

**A. Introduction**

1. **Title:** Subsynchronous Resonance (“SSR”) Assessment
2. **Number:** TPL-504-MRO-01
3. **Purpose:** To ensure subsynchronous resonance does not occur in the Midwest Reliability Organization (“MRO”).
4. **Applicability**
  - 4.1. Transmission Planner
  - 4.2. Generator Owner
  - 4.3. Transmission Owner
5. **Effective Date:** Thirty (30) days following MRO Board approval. (Proposed)

**B. Requirements**

- R1.** *[Violation Risk Factor: Medium]*. The Transmission Planner shall demonstrate through a valid subsynchronous resonance assessment that all new<sup>1</sup> series capacitors or other system additions or enhancements that are added to the Bulk Electric System that have potential to excite sustained subsynchronous oscillations are planned, designed, and constructed to avoid creating a subsynchronous resonance condition. To be valid, the Transmission Planner subsynchronous resonance assessment shall:
- R1.1** Be performed prior to the in-service date of the new series capacitor or other system additions or enhancements. Series capacitors or other system additions or enhancements that are potential SSR scenarios 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 such as ac electric arc furnaces, rolling mills, cyclo-converters, and other industrial drives, that are electrically close to a turbine-generator.
    - R1.1.3** System operating practices such as high-speed reclosing and single-pole switching on transmission lines electrically close to a turbine-generator.
  - R1.2** Consist of initial studies (such as frequency scanning) that determine whether there is evidence of a potential subsynchronous resonance (“SSR”) condition for all turbine-generators that are electrically close to the series capacitor or other system additions or enhancements. 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) if results from MRO Regional Reliability Standard TPL-504-MRO-01\_R1 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.

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<sup>1</sup> A new system addition is a system addition that receives Planning Authority agreement to interconnect to the Bulk Electric System after the effective date of this standard

- R1.4** Consider the effect of contingency conditions defined in Categories B, C and D of Table I of NERC Reliability Standards TPL-002-0, TPL-003-0 and TPL-004-0.
- R2.** *[Violation Risk Factor: Medium].* When assessments performed as prescribed in MRO Regional Reliability Standard TPL-504-MRO-01\_R1 confirm the potential for a SSR condition or the Generator Operator reports a SSR event (e.g. observable subsynchronous oscillations cause unit tripping), the Transmission Planner shall determine a corrective plan to mitigate the SSR condition, such as installing a SSR countermeasure.
- R3.** *[Violation Risk Factor: Lower].* When assessments performed as prescribed in MRO Regional Reliability Standard TPL-504-MRO-01\_R1 confirm 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 to the MRO and any impacted Transmission Owners(s) and Generator Owner(s) the results of the subsynchronous resonance assessments and corrective plans.
- R4.** *[Violation Risk Factor: Medium].* Each Transmission Owner and/or Generator Owner shall provide information to its Transmission Operator on a change in operational status of all SSR countermeasures within thirty (30) minutes, if they are 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 and/or results from field tests when results from TPL-504-MRO-01\_R1 indicate evidence of the potential for a SSR condition. Field tests 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 tests may be used to verify natural torsional mode mechanical damping as a function of generator loading when a SSR countermeasure is determined necessary in MRO Regional Reliability Standard TPL-504-MRO-01\_R2.

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 a valid SSR assessment and corrective plan as specified in MRO Regional Reliability Standard(s) TPL-504-MRO-01\_R1 and TPL-504-MRO-01\_R2.
- M2.** The Transmission Planner shall have evidence it reported documentation of results of its SSR assessments and corrective plans to the MRO and any impacted Transmission Owners(s) and Generator Owner(s) per MRO Regional Reliability Standard Reliability Standard TPL-504-MRO-01\_R3.
- M3.** The Transmission Owner and/or Generator Owner shall have evidence it reported changes in operational status of SSR countermeasures to its Transmission Operator per MRO Regional Reliability Standard TPL-504-MRO-01\_R4.
- M4.** The Generator Owner shall have evidence it provided generator manufacturer data, results from field tests or typical data to the Transmission Planner per MRO Regional Reliability Standard TPL-504-MRO-01\_R5.

**D. Compliance**

**1. Compliance Monitoring Process**

- 1.1. Compliance Monitoring Responsibility.** 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 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 Planning Authority, Transmission Planner and Generator Owner 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**

- 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 or Generator Owner, 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**

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