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: Power System Stabilizer and Small Signal Stability Assessment

2. Number: **PRC-502-MRO-01**

3. Purpose: To ensure that power system stabilizers are designed, installed and tuned as required to dampen power system oscillations in the Midwest Reliability Organization ("MRO"). To ensure small signal stability assessments are performed. To ensure testing programs are developed and poorly dampen oscillations are analyzed and corrected.

4. Applicability

4.1. Planning Coordinator

4.2. Transmission Planner

4.3. Generator Owner

5. (Proposed) Effective Date: Upon MRO Board Approval compliance monitoring for PRC-502-MRO-01 will begin. One year after Canadian provincial agency exercising regulatory authority over an MRO member and FERC approval, financial sanctions for PRC-502-MRO-01 will become effective.

A small signal stability assessment is required within three (3) years of the effective date if one has not been performed in the five years prior to the effective date.

B. Requirements

R1. *[Violation Risk Factor: Medium]*. The Generator Owner shall install power system stabilizers on all new[1] or substantially modified[2] generator units with a nameplate rating 100 MVA or larger, prior to the generator's in-service date or as required by changes in system conditions, when all of the following conditions exist:

a. Small signal stability assessments performed by the Transmission Planner or Planning Coordinator as required in MRO Regional Reliability Standard PRC-502-MRO-01_R2, provide evidence of high generator relative participation (relative participation factors greater than 10%) in a range of local, inter-plant, and inter-area modes (i.e. 0.1 to 2.0 Hz) that show small signal instability or inadequate damping. Inadequate damping is defined as a violation of the minimum acceptable damping criteria determined by the Planning Coordinator for local and inter-plant modes as defined in MRO Regional Reliability Standard PRC-502-MRO-01_R8 and determined by the MRO for inter-area modes as defined in MRO Regional Reliability Standard TPL-503-MRO-01.

[1] A new generator is a generator that receives Planning Coordinator agreement to interconnect to the Bulk Electric System after the effective date of this standard.

[2] A generator modification is considered substantial if it results in a change in the real power output by more than 10% of the original nameplate rating or more than 20 MW, whichever is less or includes any of the following: generator rewind, rotor replacement, new or refurbished excitation system, or turbine replacement. A substantially modified generator is a generator that receives Planning Coordinator agreement to make the generator modification after the effective date of this standard.

b. System performance assessments performed by the Transmission Planner or Planning Coordinator, for disturbances defined in Categories B and C of Table 1 in Reliability Standard TPL-002-0, TPL-003-0 and MRO Regional Reliability Standard TPL-503-MRO-01, show inadequate damping. Inadequate damping is as previously defined above in R1(a).

c. The generator is equipped with a suitable exciter that is able to enhance the effectiveness of the Power System Stabilizer ("PSS") in providing positive damping to local, inter-plant and inter-area modes. The Transmission Planner shall determine whether the Generator Owner's exciter is suitable for a PSS installation. The exciter assessment shall consider the measured or calculated closed-loop phase response of the generator, exciter and power system and the ability of the PSS to overcome the combined phase lag.

When conditions (a) and (b) do not exist but (c) does exist, the Generator Owner, at minimum, shall make provisions to allow for the future addition of a PSS on all new generator units 100 MVA or larger, prior to the generator's in-service date. The automatic voltage regulator shall be designed capable of accepting a PSS input signal and the appropriate PSS input signal transducers determined by the Planning Coordinator shall be installed.

R2. *[Violation Risk Factor: Lower]*. The Transmission Planner and Planning Coordinator shall each perform a small signal stability assessment for its portion of the interconnected transmission system. The assessment shall be conducted at least every five (5) years unless it can be demonstrated that significant system changes have not occurred that would require a new small signal stability assessment since the last assessment. In the event a study is not conducted after five (5) years, system conditions shall be reviewed annually until a new small signal stability assessment is conducted. The initial system conditions for small signal stability assessments shall include:

R2.1 The effect of different system loading conditions (spring light load, off-peak and peak load).

R2.2 The effect of transmission outages (defined in Categories B and C of Table 1 in Reliability Standard TPL-002-0 and TPL-003-0) prior to the implementation of any post-contingency system adjustments that may be manually implemented by the System Operator.

R2.3 The effect of increasing the power transfer to the Total Transfer Capability ("TTC") limit on stability constrained flowgates.

R3. *[Violation Risk Factor: Medium]*. The Transmission Planner and Planning Coordinator shall each determine corrective plan(s) for its portion of the interconnected transmission system to achieve the required system damping performance when a small signal stability assessment study, as prescribed in MRO Regional Reliability Standard PRC-502-MRO-01_R2, indicates small signal instability or inadequate damping; or a large signal stability assessment study, as prescribed in Reliability Standard TPL-002-0 and TPL-003-0, indicates inadequate damping. Inadequate damping is defined in PRC-502-MRO-01_R1(a). An example of a corrective plan includes installing or retuning a power system stabilizer(s) on a suitable generating unit as defined in MRO Regional Reliability Standard PRC-502-MRO-01_R1.

R4. *[Violation Risk Factor: Lower]*. The Transmission Planner and Planning Coordinator shall each demonstrate through valid assessment for its portion of the interconnected transmission system that any PSS required in accordance with MRO Regional Reliability

StandardPRC-502-MRO-01_R1 or PRC-502-MRO-01_R3 has been planned, designed and tuned to have a positive damping effect on local, inter-plant and inter-area modes without significantly impacting turbine-generator shaft torsional oscillation damping. To be valid, the Planning Coordinator and Transmission Planner PSS assessments shall:

R4.1 Be made prior to the in-service date of the generator and as required by changes in system conditions.

R4.2 Demonstrate that machine rotor angle oscillations are within damping criteria determined by the Planning Coordinator, as defined in MRO Regional Reliability Standard PRC-502-MRO-01_R8 and determined by the MRO, as defined in MRO Regional Reliability Standard TPL-503-MRO-01.

R4.3 Include results from small signal stability model data verification tests as prescribed in MRO Regional Reliability Standard PRC-502-MRO-01_R6.

R4.4 Include results from small signal stability assessments done in accordance with MRO Regional Reliability Standard PRC-502-MRO-01_R2 that are required in the design of the PSS.

R4.5 Demonstrate that the addition of the PSS does not degrade the damping ratio of each torsional mode by more than 10% on the generating unit where the PSS is installed.

R5. *[Violation Risk Factor: Lower]*. The Transmission Planner and Planning Coordinator for its portion of the interconnected transmission system shall, within thirty (30) days of a request or completion of an assessment or corrective plan, provide to the MRO and any impacted Transmission Planner(s), Planning Coordinator(s), and Generator Owner(s) the results of its latest small signal stability and PSS assessment and corrective plan.

R6. *(Violation Risk Factor: Lower]*. The Generator Owner shall perform small signal stability model and performance verification tests for excitation systems (including automatic voltage regulator controls and power system stabilizers) on all generating units that have an operation power system stabilizer. The Generator Owner may perform the tests in accordance with MRO Generator Testing Guidelines. The Generator Owner shall, within thirty (30) days of a request, provide to the MRO and applicable Planning Coordinator(s) and Transmission Planner(s) the results of its most recent small signal stability model and performance verification tests for excitation systems (including automatic voltage regulator controls and power system stabilizers).

The small signal stability model and performance verification tests shall include at minimum:

R6.1 A frequency-response test to verify the closed-loop automatic voltage regulator (“AVR”) transfer function without the PSS in-service. The generator is disconnected from the grid and operating at rated speed.

R6.2 A frequency-response test to verify the PSS open-loop transfer function, if the PSS is of analog type. The PSS output is disconnected from the AVR summing junction. Digital systems that have been type tested are exempt from the frequency-response field test. The Generator Owner shall supply manufacturer data and field settings of parameters for digital systems.

R6.3 A step-response test with the generator synchronized to the grid to verify that the gains and time constants of excitation systems (including automatic voltage regulator controls and power system stabilizers) have been designed and tuned to have a positive damping effect on local generator oscillations. A step-change in

terminal voltage reference of the AVR is performed with and without the PSS in-service. The step change shall be designed to avoid hitting excitation limits or violating applicable voltage criteria.

R6.4 A load-ramping test at the typical generating unit ramp rate to ensure that the PSS does not produce undesirable modulation of the generating unit's terminal voltage.

Tests R6.1 through R6.4 above shall be conducted during commissioning of a new unit or of a substantial modification of a generation unit to develop the model and to verify performance. The tests shall be repeated or the model may be compared against a system disturbance once every five (5) years thereafter as specified by MRO Generator Testing Guidelines for ongoing model and performance verification. A valid disturbance must cause a sudden change in system voltage of at least 2% of nominal bus voltage or a sudden change in reactive power of at least 10% of the rated generator MVA. The voltage regulator must have been in automatic voltage control mode and the PSS in service during the disturbance.

R7. *[Violation Risk Factor: Medium]*. Where a PSS is required on a generating unit(s) in accordance with MRO Regional Reliability Standard PRC-502-MRO-01_R1 or PRC-502-MRO-01_R3, the Generator Owner shall keep the PSS operational except for the reasons listed in R7.1 through R7.4 below:

R7.1 Maintenance, repair and testing.

R7.2 PSS does not operate properly due to a failed component.

R7.3 Generator unit is operating in synchronous condenser mode (near zero power level).

R7.4 A hydro unit is passing through a range of output that causes undesirable terminal voltage variations (i.e. rough-zone gate position).

The Generator Owner shall maintain a log that specifies the date, duration and reason for not keeping the PSS operational and shall, within thirty (30) days of a request, provide the log to the MRO. The Generator Owner does not need to record the PSS outage in the log if the outage is part of a normal operating procedure agreed to by the Generator Owner and Transmission Operator.

R8. *[Violation Risk Factor: Lower]*. The Planning Coordinator shall define and document a rotor angle oscillation damping criteria and calculation methodology for local and inter-plant modes. The Planning Coordinator shall make documentation of this damping criteria and calculation methodology available to other Transmission Planner(s), Planning Coordinator(s) and the MRO within thirty (30) days of a request.

C. Measures

M1. The Generator Owner shall have evidence it has installed or made provisions to install a power system stabilizer as specified in MRO Regional Reliability Standard PRC-502-MRO-01_R1.

M2. The Transmission Planner and Planning Coordinator shall each have a valid small signal stability assessment and corrective plan for its portion of the interconnected transmission system as specified in MRO Regional Reliability Standards PRC-502-MRO-01_R2 and PRC-502-MRO-01_R3.

M3. The Transmission Planner and Planning Coordinator shall each have a valid power system stabilizer assessment for its portion of the interconnected transmission system as specified in MRO Regional Reliability Standard PRC-502-MRO-01_R4.

M4. The Transmission Planner and Planning Coordinator shall each have evidence it reported documentation of results of its small signal and PSS assessments and corrective plans for its portion of the interconnected transmission system as specified in MRO Regional Reliability Standard PRC-502-MRO-01_R5.

M5. The Generator Owner shall have evidence it provided the MRO and applicable Planning Coordinator(s) and Transmission Planner(s) with small signal stability model and performance verification test results for excitation systems (including automatic voltage regulator controls and PSSs) as specified in MRO Regional Reliability Standard PRC-502-MRO-01_R6.

M6. The Generator Owner shall maintain an operational log of the PSS and have evidence it reported the log per MRO Regional Reliability Standard PRC-502-MRO-01_R7.

M7. The Planning Coordinator shall have documentation describing its rotor angle damping criteria and calculation methodology for local and inter-plant modes and evidence it reported the documentation as specified in MRO Regional Reliability Standard PRC-502-MRO-01_R8.

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 (1) calendar year from the last finding of non-compliance.

1.3. Data Retention. The Transmission Planner and Planning Coordinator shall each retain assessments for five (5) years or until the next assessment is completed. The Generator Owner shall retain information from the most current and prior small signal stability model data verification tests.

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

The Compliance Monitor shall retain the last audit and all subsequent compliance records.

1.4. Additional Compliance Information. The Planning Coordinator, Transmission Planner and Generator Owner shall demonstrate compliance through the following methods, as determined by the compliance monitor: (1) self-certification or (2) audit (periodic, as part of targeted monitoring or initiated by complaint or event).

2. Violation Severity Levels

Lower: Transmission Planner or Planning Coordinator assessment(s) and/or corrective plan(s) for its portion of the interconnected transmission system was supplied to the MRO in accordance with R5 but was incomplete in one or more areas of R2, R3 or R4.

Moderate: Transmission Planner or Planning Coordinator did perform a small signal stability assessment in accordance with R2 and determined a corrective

plan in accordance with R3 for its portion of the interconnected transmission system but did not provide documentation to the MRO in accordance with R5.

Transmission Planner or Planning Coordinator did perform a PSS assessment for its portion of the interconnected transmission system in accordance with R4 but did not provide documentation to the MRO in accordance with R5.

Generator Owner did not make provisions for the future addition of a PSS in accordance with R1.

Planning Coordinator did not develop and document a rotor angle damping criteria and calculation methodology in accordance with R8.

High: Transmission Planner or Planning Coordinator did not perform a small signal stability assessment and determine a corrective plan for its portion of the interconnected transmission system in accordance with R2 and R3. The Transmission Planner or Planning Coordinator did not perform a PSS assessment for its portion of the interconnected transmission system in accordance with R4.

Generator Owner did not verify the small signal model data for the excitation systems (including automatic voltage regulator controls and PSSs) and performance of the excitation systems in accordance with R6.

Generator Owner did not maintain a PSS operational log in accordance with R7**.**

Severe: Generator Owner did not install or retune a PSS or keep the PSS in-service under normal conditions in accordance with a corrective plan in accordance with R3 and R7.

Version History

Version	Date	Action	Change Tracking