

### 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.*

**Rotor Angle Oscillation Damping Factor** - The rate of decay of the amplitude of a rotor angle oscillation expressed in percent and calculated as one minus the Successive Positive Peak Ratio times 100.

**Successive Positive Peak Ratio (SPPR)** - The ratio of the peak amplitude of a rotor angle swing to the peak amplitude of a rotor angle swing on the previous cycle.

**A. Introduction**

**1. Title:** System Performance

**2. Number:** TPL-503-MRO-01

**3. Purpose:**

To ensure adequate interconnected transmission system performance in the MRO.

**4. Applicability**

**4.1.** Planning Coordinator

**4.2.** Transmission Planner

**5. (Proposed) Effective Date:** Thirty (30) days after MRO Board Approval.

**B. Requirements**

**R1.** The Planning Coordinator and Transmission Planner shall each demonstrate through valid assessment or assessments that its portion of the interconnected transmission system is planned such that the network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand levels over the range of forecast system demands, under the conditions defined in Category A of Table I of NERC TPL-001-0, the contingency conditions in Categories B and C of Table I of NERC TPL-002-0 and NERC TPL-003-0, and the contingency conditions as defined in the MRO System Performance Table (attached). To be valid, the Planning Coordinator and Transmission Planner annual assessment being performed to meet the NERC TPL-001-0 through NERC TPL-004-0 that is conducted for near-term (years one through five) and longer-term (years six through ten) shall also: [*Violation Risk Factor: Lower*]

**R1.1** Include current or past studies and/or simulation testing that:

**R1.1.1** Demonstrate that System Performance meets the MRO System Performance Table for Categories A through C in the same way that the Planning Coordinator and Transmission Planner demonstrates it meets NERC TPL-001 through NERC TPL-004, such as.

**R1.1.1.1** Be performed annually unless changes to system conditions do not warrant such analyses.

**R1.1.1.2** Be conducted beyond the five-year horizon only as needed to address identified marginal conditions that may have longer lead-time solutions.

**R1.1.2** Demonstrate that machine rotor angle oscillations are within damping limits as defined in the MRO System Performance Table.

**R1.1.3** Be performed with the applicable rating for each Category C disturbance that is the facility thermal rating or system voltage limit as defined by the system or facility owner.

**R1.1.3.1** Assuming acceptable loss of life, that protects against instability (including voltage instability), uncontrolled separation, or cascading outages, consistent with transient voltage deviation limits and power oscillation damping ratio limits as provided in the MRO System Performance Table.

**R1.1.3.2** In setting the applicable rating, consideration must be given to the effects of high loading, the effects of large steady-state voltage deviations, and the relay tripping values of all relay types.

**R1.1.4** Demonstrate that Normal Clearing of single line to ground (SLG) faults in Category B2 disturbances include both single pole tripping if enabled with successful reclosing and single pole tripping if enabled with unsuccessful reclosing due to permanent SLG fault followed by Normal Clearing.

**R1.2** Events for any two circuits of a multiple circuit towerline excludes events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) of 1 mile or less in length. Planning Coordinator and/or Transmission Planner may ask for a variance to the multiple circuit towerline event exclusion from the MRO on a case by case basis for short distances (e.g., station entrance, river crossings) that are longer than 1 mile.

**R1.3** Address any planned upgrades needed to meet the performance requirements of the MRO System Performance Table.

**R1.4** Demonstrate by a current or past study and/or system simulation testing that Systems are capable of readjustment within the readjustment period required by NERC standards so that facility loadings are within Normal Ratings and facility voltage levels are within normal system voltage limits following a NERC Category B or C disturbance in NERC TPL-002-0 and TPL-003-0, respectively. Permissible automatic and manual system readjustments are defined in the MRO System Performance Table (notes 2 and 3).

**R1.4.1** A safety margin shall be added when estimated model data is used to determine the actual or planned fault clearing time. The Planning Coordinator and/or the Transmission Planner shall document the basis for the safety margin.

**R2.** When studies or system simulations indicate an inability to meet the performance requirements of the MRO System Performance Table, the Planning Coordinator and Transmission Planner shall each determine corrective plans for its portion of the interconnected transmission system to achieve the required system performance as described above throughout the planning horizon. [*Violation Risk Factor: Medium*]

**R3.** The Planning Coordinator and Transmission Planner shall each document the results of these reliability assessments and corrective plans for its portion of the interconnected transmission system and shall annually provide these assessments and plans to the MRO. [*Violation Risk Factor: Lower*]

## **C. Measures**

**M1.** The Planning Coordinator and Transmission Planner shall have valid assessments and corrective plans as specified in MRO Regional Reliability Standards TPL-503-MRO-01\_R1 and TPL-503-MRO-01\_R2.

**M2.** The Planning Coordinator and Transmission Planner shall have evidence it reported documentation of results of its assessments and corrective plans per MRO Regional Reliability Standard TPL-503-MRO-01\_R3.

## **D. Compliance**

**1. Compliance Monitoring Process**

**1.1. Compliance Monitoring Responsibility**

Midwest Reliability Organization

**1.2. Compliance Monitoring Period and Reset Timeframe**

Annually

**1.3. Data Retention**

None specified.

**1.4. Additional Compliance Information**

None.

**2. Violation Severity Levels**

**Lower:** Not applicable.

**Moderate:** Valid assessments and corrective plans for the longer-term planning horizon are not available.

**High:** Not applicable.

**Severe:** Valid assessments and corrective plans for the near-term planning horizon are not available.

**Version History**

Version	Date	Action	Change Tracking

**MRO SYSTEM PERFORMANCE TABLE<sup>1</sup>**

NERC Categories	Transient voltage deviation limits (Up to 20 seconds)	Rotor Angle Oscillation Damping Ratio Limits (Up to 20 seconds)
A	Nothing in addition to NERC Requirements	
B (See Notes 2 and 6)	Minimum 0.70 p.u. at any bus. (See Note 5)	Not to be less than 0.0081633 for disturbances with faults or less than 0.0167660 for line trips. (See Note 7)
C (See Notes 2, 3, and 6)	Minimum 0.70 p.u. at any bus. (See Note 5)	Not to be less than 0.0081633 for disturbances with faults or less than 0.0167660 for line trips. (See Note 7)
D (See Notes 2, 3, and 4)	Nothing in addition to NERC Requirements	

Notes:

1. The MRO System Performance Table including the notes applies to the initial transient period following the contingency (up to 20 seconds) and the post-disturbance period (20 seconds to the end of the allowed readjustment period as described in MRO Regional Reliability Standard TPL-503-MRO-01\_R1.3).
2. The following summarizes the automatic and manual readjustments that are permissible for all NERC Category B disturbances.
  - A. Generation adjustments - Reducing or increasing generation while keeping the units on-line or by bringing additional units on line. The amount of generation change is limited to that amount that can be accomplished within the allowed readjustment period. Due consideration shall be given to start up time and ramp rates of the units.
  - B. Capacitor and reactor switching - The number of capacitors and reactors, which may be switched, is limited to those which could be switched during the allowed readjustment period. This includes

- those capacitors and reactors that would be switched by automatic controls within the same period.
- C. Adjustment of load tap changers (LTCs) to the extent possible within the allowed readjustment period. This includes both LTCs which would automatically adjust and those under operator control which could be adjusted within the readjustment period.
  - D. Adjustment of phase shifters to the extent possible within the allowed readjustment period.
  - E. An increase or decrease to the flow on HVDC facilities to the extent possible within the allowed readjustment period.
  - F. Generation rejection to the extent possible within the allowed readjustment period. Shall not exceed the normal operating reserve of the generation reserve sharing pool to which the MRO Member belongs or of the MRO Member itself if the MRO Member self-provides generation reserves.
  - G. Transmission reconfiguration - Automatic and operator initiated tripping of transmission lines or transformers to the extent possible within the allowed readjustment period.
  - H. Automatic or manual tripping of interruptible load or curtailment of or pre-determined redispatching of Firm Transmission Service to the extent possible within the allowed readjustment period.
3. The following additional readjustment may be considered for all NERC Category C contingencies.
- A. Automatic or manual tripping of firm Network Integration Transmission Service Load or Native Load or curtailment of or predetermined redispatching of Firm Transmission Service to the extent possible within the allowed readjustment period.
4. The following additional readjustments may be considered for all NERC Category D contingencies.
- A. Planned and/or controlled islanding - Automatic underfrequency load shedding, as specified in NERC PRC-006-0, is permitted to arrest declining frequency and generation rejection is permitted to arrest increasing frequency in order to assure continued operation within the resulting islands.
  - B. Automatic undervoltage load shedding is permissible to arrest declining voltages and prevent widespread voltage collapse.
5. The voltage of 0.7 per unit is the point at which load dropping begins to occur due to motor contactors dropping out and induction motors stalling.
6. Apparent impedance transient swings into the inner two zones of distance relays are unacceptable for NERC Category B disturbances, unless documentation is provided showing the actual relays will not trip for the event. Apparent impedance transient swings into the inner two zones of distance relays are unacceptable for NERC Category C disturbances, unless documentation is provided that demonstrates that a relay trip will not result in instability (including voltage instability), uncontrolled separation, or cascading outages.
7. Damping is required during the initial transient period following the disturbance (up to 20 seconds). The machine rotor angle damping ratio is determined by appropriate modal analysis (for example, Prony analysis). Alternatively, the Rotor Angle Oscillation Damping Factor or Successive Positive Peak Ratio (SPPR) can be calculated directly from the rotor angle, where the rotor angle response allows such direct calculation. For a disturbance with a fault, the SPPR must be less than 0.95 or the damping factor must be greater than 5%. For a disturbance without a fault, the SPPR must be less

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than 0.90 or the damping factor must be greater than 10%. (The SPPR criteria were chosen to define positive rotor angle damping for study purposes in MAPP. The Rotor Angle Oscillation Damping Ratio Limits were derived from the SPPR criteria.)