

### **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) Glossary. NERC and MRO defined terms are capitalized in the standard.*

**A. Introduction**

1. **Title:** Subsynchronous Resonance (SSR) Assessment
2. **Number:** TPL-504-MRO-02
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).
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 calendar quarter after applicable regulatory approval, this standard will be effective. In those jurisdictions where no regulatory approval is required, this standard becomes effective on the 1st day of the 1st calendar quarter after NERC Board of Trustees adoption.

**B. Requirements**

- R1.** Each Transmission Planner shall demonstrate through a valid subsynchronous resonance assessment that all new<sup>1</sup> system additions or new network switching practices that are added to its portion of the Bulk Electric System that have potential to excite sustained subsynchronous torsional oscillations are planned to avoid causing generating unit shaft damage. [*Violation Risk Factor: Medium*] [*Time Horizon: Long-Term Planning*]

To be valid, the assessment shall:

- 1.1 Be performed prior to the in-service date of the new system additions or new network switching practices that are potential scenarios to excite torsional oscillations in the subsynchronous range. New system additions or new network switching practices include the following:
  - 1.1.1 Transmission system equipment such as a series capacitor, HVdc rectifier terminal, or static var compensator (SVC) system that is connected to a transmission line 200kV or higher and that is electrically close to a turbine-generator.
  - 1.1.2 Large fluctuating load greater than 100MW such as an ac electric arc furnace, rolling mill, cyclo-converter, or industrial drive that is electrically close to a turbine-generator.

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<sup>1</sup> 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. A new network switching practice is one that is established after the effective date of this standard.

- 1.1.3** Network switching practice such as high-speed auto-reclosing (e.g. reclosing after a delay of less than two seconds) and single-pole switching on a transmission line 200kV or higher and that is electrically close to a turbine-generator.
  - 1.2** Consist of an initial assessment, such as frequency scanning, that determines whether there is evidence of a potential subsynchronous resonance (SSR) condition. Estimated or typical turbine-generator data may be used in the initial assessment.
  - 1.3** Consist of detailed studies, such as frequency scanning, eigenvalue analysis or electromagnetic transient simulation, if results from the initial assessment in part 1.2 indicate evidence of the potential for a SSR condition. Data from the generator manufacturer and/or from field tests per R5 shall be used in the detailed studies to confirm the condition.
  - 1.4** Consider the effect of contingency conditions under all categories other than extreme events in the currently approved NERC TPL standard(s).
  - 1.5** Include a rationale for how the size of the study area<sup>2</sup> was determined for the initial assessment in part 1.2 and detailed studies in part 1.3.
- R2.** Each Transmission Planner shall determine a corrective plan(s) to mitigate the SSR condition when an assessment, performed as prescribed in Requirement R1, confirms that subsynchronous torsional oscillations will result in generating unit shaft damage or when the Generator Operator reports a SSR event to the MRO per EOP-004-1. [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]
- R3.** Each Transmission Planner shall provide the corrective plan(s) to the adjacent Transmission Planner(s), Transmission Owner (s) and Generator Owner(s) identified in the corrective plan within thirty (30) calendar days of completion of any corrective plan(s) required by Requirement R2, and to the MRO upon request. Each Transmission Planner shall provide the results of the assessments to the adjacent Transmission Planner(s), Transmission Owner(s), and Generator Owner(s) identified in the assessment within thirty (30) calendar days of completion of any assessments required by Requirement R1 that confirm a SSR condition and to the MRO upon request. [*Violation Risk Factor: Lower*] [*Time Horizon: Operations Planning*].
- R4.** Each Transmission Owner, Generator Owner and 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*].
- R5.** Each Generator Owner shall perform field testing to verify the natural torsional mode frequencies when a SSR countermeasure is determined necessary in

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<sup>2</sup> The study area identifies which turbine-generators are electrically close to the new system additions or new network switching practices.

Requirement R2. Field testing may be used to verify natural torsional mode mechanical damping as a function of generator loading when a SSR countermeasure is determined necessary in Requirement R2. *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*.

- R6.** Each Generator Owner shall provide to the Transmission Planner, generator manufacturer data, if available, and/or results from field tests when results from part 1.2 indicate evidence of the potential for a SSR condition. *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*.

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

- 6.1** Resistance and reactance as a function of frequency for the generator as viewed from the generator terminals. Armature and rotor circuits shall be included.
- 6.2** The inertia constant for each turbine element, generator and exciter.
- 6.3** The spring constants for each shaft connecting turbine elements, generator and exciter.
- 6.4** 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.
- 6.5** 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 as specified in Requirement R1.
- M2.** The Transmission Planner shall have documented evidence that it has determined a corrective plan(s) as specified in Requirement R2.
- M3.** The Transmission Planner shall have documented evidence it reported documentation of results of its SSR assessment(s) and corrective plan(s) to the MRO and adjacent Transmission Planner(s), Transmission Owner(s), and Generator Owner(s) as specified in Requirement R3.
- M4.** The Transmission Owner, Generator Owner and Generator Operator, as applicable shall have documented evidence it reported changes in operational status of SSR countermeasures to its Transmission Operator as specified in Requirement R4.
- M5.** The Generator Owner shall have documented evidence it reported to the Transmission Planner the generator manufacturer data and results from field tests as specified in Requirement R5 and Requirement R6.

**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 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 (3) 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**

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

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<b>R5</b>	Not applicable	Not applicable	Not applicable	Generator Owner did not perform field tests per Requirement R5.
<b>R6</b>	Not applicable	Generator Owner did not provide data for part 6.4 and/or part 6.5 to the Transmission Planner per Requirement R6.	Generator Owner did not provide the data for part 6.1 and/or part 6.2 and/or part 6.3 to the Transmission Planner per Requirement R6.	Generator Owner did not provide any data to the Transmission Planner per Requirement R6.

**Version History**

<b>Version</b>	<b>Date</b>	<b>Action</b>	<b>Change Tracking</b>