

Standard Development Roadmap

This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.

Development Steps Completed:

1. SAC approves SAR for posting on January 9, 2006.
2. The SAR was posted for comment from January 16, 2006 to February 15 2006.
3. The SAC approves development of the standard on May 12, 2006.
4. The JIC assigns development of the standard to NERC on June 15, 2006.

Description of Current Draft:

This is a 45-day (August 16–September 29) posting of the initial draft of the Transmission Relay Loadability Standard. It codifies the relay loadability criteria embodied in the NERC Recommendation 8a, *Improve System Protection to Slow or Limit the Spread of Future Cascading Outages*, and U.S.–Canada Power System Outage Task Force Recommendation 21A, *Make More Effective and Wider Use of System Protection Measures*.

Future Development Plan:

Anticipated Actions	Anticipated Date
1. Consider and post response to comments.	October 16, 2006
2. Post for 30-day comment period.	October 16–November 14, 2006
3. Post for 30-day pre-ballot period.	November 20–December 19, 2006
4. Conduct first ballot.	December 20, 2006–January 3, 2006
5. Consider and post response to comments on first ballot.	January 8, 2007
6. Conduct second ballot.	January 9–18, 2007
7. BOT Adoption.	February 1, 2007

Definitions of Terms Used in Standard

This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.

None.

A. Introduction

1. **Title: Transmission Relay Loadability**
2. **Number:** PRC-023-1
3. **Purpose:** Protective relay settings shall not limit transmission loadability.
4. **Applicability:**
 - 4.1. Transmission Owners with phase protection systems as described in Attachment A, applied to:
 - 4.1.1 Transmission lines operated at 200 kV and above.
 - 4.1.2 Transmission lines operated at 100 kV to 200 kV as designated by the Regional Reliability Organization as critical to the reliability of the electric system.
 - 4.1.3 Transformers with low voltage terminals connected at 200 kV and above.
 - 4.1.4 Transformers with low voltage terminals connected at 100 kV to 200 kV as designated by the Regional Reliability Organization as critical to the reliability of the electric system.
 - 4.2. Generator Owners with phase protection systems as described in Attachment A, applied according to 4.1.1 through 4.1.4.
 - 4.3. Distribution Providers with phase protection systems as described in Attachment A, applied according to 4.1.1 through 4.1.4:
5. **(Proposed) Effective Dates:**
 - 5.1. For circuits described in 4.1.1 and 4.1.3 above — January 1, 2008.
 - 5.2. For circuits described in 4.1.2 and 4.1.4 above — July 1, 2008.

B. Requirements

- R1. Each Transmission Owner, Generator Owner, and Distribution Provider shall use any one of the following criteria to prevent its phase protective relay settings from limiting transmission system capability while maintaining reliable protection of the electrical network for all fault conditions. The relay performance shall be evaluated at 0.85 per unit voltage and a power factor angle of 30 degrees: [Risk Factor: High].
 - R1.1. 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).
 - R1.2. Set transmission line relays so they do not operate at or below 115% of the highest seasonal 15 minute Facility Rating of a circuit (expressed in amperes).
 - R1.3. Set transmission line relays so they do not operate at or below 115% of the maximum power transfer capability of the circuit (expressed in amperes) using one of the following to perform the power transfer calculation:
 - R1.3.1. An infinite source (zero source impedance) with a 1.00 per unit bus voltage at each end of the line.
 - R1.3.2. An impedance at each end of the line, which reflects the actual system source impedance with a 1.05 per unit bus voltage at each end of the line.

- R1.4.** 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 R1.3, using the full line inductive reactance.
- R1.5.** 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)¹.
- R1.6.** 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.
- R1.7.** 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.
- R1.8.** 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.
- R1.9.** 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.
- R1.10.** Set transformer fault protection relays so they do not operate at or below the greater of:
- 150% of the applicable maximum transformer nameplate rating.
 - 115% of the highest operator established emergency transformer rating.
- R1.11.** For transformer overload protection relays that do not comply with R1.10 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 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 no less than 100° C for the top oil or 140° C for the winding hot spot temperature.

¹ This requirement is based on a distance relay maximum torque angle (and thus the impedance angle) approaching 90-degrees, while the relevant load current angle is 30-degrees. In addition, if there is a weak source “behind” the relay, the fault magnitude in amperes may be limited while the distance to a fault, as measured by a distance relay, is not.

- R1.12.** 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 subject to the following constraints:
 - R1.12.1.** Set the maximum torque angle (MTA) to 90 degrees or the highest supported by the manufacturer.
 - R1.12.2.** 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.
 - R1.12.3.** Include a relay setting component of 87% of the current calculated in R1.12.2 in the Facility Rating determination for the circuit.
- R1.13.** 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.** The Transmission Owner, Generator Owner, or Distribution Provider shall obtain the approval of the Regional Reliability Organization and the Reliability Coordinator(s) prior to using the criteria established in R1.6, R1.7, R1.8, R1.9, R1.12, or R.13 as listed below. The approvals are required for each circuit terminal using the listed criteria. [Risk Factor: Lower]
 - R2.1.** The Transmission Owner, Generator Owner, or Distribution Provider that uses the criteria described in R1.6, R1.7, R1.8, or R1.9 shall obtain the approval of the Regional Reliability Organization and the Reliability Coordinator prior to using these criteria.
 - R2.2.** The Transmission Owner, Generator Owner, or Distribution Provider that uses the criteria described in Requirement 1.12, shall obtain the approval of the Regional Reliability Organization and the Reliability Coordinator prior to using this criteria.
 - R2.3.** The Transmission Owner, Generator Owner, or Distribution Provider that uses a circuit capability with the practical limitations described in Requirement 1.13, shall obtain the approval of the Regional Reliability Organization and the Reliability Coordinator before using the circuit capability and shall use the circuit capability as the Facility Rating of the circuit.

C. Measures

- M1.** The Transmission Owner, Generator Owner, and Distribution Provider shall each have evidence to show that its transmission relays are set according to one of the criteria in Requirement 1.1 through R1.13.
- M2.** The Transmission Owner, Generator Owner, and Distribution Provider with transmission relays set according to the criteria in R1.6, R1.7, R1.8, R1.9, R1.12, or R.13 shall have evidence that the use of the criteria was approved by its associated Regional Reliability Organization and Reliability Coordinator before being used and shall have evidence that the circuit rating is used as the Facility Rating of that circuit.

D. Compliance

- 1. Compliance Monitoring Process**
 - 1.1. Compliance Monitoring Responsibility**
 - 1.1.1** Regional Reliability Organization.
 - 1.2. Compliance Monitoring Period and Reset Time Frame**
 - One calendar year.

1.3. Data Retention

The Transmission Owner, Generator Owner, and Distribution Provider shall each retain documentation for three years.

The Compliance Monitor shall retain its compliance documentation for three years.

1.4. Additional Compliance Information

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

2. Levels of Non-Compliance

2.1. Level 1:

2.1.1 Criteria described in R1.6, R1.7, R1.8, R1.9, R1.12, or R.13 was used but evidence does not exist that approval was obtained in accordance with R2.

2.2. Level 2:

2.2.1 Evidence that relay settings comply with one of the criteria in R1.1 through R1.13 exists but is incomplete or incorrect.

2.3. Level 3:

2.3.1 Relay settings do not comply with transmission loadability criteria in R1, and the relay settings were causal to a Reportable Disturbance.

2.4. Level 4:

2.4.1 Evidence does not exist to support that relay settings comply with one of the criteria in R1.1 through R1.13.

E. Regional Differences

- 1. None

Version History

Version	Date	Action	Change Tracking

Attachment A

- 1.1. This standard addresses any protective functions which could trip with or without time delay, on load current, including but not limited to:
 - 1.1.1 Phase distance
 - 1.1.2 Out-of-step tripping
 - 1.1.3 Out-of-step blocking
 - 1.1.4 Switch-on-to-fault
 - 1.1.5 Overcurrent relays
 - 1.1.6 Communications aided protection schemes including but not limited to:
 - 1.1.6.1 Permissive overreach transfer trip (POTT)
 - 1.1.6.2 Permissive under-reach transfer trip (PUTT)
 - 1.1.6.3 Directional comparison blocking (DCB)
 - 1.1.6.4 Directional comparison unblocking (DCUB)
- 1.2. The following protection systems are excluded from requirements of this standard:
 - 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.
 - 1.2.2 Protection systems intended for the detection of ground fault conditions.
 - 1.2.3 Protection systems intended for protection during stable power swings.
 - 1.2.4 Generator protection relays that are susceptible to load.
 - 1.2.5 Relay elements used only for Special Protection Systems applied and approved in accordance with NERC Reliability Standards PRC-012 through PRC-017.