
Project QC-2021-06

Reliability Standard PRC-024-3 – Frequency and Voltage Protection Settings for Generating Resources

1. OVERVIEW OF THE STANDARD

1.1. Applicability of the Standard

The following table lists the functional entities to which PRC-024-3, the standard proposed for adoption (the “Standard”), applies.

Standard	Functions covered
PRC-024-3	Generator Owners (GO) that apply protection listed in Section 4.2.1. Transmission Owners (TO) (in the Québec Interconnection only) that own a BES generator step-up (GSU) transformer or main power transformer (MPT) and apply protection listed in Section 4.2.1. Planning Coordinators (PC) (in the Québec Interconnection only)

1.2. Purpose of the standard

This section describes the purpose of the Standard. More specifically, the title and purpose of the Standard are given below.

PRC-024-3 – Frequency and Voltage Protection Settings for Generating Resources: To set protection such that generating resource(s) remain connected during defined frequency and voltage excursions in support of the Bulk Electric System (BES).

1.3. Regulatory Context

1.3.1. Regulatory Context in Québec

The Standard replaces Reliability Standard PRC-024-2 adopted by the Régie de l’énergie (hereinafter, the “Régie”) in decision D-2020-167.¹ Standard PRC-024-2 came into effect in Québec on April 1, 2021.

1.3.2. U.S. Regulatory Context

Adopted by the NERC Board of Trustees on February 6, 2020, and approved by the Federal Energy Regulatory Commission (FERC) on July 9, 2020 (Letter Order, Docket No. RD20-7-000²), the Standard will become effective in the United States on October 1, 2022.

¹Régie Decision D-2020-167 [in French only], retrieved on February 9, 2021, from http://publicsde.regie-energie.qc.ca/projets/483/DocPri/R-4070-2018-A-0046-Dec-Dec-2020_12_11.pdf.

² FERC Letter Order, Docket No. RD20-7-000, retrieved on January 28, 2021, from <https://www.nerc.com/FilingsOrders/us/FERCOrdersRules/Order Approving of Reliability Standard PRC-024-3.pdf>.

1.4. Special provision for Québec

For the special provisions to be recorded in the Québec Appendix of the Standard, the Coordinator proposes to renew the special provision that deals with facilities covered by the Standard, namely the following provision:

“The facilities covered by this standard are the facilities of the Main Transmission System (RTP).”

In addition, the Coordinator proposes to renew the special provision relating to Requirement R1 and to replace the terms “wind and photovoltaic generating stations” with “inverter-based resources” in order to better reflect the text of the Standard. With the amendments, the provision reads as follows:

“Inverter-based resources, thermal generating stations as well as generating stations equipped with asynchronous generators shall adhere to the curves in Appendix 1, as specified by Requirement R1, except that they may be tripped at a frequency of ≥ 61.7 Hz.”

This provision is motivated by the fact that HQT’s technical connection requirements allow inverter-based resources, thermal generating stations and generating stations with asynchronous units to trip when the grid frequency is greater than or equal to 61.7 Hz. In addition, the equipment in these generating stations generally cannot withstand a frequency higher than 61.7 Hz and must therefore trip to avoid equipment failure.

1.5. Proposed effective dates

The Implementation Plan for NERC Project 2018-04³ proposes an effective date of PRC-024-3 twenty-four (24) months following the date of regulatory approval.

The Coordinator points out that the implementation plan complies with the Régie’s established practice for standards to come into force, namely to have standards come into force on the first day of a calendar quarter⁴ and to have a minimum delay of 60 days⁵ between the date of adoption and the effective date of the standard.

While considering the importance of a mandatory reliability regime harmonized with the United States, the Coordinator proposes to deviate from the NERC Implementation Plan in order to meet the implementation schedule set forth in Standard PRC-024-2. In fact, standard PRC-024-2 provides in its Québec Appendix that the 100% applicability of the standard on the covered facilities comes effective on July 1, 2025. Therefore, in order to take into account the necessary adjustments of the entities concerned and the regional variances for the Québec Interconnection, the Coordinator proposes that Standard PRC-

³ Implementation Plan for NERC Project 2018-04, retrieved on March 2, 2021, from [https://www.nerc.com/pa/Stand/Project 201804 Modifications to PRC0242/2018-04_PRC-024-3_Implementation_Plan_12042019.pdf](https://www.nerc.com/pa/Stand/Project%201804%20Modifications%20to%20PRC0242/2018-04_PRC-024-3_Implementation_Plan_12042019.pdf).

⁴ In decision D-2015-168, the Régie set the effective date of the standards as the first day of the calendar quarters following the date of adoption of the standard.

⁵ In decision D-2016-011, the Régie set a minimum of at least 60 days between adoption of a standard and its effective date.

024-3 come into force as soon as PRC-024-2 is fully implemented on the facilities concerned, thus leaving a delay of approximately four (4) years for the implementation of the requirements of the Standard. Furthermore, the Coordinator points out that Standard PRC-024-3 comes effective on October 1, 2022, in neighboring jurisdictions for 100% of the facilities covered by the Standard. The table below summarizes the Coordinator's proposal.

Requirement	Effective date in the United States	Proposed effective date in Québec	Rationale
R1 to R4	October 1, 2022 ⁶	July 1, 2025 ⁷	To be consistent with the implementation dates of Standard PRC-024-2.
D.A.2	Not applicable ⁸		To be consistent with the implementation of Requirement R2 of the Standard since Requirement D.A.2 must be in effect at the same time as Requirement R2.
D.A.5	Not applicable		Requirement D.A.5 shall be implemented at the same time as requirement D.A.2.

1.6. Standards or Requirements to Retire

This submission calls for retirement of the following standards:

To retire	Comments
PRC-024-2	Version 2 of PRC-024 was adopted in decision D-2020-167 ⁹ and implemented in Québec on April 1, 2021. Version 2 is to be retired as soon as PRC-024-3 becomes effective, in accordance with the NERC Implementation Plan. ¹⁰

1.7. Changes to the Glossary

No changes to the Glossary.

2. ASSESSMENT OF RELEVANCE

The assessment of the relevance of the Standard is separated into three subsections. First, the subsection on the continental standard discusses the relevance of the changes made to the Standard since its previous version to entities in North America. The second subsection deals with the relevance of the Québec Interconnection variance that was added in version 3 of PRC-024. Finally, the last subsection presents the Coordinator's conclusion on the relevance of the Standard.

⁶ 100% of the facilities covered by the Standard will have to comply with the requirements of the Standard by October 1, 2022.

⁷ The Coordinator proposes that 100% of the facilities covered by the Standard will have to comply with the requirements of the Standard by July 1, 2025.

⁸ Only applicable to the Québec Interconnection.

⁹ See note 1.

¹⁰ See note 3.

2.1. Continent-wide Standard

Reliability Standard PRC-024-3 contains a series of revisions and clarifications to ensure that inverter-based resources have adequate frequency and voltage response to System disturbances to adequately contribute to System reliability. Inverter-based resources include photovoltaic cells, wind generating stations, batteries, etc.

This revision to the Standard is in response to the recommendations of the *NERC Inverter-Based Resource Performance Task Force* (IRPTF).¹¹ These recommendations were developed with reference to the analyses and recommendations of NERC and the Western Electricity Coordinating Council following the Blue Cut Fire¹² and Canyon 2¹³ incidents in California.

In summary, these incidents have identified that inverters that trip instantaneously on near-instantaneous frequencies are susceptible to erroneous tripping during transient conditions on the grid. In addition, it was determined that inverter-based resources return to pre-disturbance voltage or frequency levels too slowly for their intended purpose because the facility controller's¹⁴ *ramp rate* limit used to balance generation and load is applied to inverter-based resources as soon as a momentary interruption occurs. To learn more about these study results, the Coordinator invites anyone interested to consult the reports on the Blue Cut Fire¹⁵ and Canyon 2¹⁶ incidents.

Specifically, recommendations from the IRPTF reports and the Blue Cut Fire and Canyon 2 incidents identified a number of fixes to the Standard that would clarify its purpose, particularly for owners, designers and manufacturers of inverter-based resource equipment. For more information on the fixes, the *Standard Authorization Request*¹⁷ is a detailed reference of the justifications. The Coordinator summarizes the corrections made below:

- 1- Requirements R1 and R2 have been modified so that a generation resource cannot trip or momentarily stop injecting power if the generation resource is within the non-trip zone specified in Appendices 1 and 2 respectively;
- 2- Clarification of some ambiguities with respect to the area outside the no-trip zone and the language used in Appendices 1 and 2;
- 3- Addition of Section 4.2 (Facilities) to clarify the protections applicable to the Standard.

In addition to the changes noted above, the revision to the Standard subject to approval in this document focuses on two additional issues identified by the NERC Drafting Committee (SDT). For more information

¹¹ Generating unit for the performance of inverter-based resources. For more details on the generating unit's objectives, see <https://www.nerc.com/comm/PC/Pages/Inverter-Based-Resource-Performance-Task-Force.aspx>.

¹² Report from the *Blue Cut Fire* incident, retrieved on March 3, 2021, from [https://www.nerc.com/pa/rrm/ea/1200 MW Fault Induced Solar Photovoltaic Resource /1200 MW Fault Induced Solar Photovoltaic Resource Interruption Final.pdf](https://www.nerc.com/pa/rrm/ea/1200%20MW%20Fault%20Induced%20Solar%20Photovoltaic%20Resource%20/1200%20MW%20Fault%20Induced%20Solar%20Photovoltaic%20Resource%20Interruption%20Final.pdf).

¹³ Report from the *Canyon 2 Fire* incident, retrieved on March 3, 2021, from [https://www.nerc.com/pa/rrm/ea/October 9 2017 Canyon 2 Fire Disturbance Report/900 MW Solar Photovoltaic Resource Interruption Disturbance Report.pdf#search=blue cut fire](https://www.nerc.com/pa/rrm/ea/October%209%202017%20Canyon%202%20Fire%20Disturbance%20Report/900%20MW%20Solar%20Photovoltaic%20Resource%20Interruption%20Disturbance%20Report.pdf#search=blue%20cut%20fire).

¹⁴ *Ramp* or *ramp rate* is the rate, expressed in megawatts per minute, at which a generator changes its output.

¹⁵ See note 7.

¹⁶ See note 8.

¹⁷ *Standard Authorization Request* from NERC Project 2018-04, retrieved on March 3, 2021, from [https://www.nerc.com/pa/Stand/Project 201804 Modifications to PRC0242/PRC-024-2 SAR Clean 02202019.pdf](https://www.nerc.com/pa/Stand/Project%20201804%20Modifications%20to%20PRC0242/PRC-024-2%20SAR%20Clean%2002202019.pdf).

on these two issues and those mentioned above, please refer to the full NERC filings in Project 2018-04.¹⁸ For the two additional issues, the *Supplemental Standard Authorization Request*¹⁹ is a good indicator of the rationale for these two issues.

First, in the previous version of the Standard, PRC-024-2, Requirements R1 and R2 refer only to “generator frequency protective relays,” which leads to an interpretation that excludes the setting of voltage and frequency protective relays on generator step-up (GSU) transformers associated with synchronous generating units. In reality, the GSU transformer and the generating set are connected to the same bus and will therefore observe the same frequency and voltage. Therefore, the voltage and frequency protective settings applied to the relays on the GSU transformers must be included in the Standard since the use of these relays could result in a trip of the generating unit and thus cause equipment failure and, incidentally, outages.

The second issue addresses the fact that the previous version of the Standard, PRC-024-2, is applicable only to Generation Owners, which excludes situations where a Transmission Owner is the entity that owns the GSU transformer and therefore the associated voltage and frequency protective relays.

In summary, this revision of the Standard subject to approval improves reliability by eliminating the two issues presented above:

- 1- Requiring that all voltage and frequency protections at the point of Interconnection (for the high voltage side of the GSU transformer) adhere to the voltage and frequency limit curves of the Standard; and
- 2- Requiring *Transmission Facility Owners* with GSU transformers and their associated voltage and frequency protective relays to comply with the Standard.

By eliminating these inconsistencies, System reliability is improved as all entities contributing to the reliability objectives through this Standard are included in this revision.

2.2. Regional Variance for the Québec Interconnection

Version 3 of PRC-024 includes regional variances applicable to the Québec Interconnection. The purpose of these regional variances is to extend the scope of Requirements R1, R3 and R4 to Transmission Owners that have a GSU transformer or MPT that is part of the RTP and has certain protections (Section 4.2.1 of the Standard). In addition, Requirement R2 is replaced in its entirety by Requirement D.A.2 and an additional requirement, D.A.5, is added to the Standard. The following two subsections outline these requirements for the Québec Interconnection.

2.2.1. The Voltage Non-trip Limit Curve (Requirement D.A.2)

The Standard provides that Requirement R2 be replaced by Requirement D.A.2 for the Québec Interconnection in order to replace the voltage non-trip limit curve, which is a more stringent requirement than NERC, primarily due to the particular topology of the Québec Interconnection System. The latter is

¹⁸ NERC Project 2018-04, retrieved on March 3, 2021, from <https://www.nerc.com/pa/Stand/Pages/Project-2018-04-Modifications-to-PRC-024-2.aspx>.

¹⁹ *Supplemental Standard Authorization Request* from NERC Project 2018-04, retrieved on March 3, 2021, from <https://www.nerc.com/pa/Stand/Project-201804-Modifications-to-PRC024/2018-04-Supplemental-SAR-PRC-024-06272019.pdf>.

more susceptible to power and voltage swings than neighboring Interconnections not only because of its weak mesh, but also because of the distance between generation centers and large pockets of load. In addition, the curve proposed in Requirement D.A.2 of the Standard mitigates the risk of disturbances leading to cascading. This requirement ensures an Adequate Level of Reliability for the entire Québec Interconnection.

In addition, Requirement D.A.2 provides that strategic power plants newly designated by the Planning Coordinator have 48 months to comply with the voltage non-trip limit curve applicable to strategic power plants (see next section for explanation of strategic power plants). Therefore, Requirement D.A.2 must be implemented at the same time as Requirement D.A.5.

2.2.2. Designation of strategic power plants (Requirement D.A.5)

In addition, Requirement D.A.5 is added to the Standard for Québec Interconnection Planning Coordinators who must designate, at least once every five (5) calendar years, the strategic power plants subject to Appendix 2a with the voltage non-trip limit curve applicable to the Québec Interconnection. Requirement D.A.2 provides for a 48-month delay for Generator Owners that have a strategic generating station newly designated by the Planning Coordinator. Therefore, Requirement D.A.5 must be in effect on the same date as Requirement D.A.2.

Strategic power plants are stations that are required to operate to protect the integrity of the transmission system equipment and therefore must remain in service without tripping a unit despite surges that may occur during separation and instability of part or all of the transmission system. Facilities subject to this requirement must be designed, built and operated in such a way that they remain in service without directly or indirectly causing generating unit tripping when voltage deviations occur for the durations specified in Appendix 2a of the Standard.

The Coordinator has obtained from the Planning Coordinator a list of the strategic power plants designated by the Coordinator. To date, the strategic power plants are strictly facilities owned by Hydro-Québec Production (HQP).

2.3. Conclusion of the Assessment of Relevance

In order to summarize the changes made to version 2 of PRC-024, the Coordinator presents in Appendix 1 of this document a summary table of the changes made to the requirements of version 2 of PRC-024.

On July 9, 2020, FERC approved the reasons set forth by NERC in its proposed adoption of PRC-024-3.²⁰ In particular, FERC found that PRC-024-3 enhances the effectiveness of Reliability Standard PRC-024-2 by clarifying the requirements for frequency and voltage protection settings for generation resources, especially as inverter-based resources are expected to contribute to the support of system stability during voltage or frequency excursions.

²⁰ See note 2.

In addition, neighboring jurisdictions, including those of New Brunswick²¹ and Ontario,²² have also adopted standard PRC-024-3.

Given the information outlined above and the fact that this standard was developed by organizations recognized in North America (including in Québec and in neighboring jurisdictions), in accordance with the agreement signed in 2009 by the Régie, NERC and the NPCC, with the authorization of the Government of Québec,²³ the Coordinator is of the opinion that standard PRC-024-3 contributes to the reliability of the Québec grid, that it is relevant for Québec and that it contributes to harmonization with neighboring territories.

3. PRELIMINARY IMPACT ASSESSMENT

This section presents the *Reliability Coordinator's* preliminary impact assessment.

PRC-024-3	Low	Moderate	High
Implementation of the Standard			X
Enforcement of the Standard	X		
Compliance monitoring	X		

Legend:

- Low:** Normal industry practice or standard that only requires minor adjustments to existing processes or practices.
- Moderate:** Change that requires the mobilization of some physical, human or financial resources to implement the proposed standard, enforce it or monitor its compliance.
- High:** Change that requires provision and mobilization of significant physical, human or financial resources to plan and implement the proposed standard, enforce it or monitor its compliance.

FINAL IMPACT ASSESSMENT

This section will be completed upon receipt of the impact assessment forms and at the conclusion of the consultation process prior to filing of the Standard with the Régie.

²¹ Reliability Standards on the *New Brunswick Energy and Utilities Board* website, retrieved on March 3, 2021, from <https://nbeub.ca/reliability-standards>.

²² NERC Reliability Standards Effective Dates on the *Independent Electricity System Operator* (Ontario) website, retrieved on March 3, 2021, from <https://www.ieso.ca/en/Sector-Participants/System-Reliability/Enforcement-Dates>.

²³ Agreement entered into pursuant to Decree No. 443-2009 issued on April 8, 2009. http://www.regie-energie.qc.ca/audiences/normes_fiab_tramp_elec/Entente_Regie_NERC_NPCC_5mai09.pdf.

APPENDIX 1 – CHANGES TO THE STANDARD’S REQUIREMENTS

The following table shows the changes to the requirements of Standard PRC-024 Version 2 reflected in PRC-024 Version 3.

Requirement	Changes in relation to the previous version
R1	Two exceptions allowing frequency protective relays to trip a generating unit within the non-trip zone specified in Appendix 1 are retired: <ul style="list-style-type: none"> • Generating unit(s) may trip if the protective functions operate due to an impending or actual loss of synchronism or an instability in power conversion control equipment. • Generating unit(s) may trip if clearing a system fault necessitates disconnecting (a) generating unit(s).
R2	Replacement of Requirement R2 with Requirement D.A.2 for the Québec Interconnection. However, three exceptions that allow voltage protection relays to trip a generating unit within the non-trip zone specified in Appendix 2 are retired. These withdrawn exceptions are also withdrawn for the Québec Interconnection: <ul style="list-style-type: none"> • A generating unit may be tripped in accordance with a Remedial Action Scheme (RAS); • Generating unit(s) may trip if clearing a system fault necessitates disconnecting (a) generating unit(s). • Generating unit(s) may trip if the protective functions operate due to an impending or actual loss of synchronism or, for asynchronous generating units, due to instability in power conversion control equipment.
R3	No substantive changes.
R4	No substantive changes.
D.A.2	This requirement replaces Requirement R2 for the Québec Interconnection. Essentially, additional exceptions to allow a unit to trip within the non-trip zone specified in Appendix 2a have been added for strategic power plants and inverter-based resources: <ul style="list-style-type: none"> • Newly designated strategic power plants have 48 months to comply with the surge curve for strategic power plants; • Inverter-based resources stop current injection momentarily during a voltage excursion under the conditions mentioned in the requirement (see Requirement D.A.2 of the Standard).
D.A.5	This requirement calls for the Planning Coordinator to designate strategic power plants at least every five (5) years.