Appendix L: SOL (IROL) Methodology for the Planning Horizon Definitions:

System Operating Limit (SOL)—The value (such as MW, MVar, Amperes, Frequency or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. System Operating Limits are based upon certain operating criteria. These include, but are not limited to:

- Facility Ratings (Applicable pre- and post-Contingency equipment or facility ratings)
- System Voltage Limits (Applicable pre- and post-Contingency Voltage Limits)

Interconnected Reliability Operating Limit[1] (IROL)—A System Operating Limit that, if violated, could lead to instability, uncontrolled separation, or Cascading Outages that adversely impact the reliability of the Bulk Electric System.

Interconnected Reliability Operating Limit Tv[1] (IROL Tv)—The maximum time that an Interconnection Reliability Operating Limit can be violated before the risk to the interconnection or other Reliability Coordinator Area(s) becomes greater than acceptable. Each Interconnection Reliability Operating Limit's Tv shall be less than or equal to 30 minutes.

1 NERC Glossary of Terms Used in Reliability Standards, revised May 2, 2007
ftp://www.nerc.com/pub/sys/all_updl/standards/rs/Glossary_02May07.pdf

Normal Rating[2] —The rating as defined by the equipment owner that specifies the level of electrical loading or output, usually expressed in megawatts (MW) or MVar or other appropriate units, that a system, facility, or element can support, produce, or withstand through the daily demand cycles without loss of equipment life.

Emergency Rating[1] **—**the rating as defined by the equipment owner that specifies the level of electrical loading or output, usually expressed in megawatts (MW) or MVar or other appropriate units, that a system, facility, or element can support, produce, or withstand for a finite period. The rating assumes acceptable loss of equipment life or other physical or safety limitations for the equipment involved.

Operating Horizon—The period from the current hour to and including the last hour of the twelfth month into the future. (Months 1-12 from current).

Planning Horizon—The period from the first hour of the thirteenth month into the future from the current hour to the last hour or the tenth year beyond the current year. (Years 1-10 from current, not including the current year).

R1 SOL Methodology:

The MISO establishes SOLs and IROLs for both the Operating and the Planning Horizons. The provided SOLs (including the subset of SOLs that are IROLs) shall include the identification of the subset of multiple contingencies (if any) from Reliability Standard TPL-003 which result in stability limits. The SOL/IROL Limits attained from Steady State, Voltage Stability, and Transient Stability analyses for the MTEP planning horizon is posted to two secure locations: The MISO Extranet Reliability Authority page and the MISO ftp site.

Instructions for access for the Extranet Reliability Authority are found at: http://extranet.midwestiso.org/How%20To%20Activate%20RA%20Information%20Access.pdf

Instructions for access for the MTEP ftp site are found at: https://www.misoenergy.org/Library/Repository/Study/MTEP/FTP%20Site%20Access%20Request%20Form.pdf

The methodology for developing SOLs and IROLs for the Planning Horizon are described in this document.

R1.1 Applicability of SOLs for the Planning Horizon:

SOLs and IROLs for the Operating Horizon are generally associated with determination of maximum power transfer limits across defined interfaces to which the system must be limited in real-time operations in order to ensure reliable and secure system operations, respectively. These transfer limits are often translated into specific flow limits on individual facilities or a group of facilities that define the interface for which the limit is established, in order that operating personnel may recognize the approach of such transfer limits and take necessary action to maintain reliable and secure operations. Such maximum transfer defined operating limits are most valuable in the Operating Horizon of up to 12 months into the future. Maximum transfer limits projected for future planning horizons of 1 year and beyond are of little value to operators in real-time operation of the system since the future system conditions for which they are established are likely to be of little relevance to the actual conditions in the operating horizon that the operator must be prepared for.

[2] NERC Glossary of Terms Used in Reliability Standards, revised May 2, 2007 ftp://www.nerc.com/pub/sys/all_updl/standards/rs/Glossary_02May07.pdf

In the Planning Horizon, SOLs and IROLs are not developed in terms of maximum transfer limits, but instead are established for specified system configurations or defined system conditions (system or area demand level and facility contingency conditions) consistent with NERC reliability Standards TPL 001, 002, 003, and 004. The SOL for the planning horizon is characterized by the system condition in terms of load level, the contingent facility outage conditions, and the thermal or voltage limit of the most limiting facility for the configuration.

R1.2 Relationship of SOLs and Facility Ratings:

Consistent with the applicability in section 3.1 above, SOLs in the planning

horizon are described as the most limiting facility rating and its design thermal or voltage rating together with the system conditions at which the limit is reached or (without planned upgrades or other remedy) exceeded when applying the TPL standards. The SOL condition shall not produce any facility loading or voltage condition that exceeds the most limiting element that determines the Facility Rating.

R1.3 Relationship of SOLs and IROLs:

By definition, IROLs are a subset of SOLs that, if violated, could lead to instability, uncontrolled separation, or Cascading Outages that adversely impact the reliability of the Bulk Electric System. Therefore, IROLs in the planning horizon are described as the system condition(s) (system or area demand level and facility contingency conditions) consistent with the NERC TPL standards for which (without planned upgrades or other remedy) instability, uncontrolled separation, or Cascading Outages are projected to occur.

R2 Determination of SOL Conditions in the Planning Horizon:

Short-term planning addresses identification of needs and solutions in the time frame of 1 to 10 years, with particular focus on the next 5 years. Screening reliability analyses are performed in the 6-10 year period to identify possible issues that may require longer lead-time solutions, as required by the NERC standards.

Baseline reliability analysis provides an independent assessment of the reliability of the currently planned MISO Transmission System for the short-term planning horizon (e.g., within the next five years). This is accomplished through a series of evaluations of the short-term system with Planned (committed) and Proposed transmission system upgrades, as identified in the expansion planning process, to ensure that they are sufficient and necessary to meet NERC and regional planning standards for reliability. This assessment is accomplished through steady-state power flow, dynamic, small-signal, load deliverability, and voltage-stability analysis of the transmission system performed by MISO staff and reviewed in an open Stakeholder process.

Regional contingency files are developed by MISO Staff collaboratively with Transmission Owner and Regional Study Group input. The list of contingencies will include events described under NERC TPL-001-0 through TPL-004-0, or any applicable local or RRO planning criteria or guidelines. Below is a list of typical contingency categories tested. The

extent that SOLs affect BES performance is determined using the following contingency criteria:

R2.1 Pre Contingency State:

The transmission system is modeled under NERC Category A conditions (e.g. system intact) using both steady-state and dynamic stability analysis. Potential planning criteria violations (thermal overloads and low or high voltage conditions) are identified using Transmission Owner's design criteria limits. In the pre-contingency state and with all Facilities in service, the BES shall demonstrate transient, dynamic and voltage stability; all Facilities shall be within their Facility Ratings and within their thermal, voltage and stability limits. In the determination of SOLs, the BES condition used shall reflect expected system conditions and shall reflect changes to the system topology such as Facility outages.

R2.2 Post Contingency State:

The transmission system is modeled under NERC Category B and C Conditions (e.g., loss of single or multiple Bulk Electric System elements, respectively) using both steady-state and dynamic stability analysis. Planning criteria violations (thermal overloads and low or high voltage conditions) are identified using Transmission Owner's design criteria limits. Following the single Contingencies—(R2.2.1) Single line to ground or three-phase fault (whichever is more severe), with Normal Clearing, on any Faulted generator, line, transformer, or shunt device or (R2.2.2) the loss of any generator, line, transformer, or shunt device without a Fault or a (R2.2.3) Single pole block, with Normal Clearing, in a monopolar or bipolar high voltage direct current system—the system shall demonstrate transient, dynamic and voltage stability; all Facilities shall be operating within their Facility Ratings and within their thermal, voltage and stability limits; and Cascading or uncontrolled separation shall not occur.

R2.3 Single Contingency System Response:

For the short-term planning horizon, any potential criteria violations under NERC Category B conditions are thoroughly analyzed. This analysis identifies possible corrective measures to prevent or mitigate potential violations, including construction of new transmission facilities, power flow switching strategies, generator re-dispatch, or controlled interruption to local network customers within the Faulted Facility affected area. The planning process also determines that appropriate preventative or mitigation measures can be put in place before the end of the planning horizon.

R2.4, R2.5, R2.5.1 Multiple Contingency System Response:

For the short-term planning horizon, modeled criteria violations under NERC Category C conditions are evaluated for their potential to result in Cascading Outages or uncontrolled separation This analysis identifies possible corrective measures to prevent or mitigate Cascading Outages or uncontrolled separation, including construction of new transmission facilities, power flow switching strategies, generator re-dispatch, or controlled load interruption or curtailment of firm transfers. The planning process also determines that appropriate preventative or mitigation measures can be put in place before the end of the planning horizon.

R3 Baseline Models:

The MISO Baseline Reliability study models will typically include power-flow models reflective of five-year out and ten-year out system conditions. Other variations of these may also be used as appropriate based on the stakeholder input for a given planning cycle. The MISO SOL methodology consists of each of the following elements:

R3.1 Topology:

The system topology in the Baseline Reliability Plan models will reflect the expected system condition for the planning horizon. This will include documented future transmission projects within the MISO Transmission System. The Baseline Reliability Plan models shall include at least the entire MISO's Planning Authority area as well as any critical modeling details from other Planning Authority areas deemed necessary to impact the Facility or Facilities under study. Following general criteria will be used to model future transmission projects:

- Planned projects with Expected In Service Date before the MTEP study horizon year (before July 1 for summer peak cases);
- Projects with Regulatory Approvals;
- Projects with system needs documented by a MISO study (i.e., a previous MTEP study, a Generator Interconnection study, a Transmission Service study, or a Coordinated Seasonal Assessment);
- Planned projects based on Conditionally Confirmed TSR upgrades;
- Upgrades related to Generator Interconnection requests with signed Interconnection Agreements;
- Projects which are not subject to cost sharing.

Future transmission upgrades are removed from the model if they have Withdrawn Planning Status, or if they do not meet the inclusion criteria above.

The non-MISO system representation will be based on the latest external system for the planning horizon.

R3.2 Contingencies:

Regional contingency files are developed by MISO Staff collaboratively with Transmission Owner and Regional Study Group input. The list of contingencies will include events described under NERC TPL 001 through TPL004, or any applicable local or Regional Entity planning criteria or guidelines. Below is a list of typical contingency categories tested.

- NERC Category A is system intact or no contingency event.
- NERC Category B1-B4 faulted events for systems under MISO operational control. Generally, greater than 100 kV, but includes some 69 kV. Category B includes single generator, transmission circuit and transformer outages. It also includes single pole block of DC lines.
- NERC Category C1, C2, and C4 through C9 faulted events. The more severe events will be studied per the standards. All events to be documented and studied over study cycle. Transmission Owners and MISO staff will document NERC Category C coverage.
- NERC Category C3 by control area including ties. This also includes double generator outages by control area. Selected generator plus branch C3 contingencies.
- NERC Category C from previous MTEP study which resulted in planning criteria violation (or exception) or used to justify upgrade project.
- NERC Category D events. Global automated bus outages to cover D8 and D9. Selected Category D events of other types to provide coverage over study cycle.

R3.3 Granularity of Models:

The MTEP base model includes all transmission system elements rated 100 kV and above. Additionally, the base model includes certain 69 kV elements that have been identified by member Transmission Owners as potentially significant for system reliability studies.

R3.4 Remedial Action Plans:

The MISO base model for evaluating SOLs includes analysis of known Special Protection Systems and Remedial Action Plans.

R3.5 Generation, Load, and Interchange:

All existing generators and future generators with a filed Interconnection Agreement will be modeled. Any additional generation needed to serve future load growth will be modeled based on input from future generation modeling processes described in Section 4.4 of this BPM. New information on generators in the external system through coordinated data exchange with other external entities will also be modeled. Retirement of existing generators will also be updated based on the information available through the System Support Resource study process (see Section 7.2). The load forecast information is based on the stakeholder input in the model building process. This information is reviewed and compared against load flow data from NERC series models, load forecast information as filed with FERC and State regulatory agencies. Interchange and transaction data are also updated via the model building process which will include any new transactions or changes from the Transmission Service Planning process.

R3.6 Criteria for determining when violating an SOL qualifies as an IROL:

In the annual MTEP planning study, thermal overloads greater than 125% of SOL are tested for potential uncontrolled separation, or Cascading Outages. Steady State simulations non-converged contingencies are tested for potential instability in Transient Stability Studies. Additionally, a Voltage Stability Study is performed to determine voltage instabilities at transfer conditions and associated monitored interface flows to identify transfer limits on voltage stability interfaces. Details of these study procedures are documented in section 4.3.7.1 of this BPM.

R4 Issuance of Documentation:

This SOL Methodology, and any change to it, will be issued to the following entities prior to the effectiveness of the change.

R4.1 Adjacent Planning Authority:

Each adjacent Planning Authority and each Planning Authority that indicated it has a reliability-related need for the SOL Methodology.

R4.2 Reliability Coordinator and Transmission Operator:

Each Reliability Coordinator (MISO) and Transmission Operator that operates any portion of the MISO's Planning Authority Area.

R4.3 Transmission Planner:

Each Transmission Planner that plans a portion of the MISO Planning Authority Area

R5 Documented Response Time:

If a recipient of this SOL Methodology provides documented technical comments on the methodology, the MISO will provide a documented response to that recipient within 45 calendar days of receipt of those comments. The response will indicate whether a change will be made to the SOL Methodology and, if no change will be made, the reasoning behind the decision.

R6 Data Retention Period:

The MISO shall keep all superseded portions of this SOL Methodology for 12 months beyond the date of the change in that methodology and shall keep all documented comments on its SOL Methodology and associated responses for three years.