effective date of this Standard
  - SDT understands, however, FERC Order 901 requires standard to be fully effective and enforced before 2030.

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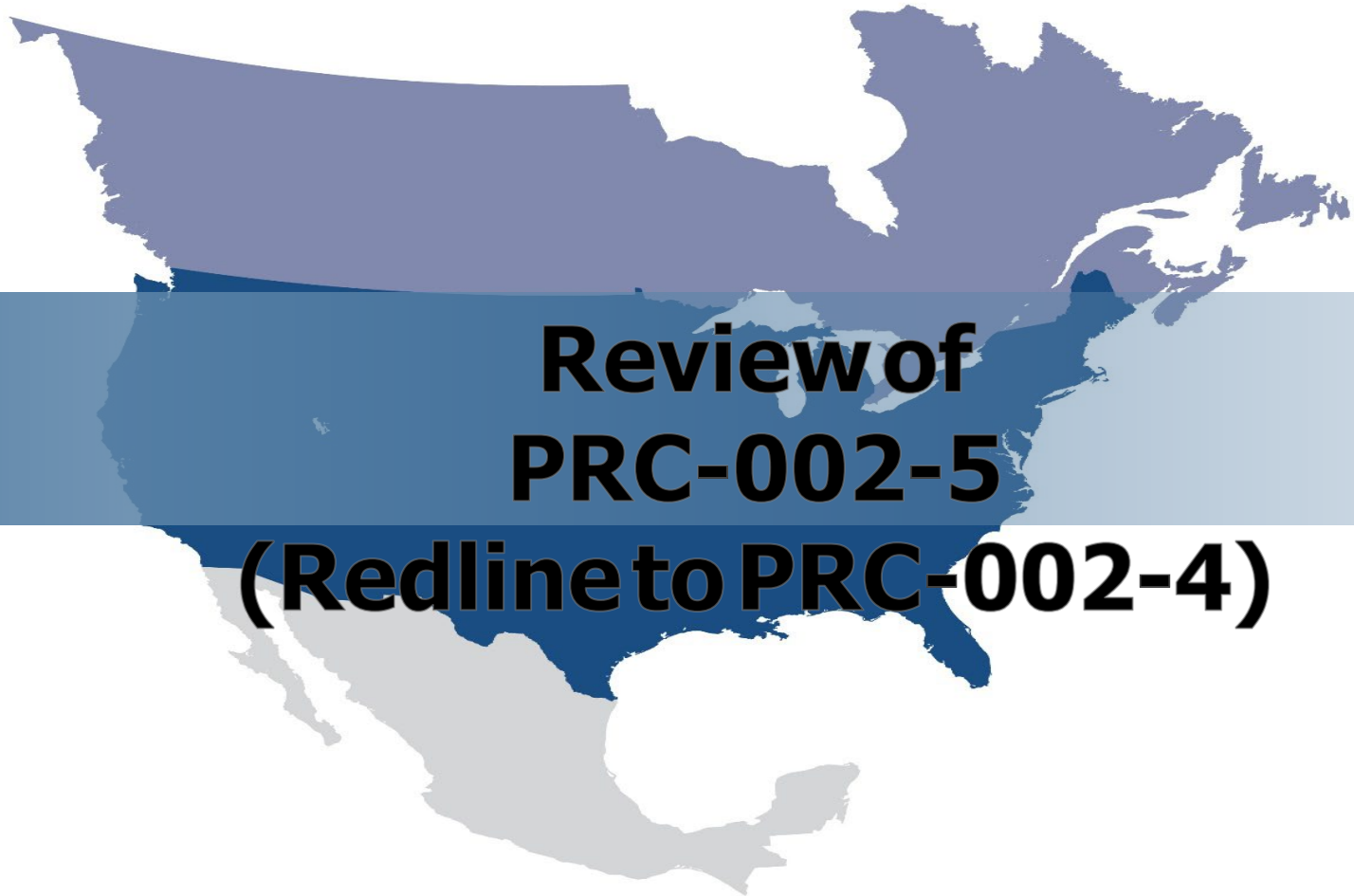


# Review of PRC-002-5 (Redline to PRC-002-4)

# Applicability

**4.1. Functional Entities:**

**4.1.1.** Reliability Coordinator

**4.1.2.** Transmission Owner

**4.1.3.** Generator Owner

**4.2.** **Facilities:** BES Elements, excluding Inverter-Based Resources.[1]

[1] Disturbance monitoring and reporting requirements for inverter-based resources are addressed in PRC-028.

# Requirement R5

**R5.** Each Reliability Coordinator shall: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

**5.1.** Identify BES Elements for which dynamic Disturbance recording (DDR) data is required, including the following:

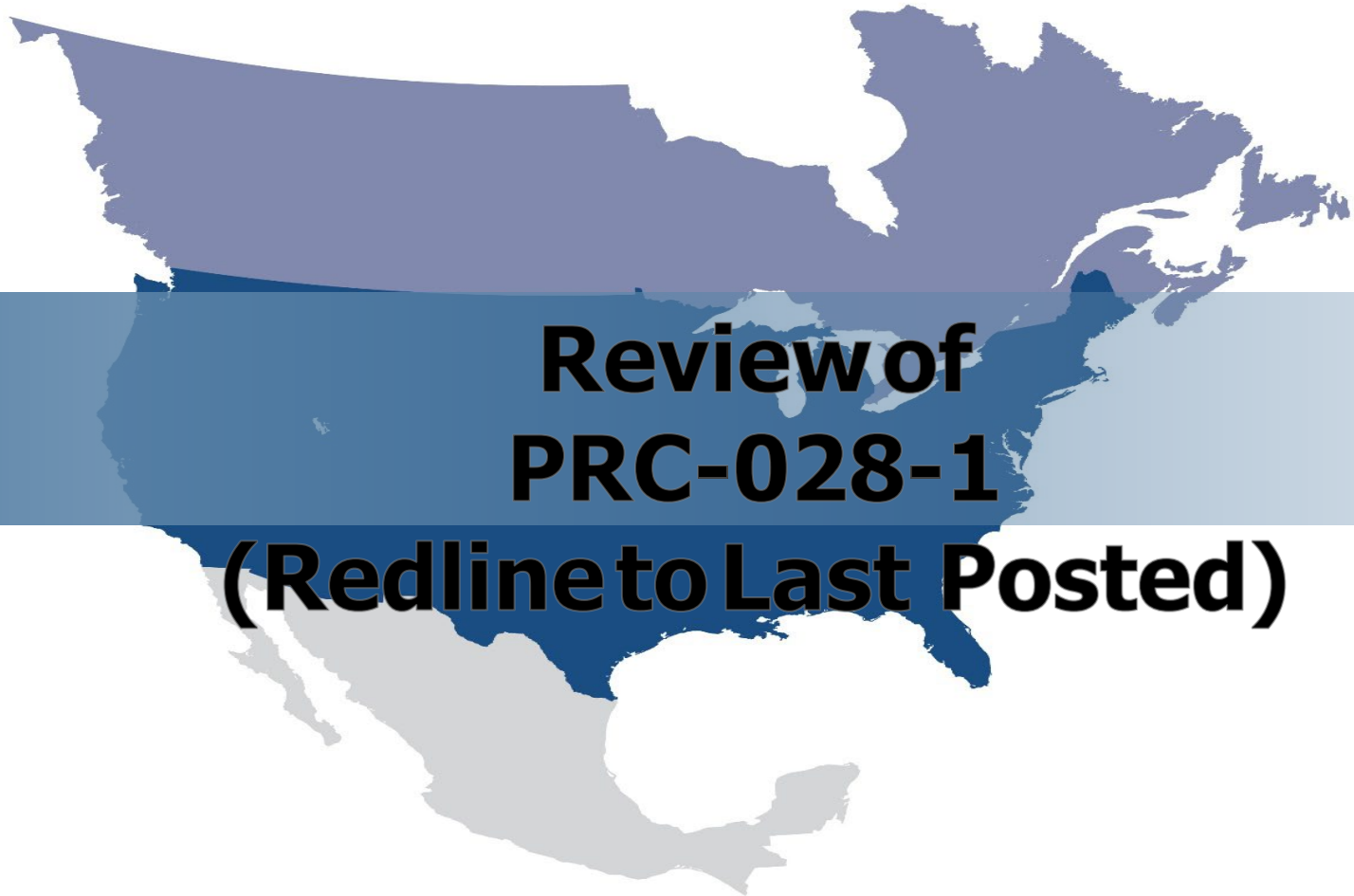
**5.1.1.** Synchronous machine based ~~G~~generating resource(s) with:

**5.1.1.1.** Gross individual nameplate rating greater than or equal to 500 MVA.

**5.1.1.2.** Gross individual nameplate rating greater than or equal to 300 MVA where the gross plant/facility aggregate nameplate rating is greater than or equal to 1,000 MVA.

## Other changes

- Minor editorial changes
- Section C, 1.2 – Data Retention: removed “measures” to align with standardized language.
- Section C, 1.3 – Aligned with latest template.
- Minor changes to VSLs of R3, R4, R6, R7, and R11.
  - Edits are clarifying in nature
  - Need was recognized as the SDT developed VSLs for PRC-028



# Review of PRC-028-1 (Redline to Last Posted)

# Project 2021-04
# PRC-028-1: Redline to Last Posted

## Purpose

**Purpose:** To have adequate data available from ~~inverter-based resources~~ Inverter-Based Resources (IBR) to facilitate analysis of IBR performance during ~~of~~ Bulk Electric System (BES) Disturbances.

## Facilities

**Facilities:** The ~~following~~ Elements associated with (1) BES Inverter-Based Resources; and (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~~BES generating plants (inverter-based portion of generating plant/Facility meeting the criteria set by Inclusion I2, Part (b) or Inclusion I4 of the BES definition.):~~

# **Requirement R1:** SER Data for following Elements

**1.1.** Circuit breaker position (open/close) for circuit breakers associated with the main power transformer(s)[3], collector bus(es), and shunt static or dynamic reactive device(s) ~~Elements identified in section 4.2~~.

**1.2.** For IBR Units in commercial operation after [the effective date of this standard]: ~~A~~at least one IBR ~~u~~Unit, per collector bus, on any of the collector feeders that is connected at a distance greater than or equal to 90% ~~to last 10%~~ of ~~each~~the longest collector feeder ~~length~~. ~~IBR units installed prior to the effective date of this standard and are not capable of recording this data are excluded.~~ The following data shall be recorded when triggered by ride-through operation or tripping of an IBR Unit.

**1.2.1.** All fault codes.

~~**1.2.2.** All fault alarms.~~

~~**1.2.3.**~~**1.2.2.** ~~Change of operating mode.~~

~~**1.2.4.**~~**1.2.3.** High and low voltage ride-through mode status.

~~**1.2.5.** High and low frequency ride-through~~ mode status.

**1.2.4.** ~~Control system command values, reference values, and feedback~~

# Project 2021-04
# PRC-028-1: Redline to Last Posted

## **Requirement R1:** SER Data for following Elements

**1.3.** For IBR Units in commercial operation prior to [the effective date of this standard]: at least one IBR Unit, per collector bus, on any of the collector feeders that is connected at a distance greater than or equal to 90% of the longest collector feeder. The following data shall be recorded, if capable of recording, 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.

# Project 2021-04
# PRC-028-1: Redline to Last Posted

**Requirement R2:** Triggered FR Data to determine following electrical quantities

**2.2.** IBR ~~u~~Unit FR data from at least one IBR ~~u~~Unit, per collector bus, on any of the collector feeders that is connected at a distance greater than or equal to 90% ~~to last 10%~~ of ~~each~~the longest collector feeder ~~length~~:

**2.2.1.** Each AC phase-to-neutral or phase-to-phase voltage, as applicable, at IBR ~~u~~Unit terminals or on high-side of the IBR ~~u~~Unit transformer.

~~**2.2.2.**~~ Each AC phase current and the residual or neutral current, as applicable, on IBR ~~u~~Unit terminals or on high-side of the IBR ~~u~~Unit transformer.

~~**2.2.3.**~~**2.2.2.** ~~DC bus current and voltage. IBR units installed prior to the effective date of this standard and are not capable of recording this data are excluded.~~

# Project 2021-04
# PRC-028-1: Redline to Last Posted

## Other Important Changes:

- FR Data: Minimum recording rate for FR data reduced to 64 samples per cycle from 128 samples per cycle.
- Time synchronization: Synchronized device clock accuracy reduced to within ±1 millisecond from ±100 microsecond.
- Data Sharing: In addition to RC, RE, or NERC, required TO/GO to provide data to TP, PC, TOP, and BA, upon request.
- Data retrievable period in R7-Part 7.1 is reduced to 20 calendar days from 30 calendar days.

# Project 2021-04
# PRC-028-1: Redline to Last Posted

## Requirement R9:

**R9.** Each Transmission Owner and Generator Owner of an applicable facility as specified in section A.4.2 that is in commercial operation before the effective date of this standard that is not able to install disturbance monitoring equipment in accordance with Requirements R1 through R7 in the time provided for compliance shall develop, maintain, and implement a Corrective Action Plan to provide the required capability. For each Corrective Action Plan, the Transmission Owner and Generator Owner shall: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

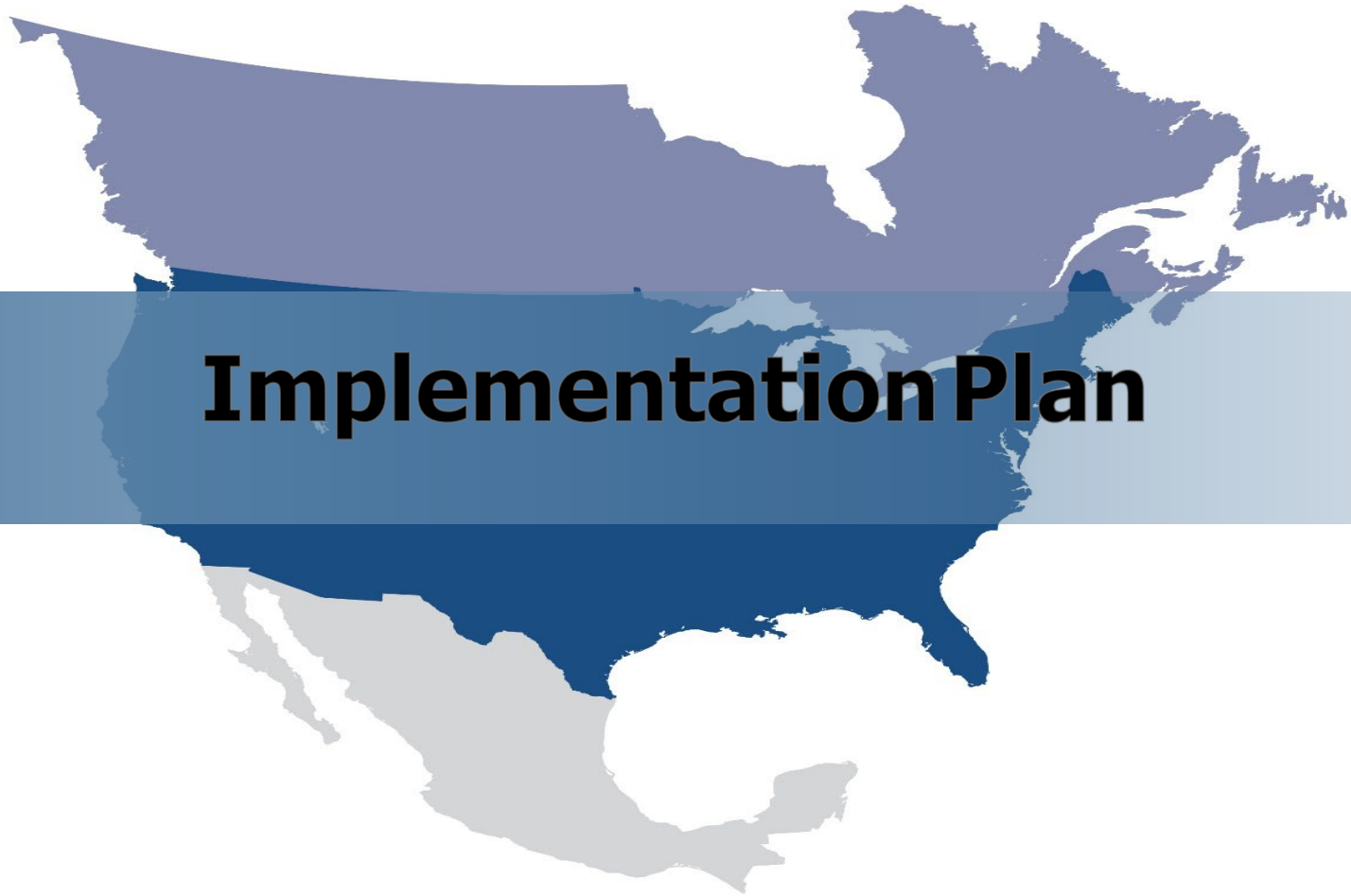
**9.1.** Identify corrective actions and a timetable for completion.

**9.2.** Specify the circumstances causing the delay for fully or partially implementing Requirements R1 through R7 and explain how those circumstances are beyond the control of the responsible entity.

**9.3.** Identify revisions to the selected actions in Part 9.1, if any.

**9.4.** Identify updates to the timetable for implementing the selected actions in Part 9.1, if any.

**9.5.** Submit the Corrective Action Plan, and any revisions, to the Regional Entity, with a request to extend the time provided for compliance.



# Implementation Plan

# Compliance Date for Requirements R1-R7

**For Plants/Facilities in commercial operation on or before the effective date:**

Entities shall ~~be fully compliant~~ comply with Requirements R1 through R7 at 50% ~~percent~~ of their generating plants/Facilities within three (3) calendar years of the effective date of PRC-028-1 and ~~fully compliant at~~ 100% of their generating plant/Facilities by January 1, 2030~~within six~~five ~~(5~~6) ~~calendar years of the effective date of Reliability Standard PRC-028-1~~.

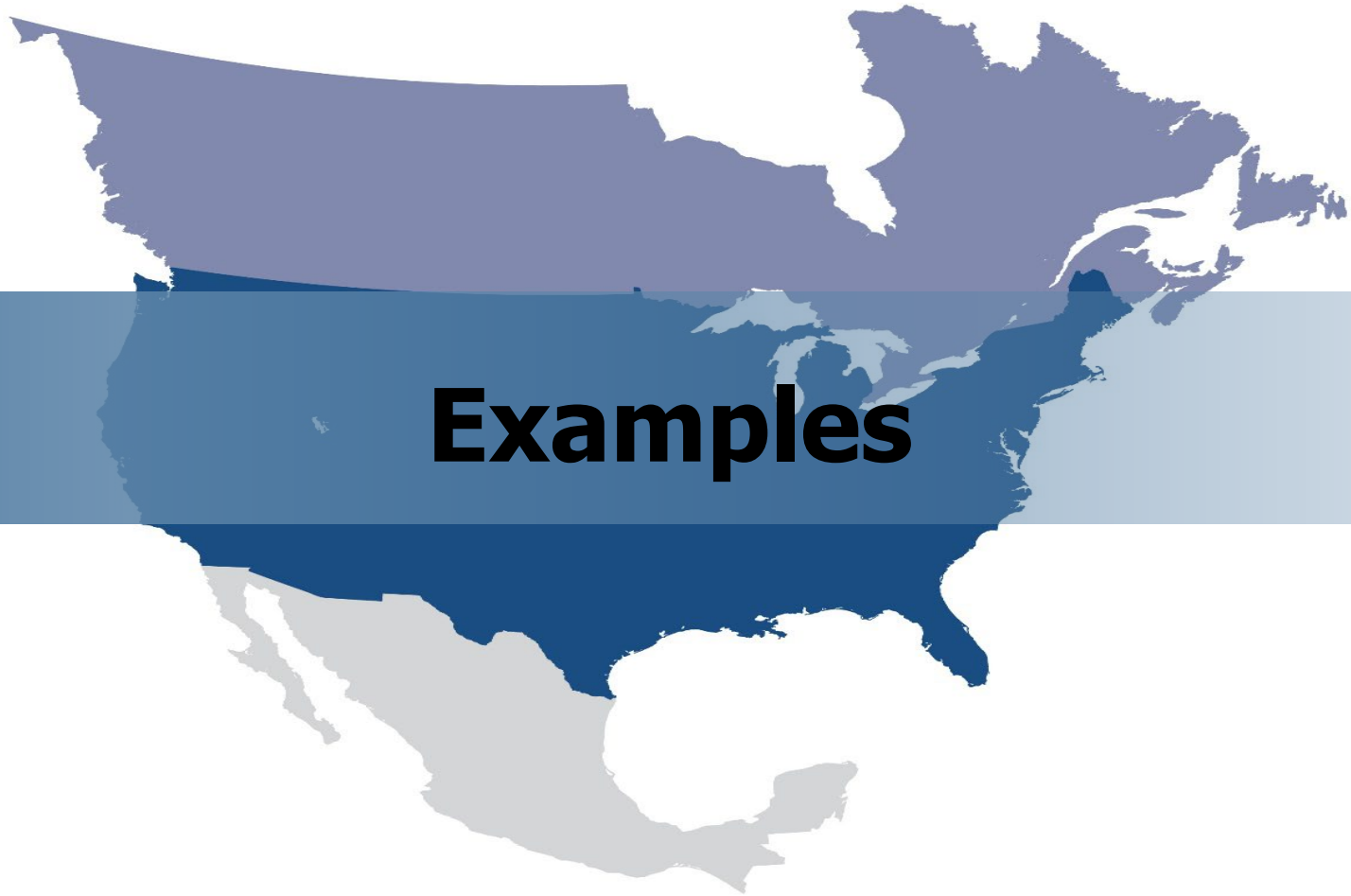
Entities that are required to monitor only one (1) generating plant/Facility shall ~~be fully compliant~~ comply with Requirements R1 through R7 within three (3) calendar years of the effective date of Reliability Standard PRC-028-1.

~~Entities with more than one (1) generating plant/Facility are encouraged to develop a strategy, to be shared with ERO Compliance Monitoring and Enforcement Program staff as requested, for how they will implement Reliability Standard PRC-028-1 across their generating fleet.~~

# Compliance Date for Requirements R1-R7

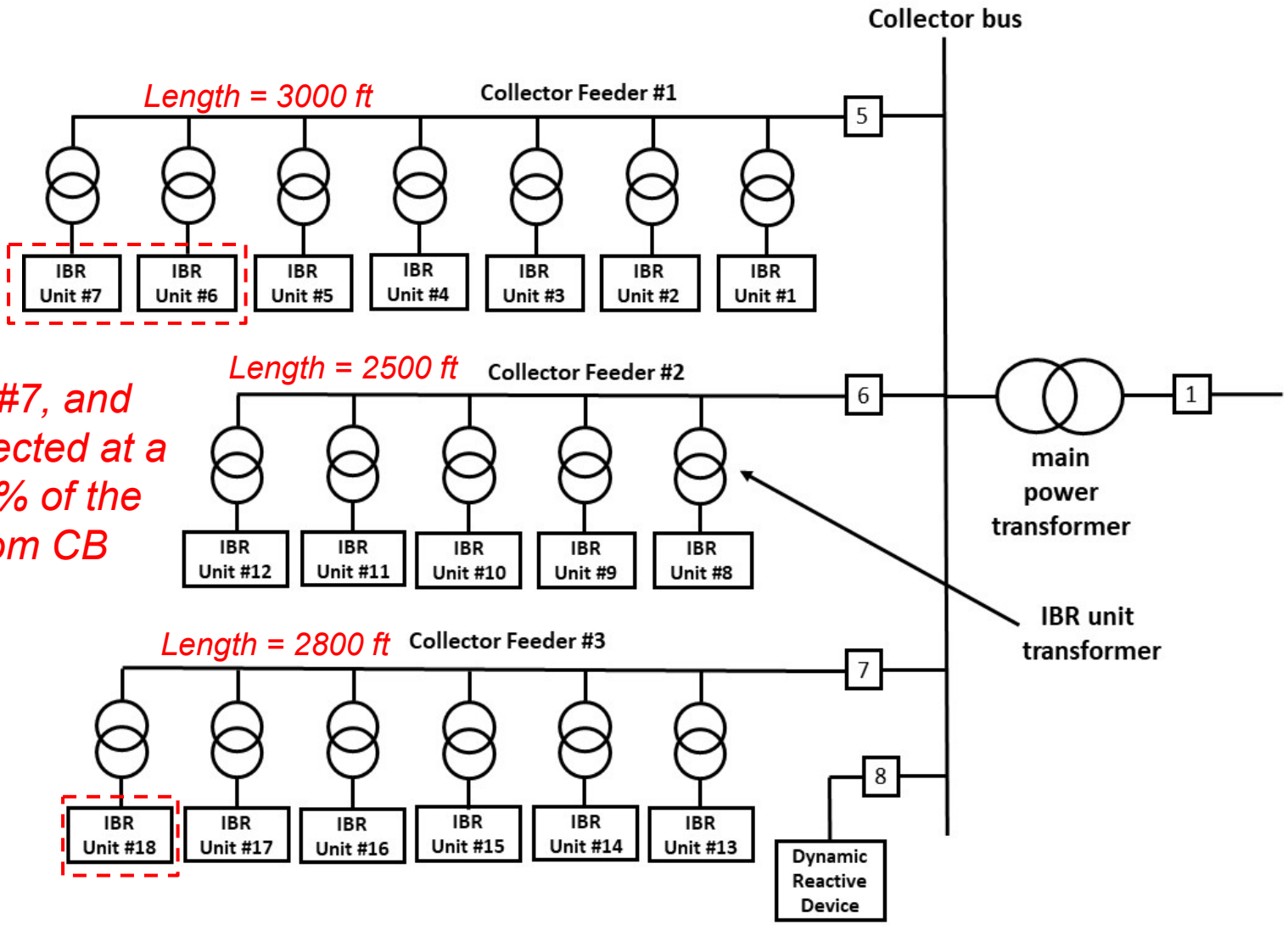
**For Plants/Facilities entering commercial operation within one year after the effective date:**
Entities shall comply with Requirements R1 through R7 by the end of the first calendar year that is 12 months following the effective date of the standard.

**For Plants/Facilities entering commercial operation one year or later after the effective date:**
Entities shall comply with Requirements R1 through R7 at the date of entering commercial operation.



# Examples

# Project 2021-04 Example

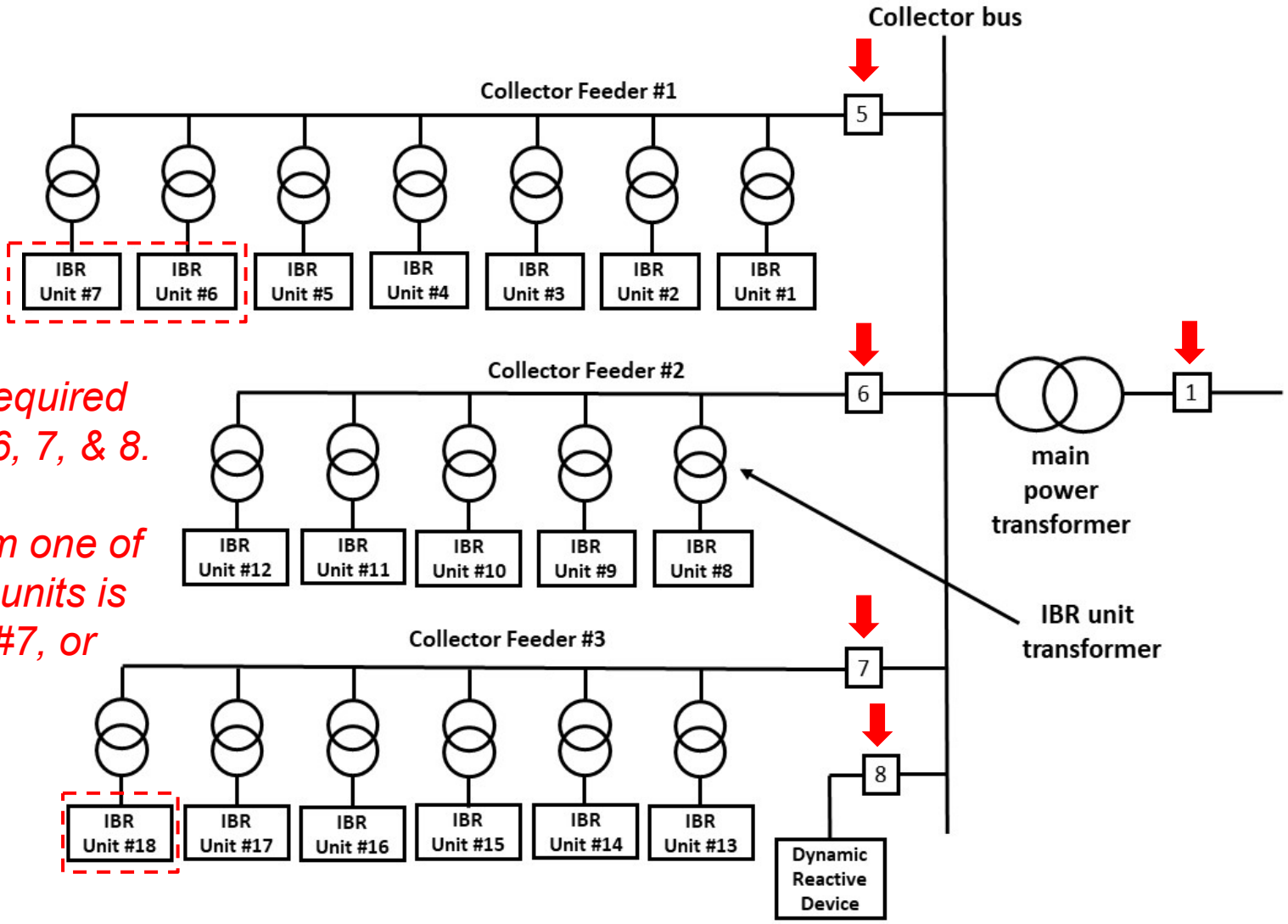



*IBR units #6, #7, and #18 are connected at a distance ≥ 90% of the longest CF from CB*

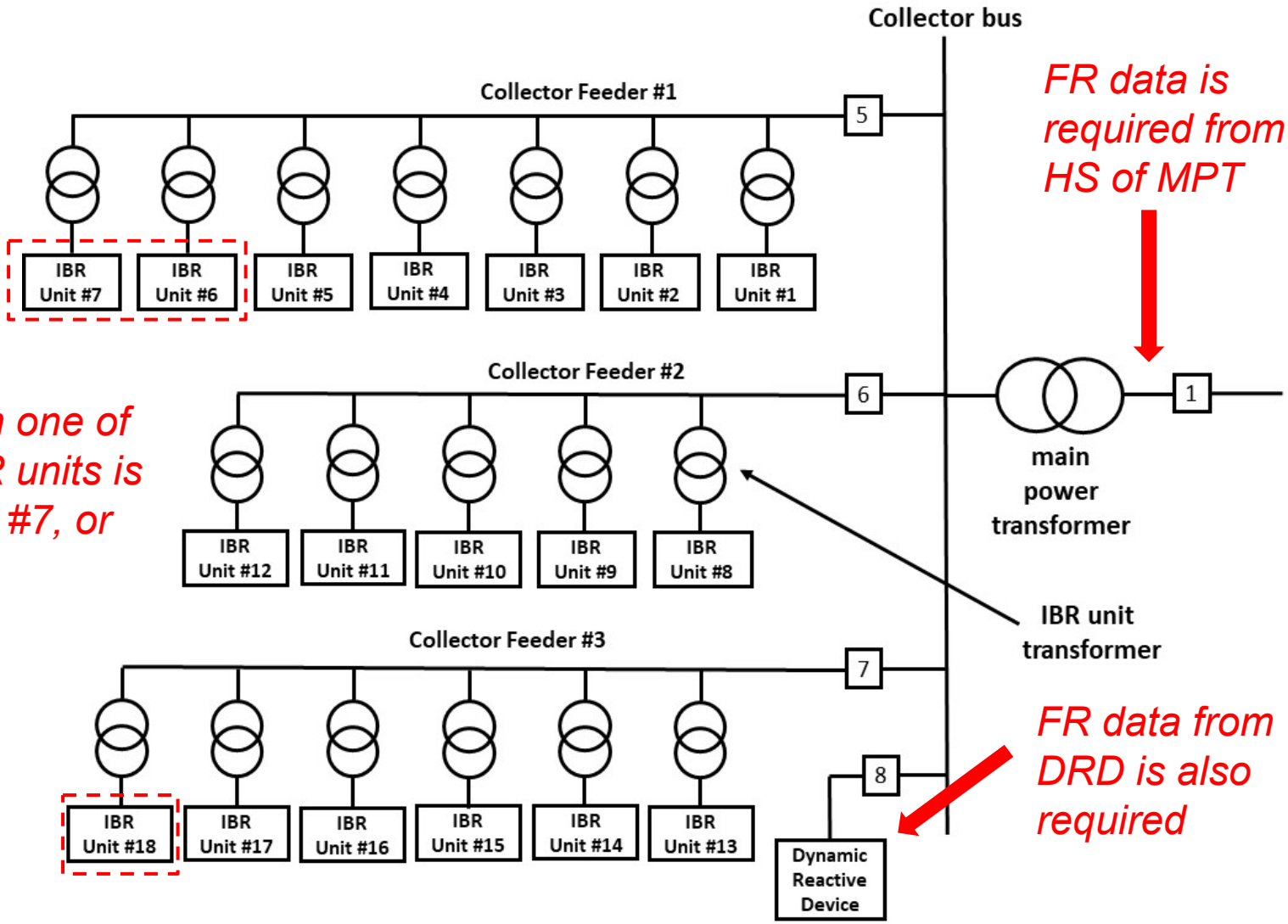
# Project 2021-04 Example – SER Data

*SER data is required for CBs 1, 5, 6, 7, & 8.*

*SER data from one of following IBR units is required: #6, #7, or #18.*



# Project 2021-04 Example – FR Data

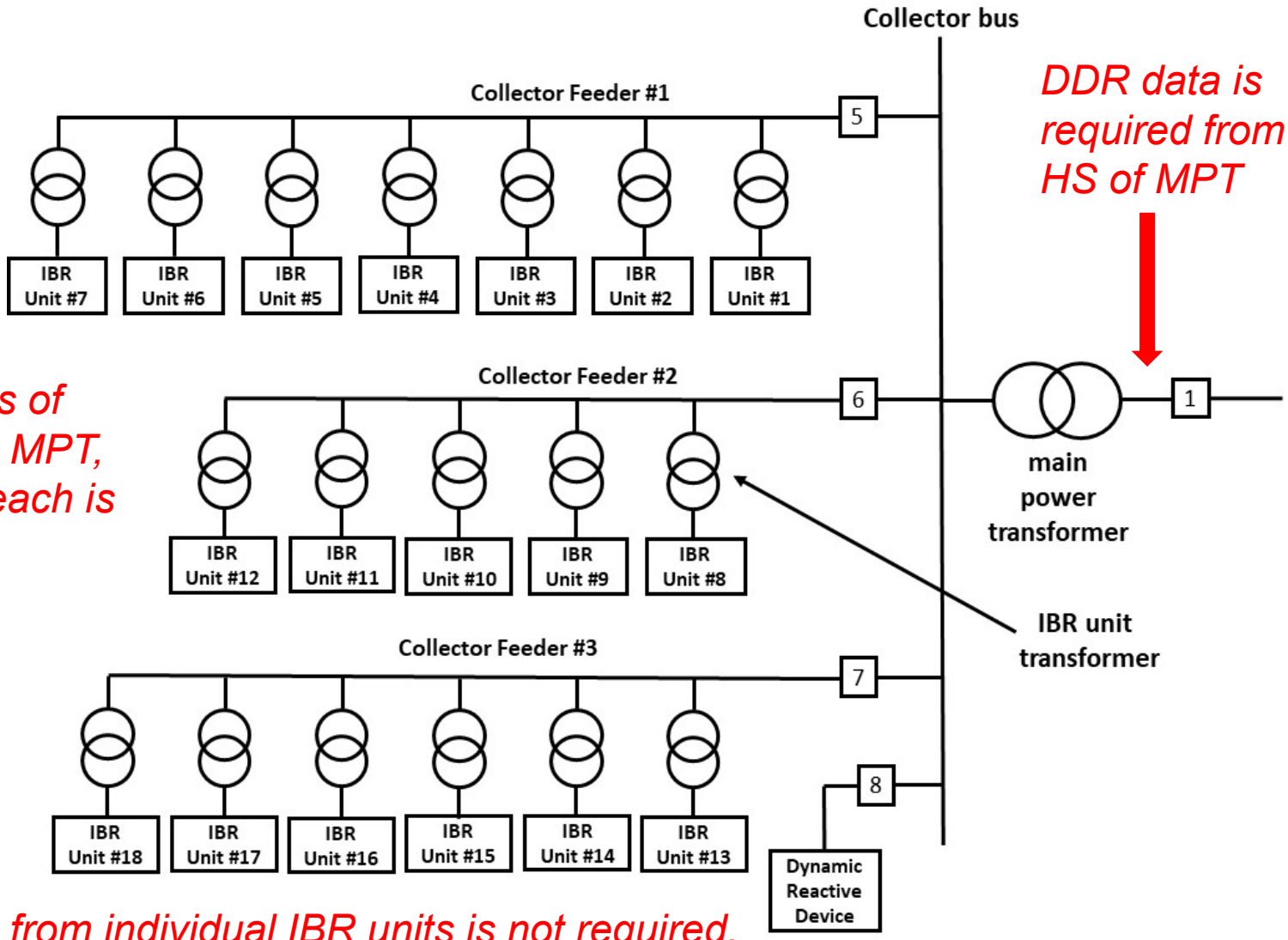



*FR data is required from HS of MPT*

*FR data from one of following IBR units is required: #6, #7, or #18.*

*FR data from DRD is also required*

# Project 2021-04 Example – DDR Data




*If plant consists of more than one MPT, DDR data for each is required.*

*DDR data from individual IBR units is not required.*

# Next Steps

# Project 2021-04 Next Steps

- Posting
  - Project Page 2021-04
  - 25-day comment period and formal ballot March 18 – April 11, 2024
- Point of contact
  - Ben Wu, Senior Standards Developer
  - Ben.Wu@nerc.net or call 470-542-6882
- Webinar posting
  - Three business days
  - Standards Bulletin

# Questions and Answers

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# Project 2020-02

Modifications to PRC-024 (Generator Ride-through)
PRC-024-4 and PRC-029-1
March 28, 2024

Xiaoyu (Shawn) Wang, Chair (Enel North America)
Husam Al-Hadidi, Vice Chair (Manitoba Hydro)
Jamie Calderon, NERC Standards Developer

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# Drafting Team Roster

| | Name | Entity |
|---|---|---|
| **Chair** | Xiaoyu (Shawn) Wang | Enel North America |
| **Vice Chair** | Husam Al-Hadidi | Manitoba Hydro |
| **Members** | Ebrahim Rahimi | California ISO |
| | John B. Anderson | Xcel Energy |
| | Johnny C. Carlisle | Southern Company Services, Inc. |
| | Robert J. O'Keefe | American Electric Power |
| | Rajat Majumder | Invenergy |
| | Alex Pollock | RES |
| | Ebrahim Rahimi | California ISO |
| | Fabio Rodriguez | Duke Energy |
| | Kenneth Silver | 8minute Solar Energy |
| | Ovidiu Vasilachi | Independent Electricity System Operator (IESO) |
| | John Zong | Electric Power Engineers |
| **NERC Staff** | Jamie Calderon | North American Electric Reliability Corporation |

# Project 2020-02 SAR1

- **Title**: Revision of relevant Reliability Standards to include applicability of transmission-connected dynamic reactive resources
- **Date Submitted**: Feb 24, 2020 (Revised on February 3, 2022)

# Project 2020-02 SAR2

- **Title**: **Generator Ride-Through Standard (PRC-024-03 Replacement)**
- **Date Submitted**: April 28, 2022 (revised March 31, 2023)
- **Industry Need:**
- Based on the ERO Enterprise analyzing over 10 disturbances reports highlighting key findings and recommendations
  - A widespread loss of generating resources – solar PV, wind, synchronous generation, and battery energy storage systems (BESS)
  - Multiple IBR experience abnormally tripping, ceasing current injection, or reducing power output with control interactions.
  - Generator ride-through is a foundational essential reliability service.
  - The unexpected loss of widespread generating assets poses a significant risk to BPS reliability.
- The existing PRC-024-3 is an equipment settings standard focused solely on voltage and frequency protection and is inadequate to address the IBR performance issues

# Project 2020-02 SAR2 (Cont'd) - Industry Need

- NERC has experienced multiple asset owners during the event analyses who have misconstrued PRC-024-3, resulting in incorrect or unnecessary protections applied to generating assets that have resulted in spurious and abnormal tripping events.
- This proposed standards project will address this known reliability risk with a more suitable performance-based standard that ensures generating resource ride-through performance for expected or planned BPS disturbances rather than focusing solely on a small subset of protections and controls that can trip generating resources.

# Project 2020-02 SAR2- Purpose

- The purpose of this SAR is to retire PRC-024-3 and replace it with a performance-based ride-through standard that ensures generators remain connected to the BPS during system disturbances.
- Focuses on the generator protection and control systems that can result in the reduction or disconnection of generating resources during these events.
- The SAR also ensures protection or controls that fail to ride through system events are analyzed, addressed with a corrective action plan (if possible),
- From a risk-based perspective, to mitigate the ongoing and systemic performance issues identified across multiple Interconnections and across many disturbances analyzed by NERC and the Regions.

# Project 2020-02 SAR2- Project Scope

- Key project scopes include:
  - Retire PRC-024-3, and create a new PRC standard or completely overhaul and replace the existing PRC-024 standard
  - Allow for the possible modification or retirement of other relay-setting standards such as but not limited to PRC-006, PRC-019, PRC-025, and PRC-026, to prevent duplicative requirements and compliance obligations
  - Create a comprehensive, performance-based ride-through standard to ensure BES generating resources remain connected and providing essential reliability services during grid disturbances

# Project 2020-02 SDT Approach

- Modify PRC-024-3 to retain the Reliability Standard as a protection-based standard with applicability to only synchronous generators and synchronous condensers.
- Create a new Reliability Standard (PRC-029-1) to address inverter-based resource (IBR) disturbance ride-through performance criteria.
- Coincide with ride-through requirements of IEEE standards but structure to follow language from FERC Order No. 901, which states that “NERC has the discretion to consider during its standards development process whether and how to reference IEEE standards in the new or modified Reliability Standards.”

# Project 2020-02 Summary of Changes (PRC-024-4)

- Expanding functional entity applicability to includes Transmission Owners (section 4.2.2).
- Modifying Applicability Facilities Section to restrict PRC-024-4 to synchronous generators and added as new subparts to identify which synchronous condensers and equipment.
- Modifying Requirements R1, R2, R3, and R4 to include:
  - Adding Transmission Owner as a functional entity applicable to each requirement.
  - Adding language for synchronous condensers and
  - removing language that relates to inverter-based resource functionality (i.e. “cease injecting current”).

# Project 2020-02 Draft Language PRC-029-1

- ***Functional Entities (4.1)***
  The functional entity responsible for assuring acceptable ride-through performance of IBR is the Generator Owner (GO) and Transmission Owner (TO).
- ***Facilities (4.2)***
  Applicability Facilities includes:
  - IBR that meet NERC registration criteria.
  - Consistent with FERC Order No. 901, IBR performance is based on the overall IBR plant
  - Requirements do not apply to individual inverter units or measurements taken at individual inverter unit terminals
  - Utilize the disturbance monitoring equipment requirements established under the proposed PRC-028-1

.

# Project 2020-02 Draft Language PRC-029-1

**R1.** Each Generator Owner or Transmission Owner of an applicable IBR shall ensure that each IBR remains electrically connected and continues to exchange current in accordance with the no-trip zones and operation regions as specified in **Attachment 1** unless needed to clear a fault or a documented equipment limitation exists in accordance with **Requirement R6**. *[Violation Risk Factor: High] [Time Horizon: Operations Assessment]*

| Voltage (per unit) | Minimum Ride-Through Time (sec) |
|---|---|
| ≥1.200 | N/A |
| ≥1.1 | 1.0 |
| ≥1.05 | 1800 |
| < 0.90 | 3.00 |
| < 0.70 | 2.50 |
| < 0.50 | 1.20 |
| < 0.25 | 0.16 |
| < 0.10 | 0.16 |

***AC-Connected Wind IBR***

| Voltage (per unit) | Minimum Ride-Through Time (sec) |
|---|---|
| ≥1.200 | N/A |
| ≥1.1 | 1.0 |
| ≥1.05 | 1800 |
| < 0.90 | 6.00 |
| < 0.70 | 3.00 |
| < 0.50 | 1.20 |
| < 0.25 | 0.32 |
| < 0.10 | 0.32 |

***None AC-Connected Wind IBR***

# Project 2020-02 Summary of PRC-029-1

**R2.** Each Generator Owner or Transmission Owner of an applicable IBR shall ensure that during a System disturbance, each IBR's voltage performance adheres to the following, unless a documented equipment limitation exists in accordance with Requirement R6: *[Violation Risk Factor: High] [Time Horizon: Operations Assessment]*

**2.1.** While the voltage at the high side of the main power transformer remains within the Continuous Operation Region as specified in **Attachment 1**, each IBR shall:

**2.1.1** Continue to deliver the pre-disturbance level of active power or available active power, whichever is less, and continue to deliver active power and reactive power up to its apparent power limit.

**2.1.2** If the IBR cannot deliver both active and reactive power due to a current or apparent power limit, when the applicable voltage is below 95% and still within the Continuous Operation Region, then preference shall be given to active or reactive power according to requirements specified by the Transmission Planner, Planning Coordinator, Reliability Coordinator, or Transmission Operator.

# Project 2020-02 Summary of PRC-029-1

**2.2.** While voltage at the high side of the main power transformer is within the Mandatory Operation Region as specified in **Attachment 1**, each IBR shall:

**2.2.1** Exchange current, up to the maximum capability while maintaining automatic voltage regulation, on the affected phases during both symmetrical and asymmetrical voltage disturbances.

**2.2.2** Adjust reactive current injection at the high-side of the main power transformer so that the magnitude of the reactive current responds to changes in voltage at the high-side of the main power transformer in accordance with default reactive prioritization unless the Transmission Planner, Planning Coordinator, Reliability Coordinator, or Transmission Operator specifies a certain magnitude of reactive power response to voltage changes or specifies active power priority instead of reactive power priority.

# Project 2020-02 Summary of PRC-029-1

**2.3.** The IBR shall not itself cause voltage at the high-side of the main power transformer to exceed the applicable **Attachment 1** Table 1 or Table 2 no-trip zone voltage thresholds and time durations in its response from Mandatory or Permissive Operation Regions to the Continuous Operating Region.

**2.4.** Each IBR shall restore active power output to the pre-disturbance or available level within 1.0 second when the voltage at the high-side of the main power transformer returns to the Continuous Operation Region from the Mandatory Operation Region or Permissive Operation Region (including operation in current block mode) as specified in **Attachment 1**, unless the Transmission Planner, Planning Coordinator, Reliability Coordinator, or Transmission Operator specifies a lower post-disturbance active power level requirement or specifies a different post-disturbance active power restoration time.

**2.5.** Each IBR shall only trip to prevent equipment damage, when the voltage at the high-side of the main power transformer is outside of the no-trip zone as specified in **Attachment 1**.

# Project 2020-02 Summary of PRC-029-1

**R3.** Each Generator Owner or Transmission Owner of an applicable IBR shall ensure that during a transient overvoltage as a result of a switching event whereby instantaneous voltage at the high side of the main power transformer exceeds 1.2 per unit, each IBR shall either: *[Violation Risk Factor: Lower] [Time Horizon: Operations Assessment]*

- Remain electrically connected and continue to exchange current in accordance with instantaneous transient overvoltage levels and durations specified in **Attachment 2**; or
- Remain electrically connected in current block mode in accordance with instantaneous transient overvoltage levels and durations specified in **Attachment 2** and restart current exchange within 5 cycles of the instantaneous voltage falling below (and remaining below) 1.2 per unit.

| Voltage (per unit) at the high side of the MPT | Minimum Ride-Through Time (millisec) |
|---|---|
| > 1.8 | May trip |
| > 1.7 | 0.2 |
| > 1.6 | 1.0 |
| > 1.4 | 3.0 |
| > 1.2 | 15.0 |

# Project 2020-02 Summary of PRC-029-1

**R4.** Each Generator Owner or Transmission Owner of an applicable IBR shall ensure each IBR remains electrically connected and continues to exchange current during a frequency excursion event whereby the frequency remains within the "no trip zone" according to **Attachment 3** and the absolute rate of change of frequency (ROCOF)[2] magnitude is less than or equal to 5 Hz/second. *[Violation Risk Factor: Lower] [Time Horizon: Operations Assessment]*

| Averaged System Frequency (Hz) | Minimum Ride-Through Time (sec) |
|---|---|
| ≥64 | May trip |
| ≥61.8 | 6 |
| > 61.5 | 299 |
| > 61.2 | 660 |
| < 58.8 | 660 |
| < 58.5 | 299 |
| < 57.0 | 6 |
| < 56 | May trip |

# Project 2020-02 Summary of PRC-029-1

**R5.** Each Generator Owner or Transmission Owner of an applicable IBR shall ensure each IBR remains electrically connected and continues to exchange current during instantaneous positive sequence voltage phase angle changes that are initiated by non-fault switching events on the transmission system and are changes of less than 25 electrical degrees at the high-side of the main power transformer. *[Violation Risk Factor: Lower] [Time Horizon: Operations Assessment]*

**5.1.** When the instantaneous positive sequence voltage phase angle change is more than 25 electrical degrees at the high-side of the main power transformer and is initiated by a non-fault switching event on the transmission system, the IBR may trip, but shall only trip to prevent equipment damage.

# Project 2020-02 Summary of PRC-029-1

**R6.** Each Generator Owner and Transmission Owner with a documented equipment limitation that would prevent an applicable IBR that is in-service by the effective date of this standard from meeting voltage ride-through requirements as detailed in Requirements R1 and R2 shall communicate each equipment limitation to the associated Planning Coordinator(s), Transmission Planner(s), and Reliability Coordinator(s). *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

**6.1.** Each Generator Owner and Transmission Owner shall include in its documentation:

**6.1.1** Identifying information of the IBR (name, facility #, other)

**6.1.2** Which aspects of voltage ride-through requirements that the IBR would be unable to meet

**6.1.3** Identify the specific piece(s) of equipment causing the limitation

**6.1.4** Information regarding any plans to repair or replace the limiting equipment that would remove the limitation (such as estimated date of repair/replacement)

# Project 2020-02 Summary of PRC-029-1

**6.2.** Each Generator Owner and Transmission Owner with a previously communicated equipment limitation that repairs or replaces the equipment causing the limitation shall document and communicate such equipment change to the associated Planning Coordinator(s), Transmission Planner(s), and Reliability Coordinator(s) within 30 days of the equipment change.

# Project 2020-02 Compliance with PRC-029

- Event-Based Standard, it is **not protection settings** compliance standard ( PRC-024)
- IBR ride-through performance during transmission system events in the field and not from interconnection studies, transmission planning studies, operational planning studies, or from IBR models.
- An IBR becomes noncompliant with Standard only when an event in the field occurs that shows that one or more requirements were not satisfied.
- *The Operations Assessment* as the Time Horizon designation of requirements R1-R5.

# Project 2020-02 Summary

- Revisions were made in PRC-024-4 to specify the Frequency and Voltage Protection Settings for Synchronous Generators and Synchronous Condensers
- New requirements were proposed in PRC-029-1 to specify the Frequency and Voltage Ride-Through Requirements for Inverter-Based Generating Resources

# Project 2020-02 Implementation Plan

- Effective Date for PRC-024-4
  - 6 months after approval by applicable governmental authority
- Effective Retirement Date of PRC-024-3
  - Immediately prior to effective date of version 4
- Effective Date for PRC-029-1
  - 6 months after approval by applicable governmental authority
  - Requirement R6 is effective another 6 months after (12 months total following approval)

# Project 2020-02 Next Steps

- Relevant information
  - Project page
- Ballot dates
  - 25 day formal comment period and ballot
  - March 27th$^{th}$ 2024 to April 22$^{nd}$ 2024
  - Non-binding polls of VRF and VSL will be from April 12$^{th}$ to April 22$^{nd}$ 2024
- Contact information
  - Jamie Calderon: Jamie.Calderon@nerc.net
  - Xiaoyu (Shawn) Wang: xiaoyu.wang@enel.com
  - Husam Al-Hadidi: halhadidi@hydro.mb.ca

# Questions and Answers

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    – so we can respond to all questions!

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NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

# Project 2023-02

PRC-030-1 Unexpected Inverter-Based Resource Event Mitigation
March 28, 2024

Mark Gutzmann, Chair (XCEL Energy)
Biju Gopi, Vice Chair (CAISO)
Josh Blume, NERC Standards Developer

RELIABILITY | RESILIENCE | SECURITY




# Project 2023-02 Drafting Team- SAR and Standard

| | Name | Entity |
|---|---|---|
| **Chair** | Mark Gutzmann | Xcel Energy |
| **Vice Chair** | Biju Gopi | California ISO |
| **Members** | Patrick Dalton | Midwest Independent System Operator |
| | Mohamed Elnozahy | Independent Electricity System Operator of Ontario (IESO) |
| | Patrick Gravois | ERCOT |
| | Emily Greene | Electric Power Engineers |
| | Andy Hoke | NREL |
| | Anuradha Kariyawasam | Electranix Corporation |
| | Chester Li | Hydro One |
| | Tracy MacNicoll | Utility Services of Vermont |
| | David Marshall | Southern Company Services |
| | Dan Waugh | NextEra Energy |
| | Anthony Williams | Duke Energy |
| | Li Yu | Hawaiian Electric Company |
| **PMOS Liaison** | Claudine Fritz | Exelon Corp |
| **NERC Staff** | Josh Blume, Standards Developer | North American Electric Reliability Corporation |
| | Lauren Perotti, Counsel | North American Electric Reliability Corporation |

# Project 2023-02 SAR

- Part of FERC Order No. 901
  - Title: Analysis and Mitigation of BES Inverter-Based Resource Performance Issues

Industry Need:

- Multiple NERC disturbance reports identifying undesired performance of BPS-connected IBRs during grid faults
  - Significant reliability risks posed by such undesired performance
  - Identify data and information exchanges between provider and requester that are facilitated through a third-party intermediary
- All such events to be analyzed with root causes of undesired performance identified and possible mitigating actions documented and taken as appropriate
  - Responsibility of the GO to analyze all applicable events, has necessary monitoring equipment installed, and cooperates with reliability entities such as RC or BA by providing operational data and analytical results
  - Provides flexibility to determine appropriate and timely course of actions

# Project 2023-02 SAR- Primary Purpose

The SAR Drafting Team believes that a new standard should be developed specific to IBRs to ensure that any unexpected ceasing of current injection (partial or full) is analyzed by the applicable Generator Owner and mitigated to the extent possible.

# Project 2023-02 FERC Order No. 901

## Part 3: Post-Event Performance Validation

Responsibilities for triggering and conducting a post-event analysis by functional registrations with a wider view and the establishment of corrective action plans will be identified through the completion of active **Project 2023-02** (Analysis and Mitigation of BES Inverter-Based Resource Performance Issues).[12] Some modifications may be needed by the team to assure all directives from Order No. 901 are effectively addressed. The standard developer on this project will work their drafting team to review and update their project as appropriate to address the directives identified in Appendix B: **Milestone 2 Part 3: Post-Event Performance Validation**.

### Additional Notes for this Drafting Team

- The Generator Operator function was not previously identified in earlier drafts. Both drafting teams will ensure that the drafts include clear expectations for Generator Owners (to assure control systems are set in accordance with criteria) and for Generator Operators (to assure the applicable facilities adhere to criteria during a system disturbance). Clarity regarding who is responsible for implementing corrective action plans will be addressed.
- Corrective Action Plans, as required for entities in **Project 2023-02** (Analysis and Mitigation of BES Inverter-Based Resource Performance Issues), could include other system or facility enhancements that are irrespective of individual IBR plant level exemptions from **Project 2020-02** (Modifications to PRC-024 Generator Ride-through). It would be the responsibility of these wider area entities to resolve larger issues resulting from IBRs not meeting performance expectations.

# Project 2023-02 Proposed PRC-030-1



## A. Introduction

1. **Title:** Unexpected Inverter-Based Resource Event Mitigation
2. **Number:** PRC-030-1
3. **Purpose:** Identify, analyze, and mitigate unexpected Inverter-Based Resource change of power output.
4. **Applicability:**
   - **4.1. Functional Entities:**
     - **4.1.1.** Generator Owner
   - **4.2. Facilities:**
     - **4.2.1.** Bulk Power System (BPS) Inverter-Based Resources (IBR)
5. **Effective Date:** See Implementation Plan for PRC-030-1

# Project 2023-02 Proposed PRC-030-1 R1

**R1.** Each applicable Generator Owner shall have a documented process to identify unexpected changes[1] in power output occurring within a two-second period and is the greater of either 20% of the plant's gross nameplate rating, or 20 MVA. *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

**M1.** Each applicable Generator Owner shall have evidence which may include but is not limited to: (1) a documented process for detecting unexpected changes in output as described in Requirement R1, (2) actual data recordings, and (3) identification of gross nameplate rating.

**Exceptions to Requirement R1**

[1] Unexpected changes in power output includes any change of generation that is not attributed to factors such as weather patterns, change of wind, change in irradiance, curtailment, ramping, planned outage, planned testing, or the loss of a Transmission Line connecting the IBR generators.

# Project 2023-02 Proposed PRC-030-1 R2

**R2.** Each applicable Generator Owner shall implement its process established in Requirement R1 to identify unexpected changes in power output. *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

**M2.** Acceptable evidence of implementation may include, but is not limited to, dated electronic or hard copy documentation to demonstrate that the applicable Generator Owner implemented its process established in Requirement R1.

# Project 2023-02 Proposed PRC-030-1 R3

**R3.** Each applicable Generator Owner shall provide data when requested from its Balancing Authority, Reliability Coordinator, or Transmission Operator regarding IBR responses during an identified system level event within 30 calendar days of the receipt of the request. *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

**M3.** Each applicable Generator Owner shall have evidence as specified in Requirement R3 which may include, but is not limited to, dated documentation (electronic or hardcopy format): emails, facsimiles, or transmittals.

# Project 2023-02 Proposed PRC-030-1 R4

**R4.** Each applicable Generator Owner shall analyze its IBRs performance within 45 calendar days of either the event identified pursuant to Requirement R2 or receipt of a request pursuant to Requirement R3. The analysis shall include all of the following: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

- **4.1.** The cause(s) of unexpected change(s) in power output;
- **4.2.** The applicability to its other IBR facilities that could be affected by the same cause of unexpected change(s) in power output; and
- **4.3.** Notification to each applicable Balancing Authority, Reliability Coordinator, or Transmission Operator of the analysis results.

**M4.** Each applicable Generator Owner shall have dated analysis documentation, developed in accordance with Requirements R4. Evidence may include, but is not limited to: (1) an analysis report, (2) actual data recordings or derivations, (3) documents describing the device specification and device configuration or settings, and (4) plant configuration.

# Project 2023-02 Proposed PRC-030-1 R5

**R5.** Each applicable Generator Owner shall, within 45 days of completing the analysis in Requirement R4, develop one of the following and provide it to each applicable Reliability Coordinator: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

**5.1.** A Corrective Action Plan (CAP) for the identified Inverter Based Resource(s), including other applicable facilities owned by the Generator Owner as identified in Requirement R4 Part 4.2; or

**5.2.** A technical justification that addresses why corrective actions will not be applied nor implemented.

**M5.** Each applicable Generator Owner shall have dated evidence (electronic or hardcopy format) that demonstrates it developed a CAP or a technical justification, and evidence of transmittal to the Reliability Coordinator in accordance with Requirement R5.

# Project 2023-02 Proposed PRC-030-1 R6

**R6.** Each applicable Generator Owner shall, for each of its CAPs developed pursuant to Requirement R5: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*

**6.1.** Implement the CAP;

**6.2.** Update the CAP if actions or timetables change; and

**6.3.** Notify each applicable Reliability Coordinator if CAP actions or timetables change and when the CAP is completed.

**M6.** Acceptable evidence may include, but is not limited to, dated documentation such as CAPs, project or work management program records, settings sheets, work orders, maintenance records, communication with equipment manufacturers, and communication with each applicable Reliability Coordinator that documents the implementation, updating, or completion of a CAP in accordance with Requirement R5.

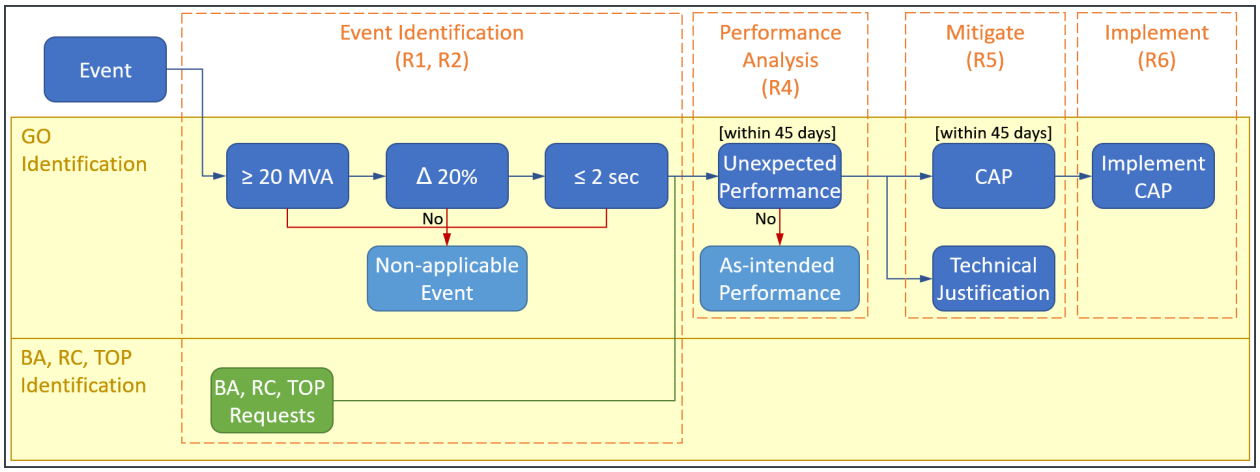


Figure 1.1: PRC-030-1 Flowchart

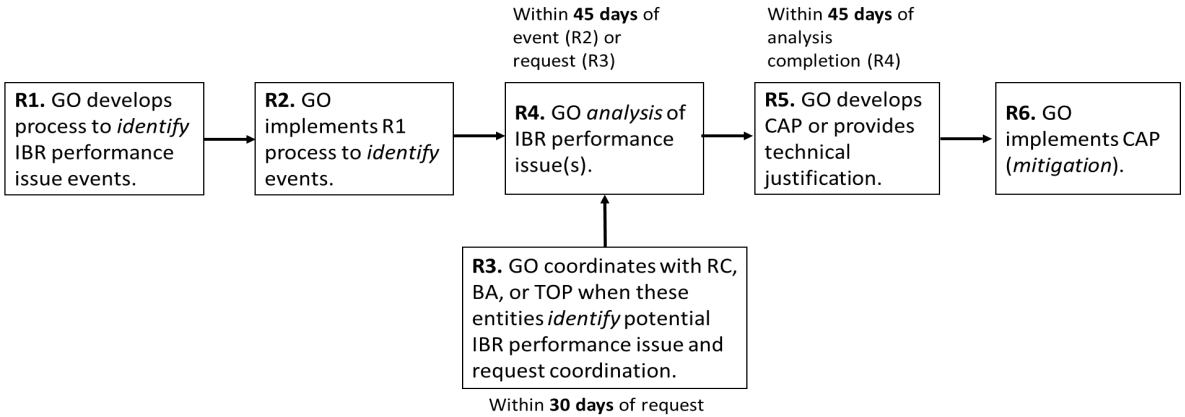


Figure 1.2: Relationship of PRC-030-1

# Project 2023-02 Implementation Plan

- Effective Date Reliability Standards PRC-030-1
  - Within six months after FERC adopts the reliability standard

**Effective Date**

The effective date for the proposed Reliability Standard is provided below.

**Standard PRC-030-1**

Where approval by an Applicable Governmental Authority is required, Reliability Standard PRC-030-1 shall become effective on the first day of the first calendar quarter that is six months after the effective date of the applicable governmental authority's order approving the standard, or as otherwise provided for by the applicable governmental authority.

Where approval by an applicable governmental authority is not required, Reliability Standard PRC-030-1 shall become effective on the first day of the first calendar quarter that is six months after the date the standard is adopted by the NERC Board of Trustees, or as otherwise provided for in that jurisdiction.

# Project 2023-02 Next Steps

- Relevant information
  - Project page
- Ballot dates
  - 25-day initial ballot and comment period
  - March 25, 2024 to April 18, 2024
  - Non-binding polls and information for VRFs and VSLs will be from April 9 to April 18, 2024
- Contact
  - Josh Blume: josh.blume@nerc.net
  - Mark Gutzmann : mark.g.gutzmann@xcelenergy.com
  - Biju Gopi : BGopi@caiso.com

# Questions and Answers

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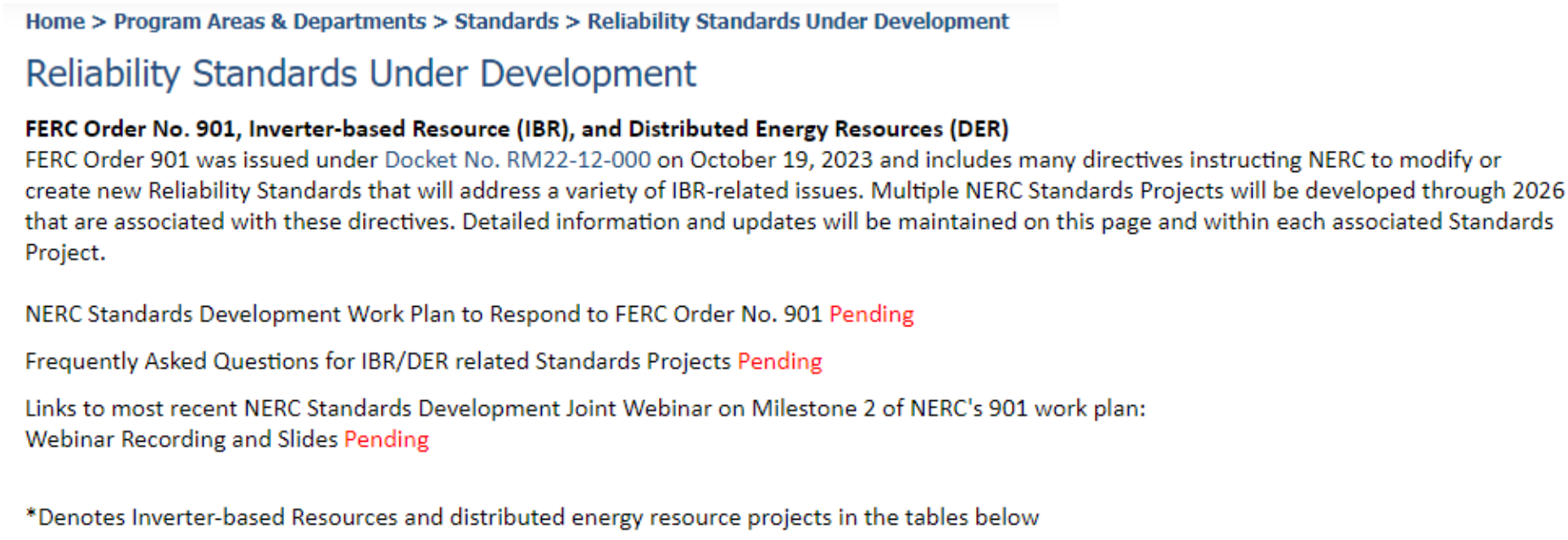
# Closing Remarks

- Thank you for attending!
- Location of webinar recording and slides
- Please comment and vote on active postings
- Please share!



Home > Program Areas & Departments > Standards > Reliability Standards Under Development

## Reliability Standards Under Development

**FERC Order No. 901, Inverter-based Resource (IBR), and Distributed Energy Resources (DER)**
FERC Order 901 was issued under Docket No. RM22-12-000 on October 19, 2023 and includes many directives instructing NERC to modify or create new Reliability Standards that will address a variety of IBR-related issues. Multiple NERC Standards Projects will be developed through 2026 that are associated with these directives. Detailed information and updates will be maintained on this page and within each associated Standards Project.

NERC Standards Development Work Plan to Respond to FERC Order No. 901 Pending

Frequently Asked Questions for IBR/DER related Standards Projects Pending

Links to most recent NERC Standards Development Joint Webinar on Milestone 2 of NERC's 901 work plan:
Webinar Recording and Slides Pending

*Denotes Inverter-based Resources and distributed energy resource projects in the tables below

# Resources

- Project 2020-06 Verification of Models and Data for Generators
- Project 2021-04 Modifications to PRC-002-2
- Project 2020-02 Modifications to PRC-024 (Generator Ride-Through)
- Project 2023-02 Analysis and Mitigation of BES Inverter-Based Resource Performance Issues
- Inverter-Based Resource Strategy, June 2022
- FERC Order No. 901, October 2023
- NERC Work Plan to Address FERC Order No. 901, January 2024
- IBR Registration Initiative Resources, February 2024
  - IBR Registration Quick Reference Guide, February 2024
  - Proposed Revisions to ROP, March 2024

# Quick Reference Guide: IBR Registration Initiative

February 2024

As part of its *Inverter-Based Resource Strategy*, NERC is dedicated to identifying and addressing challenges associated with inverter-based resources (IBR) as the penetration of these resources continues to increase. ERO Enterprise assessments identified a reliability gap associated with the increasing integration of IBRs as part of the grid in which a significant level of bulk power system-connected IBR owners and operators are not yet required to register with NERC or adhere to its Reliability Standards.

In response, FERC issued an order in 2022 directing NERC to identify and register owners and operators of currently unregistered bulk power system-connected IBRs. Working closely with industry and stakeholders, NERC is executing a FERC-approved work plan to achieve the identification and registration directive by 2026. Resources are also posted on the Registration page of the NERC website.

## Key Activity

- NERC submitted its quarterly work plan update to FERC on February 12.
- NERC's Board of Trustees approved proposed Rules of Procedure revisions on February 22.
- NERC plans to submit these proposed revisions to FERC in early March.

## IBR Registration Milestones

**Phase 1: May 2023–May 2024**

- Complete Rules of Procedure revisions and approvals
- Commence Category 2 GO and GOP candidate outreach and education (e.g., through trade organizations)

**Phase 2: May 2024–May 2025**

- Complete identification of Category 2 GO and GOP candidates
- Continue Category 2 GO and GOP candidate outreach and education (e.g., quarterly updates, webinars, workshops, etc.)

**Phase 3: May 2025–May 2026**

- Complete registration of Category 2 GO and GOP candidates thereafter subject to applicable NERC Reliability Standards
- Conduct specific Category 2 GO and GOP outreach and education (e.g., quarterly updates, webinars, workshops, etc.)

## Available Resources

- Frequently Asked Questions – Rules of Procedure Approach to Registration of Unregistered IBRs
- IBR Webinar Series and FAQs
- Quick Reference Guide: Candidate for Registration
- Quick Reference Guide: Inverter-Based Resource Activities
- NERC Registration Page
- Join the E-ISAC

LEARN MORE ABOUT NERC AND THE E-ISAC