NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Industry Webinar

Project 2020-02 Modifications to PRC-024 (Generator Ride-through)
PRC-024-4 and PRC-029-1
April 15, 2024

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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

Order 901 Summary

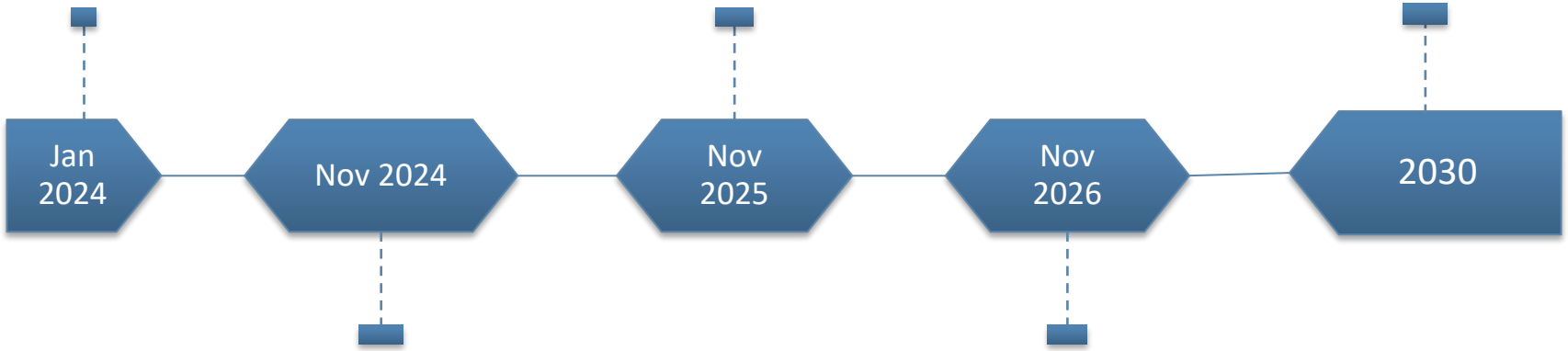
- FERC Order 901
  - Issued October 2023
  - Includes 4 Milestones dates through November 2026
  - Addresses a wide spectrum of IBR related performance issues and Reliability Standards
  - Brings forward RSTC guidance and expertise into standards projects

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

Drafting Team Roster

	Name	Entity
Chair	Xiaoyu (Shawn) Wang	Enel North America
Vice Chair	Husam Al-Hadidi	Manitoba Hydro
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	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

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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 27thth 2024 to April 22nd 2024
  - Non-binding polls of VRF and VSL will be from April 12th to April 22nd 2024
- Contact information
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Questions and Answers