MAPP Members Reliability Criteria Manual

September 2014

Version 1.2

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Approval History

Issue	Reason for Issue	Date
1.0	First Issue	November 16, 2012
1.1	TOS Recommended Update to Clarify Bus Voltage Criteria and update MPC Voltage Criteria	September 9, 2013
1.2	Annual TRAS Review and Updates to Member Companies List and Addition of Transient Voltage Criteria	September 9, 2014

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Introduction

This document outlines the specific MAPP Bulk Electric System (BES) transmission reliability criteria which are to be used for MAPP planning and operating studies. It also describes their relationship to the North American Electric Reliability Corporation (NERC) and Midwest Reliability Organization (MRO) Reliability Standards.

This document provides deterministic criteria for use in MAPP system studies so that a sound basis of comparison exists between MAPP system performance studies. It also provides a set of evaluation criteria from which individual MAPP members' study scopes, procedures, and reports can be produced.

This document sets forth the specific BES reliability criteria established by Transmission Owners and Transmission Providers in MAPP. These specific reliability criteria are in addition to the general criteria outlined in the NERC and MRO Reliability Standards.

The MAPP Transmission Reliability Assessment Subcommittee (TRAS) maintains this document. This document will be updated and/or revised as Transmission Owner and Transmission Provider criteria, operating limits, interface definitions, analysis techniques, utilities' operating practices, standards, and study philosophies evolve.

The capitalized terms in this document have the same definitions as in the NERC and MRO Reliability Standards. Any additional capitalized key words are defined in this document. All definitions are consistent with current NERC, MAPP, and IEEE documents.

Abbreviations and Definitions

Terms and Definitions

Automatic	Any operation not requiring human intervention.
Interface	A set of one or more transmission lines or other facilities on which flow measurements are made and totaled. Note that the total power flowing across an interface may not necessarily equal the net of the schedules between the areas connected along the interface, because other schedules flowing through an area may contribute to the interface measurement.
Pre-Disturbance/Pre-Contingency	Normal steady-state system operation.
Post-Disturbance/Post-Contingency	Period immediately following Disturbance in which transients have damped but before permissible Readjustments occur. Special Protection Systems may operate if appropriate.
UIP	User Interface Package used by Transmission Owners for stability studies
Voltage Instability:	Uncontrolled voltage excursions or voltage collapse on bus or group of buses with subsequent inability to recover to acceptable voltage levels.

Committee/Study Group Designations

TRAS	MAPP Transmission Reliability Assessment Subcommittee
TOS	MAPP Transmission Operations Subcommittee

Other Study Groups

ISG	Interconnected Studies Group
UMTAG	Upper Midwest Technical Ad-hoc Group

MAPP Member Company Abbreviations

BEPC	Basin Electric Power Cooperative
CIPCO	Central Iowa Power Cooperative
CBPC	Corn Belt Power Cooperative
HCPD	Heartland Consumers Power District
MMPA	Minnesota Municipal Power Agency
MPC	Minnkota Power Cooperative, Inc.
MRES	Missouri River Energy Services (In MAPP Planning Authority footprint)
NWE	Northwestern Energy
RPU	Rochester Public Utilities
WAPA	Western Area Power Administration

Other Abbreviations

MISO	Midcontinent Independent System Operator
SPP	Southwest Power Pool

MAPP SPECIFIC BULK TRANSMISSION RELIABILITY CRITERIA

1.0 Specific Planning and Operating Reliability Criteria

1.1 Voltage Criteria

Voltage criteria will be established by and be the responsibility of the Transmission Owner. The criteria parameters monitored in the study work shall be rounded to the nearest 0.01 p.u. to ensure consistent application of the criteria and to allow for small modeling variances. The initial transient period refers to the first 20 seconds after the contingency. The post-disturbance period refers to the period 20 seconds to 30 minutes after the contingency.

These voltage criteria can be utilized as guidelines for real-time operations, however depending upon operating conditions, the real-time voltages may vary outside of the recommended ranges below and the owner of the bus should be contacted for guidance on the application of these voltage criteria during real-time operations.

The threshold for significant impact to BES bus voltages is defined by the MAPP Design Review Subcommittee (for MAPP Members whose facilities are not in MISO) and by MISO (for MAPP Members whose facilities are in MISO), or other applicable Transmission Authority.

1.1.1 Pre-contingency Voltage Limitations

All steady state BES voltages in the study base case shall meet these criteria after all documented system adjustments have been made. These criteria are intended to be consistent with the NERC and MRO Reliability Standards, as applicable, and apply to the pre-contingency conditions.

System	Facility	Maximum kV/p.u.	Minimum kV/p.u.
MAPP	Default for all buses	1.05 p.u.	0.95 p.u.
MPC	All buses	1.05 p.u.	0.97 p.u.
WAPA	Philip 230 kV bus	244/1.06	219/0.95
WAPA	Philip 230 kV tap	244/1.06	219/0.95

1.1.2 Post Contingency Voltage Limitations

These criteria are intended to be consistent with the NERC and MRO Reliability Standards, as applicable, and apply to the post-contingency conditions prior to any operator intervention. All steady state BES voltages following contingencies in the power flow simulations must meet these criteria.

System	Facility	Maximum kV/p.u.	Minimum kV/p.u.
MAPP	Default for all buses	1.10 p.u.	0.90 p.u.
MPC	All Buses	1.10 p.u.	0.92 p.u.

1.1.3 Transient Period Voltage Limitations

All BES voltages in the simulation study shall meet these criteria:

System	Facility	Maximum kV/p.u.	Minimum kV/p.u.	Max.Time below Min. kV/p.u. after fault clearing
MAPP	Default for all buses	1.20 p.u.	0.70 p.u.	30 cycles
MPC	Drayton 230 kV	265/1.15	184/0.80	30 cycles
WAPA	Watertown 345 kV	407/1.18	259/0.75	30 cycles

The bus voltages in the MAPP area are allowed to increase to 1.3 p.u. for a duration up to 200 msec. unless otherwise noted.

The Miles City East and West 230kV bus voltages are allowed to increase to 1.3 p.u. for a duration up to 270 msec. during Miles City Converter Station block/bypass operation. Dynamic overvoltage devices (zinc oxide arresters) are installed on both the East and West Miles City 230 kV buses to clip the transient overvoltage to a 1.3 p.u. maximum. The surrounding area buses will also experience transient overvoltages (less than the 1.3 p.u. maximum and reduced based upon their electrical distance from Miles City) during this condition. These are acceptable. No specific overvoltage criteria for this condition are listed for the surrounding area buses due to the variance in the overvoltages for different system configurations.

1.2 Facility Loading Limits

Facility Loading Limits will be established by and be the responsibility of the Transmission Owner. The normal and emergency rating values supplied with the MRO power flow models should be used[1]. The normal rating is the continuous rating unless noted (e.g. dynamic ratings could be an example where the normal rating is different from the continuous rating).

Some systems have specifically identified higher dynamic ratings for some facilities under certain conditions. These are documented through applicable

1 The normal rating and emergency ratings are currently included as "Rate A" and "Rate B" respectively in the MRO power flow models. The conductor rating is sometimes included as "Rate C" in the MRO power flow models. Prior to the 2007 MRO models, “Rate C” is defined as the emergency rating and “Rate B” is defined as the conductor rating.

operating guides. These ratings may differ from the normal and emergency ratings that are included in the MRO power flow models.

1.3 Transient Period Damping Criteria

All machine rotor angle oscillations will be positively damped and meet the criteria below. The criterion does not apply to bus voltages. The Damping Factor will be calculated from the “Successive Positive Peak Ratio” (SPPR) of the peak-to-peak amplitude of the rotor oscillation. SPPR and the associated Damping Factor will be calculated as:

SPPR = Successive swing amplitude / Previous swing amplitude and,

Damping Factor = (1 - SPPR) * 100 (in %)

The damping criteria are as follows (with increased damping required for higher probability events):

For disturbances (with faults): SPPR (maximum) = 0.95; Damping Factor (minimum) = 5%

For line trips: SPPR (maximum) = 0.90; Damping Factor (minimum) = 10%

A PSS/E user model “DAMPCK” exists within the UIP study package, which performs the calculation of damping based on successive positive peak ratios for 0.25Hz mode.

In some cases, the SPPR calculation from the “DAMPCK” fails due to a constant rate of change of rotor angles caused by a significant generation loss and resulting significant frequency change. In these cases, Prony analysis should be utilized to calculate damping ratios on the appropriate modes of oscillation, and the damping ratio criteria (equivalent to the damping factor criteria above) are as follows:

For disturbances (with faults): Minimum Damping Ratio = 0.0081633

For line trips: Minimum Equivalent Damping Ratio = 0.016766

As an alternative method to automatic damping calculations such as DAMPCK and Prony analysis, the damping factor may be calculated manually by measuring the SPPR of the last two cycles (if they are discernible) of a 20 second simulation. If the swing within the last two cycles is less than one degree, the oscillations are sufficiently damped regardless of the SPPR calculation.

In all cases when measuring damping, simulations should be run out to 20 seconds in order to remove well-damped frequencies from the waveform.

1.4 Relay Encroachment and Out-of-Step Margins

1.4.1 Canada-USA Out-of-Step (OOS) Relay Margin Security Parameters

Relay	Steady State Pre	Steady State Post	Dynamic
OOS relay at Drayton 230 kV bus, monitoring the Drayton to Letellier 230 kV line	110%	50%	25%
OOS relay #1 at Moranville 230 kV bus monitoring the Moranville to Richer 230 kV line	110%	50%	25%

The definitions of these specific relay margin calculations are shown in Figure 1.4.1.

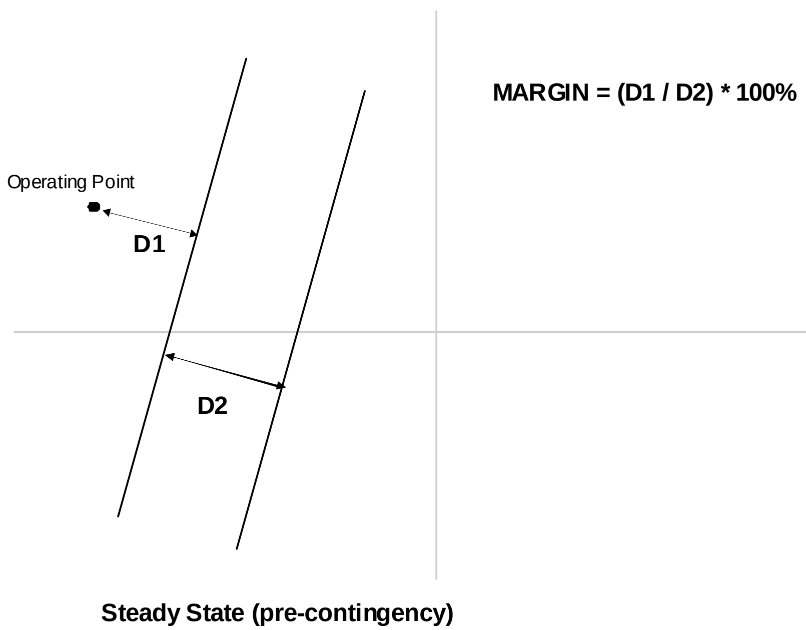

Figure 1.4.1 - Relays at Drayton and Moranville

1.4.2 Distance Relaying - Apparent Impedance Transient Criteria

The transient apparent impedance swings on all lines shall be monitored, after fault clearing, against a three-zone mho (or offset impedance) circle characteristic with the following zones:

Circle A = 1.00 x Line Impedance
Circle B = 1.25 x Line Impedance
Circle C = 1.50 x Line Impedance

Apparent impedance transient swings into the inner zones (Circles A or B) are considered unacceptable, unless documentation is provided showing the actual relays will not trip for the event.

A PSS/E dynamic user model "MRELY1" is maintained in the UIP study package, which performs the required global monitoring.

1.5 Voltage Stability Criteria

A voltage stability study may be necessary to demonstrate that there is sufficient margin between the normal operating point and the collapse point. The study shall include voltage versus power transfer or system demand (P-V curve). Sufficient margin is maintained by operating at or below P_{limit}. P_{limit} is determined by developing P-V curves for those buses that have the largest contribution to voltage instability due to the most limiting NERC Category B disturbance, per NERC TPL standards. P_{limit} is calculated as the lesser of:

- (0.9) * Pcrit (shown below in Figure 1.5.1 as point “a”) where Pcrit is defined as the maximum power transfer or system demand (nose of P-V curve) or
- The maximum power transfer or system demand which does not result in a post-contingency voltage violation as defined in this manual.

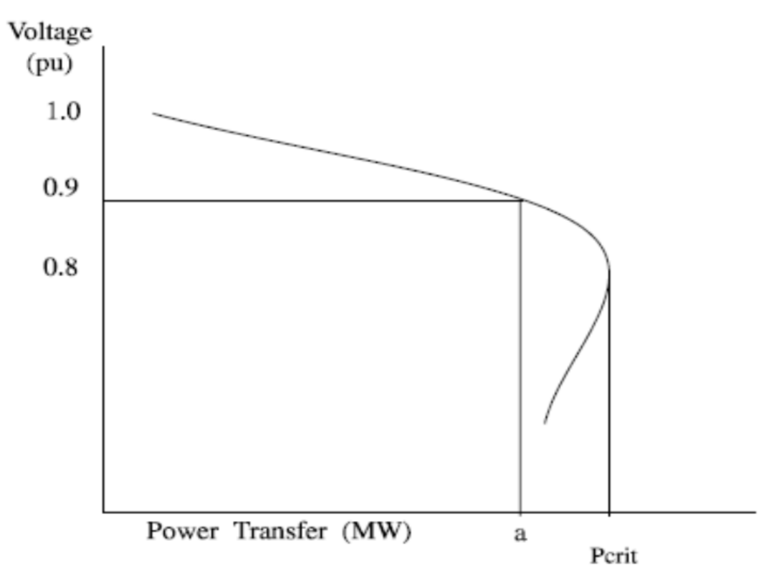

Figure 1.5.1 – P-V Curve