Reliability Criteria

Effective Date: March 2012
Areas Affected: Transmission System Planning
Supersedes: November 2011

APPENDIX A: PLANNING CRITERIA

Table A 1

Summary of Tri-State Steady-State Planning Criteria

System Condition	Operating Voltages [1] (per unit)		Maximum Loading [2] (Percent of Continuous Rating)	
	Maximum	Minimum	Transmission Lines	Other Facilities
Normal	1.05	0.95	80/100	100
N – k	1.10	0.90	100	100

[1] Exceptions may be granted for high side buses of Load-Tap-Changing (LTC) transformers that violate this criterion, if the corresponding low side busses are well within the criterion.

[2] The continuous rating is synonymous with the static thermal rating. Facilities exceeding 80% criteria will be flagged for close scrutiny. By no means, shall the 100% rating be exceeded without regard in planning studies.

Table A 2

Tri - State Voltage Criteria				
Conditions	**Operating Voltages**	**Delta-V**	**Areas**	**Bus List Name in Spreadsheet**
Normal	0.95 - 1.05			
Contingency N-1	0.90 - 1.10	7%	Northeastern New Mexico	NE New Mexico
Contingency N-1	0.90 - 1.10	7%	Southern New Mexico	S New Mexico
Contingency N-1	0.90 - 1.10	6%	Other buses in PNM area	O New Mexico
Contingency N-1	0.90 - 1.10	7%	Western Colorado	W Colorado
Contingency N-1	0.90 - 1.10	7%	Southern Colorado	S Colorado
Contingency N-1	0.90 - 1.10	6%	Other Tri-State areas	
Contingency N-2	0.90 - 1.10	10%	All	

Tri-State Generation and Transmission Assoc. (TP) –Reactive Power & Voltage Regulation Requirements for Generation Interconnections

A. Tri-State's Steady State VAR, and Voltage Regulation Requirements: Note - while these generally make reference to wind generation facilities, they shall apply to all generation interconnections, PV solar plants may be exempt if the requirement is not feasible.

1) All interconnections are subject to detailed study and may require mitigation in excess of minimums imposed by published standards, according to the best judgement of Tri-State engineers. The IC's Generating Facilities (GF) shall be capable of either producing or absorbing reactive power (VAR) as measured at the

HV POI bus at an equivalent 0.95 p.f., across the range of near 0% to 100% of facility MW rating, with the magnitude of VAR calculated on the basis of nominal POI voltage (1.0 p.u. V). This would be the net MVAR able to be either produced or absorbed by the IC facility, depending upon the voltage regulating conditions at the POI (see next item).

2) The POI voltage range where the IC's GF may be required to produce VAR is from 0.90 p.u. V through 1.04 p.u. V. In this range the IC facilities are being utilized to help support or raise the POI bus voltage.

3) The POI voltage range where the IC's GF may be required to absorb VAR is from 1.02 p.u. V through 1.10 p.u. V. In this range the IC facilities are being utilized to help reduce the POI bus voltage.

4) Note that the POI voltage range where the IC's GF may be required to either produce VAR or absorb VAR is 1.02 p.u. V through 1.04 p.u. V, with the typical target regulating voltage being 1.03 p.u. V.

5) The IC's GF may supply reactive power from the generators, from the generators' inverter systems alone (if capable), or a combination of the generators, generators' inverter systems plus switched capacitor banks and/or reactors, or continuously variable STATCOM or SVC type systems. The IC's GF is required to supply a portion of the reactive power (VAR) in a continuously variable fashion, such as supplied from either the generators, the generators' inverter systems, or a STATCOM or SVC system. The amount of continuously variable VAR shall be a value equivalent to a minimum of 0.95 p.f. produced or absorbed at the generator terminal Low Voltage (LV) bus, across the full range (0 to 100%) of rated MW output. The remainder of VAR required to meet the 0.95 p.f. net criteria at the HV POI bus may be achieved with switched capacitors and reactors, so long as the resultant step-change voltage is no greater than 3% of the POI operating bus voltage. This step change voltage magnitude shall be initially calculated based upon the minimum system (N-1) short circuit POI bus MVA level as supplied by the TP.

6) Under conditions when the IC's GF is not producing any real power (near 0 MW, and typically less than 2 MVAR), the reactive power exchange at the POI shall be near 0 MVAR ("VAR neutral"). This condition assumes that the facility needs to remain energized to supply base-level station-service "house power" for the control facilities, maintain wind turbines on turning gear, etc., and that tripping open the IC transmission line supply is not a normal or acceptable means to create this VAR neutral condition. In this non-generating mode, the IC Facility appears as a transmission connected load customer, and therefore must meet TP's requirements for load p.f., which requires that the load p.f. be 0.95 or better.

7) All interconnections are subject to additional detailed study, utilizing more complex models and software such as PSCAD, EMTP, or similar, and may require mitigation in excess of minimums imposed by published standards, according to the best judgement of the TP's engineers.

Basic WECC Dynamic Criteria:

Tri-State's dynamic reactive power and voltage control / regulation criteria are in accordance with the NERC/WECC dynamic performance standard shown in Figure W-1 and Table W-1 of the "TPL-(001 thru 004)-WECC-1-CR, System Performance Criteria" dated April 18, 2008.. Additional Tri-State dynamic reactive power and voltage criteria are listed below.

B. Tri-State's Dynamic VAR and Low Voltage Ride-Through Requirements (consistent with FERC Order 661-A):

Note - while these requirements generally make reference to wind generation facilities, they shall apply to all types of generation interconnections. PV solar plants may be exempt if the requirement is not feasible.

1) The IC's GF shall be able to meet the dynamic response Low Voltage Ride-Through (LVRT) requirements consistent with the latest WECC / NERC criteria. In particular, as per the Tri-State Appendix G to the GIA, and FERC Order 661a for LVRT (applicable to Wind Generation Facilities).

2) Generating plants are required to remain in service during and after faults, three-phase or single line-to-ground (SLG) whichever is worse, with normal total clearing times in the range of approximately 4 to 9 cycles, SLG faults with delayed clearing, and subsequent post-fault voltage recovery to pre-fault voltage unless clearing the fault effectively disconnects the generator from the system. The clearing time requirement for a three-phase fault will be specific to the circuit breaker clearing times of the effected system to which the IC facilities are interconnecting. The maximum clearing time the generating plant shall be required to withstand for a fault shall be 9 cycles after which, if the fault remains following the location-specific normal clearing time for faults, the wind generating plant may disconnect from the transmission system. A wind generating plant shall remain interconnected during such a fault on the transmission system for a voltage level as low as zero volts, as measured at the Point of Interconnection (POI). To elaborate, before time 0.0, the voltage at the POI is the nominal voltage. At time 0.0, the voltage drops. The plant must stay online for at least 0.15 seconds regardless of voltage during the fault. Further, if the voltage returns to 90 percent of the nominal voltage within 3 seconds of the beginning of the voltage drop, the plant must continuously stay online. The Interconnection Customer may not disable low voltage ride-through equipment while the wind plant is in operation.

3) This requirement does not apply to faults that would occur between the generator terminals and the POI.

4) Generating plants may be tripped after the fault period if this action is intended as part of a special protection system.

5) Wind generating plants may meet the LVRT requirements of this standard by the performance of the generators or by installing additional equipment (e.g., Static VAR Compensator) within the wind generating plant or by a combination of generator performance and additional equipment.

Table A 3

Category	Contingencies	System Limits or Impacts		
	Initiating Event(s) and Contingency Element(s)	System Stable and both Thermal and Voltage Limits within Applicable Rating [a]	Loss of Demand or Curtailed Firm Transfers	Cascading Outages
A No Contingencies	All Facilities in Service	Yes	No	No
B Event resulting in the loss of a single element.	Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing: 1. Generator 2. Transmission Circuit 3. Transformer Loss of an Element without a Fault.	Yes Yes Yes Yes	No [b] No [b] No [b] No [b]	No No No No
	Single Pole Block, Normal Clearing [e]: 4. Single Pole (dc) Line	Yes	No[b]	No
C Event(s) resulting in the loss of two or more (multiple) elements.	SLG Fault, with Normal Clearing [e]: 1. Bus Section 2. Breaker (failure or internal Fault)	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG or 3Ø Fault, with Normal Clearing [e], Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing [e]: 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency	Yes	Planned/ Controlled[c]	No
	Bipolar Block, with Normal Clearing [e]: 4. Bipolar (dc) Line Fault (non 3Ø), with Normal Clearing [e]: 5. Any two circuits of a multiple circuit towerline[f]	Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c]	No No
	SLG Fault, with Delayed Clearing [e] (stuck breaker or protection system failure): 6. Generator 7. Transformer 8. Transmission Circuit 9. Bus Section	Yes Yes Yes Yes	Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c] Planned/ Controlled[c]	No No No No

D [d] Extreme event resulting in two or more (multiple) elements removed or Cascading out of service	3Ø Fault, with Delayed Clearing [e] (stuck breaker or protection system failure): 1. Generator 3. Transformer 2. Transmission Circuit 4. Bus Section 3Ø Fault, with Normal Clearing [e]: 5. Breaker (failure or internal Fault) 6. Loss of towerline with three or more circuits 7. All transmission lines on a common right-of way 8. Loss of a substation (one voltage level plus transformers) 9. Loss of a switching station (one voltage level plus transformers) 10. Loss of all generating units at a station 11. Loss of a large Load or major Load center 12. Failure of a fully redundant Special Protection System (or remedial action scheme) to operate when required 13. Operation, partial operation, or misoperation of a fully redundant Special Protection System (or Remedial Action Scheme) in response to an event or abnormal system condition for which it was not intended to operate 14. Impact of severe power swings or oscillations from Disturbances in another Regional Reliability Organization.	Evaluate for risks and consequences. ▪ May involve substantial loss of customer Demand and generation in a widespread area or areas. ▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point. ▪ Evaluation of these events may require joint studies with neighboring systems.

a) Applicable rating refers to the applicable Normal and Emergency facility thermal Rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable Ratings may include Emergency Ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All Ratings must be established consistent with applicable NERC Reliability Standards addressing Facility Ratings.

b) An objective of the planning process should be to minimize the likelihood and magnitude of interruption of firm transfers or Firm Demand following Contingency events. Curtailment of firm transfers is allowed when achieved through the appropriate re-dispatch of resources obligated to re-dispatch, where it can be demonstrated that Facilities, internal and external to the Transmission Planner's planning region, remain within applicable Facility Ratings and the re-dispatch does not result in the shedding of any Firm Demand. It is recognized that Firm Demand will be interrupted if it is: (1) directly served by the Elements removed from service as a result of the Contingency, or (2) Interruptible Demand or Demand-Side Management Load. Furthermore, in limited circumstances Firm Demand may need to be interrupted to address BES performance requirements. When interruption of Firm Demand is utilized within the planning process to address BES performance requirements, such interruption is limited to circumstances where the use of Demand interruption are documented, including alternatives evaluated; and where the Demand interruption is subject to review in an open and transparent stakeholder process that includes addressing stakeholder comments.

c) Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted Firm (non-recallable reserved) electric power Transfers may be necessary to maintain the overall reliability of the interconnected transmission systems.

d) A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.

e) Normal clearing is when the protection system operates as designed and the Fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a Fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer, and not because of an intentional design delay.

f) System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

Table A 4

WECC DISTURBANCE-PERFORMANCE TABLE OF ALLOWABLE EFFECTS ON OTHER SYSTEMS

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard (See Note 2)
A	Not Applicable	Nothing in addition to NERC		
B	≥ 0.33	Not to exceed **25%** at load buses or **30%** at non-load buses. Not to exceed **20% for more than 20 cycles** at load buses.	Not below **59.6** Hz for 6 cycles or more at a load bus.	Not to exceed **5%** at any bus.
C	0.033 – 0.33	Not to exceed **30%** at any bus. Not to exceed **20% for more than 40 cycles** at load buses.	Not below **59.0** Hz for 6 cycles or more at a load bus.	Not to exceed **10%** at any bus.
D	< 0.033	Nothing in addition to NERC		

Notes:

1. *The WECC Disturbance-Performance Table applies equally to either a system with all elements in service, or a system with one element removed and the system adjusted.*

2. *As an example in applying the WECC Disturbance-Performance Table, a Category B disturbance in one system shall not cause a transient voltage dip in another system that is greater than 20% for more than 20 cycles at load buses, or exceed 25% at load buses or 30% at non-load buses at any time other than during the fault.*

3. *Additional voltage requirements associated with voltage stability are specified in Standard I-D. If it can be demonstrated that post transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) should cooperate in mutually resolving the problem.*

4. *Refer to Figure W-1 for voltage performance parameters.*

5. *Load buses include generating unit auxiliary loads.*

6. *To reach the frequency categories shown in the WECC Disturbance-Performance Table for Category C disturbances, it is presumed that some planned and controlled islanding has occurred. Underfrequency load shedding is expected to arrest this frequency decline and assure continued operation within the resulting islands.*

7. *For simulation test cases, the interconnected transmission system steady state loading conditions prior to a disturbance should be appropriate to the case. Disturbances should be simulated at locations on the system that result in maximum stress on other systems. Relay action, fault clearing time, and reclosing practice should be represented in simulations according to the planning and operation of the actual or planned systems. When simulating post transient conditions, actions are limited to automatic devices and no manual action is to be assumed.*

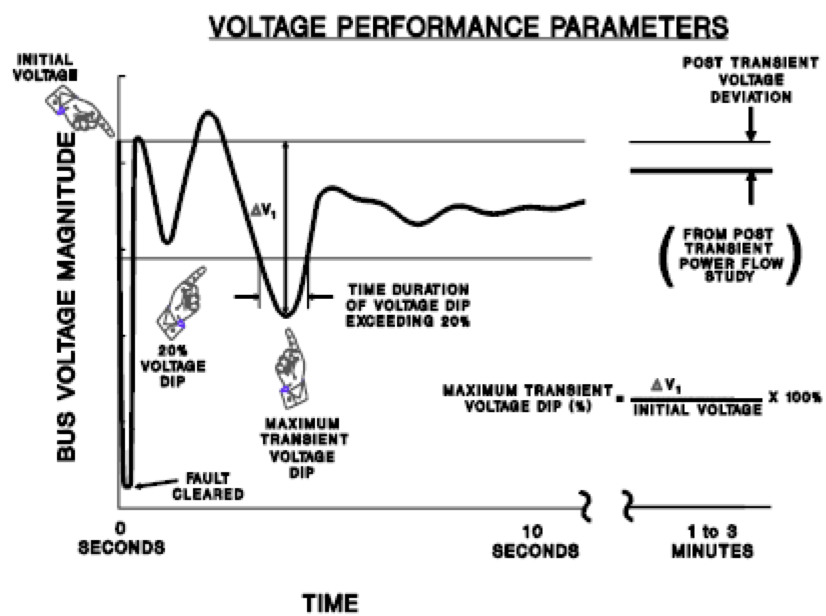

Figure W-1

Table A 5

Table 1

WSCC VOLTAGE STABILITY CRITERIA(*)

Performance Level	Disturbance (1)(2)(3)(4) Initiated By: Fault or No Fault DC Disturbance	MW Margin (P-V Method) (5)(6)(7)	MVAR Margin (V-Q Method) (6)(7)
A	Any element such as: One Generator One Circuit One Transformer One Reactive Power Source One DC Monopole	$\geq$ 5%	Worst Case Scenario (8)
B	Bus Section	$\geq$ 2.5%	50% of Margin Requirement in Level A
C	Any combination of two elements such as: A Line and a Generator A Line and a Reactive Power Source Two Generators Two Circuits Two Transformers Two Reactive Power Sources DC Bipole	$\geq$ 2.5%	50% of Margin Requirement in Level A
D	Any combination of three or more elements such as: Three or More Circuits on ROW Entire Substation Entire Plant Including Switchyard	> 0	> 0

(1) This table applies equally to the system with all elements in service and the system with one element removed and the system readjusted (see Section 2.2).

(2) For application of this criteria within a member system, controlled load shedding is allowed to meet Performance Level A (see Section 2.2 for a description of provisions for application of this criteria within a member system).

(3) The list of element outages in each Performance Level is not intended to be different than the Disturbance Performance Table in the WECC Reliability Criteria. Additional element outages have been added to this table to show more examples of contingencies. Determination of credibility for contingencies for each Performance Level is based on the definitions used in the existing WECC Reliability Criteria.

(4) Margin for N-0 (base case) conditions must be greater than the margin for Performance Level A.

(5) Maximum operating point on the P axis must have a MW margin equal to or greater than the values in this table as measured from the nose point of the P-V curve for each Performance Level.

(6) Post-transient analysis techniques shall be utilized in applying the criteria.

(7) Each member system should consider, as appropriate, the uncertainties in Section 2.3 to determine the required margin for its system.

(8) The most reactive deficient bus must have adequate reactive power margin for the worst single contingency to satisfy either of the following conditions, whichever is worse: (i) a 5% increase beyond maximum forecasted loads or (ii) a 5% increase beyond maximum allowable interface flows. The worst single contingency is the one that causes the largest decrease in the reactive power margin.

(*) Table 1 is an excerpt from the WSCC Reliability Criteria for Transmission System Planning in effect at the time of this document's approval. The most current version of the Council's Table of Allowable Effects on Other Systems should be referred to when conducting studies.

Final Report – May 1998

Maximum Allowable Voltage Flicker on High Voltage Transmission Buses

These criteria address the maximum allowable steady-state voltage flicker that can be caused by starting a motor or by switching a reactive device. The pertinent reference is REA-Bulletin 160-3, dated October 1969.

Tri-State Steady-State Voltage Flicker Criteria

Maximum Allowable Voltage Flicker (per unit)	**Allowable Switching Frequency**
0.0600	Voltage flicker of this magnitude cannot be exceeded, and is limited to 3 occurrences per day.
0.0333	Voltage flicker of this magnitude is limited to 15 occurrences per day.
0.030	Voltage flicker (step-change voltage) as applicable for switched shunt capacitors or reactors not controlled by Tri-State, as measured at the HV transmission reference bus.
0.0250	Voltage flicker of this magnitude is limited to 1 occurrence per minute.
0.0167	Voltage flicker of this magnitude is limited to 12 occurrences per minute.
0.0125	Voltage flicker of this magnitude is limited to 1 occurrence per second.
0.0083	Voltage flicker of this magnitude can occur at an unlimited frequency.