

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 NERC Reliability Standards Glossary of Terms or the MRO 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 Midwest Reliability Organization (MRO)(~~“MRO”~~) Glossary. NERC and MRO defined terms are capitalized in the standard.

A. Introduction

1. **Title:** Subsynchronous Resonance (~~SSR~~) (“~~SSR~~”) Assessment
2. **Number:** ~~TPL-504-MRO-02~~ **TPL-504-MRO-01**
3. **Purpose:** To ensure subsynchronous resonance with series compensated lines, torsional interaction with power system controls and generator shaft damage or excessive torsional fatigue due to network switching does not occur in the Midwest Reliability Organization (~~MRO~~) (“~~MRO~~”).
4. **Applicability**
 - 4.1. Transmission Planner
 - 4.2. Generator Owner
 - 4.3. Transmission Owner
 - 4.4. Generator Operator
5. **Effective Date:** 1st day of the 1st quarter following all appropriate Regulatory Authority approvals. ~~Upon MRO Board Approval compliance monitoring for TPL-504-MRO-01 will begin. One year after Canadian provincial agency exercising regulatory authority over an MRO member and FERC approval, financial sanctions for TPL-504-MRO-01 will become effective.~~

B. Requirements

- R1.** ~~[Violation Risk Factor: Medium].~~ The Transmission Planner shall demonstrate through a valid subsynchronous resonance assessment that all new¹ system additions or system operating practices that are added to ~~the~~ its portion of the ~~Bulk Electric System~~ interconnected transmission system that have potential to excite sustained subsynchronous torsional oscillations are planned, designed, and constructed to avoid causing generating unit shaft damage. ~~[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]~~ ~~To be valid, the Transmission Planner subsynchronous resonance assessment shall:~~

To be valid, the assessment shall:

- R1.1** Be performed prior to the in-service date of the new system additions or system operating practices that are potential scenarios to excite torsional oscillations in the subsynchronous range. System additions or system operating practices include the following:
- R1.1.1** Transmission system equipment such as series capacitors, HVdc rectifier terminals, and SVC systems that are 100 kV or higher and that are electrically close to a turbine-generator.
 - R1.1.2** Large fluctuating loads greater than 100MW such as ac electric arc furnaces, rolling mills, cyclo-converters, and other industrial drives, that are electrically close to a turbine-generator.

¹ A new system addition is a system addition that receives Planning Coordinator agreement to interconnect to the Bulk Electric System after the effective date of this standard

- R1.1.3** System operating practices such as high-speed reclosing and single-pole switching on transmission lines 100kV or higher and that are electrically close to a turbine-generator.
- R1.2** Consist of initial studies, ~~(such as frequency scanning, seanning)~~ that determine whether there is evidence of a potential subsynchronous resonance (SSR) (“SSR”) condition. Estimated or typical turbine-generator data may be used.
- R1.3** Consist of detailed studies, ~~(such as frequency scanning, eigenvalue analysis or electromagnetic transient simulation, simulation)~~ if results from ~~MRO Regional Reliability Standard TPL 504 MRO 01 R1.2~~ indicate evidence of the potential for a SSR condition. Data available from the generator manufacturer and/or from field tests as per ~~MRO Regional Reliability Standard TPL 504 MRO 01 R5~~ shall be used to confirm the condition.
- R1.4** Consider the effect of contingency conditions ~~under all categories other than extreme events defined in the currently approved Categories B, and C of Table I of NERC Reliability Standards TPL standard(s) 002 0 and TPL 003 0.~~
- R2.** ~~[Violation Risk Factor: Medium].~~ When ~~an assessment is~~ assessments performed as prescribed in ~~MRO Regional Reliability Standard TPL 504 MRO 01 R1~~ confirms the potential for a SSR condition or the Generator Operator reports a SSR event, ~~(e.g. observable subsynchronous torsional oscillations cause unit tripping),~~ the Transmission Planner shall determine a corrective plan to mitigate the SSR condition. ~~[Violation Risk Factor: Medium] [Time Horizon: Operations Planning] condition, such as installing a SSR countermeasure.~~
- R3.** ~~[Violation Risk Factor: Lower].~~ When ~~an assessment~~ assessments performed as prescribed in ~~MRO Regional Reliability Standard TPL 504 MRO 01 R1~~ confirms the potential for a SSR condition, the Transmission Planner shall, within thirty (30) days of completion of the assessments and corrective plans or ~~the~~ request, ~~whichever is later,~~ provide ~~the results of the assessments and corrective plans~~ to the MRO, ~~adjacent Transmission Planners~~ and ~~any impacted~~ Transmission Owners(s) ~~or and~~ Generator Owner(s) ~~identified in the results of the subsynchronous resonance assessments and corrective plan.~~ ~~[Violation Risk Factor: Lower] [Time Horizon: Operations Planning].~~ ~~plans.~~
- R4.** ~~[Violation Risk Factor: Medium].~~ Each Transmission Owner, Generator Owner or Generator Operator that owns or operates a SSR countermeasure shall provide information to its Transmission Operator on a change in operational status of the SSR countermeasure within thirty (30) ~~minutes.~~ ~~[Violation Risk Factor: Medium] [Time Horizon: Same Day Operations].~~ ~~minutes, if the SSR countermeasure is critical to preventing subsynchronous resonance for any contingencies defined in Category B or Category C of Table I of Reliability Standard TPL 002 0 and TPL 003 0.~~

- R5.** ~~[Violation Risk Factor: Lower].~~ The Generator Owner shall provide to the Transmission Planner, generator manufacturer data, if available, and/or results from field tests when results from ~~TPL-504-MRO-01-R1~~ indicate evidence of the potential for a SSR condition. Field ~~testingtests~~ to verify the natural torsional mode frequencies shall be performed when a SSR countermeasure is determined necessary in ~~MRO Regional Reliability Standard TPL-504-MRO-01-R2~~. Field ~~testingtests~~ may be used to verify natural torsional mode mechanical damping as a function of generator loading when a SSR countermeasure is determined necessary in ~~R2. [Violation Risk Factor: Lower] [Time Horizon: Operations Planning]. MRO Regional Reliability Standard TPL-504-MRO-01-R2.~~

~~The minimum data to be provided by the Generator Owner shall include:~~

The minimum data to be provided by the Generator Owner shall include:

- R5.1** Resistance and reactance as a function of frequency for the generator as viewed from the generator terminals. Armature and rotor circuits shall be included.
- R5.2** The inertia constant for each turbine element, generator and exciter.
- R5.3** The spring constants for each shaft connecting turbine elements, generator and exciter.
- R5.4** Estimated turbine-generator natural torsional mode mechanical damping for all subsynchronous modes as a function of generator loading, ranging from no load to full load.
- R5.5** Fatigue life expenditure data for each shaft connecting the turbine elements, generator and exciter. Assumptions made in the preparation of this data shall also be provided.

C. Measures

- M1.** The Transmission Planner shall have documented evidence of a valid SSR assessment that has been conducted and corrective plan as specified in ~~MRO Regional Reliability Standard(s) TPL-504-MRO-01-R1~~.
- M2.** The Transmission Planner shall have documented evidence that it has determined a corrective plan to mitigate an identified potential, or observed, SSR condition as specified in ~~and TPL-504-MRO-01-R2~~.
- M3.** The Transmission Planner shall have evidence it reported documentation of results of its SSR assessments and corrective plans to the MRO and adjacent Transmission Planners and any impacted Transmission Owners(s) or and Generator Owner(s) as specified in ~~MRO Regional Reliability Standard Reliability Standard TPL-504-MRO-01-R3~~.
- M4.** The Transmission Owner, Generator Owner and Generator Operator, as applicable shall have evidence it reported changes in operational status of SSR countermeasures to its Transmission Operator as specified in ~~MRO Regional Reliability Standard TPL-504-MRO-01-R4~~.

M5. The Generator Owner shall have evidence it reported to the Transmission Planner ~~the provided~~ generator manufacturer data, results from field tests or typical data ~~to the Transmission Planner~~ as specified in ~~MRO Regional Reliability Standard TPL-504-MRO-01-R5~~.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Monitoring Responsibility.

ERO delegated to Midwest Reliability Organization.

1.2. Compliance Monitoring Period and Reset Timeframe.

The Performance-Reset period shall be one calendar year from the last finding of non-compliance.

1.3. Data Retention.

The Transmission Planner shall retain assessments from last finding of full compliance ~~for ten (10) years or~~ until the next assessment is completed.

The Generator Owner shall retain detailed manufacturer turbine-generator data for the life of the plant.

In addition, entities found non-compliant shall keep information related to the non-compliance until found compliant.

The Compliance Monitor shall retain any audit data for three years.

1.4. Additional Compliance Information.

The Transmission Planner, Transmission Owner, Generator Owner and Generator Operator shall demonstrate compliance through the following methods, as determined by the compliance monitor: (1) Self certification or (2) Audits (periodic, as part of targeted monitoring or initiated by complaint or event).

Violation Severity Levels

| <u>R #</u> | <u>Lower VSL</u> | <u>Moderate VSL</u> | <u>High VSL</u> | <u>Severe VSL</u> |
|-------------------|---|--|--|---|
| <u>R1</u> | <u>Not applicable</u> | <u>Transmission Planner performed a SSR assessment that was incomplete prior to in-service date.</u> | <u>Transmission Planner performed a SSR assessment after in-service date</u> | <u>Transmission Planner did not perform a SSR assessment per R1</u> |
| <u>R2</u> | <u>Not applicable</u> | <u>Not applicable</u> | <u>Transmission Planner did not determine a corrective plan where a SSR assessment indicated a need for a corrective plan or a SSR event was reported.</u> | <u>Transmission Planner did not implement a corrective plan where a SSR assessment indicated a need for a corrective plan or a SSR event was reported per R2.</u> |
| <u>R3</u> | <u>Not applicable</u> | <u>Documentation was provided to one or more of these entities identified in the corrective plan after 30 days: MRO, adjacent Transmission Planners and Transmission Owners(s) or Generator Owner(s)</u> | <u>Documentation was not provided to one or more of these entities identified in the corrective plan: MRO, adjacent Transmission Planners and Transmission Owners(s) or Generator Owner(s)</u> | <u>Documentation was not provided to the MRO, adjacent Transmission Planners and Transmission Owners(s) or Generator Owner(s) identified in the corrective plan per R3.</u> |
| <u>R4</u> | <u>Transmission Owner, Generator Owner or Generator Operator, did not report operational status changes of SSR countermeasures within sixty (60) minutes to the Transmission Operator</u> | <u>Transmission Owner, Generator Owner or Generator Operator, did not report operational status changes of SSR countermeasures within six (6) hours to the Transmission Operator</u> | <u>Transmission Owner, Generator Owner or Generator Operator, did not report operational status changes of SSR countermeasures within twelve (12) hours to the Transmission Operator</u> | <u>Transmission Owner, Generator Owner or Generator Operator, reported operational status changes of SSR countermeasures to the Transmission Operator next day</u> |

Standard TPL-504-MRO-01 — Subsynchronous Resonance (SSR) Assessment

| | | | | |
|-----------|-----------------------|-----------------------|---|--|
| <u>R5</u> | <u>Not applicable</u> | <u>Not applicable</u> | <u>Generator Owner did not provide to the Transmission Planner all the gathered and/or developed generator manufacturer data and/or results from field tests per R5</u> | <u>Generator Owner did not provide the data that they had gathered and/or developed generator manufacturer data and/or results from field tests per R5</u> |
|-----------|-----------------------|-----------------------|---|--|

~~**Lower:** — Transmission Planner provided an SSR assessment and corrective plan to the MRO per R3, but the assessment and/or corrective plan was incomplete in one or more areas of R1 and R2.~~

~~**Moderate:** — Transmission Planner performed a SSR assessment and corrective plan per R1 and R2 but documentation was not provided to the MRO or any impacted Transmission Owner(s) or Generator Owner(s) per R3.~~

~~Generator Owner gathered and/or developed generator manufacturer data and/or results from field tests but did not provide to the Transmission Planner per R5.~~

~~**High:** — Transmission Planner did not perform a SSR assessment and/or corrective plan per R1 and R2.~~

~~Generator Owner did not gather and/or develop generator manufacturer data and/or results from field tests per R5.~~

~~Transmission Owner, Generator Owner or Generator Operator, as applicable, did not report operational status changes of SSR countermeasures within thirty (30) minutes to the Transmission Operator per R4.~~

~~**Severe:** — Transmission Planner did not determine and implement a corrective plan per R2 where a SSR assessment indicated a need for a corrective plan or a SSR event was reported.~~

Version History

| Version | Date | Action | Change Tracking |
|---------|------|--------|-----------------|
| | | | |
| | | | |