

## Standard PRC-023-2 — Transmission Relay Loadability

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### A. Introduction

1. **Title:** Transmission Relay Loadability

2. **Number:** PRC-023-~~12~~

3. **Purpose:** Protective relay settings shall not limit transmission loadability; not interfere with system operators' ability to take remedial action to protect system reliability and; be set to reliably detect all fault conditions and protect the electrical network from these faults.

4. **Applicability:**

**4.1. Functional Entity**

**4.1.1** Transmission Owners with load-responsive phase protection systems as described in PRC-023-2 - Attachment A, applied to ~~facilities~~circuits defined ~~below~~in 4.2.1 (Circuits Subject to Requirements R1 – R5).

**4.1.2** Generator Owners with load-responsive phase protection systems as described in PRC-023-2 - Attachment A, applied to circuits defined in 4.2.1 (Circuits Subject to Requirements R1 – R5).

**4.1.3** Distribution Providers with load-responsive phase protection systems as described in PRC-023-2 - Attachment A, applied to circuits defined in 4.2.1 (Circuits Subject to Requirements R1 – R5), provided those circuits have bi-directional flow capabilities.

**4.1.4** Planning Coordinators

**4.2. Circuits**

**4.2.1 Circuits Subject to Requirements R1 – R5**

~~4.1.1.14.2.1.1~~ **4.2.1.1** Transmission lines operated at 200 kV and above.

**4.2.1.2** Transmission lines operated at 100 kV to 200 kV ~~as designated~~selected by the Planning Coordinator ~~as~~.

~~4.1.1.24.2.1.3~~ **4.2.1.3** Transmission lines operated below 100 kV that are included on a critical ~~to~~facilities list defined by the reliability of Regional Entity<sup>1</sup> and selected by the Bulk Electric System. Planning Coordinator in accordance with R6.

~~4.1.1.34.2.1.4~~ **4.2.1.4** Transformers with low voltage terminals connected at 200 kV and above.

~~4.1.1.44.2.1.5~~ **4.2.1.5** Transformers with low voltage terminals connected at 100 kV to 200 kV ~~as designated~~selected by the Planning Coordinator ~~as critical to the reliability of the Bulk Electric System~~.

**4.2.1.6** ~~Generator Owners~~Transformers with ~~load responsive phase low voltage~~ terminals connected below 100 kV that are included on a critical facilities list defined by the Regional Entity and selected by the Planning Coordinator in accordance with R6.

**4.2.2 Circuits Subject to Requirement R6**

**4.2.2.1** Transmission lines operated at 100 kV to 200 kV and transformers with low voltage terminals connected at 100 kV to 200 kV

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<sup>1</sup> If the Regional Entity has developed such a list.

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4.2.2.2 Transmission lines operated below 100 kV and transformers with low voltage terminals connected below 100 kV that are included on a critical facilities list defined by the Regional Entity

### 5. Effective Dates

#### 5.1. Requirement R1

5.1.1 For transmission lines operating at 200 kV and above and transformers with low voltage terminals connected at 200 kV and above.

5.1.1.1 The first day of the first calendar quarter after applicable regulatory approval or in those jurisdictions where no regulatory approval is required, the first calendar quarter after Board of Trustees adoption, except as noted below.

5.1.1.1.1 For the addition to Requirement R1, criterion 10, to set transformer fault protection systems relays and transmission line relays on transmission lines terminated only with a transformer such that the protection settings do not expose the transformer to fault level and duration that exceeds its mechanical withstand capability, the first day of the first calendar quarter 12 months after applicable regulatory approval, or in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter 12 months after Board of Trustees adoption.

4.1.1.4.15.1.1.1.2 For supervisory elements as described in PRC-023-2 - Attachment A, applied to facilities defined in 4. Section 1.4 through 4.1.46, the first day of the first calendar quarter 24 months after applicable regulatory approvals, or in those jurisdictions where regulatory approval is not required, the first day of the first calendar quarter 24 months after Board of Trustees adoption.

4.2. Distribution Providers with load responsive phase protection systems For switch-on-to-fault schemes as described in PRC-023-2 - Attachment A, applied according to facilities defined in 4.1.1 through 4.1.4., provided that those facilities have bi-directional flow capabilities.

4.3. Planning Coordinators:

### 5. Effective Dates<sup>2</sup>:

5.1. Requirement 1, Requirement 2:

5.1.1 For circuits described in 4.1.1 and 4. Section 1.3 above (except for switch on to fault schemes) —, the beginning later of the first day of the first calendar quarter following after applicable regulatory approvals.

5.1.1.1.15.1.1.1.3 For circuits described in 4.1. approval of PRC-023-2 and 4.1.4 above (including switch on to fault schemes) — at the beginning or the first day of the first calendar quarter 39 months following applicable regulatory approvals, approval of PRC-023-1; or in those jurisdictions where no regulatory approval is required, the later of the first day of the

<sup>2</sup>Temporary Exceptions that have already been approved by the NERC Planning Committee via the NERC System Protection and Control Task Force prior to the approval of this standard shall not result in either findings of non-compliance or sanctions if all of the following apply: (1) the approved requests for Temporary Exceptions include a mitigation plan (including schedule) to come into full compliance; and (2) the non-conforming relay settings are mitigated according to the approved mitigation plan.

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first calendar quarter after Board of Trustees adoption of PRC-023-2 or July 1, 2011.

5.1.2 Each Transmission Owner, Generator Owner, and Distribution Provider shall have 24 months after being notified by its For circuits identified by the Planning Coordinator pursuant to R3.3 to comply with R1 (including all sub requirements) for each facility that is added to Requirement R6

5.1.2.1 The later of the first day of the first calendar quarter 39 months following notification by the Planning Coordinator's critical facilities list determined Coordinator of a circuit's inclusion on a list of circuits subject to PRC-023-2 per application of Attachment B, or the first day of the first calendar year in which any criterion in Attachment B applies.

### 5.2. Requirements R2 and R3

5.2.1 For transmission lines operating at 200 kV and above and transformers with low voltage terminals connected at 200 kV and above.

5.2.1.1 The first day of the first calendar quarter after applicable regulatory approval, or in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter after Board of Trustees adoption.

5.1.2.2 For circuits identified by the Planning Coordinator pursuant to R3.1-Requirement R6

5.2. Requirement 3: 18 months following applicable regulatory approvals:

5.2.2.1 Requirements The later of the first day of the first calendar quarter 39 months following notification by the Planning Coordinator of a circuit's inclusion on a list of circuits subject to PRC-023-2 per application of Attachment B, or the first day of the first calendar year in which any criterion in Attachment B applies.

### 5.3. Requirements R4 and R5

The first day of the first calendar quarter six months after applicable regulatory approval, or in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter six months after Board of Trustees adoption.

### 5.4. Requirement R6

The first day of the first calendar quarter 18 months after applicable regulatory approval, or in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter 18 months after Board of Trustees adoption.

## B. Requirements

- R1.** Each Transmission Owner, Generator Owner, and Distribution Provider shall use any one of the following criteria (Requirement R1, criteria 1 through R1.13) for any specific circuit terminal to prevent its phase protective relay settings from limiting transmission system loadability while maintaining reliable protection of the Bulk Electric System BES for all fault conditions. Each Transmission Owner, Generator Owner, and Distribution Provider shall evaluate relay loadability at 0.85 per unit voltage and a power factor angle of 30 degrees: [Violation Risk Factor: High] [Mitigation Time Horizon: Long Term Planning].

### Criteria:

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1. Set transmission line relays so they do not operate at or below 150% of the highest seasonal Facility Rating of a circuit, for the available defined loading duration nearest 4 hours (expressed in amperes).
2. Set transmission line relays so they do not operate at or below 115% of the highest seasonal 15-minute Facility Rating<sup>3</sup> of a circuit (expressed in amperes).
3. Set transmission line relays so they do not operate at or below 115% of the maximum theoretical power transfer capability (using a 90-degree angle between the sending-end and receiving-end voltages and either reactance or complex impedance) of the circuit (expressed in amperes) using one of the following to perform the power transfer calculation:
  - An infinite source (zero source impedance) with a 1.00 per unit bus voltage at each end of the line.
  - An impedance at each end of the line, which reflects the actual system source impedance with a 1.05 per unit voltage behind each source impedance.
4. Set transmission line relays on series compensated transmission lines so they do not operate at or below the maximum power transfer capability of the line, determined as the greater of:
  - 115% of the highest emergency rating of the series capacitor.
  - 115% of the maximum power transfer capability of the circuit (expressed in amperes), calculated in accordance with [R1-Requirement R1, criterion 3](#), using the full line inductive reactance.
5. Set transmission line relays on weak source systems so they do not operate at or below 170% of the maximum end-of-line three-phase fault magnitude (expressed in amperes).
6. Set transmission line relays applied on transmission lines connected to generation stations remote to load so they do not operate at or below 230% of the aggregated generation nameplate capability.
7. Set transmission line relays applied at the load center terminal, remote from generation stations, so they do not operate at or below 115% of the maximum current flow from the load to the generation source under any system configuration.
8. Set transmission line relays applied on the bulk system-end of transmission lines that serve load remote to the system so they do not operate at or below 115% of the maximum current flow from the system to the load under any system configuration.
9. Set transmission line relays applied on the load-end of transmission lines that serve load remote to the bulk system so they do not operate at or below 115% of the maximum current flow from the load to the system under any system configuration.
10. Set transformer fault protection relays and transmission line relays on transmission lines terminated only with a transformer so that ~~they~~[the relays](#) do not operate at or below the greater of:
  - 150% of the applicable maximum transformer nameplate rating (expressed in amperes), including the forced cooled ratings corresponding to all installed supplemental cooling equipment.

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<sup>3</sup> When a 15-minute rating has been calculated and published for use in real-time operations, the 15-minute rating can be used to establish the loadability requirement for the protective relays.

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- 115% of the highest operator established emergency transformer rating.

10.1 Set load responsive transformer fault protection relays, if used, such that the protection settings do not expose the transformer to a fault level and duration that exceeds the transformer's mechanical withstand capability<sup>4</sup>.

11. For transformer overload protection relays that do not comply with ~~R1~~ the loadability component of Requirement R1, criterion 10 set the relays according to one of the following:

- Set the relays to allow the transformer to be operated at an overload level of at least 150% of the maximum applicable nameplate rating, or 115% of the highest operator established emergency transformer rating, whichever is greater. ~~The protection must allow this overload,~~ for at least 15 minutes to ~~allow~~ provide time for the operator to take controlled action to relieve the overload.
- Install supervision for the relays using either a top oil or simulated winding hot spot temperature element. ~~The setting should be set~~ no less than 100° C for the top oil ~~or temperature or no less than~~ 140° C for the winding hot spot temperature<sup>5</sup>.

12. When the desired transmission line capability is limited by the requirement to adequately protect the transmission line, set the transmission line distance relays to a maximum of 125% of the apparent impedance (at the impedance angle of the transmission line) subject to the following constraints:

- a. Set the maximum torque angle (MTA) to 90 degrees or the highest supported by the manufacturer.
- b. Evaluate the relay loadability in amperes at the relay trip point at 0.85 per unit voltage and a power factor angle of 30 degrees.
- c. Include a relay setting component of 87% of the current calculated in Requirement R1, ~~criteria~~ 12-2 in the Facility Rating determination for the circuit.

13. Where other situations present practical limitations on circuit capability, set the phase protection relays so they do not operate at or below 115% of such limitations.

~~R2.~~ R2. ~~The~~Each Transmission Owner, Generator Owner, ~~or~~ and Distribution Provider shall set its out-of-step blocking elements to allow tripping of phase protective relays for faults that occur during the loading conditions used to verify transmission line relay loadability per Requirement R1. [Violation Risk Factor: High] [Time Horizon: Long Term Planning]

~~R2-R3.~~ R3. Each Transmission Owner, Generator Owner, and Distribution Provider that uses a circuit capability with the practical limitations described in ~~R1~~ Requirement R1, criterion 6, ~~R1~~-7, ~~R1~~-8, ~~R1~~-9, ~~R1~~-12, or ~~R1~~-13 shall use the calculated circuit capability as the Facility Rating of the circuit and shall obtain the agreement of the Planning Coordinator, Transmission Operator, and Reliability Coordinator with the calculated circuit capability. [Violation Risk Factor: Medium] [Time Horizon: Long Term Planning]

<sup>4</sup> As illustrated by the "dotted line" in IEEE C57.109-1993 - IEEE Guide for Liquid-Immersed Transformer Through-Fault-Current Duration, Clause 4.4, Figure 4

<sup>5</sup> IEEE standard C57.115, Table 3, specifies that transformers are to be designed to withstand a winding hot spot temperature of 180 degrees C, and cautions that bubble formation may occur above 140 degrees C.

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- ~~R3, R4.~~ The Planning Coordinator shall determine which of the facilities (transmission lines operated at 100 kV to 200 kV and transformers with low-voltage terminals connected at 100 kV to 200 kV) in its Planning Coordinator Area are critical to the reliability of the Bulk Electric System to identify the facilities from 100 kV to 200 kV. Each Transmission Owner, Generator Owner, and Distribution Provider that must meet chooses to use Requirement 1 to prevent potential cascade tripping that may occur when protective relay settings limit transmission. R1 criterion 2 as the basis for verifying transmission line relay loadability shall provide its Planning Coordinator, Transmission Operator, and Reliability Coordinator with an updated list of circuits associated with those transmission line relays at least once each calendar year, with no more than 15 months between reports. [Violation Risk Factor: ~~Medium~~ Lower] [Time Horizon: Long Term Planning]
- ~~R5.~~ The Each Transmission Owner, Generator Owner, and Distribution Provider that sets transmission line relays according to Requirement R1 criterion 12 shall provide an updated list of the circuits associated with those relays to its Regional Entity at least once each calendar year, with no more than 15 months between reports, to allow the ERO to compile a list of all circuits that have protective relay settings that limit circuit capability. [Violation Risk Factor: Lower] [Time Horizon: Long Term Planning].
- ~~1.1~~ Each Planning Coordinator shall have a process conduct an assessment at least once each calendar year, with no more than 15 months between assessments, by applying the criteria in Attachment B to determine the facilities that are critical to the reliability of the Bulk Electric System.
- ~~1.3.1~~ This process shall consider input from adjoining Planning Coordinators and affected Reliability Coordinators.
- ~~1.2~~ The circuits in its Planning Coordinator shall maintain a current list of facilities determined according to the process described in R3.1.
- ~~R6.~~ The area for which Transmission Owners, Generator Owners, and Distribution Providers must comply with Requirements R1 through R5. The Planning Coordinator shall: [Violation Risk Factor: High] [Time Horizon: Long Term Planning] Coordinator shall provide a list of facilities to its/
- ~~6.1~~ Maintain a list of circuits subject to PRC-023-2 per application of Attachment B, including identification of the first calendar year in which any criterion in Attachment B applies.
- ~~6.3.2~~ Provide the list of circuits to all Regional Entities, Reliability Coordinators, Transmission Owners, Generator Owners, and Distribution Providers within 30 its Planning Coordinator area within 30 calendar days of the establishment of the initial list and within 30 calendar days of any changes to the that list.

### C. Measures

- ~~M1.~~ The Each Transmission Owner, Generator Owner, and Distribution Provider shall each have evidence such as spreadsheets or summaries of calculations to show that each of its transmission relays are set according to one of the criteria in ~~R1-Requirement R1, criterion 1~~ through ~~R1-13-c~~ and shall have evidence such as coordination curves or summaries of calculations that show that relays set per criterion 10 do not expose the transformer to fault levels and durations beyond those indicated in the standard. (R1)
- ~~M1-M2.~~ Each Transmission Owner, Generator Owner, and Distribution Provider shall have evidence such as spreadsheets or summaries of calculations to show that each of its out-of-step blocking elements is set to allow tripping of phase protective relays for faults that

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occur during the loading conditions used to verify transmission line relay loadability per Requirement R1. (R2)

~~M2-M3.~~ TheEach Transmission Owner, Generator Owner, and Distribution Provider with transmission relays set according to ~~the criteria in Requirement R1, criterion 6, R1-7, R1-8, R1-9, R1-12, or R1-13~~ shall have evidence such as Facility Rating spreadsheets or Facility Rating database to show that it used the calculated circuit capability as the Facility Rating of the circuit and evidence such as dated correspondence that the resulting Facility Rating was agreed to by its associated Planning Coordinator, Transmission Operator, and Reliability Coordinator. ~~(R2R3)~~

M4. ~~The~~Each Transmission Owner, Generator Owner, or Distribution Provider that sets transmission line relays according to Requirement R1, criterion 2 shall have evidence such as dated correspondence to show that it provided its Planning Coordinator ~~shall have,~~ Transmission Operator, and Reliability Coordinator with an updated list of circuits associated with those transmission line relays within the required timeframe. The updated list may either be a documented process for the determination of facilities as described in R3 full list or a list of incremental changes to the previous list. (R4)

M5. Each Transmission Owner, Generator Owner, or Distribution Provider that sets transmission line relays according to Requirement R1, criterion 12 shall have evidence such as dated correspondence that it provided an updated list of the circuits associated with those relays to its Regional Entity within the required timeframe. The updated list may either be a full list or a list of incremental changes to the previous list. (R5)

~~M3-M6.~~ Each Planning Coordinator shall have evidence such as power flow results, calculation summaries, or study reports that it used the criteria established within Attachment B to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard as described in Requirement R6. The Planning Coordinator shall have a current/dated list of such ~~facilities~~circuits and shall have evidence such as dated correspondence that it provided the list to the ~~appropriate~~Regional Entities, Reliability Coordinators, Transmission ~~Operators~~Owners, Generator ~~Operators~~Owners, and Distribution Providers. ~~(R3 within its Planning Coordinator area within the required timeframe. (R6)~~

**D. Compliance**

**1. Compliance Monitoring Process**

**1.1. Compliance Monitoring Responsibility**

- For entities that do not work for the Regional Entity, the Regional Entity shall serve as the Compliance Enforcement Authority.

**~~1.2. Compliance Monitoring Period and Reset Time Frame~~**

~~One calendar year.~~

- For functional entities that work for their Regional Entity, the ERO shall serve as the Compliance Enforcement Authority.

**~~1.3.1.2. Data Retention~~**

The Transmission Owner, Generator Owner, Distribution Provider and Planning Coordinator 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 Transmission Owner, Generator Owner, and Distribution Provider shall each retain documentation to demonstrate compliance with Requirements R1 through R5 for three calendar years.

The Planning Coordinator shall retain documentation of the most recent review process required in ~~R3R6~~. The Planning Coordinator shall retain the most recent list of ~~facilities that are critical to circuits in its Planning Coordinator area for which applicable entities must comply with the reliability of the electric system standard, as~~ determined per ~~R3R6~~.

If a Transmission Owner, Generator Owner, Distribution Provider or Planning Coordinator is found non-compliant, it shall keep information related to the non-compliance until found compliant or for the time specified above, whichever is longer.

The Compliance Monitor shall ~~retain its compliance documentation for three years~~keep the last audit record and all requested and submitted subsequent audit records.

**1.3. Compliance Monitoring and Assessment Processes**

- Compliance Audit
- Self-Certification
- Spot Checking
- Compliance Violation Investigation
- Self-Reporting
- Complaint

**1.4. Additional Compliance Information**

~~The Transmission Owner, Generator Owner, Planning Coordinator, and Distribution Provider shall each demonstrate compliance through annual self-certification, or compliance audit (periodic, as part of targeted monitoring or initiated by complaint or event), as determined by the Compliance Enforcement Authority.~~



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| None.

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2. Violation Severity Levels:

R#Requirement	Lower	Moderate	High	Severe
R1	<u>N/A</u>	Evidence that relay settings comply with criteria in R1.1 through 1.13 exists, but evidence is incomplete or incorrect for one or more of the subrequirements. <u>N/A</u>	<u>N/A</u>	Relay settings do not comply with any of the sub requirements R1.1 through R1.13 OR Evidence does not exist to support that relay settings comply with one of the criteria in subrequirements R1.1 through R1.13. The responsible entity did not use any one of the following criteria (Requirement R1 criterion 1 through 13) for any specific circuit terminal to prevent its phase protective relay settings from limiting transmission system loadability while maintaining reliable protection of the Bulk Electric System for all fault conditions. OR The responsible entity did not evaluate relay loadability at 0.85 per unit voltage and a power factor angle of 30 degrees.
<u>R2</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	The responsible entity failed to ensure that its out-of-step blocking elements allowed tripping of phase protective relays for faults that occur during the loading conditions used to verify transmission line relay loadability

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R# Requirement	Lower	Moderate	High	Severe
				per Requirement R1.
<u>R2R3</u>	Criteria described in R1.6, R1.7, R1.8, R1.9, R1.12, or R.13 was used but evidence does not exist that agreement was obtained in accordance with R2.N/A	N/A	N/A	<p>The responsible entity that uses a circuit capability with the practical limitations described in Requirement R1 criterion 6, 7, 8, 9, 12, or 13 did not use the calculated circuit capability as the Facility Rating of the circuit.</p> <p>OR</p> <p>The responsible entity did not obtain the agreement of the Planning Coordinator, Transmission Operator, and Reliability Coordinator with the calculated circuit capability.</p>
<u>R4</u>	N/A	N/A	N/A	The responsible entity did not provide its Planning Coordinator, Transmission Operator, and Reliability Coordinator with an updated list of circuits that have transmission line relays set according to the criteria established in Requirement R1 criterion 2 at least once each calendar year, with no more than 15 months between reports.
<u>R5</u>	N/A	N/A	N/A	The responsible entity did not provide its Regional Entity, with an updated list of circuits that have transmission line relays set according to the criteria established in Requirement R1 criterion 12 at least once each calendar year, with no more than 15 months between reports.

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R# Requirement	Lower	Moderate	High	Severe
<p><b>R3R6</b></p>	<p>N/A</p>	<p><del>Provided the list of facilities critical to the reliability of the Bulk Electric System standard and met parts 6.1 and 6.2, but more than 15 months and less than 24 months lapsed between assessments.</del></p> <p><del>OR</del></p> <p><del>The Planning Coordinator used the criteria established within Attachment B at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard and met 6.1 and 6.2 but failed to include the criterion in Attachment B first applies.</del></p> <p><del>OR</del></p> <p><del>The Planning Coordinator used the criteria established within Attachment B at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its Planning Coordinator area for which applicable entities must</del></p>	<p><del>Provided the list of facilities critical to the reliability of the Bulk Electric System standard and met parts 6.1 and 6.2, but 24 months or more lapsed between assessments.</del></p> <p><del>OR</del></p> <p><del>The Planning Coordinator used the criteria established within Attachment B at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard and met 6.1 and 6.2 but provided the list of circuits to the Reliability Coordinators, Transmission Owners, Generator Owners, and Distribution Providers within its Planning Coordinator area between 46 days and 60 days after list was established or updated. (part 6.2)</del></p>	<p><del>Does not have a process in place to determine facilities that are critical to the reliability of the Bulk Electric System.</del></p> <p><del>The Planning Coordinator failed to use the criteria established within Attachment B to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard.</del></p> <p><del>OR</del></p> <p><del>Does not maintain a current list of facilities critical to the reliability of the Bulk Electric System.</del></p> <p><del>OR</del></p> <p><del>Did not use the criteria established within Attachment B, at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard but failed to meet parts 6.1 and 6.2.</del></p> <p><del>OR</del></p> <p><del>The Planning Coordinator used the criteria established within Attachment B at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its</del></p>

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R# Requirement	Lower	Moderate	High	Severe
		<p><u>comply with the standard and met 6.1 and 6.2 but provided the list of circuits to the</u> Reliability Coordinators, Transmission Owners, Generator Owners, and Distribution Providers <u>within its Planning Coordinator area</u> between 31 days and 45 days after the list was established or updated. <u>(part 6.2)</u></p>		<p><u>Planning Coordinator area for which applicable entities must comply with the standard but failed to maintain the list of circuits determined according to the process described in Requirement R6. (part 6.1)</u></p> <p><u>OR</u></p> <p><u>The Planning Coordinator used the criteria established within Attachment B at least once each calendar year, with no more than 15 months between assessments to determine the circuits in its Planning Coordinator area for which applicable entities must comply with the standard and met 6.1 but failed to provide the list of facilities critical to the reliability of the Bulk Electric System to the appropriate circuits to the</u> Reliability Coordinators, Transmission Owners, Generator Owners, and Distribution Providers, <u>within its Planning Coordinator area</u> or provided the list more than 60 days after the list was established or updated. <u>(part 6.2)</u></p>

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### E. Regional Differences

None

### F. Supplemental Technical Reference Document

1. The following document is an explanatory supplement to the standard. It provides the technical rationale underlying the requirements in this standard. The reference document contains methodology examples for illustration purposes it does not preclude other technically comparable methodologies

“Determination and Application of Practical Relaying Loadability Ratings,” Version 1.0, January 9, 2007, prepared by the System Protection and Control Task Force of the NERC Planning Committee, available at: <http://www.nerc.com/~filez/reports.html>.

### Version History

Version	Date	Action	Change Tracking
1	February 12, 2008	Approved by Board of Trustees	New
1	March 19, 2008	Corrected typo in last sentence of Severe VSL for Requirement 3 — “then” should be “than.”	Errata
1	March 18, 2010	Approved by FERC	
<u>2</u>	<u>November 1, 2010</u>	<u>Revised to address directives from Order 733</u>	

## Standard PRC-023-2 — Transmission Relay Loadability

### PRC-023 — Attachment A

1. This standard includes any protective functions which could trip with or without time delay, on load current, including but not limited to:
  - 1.1. Phase distance.
  - 1.2. Out-of-step tripping.
  - 1.3. Switch-on-to-fault.
  - 1.4. Overcurrent relays.
  - 1.5. Communications aided protection schemes including but not limited to:
    - 1.5.1 Permissive overreach transfer trip (POTT).
    - 1.5.2 Permissive under-reach transfer trip (PUTT).
    - 1.5.3 Directional comparison blocking (DCB).
    - 1.5.4 Directional comparison unblocking (DCUB).
- ~~2. This standard includes out of step blocking schemes which shall be evaluated to ensure that they do not block trip for faults during the loading conditions defined within the requirements.~~
  - 1.6. Supervisory elements associated with current-based, communication-assisted schemes where the scheme is capable of tripping for loss of communications.
- ~~3.2.~~ The following protection systems are excluded from requirements of this standard:
  - ~~3.1.2.1.~~ Relay elements that are only enabled when other relays or associated systems fail. For example:
    - Overcurrent elements that are only enabled during loss of potential conditions.
    - Elements that are only enabled during a loss of communications- except as noted in section 1.6
  - ~~3.2.2.2.~~ Protection systems intended for the detection of ground fault conditions.
  - ~~3.3.2.3.~~ Protection systems intended for protection during stable power swings.
  - ~~3.4.2.4.~~ Generator protection relays that are susceptible to load.
  - ~~3.5.2.5.~~ Relay elements used only for Special Protection Systems applied and approved in accordance with NERC Reliability Standards PRC-012 through PRC-017 or their successors.
  - ~~3.6.2.6.~~ Protection systems that are designed only to respond in time periods which allow ~~operators~~ 15 minutes or greater to respond to overload conditions.
  - ~~3.7.2.7.~~ Thermal emulation relays which are used in conjunction with dynamic Facility Ratings.
  - ~~3.8.2.8.~~ Relay elements associated with ~~DCdc~~ lines.
  - ~~3.9.2.9.~~ Relay elements associated with ~~DCdc~~ converter transformers.

**PRC-023 — Attachment B**

**Circuits to Evaluate**

- Transmission lines operated at 100 kV to 200 kV and transformers with low voltage terminals connected at 100 kV to 200 kV.
- Lines operated below 100 kV and transformers with low voltage terminals connected below 100 kV that are included on a critical facilities list defined by the Regional Entity.

**Criteria**

If any of the following criteria apply to a circuit, the applicable entity must comply with the standard for that circuit.

- B1.** The circuit is a monitored Facility of a permanent flowgate in the Eastern Interconnection, a major transfer path within the Western Interconnection as defined by the Regional Entity, or a comparable monitored Facility in the Québec Interconnection, that has been included to address reliability concerns for loading of that circuit, as confirmed by the applicable Planning Coordinator.
- B2.** The circuit is a monitored Facility of an IROL, where the IROL was determined in the planning horizon pursuant to FAC-010.
- B3.** The circuit forms a path (as agreed to by the plant owner and the transmission entity) to supply off-site power to a nuclear plant as established in the Nuclear Plant Interface Requirements (NPIRs) pursuant to NUC-001.
- B4.** The circuit is identified through the following sequence of power flow analyses<sup>6</sup> performed by the Planning Coordinator for the one-to-five-year planning horizon:
- a. Simulate double contingency combinations selected by engineering judgment, without manual system adjustments in between the two contingencies (reflects a situation where a System Operator may not have time between the two contingencies to make appropriate system adjustments).
  - b. For circuits operated between 100 kV and 200 kV evaluate the post-contingency loading, in consultation with the Facility owner, against a threshold based on the Facility Rating assigned for that circuit and used in the power flow case by the Planning Coordinator.
  - c. When more than one Facility Rating for that circuit is available in the power flow case, the threshold for selection will be based on the Facility Rating for the loading duration nearest four hours.
  - d. The threshold for selection of the circuit will vary based on the loading duration assumed in the development of the Facility Rating.

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<sup>6</sup> Past analyses may be used to support the assessment if no material changes to the system have occurred since the last assessment



## Standard PRC-023-2 — Transmission Relay Loadability

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- i. If the Facility Rating is based on a loading duration of up to and including four hours, the circuit must comply with the standard if the loading exceeds 115% of the Facility Rating.
- ii. If the Facility Rating is based on a loading duration greater than four and up to and including eight hours, the circuit must comply with the standard if the loading exceeds 120% of the Facility Rating.
- iii. If the Facility Rating is based on a loading duration of greater than eight hours, the circuit must comply with the standard if the loading exceeds 130% of the Facility Rating.
- e. Radially operated circuits serving only load are excluded.
- B5. The circuit is selected by the Planning Coordinator based on technical studies or assessments, other than those specified in criteria B1 through B4, in consultation with the Facility owner.**
- B6. The circuit is mutually agreed upon for inclusion by the Planning Coordinator and the Facility owner.**