System Operating Limit (SOL) Methodology for the Planning Horizon

(FAC-010-2.1)

Western Area Power Administration

Planning Authorities

Version 3

Effective

September 1, 2014

Table of Contents

1. Purpose

The North American Electric Reliability Corporation (NERC) Standards FAC-0l0-2.l and FAC-014-2 require that each Planning Authority "shall have a documented System Operating Limits (SOL) Methodology for use in developing SOLs within its Planning Authority Area" for the planning horizon. This document describes the System Operating Limits Methodology utilized for all Western Area Power Administration (Western) Planning Authority areas. This methodology is only applicable to the planning horizon, the timeframe one to ten years out. [R1.1]

This document is updated periodically as needed to maintain consistency with current NERC Reliability Standards, Peak RC System Operating Limits Methodology for the Operating Horizon and WECC Regional Business Practices.

2. Definitions

This document is based on the following definitions from the NERC Glossary of Terms Used in Reliability Standards:

2.1. ***Bulk Electric System (BES)*** - Unless modified by [list of inclusions and exclusions], all Transmission Elements operated at 100 kV or higher and Real Power and Reactive Power resources connected at 100 kV or higher. This does not include facilities used in the local distribution of electric energy.

2.2. ***Cascading*** - The uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies.

2.3. ***Facility*** - A set of electrical equipment that operates as a single Bulk Electric System Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)

2.4. ***Facility Rating***- The maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility.

2.5. ***Interconnection Reliability Operating Limit (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.

2.6. ***Interconnection Reliability Operating Limit T_V (IROL T_V)*** - 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.

2.7. ***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)
- Transient Stability Ratings (Applicable pre- and post-Contingency Stability Limits)
- Voltage Stability Ratings (Applicable pre- and post-Contingency Voltage Stability)
- System Voltage Limits (Applicable pre- and post-Contingency Voltage Limits)

3. SOL Methodology for the Planning Horizon

3.1. SOL Applicability and Requirements

Western performs annual transmission planning assessments and numerous studies throughout the year. When these studies indicate that there are potential reliability performance violations during certain scenarios, corrective action plans are established. These corrective action plans could include system upgrades, but other alternatives might be more effective or efficient. Sometimes it is best to place restrictions on the system which must be adhered to in establishing long term plans.

For example, a flow limit could be placed on a specific set of lines to avoid potential load tripping due to under-voltages after a contingency. This limit could in turn be used to develop operating procedures, coordinate protection systems, determine the maximum transmission capacity that can be sold, provide stipulations for generator dispatch levels in interconnection agreements, assist in procurement of adequate reactive service, and many other activities that take place in the planning horizon. Utilizing this limit throughout the planning horizon will ensure that the system does not reach a scenario with potential reliability performance violations.

In general terms, a value that ensures operation within acceptable reliability criteria for a given configuration is an SOL. In addition to limits developed through studies, all Facility Ratings are SOLs. SOLs shall not exceed associated Facility Ratings [R1.2].

This methodology is applicable for determining System Operating Limits for the planning horizon within Western Planning Authority areas. The planning horizon is assumed to be beyond one year to a maximum of ten years [R1.1]. This methodology does not apply to the operating horizon, the time period less than one year out.

3.2. System Performance

In performing studies to establish SOLs, BES performance shall be based on the NERC System Performance Table provided in Appendix 1, titled "Transmission System Standards - Normal and Emergency Conditions." [R2]

Pre-contingency State - In the pre-contingent state, with all Facilities in service, this methodology requires that the BES demonstrate transient, dynamic, and voltage stability; all Facilities shall be within their thermal, voltage, and stability limits for system intact and planned (i.e. prior) outage conditions. The requirements for the pre-contingent state are also summarized under Category A of the System Performance Table in Appendix 1. [R2.1]

Thermal Facility Ratings are shared through WECC base case coordination.[1] The thermal ratings may vary from current operating procedures or from season to season. This is because the thermal ratings are provided for the corresponding season and timeframe for which the case is modeled. In the pre-contingent state, all normal thermal Facility Ratings in WECC base cases will be SOLs for the planning horizon.

Unless specified otherwise Western bus voltage limits for any bus in pre-contingent conditions will be +/- 5% of the nominal voltage (0.95 to 1.05 per unit). Note that "500 kV" elements normally have a nominal voltage of 525 kV and are thus operated between 1.00 and 1.10 per unit of the 500 kV baseline. In the pre-contingent state, all normal bus voltage limits will be SOLs.

Regional criteria are used as proxies to establish what constitutes "transient, dynamic, and voltage stability" in planning studies.[2] However, there are not defined criteria for the pre-contingent state, and thus there are no stability limits on facilities in the pre-contingent state. Steady state and dynamic simulations must converge prior to contingencies, and no elements should be out of synchronism prior to simulating contingencies in dynamic analysis.

Additionally, WECC annually posts a Path Rating Catalog.[3] The ratings in this catalog are thermal, voltage, and/or stability limits which constitute SOLs.

Single Contingencies - Following the single contingencies described in Category B of the NERC System Performance Table in Appendix 1, the system shall demonstrate transient, dynamic and voltage stability; all Facilities shall be within their thermal, voltage, and stability limits; Cascading outages or uncontrolled separation shall not occur. The requirements for the post-contingent state are also summarized in the Table. Additionally, Western uses the established proxies in Table W-1 of Appendix 1 as transient, dynamic, and

[1] For the cases with ratings see: http://www.wecc.biz/committees/StandingCommittees/PCC/TSS/BaseCases/Pages/default.aspx

[2] Order No. 693 at P1819 states, "The Commission agrees with SoCal Edison that, if an entity models overload relays, undervoltage relays, all remedial action schemes including those of neighboring systems and has a good load representation, then proxies are not required. However, due to modeling and simulation limitations this is often not the case and planners invariably use proxies. Recognizing this and the range of proxies currently in use, the Transmission Issues Subcommittee of the NERC Planning Committee recommended that proxies used in simulations be defined until such time as improved analytical tools and models are available to simulate cascading events."

[3] http://www.wecc.biz/library/Pages/Path%20Rating%20Catalog.aspx

voltage stability limits following single and multiple contingencies within the Western Interconnection. [R2.2, R2.2.1, R2.2.2, and R2.2.3]

Emergency thermal Facility Ratings will be used as the applicable post-contingent limits. These ratings have a limited duration. Typically, a 30 minute Emergency Rating is used, but this can be adjusted on a case-by-case basis. Simulations must prove that the system can be readjusted to bring facilities within their next lowest rating before the applicable timeframe expires. For example, some facilities have been given a 15 minute emergency rating greater than their 30 minute rating. If simulations show that the facility will exceed its 30 minute rating after a contingency but remain within its 15 minute rating, the limit has not been violated as long as the facility can be brought below the 30 minute rating within 15 minutes and there is an operating procedure to state how that will be done.

Unless specified otherwise in operating procedures, the applicable voltage limits for any bus after single and multiple contingencies will be +/- 10% of the nominal voltage (0.90 to 1.10 p.u.). Note that "500 kV" elements normally have a nominal voltage of 525 kV and are thus limited between 0.95 and 1.15 per unit of the 500 kV baseline. Post-contingency bus voltage limits cannot exceed 30 minutes in duration. Simulations must prove that the system can be readjusted to bring buses within their normal voltage ratings before this timeframe expires.

Additionally, the following proxy will be used to assess whether the system demonstrates voltage stability:

- When studying transmission paths/interfaces, the simulation must converge after single contingencies with the pre-contingency path/interface transfer modeled at a minimum of 105 percent of the simulated transfer level. For multiple contingencies, the simulation must converge with the pre-contingency transfer path/interface transfer modeled at a minimum of 102.5 of the simulated transfer level.
- When studying load areas, the simulation must converge after single contingencies at a minimum of 105 percent of the simulated load level. For multiple contingencies, the simulation must converge with the area modeled at a minimum of 102.5 percent of the simulated load level.

The BES response to a single contingency may include the following [R2.3]:

- Planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the Faulted Facility or by the affected area. [R2.3.1]

- System reconfiguration through manual or automatic control or protection actions. [R2.3.2]

To prepare for the next Contingency, system adjustments may be made, including changes to generation, uses of the transmission system, and the transmission system topology. [R2.4]

Multiple Contingencies - Starting with all Facilities in service and following any of the multiple Contingencies identified in Reliability Standard TPL-003 (and defined under

Category C of the System Performance Table in Appendix 1), 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. The proxies to identify "Cascading" are summarized under Category C in the WECC Disturbance Performance Table of Allowable Effects on Other Systems in Appendix 1. [R2.5]

The BES response to a multiple contingency may include the following [R2.6]:

- Planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the Faulted Facility or by the affected area. [R2.3.1]
- System reconfiguration through manual or automatic control or protection actions. [R2.3.2]
- Planned or controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or curtailment of contracted Firm (non-recallable reserved) electric power Transfers [R2.6.1]. Several methods might be used to model curtailment of contracted Firm Transfers in a simulation. These include, but are not limited to, generation redispatch, opening of lines or transformers, adjusting phase shifters, or other methods to reduce flow across a path.

3.3. Determining SOLs

The following describes Western's considerations to be addressed when determining SOLs in the planning horizon:

Study Model [R3.1, R3.5] - Study models shall be based on the most recent WECC approved base cases available for the study time frame and conditions unless otherwise noted and justified. Models shall reflect an adequate range of system stressing scenarios.

- Full loop representation is to be used with the entire WECC topology modeled. [R3.1]
- Anticipated system configurations such as planned outages, generation dispatch and seasonal load levels will be modeled. Generation and load levels will be selected to appropriately stress the study area and any associated transmission paths. Generation dispatch may vary due to wind, hydro, or other conditions. [R3.5]
- Residential, commercial, and industrial load models, with constant power, current, and impedance should be included as appropriate. Transient stability models shall represent voltage and frequency characteristics, actual load models when available, or accepted industry modeling. Loads shall include appropriate power factor representation and demand uncertainty margins of 5% for Categories A and B, and 2.5% for Category C. [R3.5]

- System transfer level limits for transmission paths defined within the WECC Path Rating Catalog. Additional transfer paths should be included if appropriate. [R3.1]

- Voltage profiles and equipment loadings within all accepted BES Facility Ratings and WECC Reliability Criteria. [R3.1]

- Applicable AC-DC-AC converter operating criteria. [R3.1]

- Applicable Phase Shifter operating criteria. [R3.1]

- Applicable series compensation assumptions for existing Extra High Voltage (EHV) lines. [R3.1]

- Applicable generation and load shedding necessary to ensure system security and reliability. [R3.1]

Selection of Contingencies [R3.2] – When performing simulations to determine SOLs, Western models Category B and C contingencies, including those in Appendix 2 where applicable. Effects of contingencies within Western and in other areas shall be considered. The contingencies selected for a detailed study will be the ones that are most pertinent to the area or path of concern. Contingencies of facilities above and below 100 kV shall be considered. Generally, the contingency list shall include:

- Any contingencies that have been previously studied and set or significantly impact a System Operating Limit.

- Additional contingencies based on historical system response or judgment of the engineer.

- New outages, resulting from changes in the system configuration, that have not yet been studied.

Thermal and Voltage Limits [R3.2] - The single contingencies must meet and exceed requirements R2.2, R2.3 and R2.4 of FAC-010-2. Multiple contingencies must meet and exceed the requirements R2.5, R2.6, and WECC Regional Difference E.l. of FAC-010-2 (see Appendix 2).

Voltage Stability Limits [R3.2] –Contingency cases that will not solve, or evidence difficulty solving, are analyzed for potential voltage problems.

Transient Stability Limits [R3.2] – The following methodology shall be used to determine transient stability limits:

- The contingency list for transient stability determination is a subset of the contingencies used for the thermal and voltage stability studies. This contingency list includes:

- Any contingencies that have been previously studied that set or significantly impacted a SOL.

- Additional contingencies based on historical system response and/or engineering judgment.

- New outages, resulting from changes in the system configuration, that have not yet been studied.

- Each contingency will be simulated for at least 10 seconds.

Acceptable transient performance will be determined using WECC System Performance Criteria and Disturbance Performance Table (see Appendix 1). Performance is based on, but not limited to, system damping, low frequency dip and maximum first swing voltage dip and duration.

Model Detail [R3.3] - A detailed system representation of the study area should be modeled when appropriate. During simulation, monitoring criteria will be set to adequately analyze the impacts on BES facilities and other critical facilities below 100 kV. Facilities both inside and outside of Western will be considered for monitoring if included in the WECC approved base case model.

Special Protection Systems [R3.4] - Special Protection Systems or Remedial Action Systems will be modeled as they are known to operate.

System Configuration [R3.5] - A WECC base case will be selected based on the generation dispatch, load level (peak/off-peak) and season. The study model will assume all lines in service, with known planned outages. The base load level will be updated with the latest forecast. Loads shall be modeled as accurately as possible, including the appropriate load power factor. The generation and load level should then be adjusted to appropriately stress the study area or path.

IROL Criteria [R1.3, R3.6] –
An IROL is an SOL, that if violated, could lead to instability, uncontrolled separation, or Cascading Outages that adversely impact the reliability of the BES. SOLs qualify as IROLs when impact containment cannot be demonstrated as described in the 'Impact Containment and IROL Load Impact' section below or when studies indicate that instability, Cascading, or uncontrolled separation may occur resulting in uncontrolled interruption of load equal to or greater than 1000 MW.

Impact Containment and IROL Load Impact
Impact containment is considered to be adequately demonstrated when all the following are accomplished:

a. Impacted area is predefined by studies.
b. Cascading is restrained from sequentially spreading beyond the impacted area.
c. If the impacted area has been identified to involve more than one Planning Authority area, studies have been coordinated and all concerns resolved.

d. Impacted Planning Authorities have developed and documented agreed upon coordinated plans, processes, and procedures to ensure adequate containment within the impacted area and have provided this documentation to the RC.

Determining Transient Stability Limited IROLs

Western will identify Transmission Path/Interface SOLs that qualify as IROLs to prevent intra-area or inter-area instability or uncontrolled tripping of BES Facilities due to out-of-step conditions. Where transient simulations show loss of synchronism due to disturbances internal or external to its Planning Authority Area, Western will coordinate with the impacted Planning Authorities to make a determination of whether an IROL exists.

Determining Steady State (Post-Transient) Voltage Stability Limited IROLs

The maximum pre-contingency megawatt power transfer or area load for which a post-contingency solution can be achieved for the limiting (critical) Contingency qualifies as an IROL unless impact containment can be demonstrated as described in the 'Impact Containment and IROL Load Impact' section above and the level of uncontrolled load interruption is less than 1000 MW.

Determining Thermally Limited IROLs

Cascading potentially occurs when studies indicate that a Contingency results in severe loading on a Facility, triggering a chain reaction of Facility disconnections by relay action, equipment failure, or forced immediate manual disconnection of the Facility (for example, due to public safety concerns). Western will identify the subset of SOLs that qualify as thermally limited IROLs when studies indicate post-contingency overloading and subsequent loss of BES Facility(ies) resulting in Cascading outages beyond an area pre-determined by studies. The process outlined below shall be followed:

a. Run Contingency analysis and flag Credible Contingencies that result in post-contingency loading in excess of the lower of:
    i. The Facility(ies)'s trip setting.
    ii. 125 percent of the highest Facility(ies) Rating.

b. For each flagged Credible Contingency, open both the contingent element(s) that cause(s) the post contingency loading and all consequent Facilities that overload in excess of (a) (i) or (ii) above. Rerun Contingency analysis.
c. Repeat step (b) for any newly overloaded Facility(ies) in excess of (a) (i) or (ii) above. Continue with this process until Cascading stops within a predefined area or the solution diverges.
d. Evaluate results to identify thermally limited SOLs that qualify as IROLs.

IROL T_V

A goal of the long term planning process is to ensure that the system will not exceed IROLs in pre-contingency conditions. Furthermore, if planning simulations show a potential for an IROL to be exceeded post-contingency, the planning simulations must demonstrate that the system can be brought below the IROL within its corresponding IROL T_V. The default IROL

T_V shall be 30 minutes in Western areas for the planning horizon.[4] However, shorter duration IROL Tv may be established in coordination with other impacted Planning Authorities based on relay/protection settings and other considerations.

4. Availability

4.1. **Issuance of Methodology [R4] –** Prior to the effectiveness of any change, Western will issue this methodology on its OASIS website and notify the following applicable entities of such posting. [R4]:

- Each adjacent Planning Authority and each Planning Authority that indicates it has a reliability-related need for the methodology. [R4.l]

- Each Reliability Coordinator and Transmission Operator that operates in any portion of Western's Planning Authority Areas. [R4.2]

- Each Transmission Planner that works in Western's Planning Authority Areas. [R4.3]

[4] The Peak Reliability and Western TOPs might implement an IROL T_V of different duration in the operating horizon.

Revision History

WAPA-DSW			
Revision	**Date**	**Action**	**Name of Editor**
0	5/24/07	Original document	Nick Saber
WAPA-RMR			
Revision	**Date**	**Action**	**Name of Editor**
0	12/23/2008	1.Drafted and published original document	Bob Easton
1	7/24/2009	1. Changed title page from Balancing Authority to Planning Authority	Jared Griffiths
WAPA-UGP			
Revision	**Date**	**Action**	**Name of Editor**
A	5/5/10	Original Document	Frank Jarvenpaa
2	3/25/13	Updates relative to FAC-010, Version 2.1 and WECC RC SOL Methodology for the Operations Horizon, Version 6.1	Frank Jarvenpaa
WAPA-DSW and WAPA-RMR Combined			
Revision	**Date**	**Action**	**Name of Editor**
2	9/30/2013	Combined WAPA-DSW and WAPA-RMR methodologies and redrafted to better align with WECC RC "Phase II" SOL Methodology	Patrick Harwood
2.1	4/30/2014	Periodic review and errata changes	Patrick Harwood
WAPA All Regions Combined			
Revision	**Date**	**Action**	**Name of Editor**
3	8/17/2014	Combined Western methodologies	James Hirning

Approval:

/S/ Robert H. Easton
Robert Easton
Manager, Transmission Planning – North, RMR

/S/ Gayle Nansel
Gayle Nansel
Manager, Transmission System Planning, UGP

/S/ Michael Olson
Michael Olson
Manager, Transmission Planning – South, RMR

/S/ Lawrence Tobias
Lawrence Tobias
Manager, Engineering Operations & Planning, SNR

Appendix 1 - System Performance Table

Table I. Transmission System Standards - Normal and Emergency Conditions

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 (3O) 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 3O Fault, with Normal Clearing [e], Manual System Adjustments, followed by another SLG or 3O 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 3O), 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

Appendix 1 - System Performance Table (cont.)

D [d] Extreme event resulting in two or more (multiple) elements removed or Cascading out of service.	3O Fault. with Delayed Clearing [e] (stuck breaker or protection system failure): 1. Generator 2. Transmission Circuit 3. Transformer 4. Bus Section 3O 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 mother Regional Reliabalty 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 of facility owner. Applicable Ratings may include Emergency Rating, 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) Planned or controlled interruption of electric supply to radial customers or some local Network: customers connected to or supplied by the Faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted- including curtailments of contracted firm (non-recallable reserved) electric power Transfers.

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 rune normally expected with proper functioning of the installed protection system. 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.

Appendix 1 - System Performance Table (cont.)

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 3)
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.		

Appendix 1 - System Performance Table (cont.)

Table W-1

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 WECC's 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. *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) shall cooperate in mutually resolving the problem.*

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

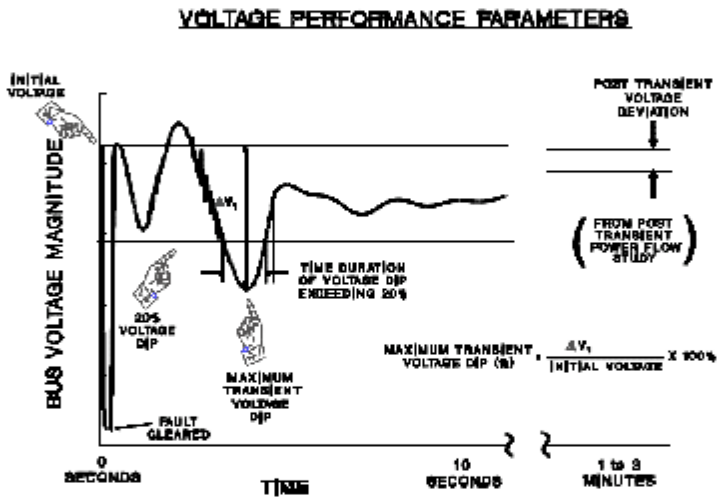
5. *Load buses include generating unit auxiliary loads.*

6. *To reach the frequency categories shown in WECC's Disturbance-Performance Table for Category C disturbances, some planned and controlled islanding may occur. 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 shall be appropriate to the case. Disturbances shall be simulated at locations on the system that result in maximum stress on other systems. Relay action, fault clearing time, and reclosing practice shall 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.*

Appendix 1 - System Performance Table (cont.)

Figure W-1



Appendix 2 – Contingencies Based on WECC Regional Differences

The following Interconnection-wide Regional Differences for the Western Interconnection shall be applied when developing SOLs for the Planning Horizon:

A2.1 Starting with all Facilities in service, the following multiple Facility Contingencies shall be evaluated when establishing SOLs:

A2.1.1 Simultaneous permanent phase to ground Faults on different phases of each of two adjacent transmission circuits on a multiple circuit tower, with Normal Clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition is an acceptable risk and therefore can be excluded.

A2.1.2 A permanent phase to ground Fault on any generator, transmission circuit, transformer, or bus section with Delayed Fault Clearing except for bus sectionalizing breakers or bus-tie breakers addressed in A2.1.7.

A2.1.3 Simultaneous permanent loss of both poles of a direct current bipolar Facility without an alternating current Fault.

A2.1.4 The failure of a circuit breaker associated with a Special Protection System to operate when required following: the loss of any element without a Fault; or a permanent phase to ground Fault, with Normal Clearing, on any transmission circuit, transformer or bus section.

A2.1.5 A non-three phase Fault with Normal Clearing on common mode Contingency of two adjacent circuits on separate towers unless the event frequency is determined to be less than one in thirty years.

A2.1.6 A common mode outage of two generating units connected to the same switchyard, not otherwise addressed by FAC-010.

A2.1.7 The loss of multiple bus sections as a result of failure or delayed clearing of a bus tie or bus sectionalizing breaker to clear a permanent Phase to Ground Fault.

A2.2 For multiple Facility Contingencies in A2.1.1 through A2.1.5, SOLs shall be established such that operation within the SOL shall provide system performance consistent with the following:

A2.2.1 All Facilities are operating within their applicable Post-Contingency thermal, frequency and voltage limits.

A2.2.2 Cascading does not occur.

A2.2.3 Uncontrolled separation of the system does not occur.

A2.2.4 The system demonstrates transient, dynamic and voltage stability.

A2.2.5 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 security of the interconnected transmission systems.

A2.2.6 Interruption of firm transfer, Load or system reconfiguration is permitted through manual or automatic control or protection actions.

A2.2.7 To prepare for the next Contingency, system adjustments are permitted, including changes to generation, Load and the transmission system topology when determining limits.

A2.3 For multiple Facility Contingencies in A2.1.6 through A2.1.7, SOLs shall be established such that operation within the SOL shall provide system performance consistent with the following with respect to impacts on other systems:

A2.3.1 Cascading does not occur.

A2.4 The Western Interconnection may make changes (performance category adjustments) to the Contingencies required to be studied and/or the required responses to Contingencies for specific facilities based on actual system performance and robust design. WAPA-DSW will apply such changes in determining SOLs.