Bonneville Power Administration

Technical Operations

System Operating Limit Methodology

for the

Operations Horizon

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Version 3.3

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1.0 Purpose

Bonneville Power Administration is committed to operating the Transmission System in a safe, reliable, available and compliant manner by setting appropriate System Operating Limits (SOLs). This document establishes the methods BPA will follow to do so.

The North American Electric Reliability Corporation (NERC) FAC-011 Standard requires the Reliability Coordinators to have a documented methodology for the development of SOLs within their Reliability Coordination area. This document describes how BPA applies the Peak Reliability Coordinator's (Peak RC) SOL Methodology to the BPA transmission grid in establishing SOLs for the Operations Horizon, as required by NERC FAC-014-2 R2. The Operations Horizon is defined as the time period from real-time (current operating time) up to one year.

2.0 Background

2.1 Reliability Standards

2.1.1 Applicable Reliability Standards

This document is based on the NERC Reliability Standards FAC-014-2 R2 and is consistent with the Peak RC's SOL Methodology for the Operations Horizon.

FAC-014-2 R2 states: "The Transmission Operator shall establish SOLs (as directed by its Reliability Coordinator) for its portion of the Reliability Coordinator Area that are consistent with its Reliability Coordinator's SOL Methodology."

2.1.2 Defined Terms

Unless otherwise specified capitalized terms are defined in the Peak RC SOL Methodology or NERC glossary.

2.2 Applicability

2.2.1 Applicability to BPA

BPA's SOL Methodology is applicable to the BPA Technical Operations (TOT) organization. BPA establishes SOLs to ensure acceptable Bulk Electric System (BES) performance throughout the Operations Horizon (including the Real-Time Sub-Horizon). An SOL exceedance results if any of the acceptable pre-or post-contingency system performance criteria stipulated in this Methodology are not being met.

2.2.2 SOLs and IROLs

All operating limits, including Facility Ratings, WECC Path Ratings, cut-plane ratings, and Total Transfer Capabilities (TTCs), are designated as SOLs in the Operations Horizon. Exceedance of one or more of these SOLs could cause severe impacts (i.e.; instability,

uncontrolled separation, and cascading outages). A subset of these SOLs may also be designated as an Interconnection Reliability Operating Limit (IROL) by the Peak RC on BPA and neighboring Balancing Authorities (BAs) and/or Transmission Operators (TOPs). All IROLs will be coordinated with Peak RC and other TOPs.

2.2.3 Thermally Limited SOLs and Associated Facility Ratings

BPA transmission line ratings are based on the maximum current carrying capability, at a particular ambient temperature range, that will not exceed the Maximum Operating Temperature (MOT) of the conductor itself. BPA Transmission Line Design provides continuous operating ratings for transmission lines for use by Planning and Operations in system studies (not emergency or Contingency ratings). However, study engineers utilize the ByLine Tool Time vs. Temperature Analysis Calculator to determine over current capability of lines where the over current can be mitigated by Dispatch within 20 minutes. This is explained further in section **3.1.1.** The 20-minute time horizon to reach the conductor MOT provides sufficient lead time for Dittmer or Munroe Dispatchers to take action to relieve the line over current condition. This 20-minute acceptable response time is a BPA Operations internal limit, and is not to be confused with the 30-minute time limit to mitigate an SOL or IROL violation.

The Thermal Rating for post-contingency operation is defined as the short-term emergency Thermal Rating for foreign Facilities. If an emergency rating is not available, BPA will utilize the normal/continuous rating.

Foreign utility lines are rated for normal (continuous) operation and emergency (or Contingency) operation. The WECC Planning and Operations base cases incorporate normal and Contingency ratings for all three seasons. Example – summer normal is the 'A' rating set, summer contingency is the 'B' rating set. In these cases the BPA 'A' and 'B' ratings are identical, per the BPA rating philosophy previously noted.

Both the normal and Contingency case rating set limits are intended as pre- and post-contingency limits that cannot be exceeded. However, these are continuous limits — in other words, there is no time limit for transmission line loading that reaches Contingency limits.

3.0 Methodology

3.1 Study Methodology

An SOL represents 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 operating criteria as set out in this document. These criteria include, but are not limited to, the following:

3.1.1 Thermal Limits

Following an outage condition, paths are screened for limitations caused by thermal equipment limits using the following methodology:

- The power flow base case will be checked for:
  - Accurate system topology
  - Reasonable load and generation levels for the time period of the study
  - Appropriate voltage profile
  - Load versus temperature analysis may be used to develop base cases for different operating conditions.
- The contingencies that need to be considered for determining thermal limits are described in section **3.1.6** and **3.1.7.**
- If an unplanned outage occurs affecting a thermally limited path, BPA Dispatchers have 30 minutes to identify and implement a SOL.
  - SOLs are based upon these new system conditions and to protect for the next, worst Contingency. The SOL is determined from Seasonal and Outage Planning studies performed by TOT or use of engineering judgment.
- When studies indicate potential post-contingency overloading, BPA can employ one of the following procedures for addressing an overload issue:
  - Option 1: BPA uses the continuous rating for the limiting element and reduces powerflows in the study so that the post contingency loading on the limiting element is at or below the continuous rating.
  - Option 2: The ByLine/DataBases & Utilities ToolBox/ByLine DataBases/Display & Navigation ByLine ToolBox/Temperature vs Time Analysis may be used to maximize limits, ensuring that the MOT on the Facility is not reached within 20 minutes.
    - This tool is able to calculate the amount of time to reach MOT (Facility Rating) for a line based upon pre and postcontingency current loading, along with ambient air temperature. The results are case specific, and may require multiple iterations.
    - The 20-minute window allows adequate time for manual Dispatcher response to reduce Facility loading issues through a planned procedure.
- Generation variations can be taken into account in cases where generator output can be monitored.
- Limiting elements within contingencies with Outage Transfer Distribution Factors (OTDF) below 3.0% may be ignored.

    - This allows the removal of limiting elements that are relatively insensitive to power transfers on a path for a contingency.
- Remedial Action Schemes (RAS), if applicable, are modeled and include:
    - Generation dropping
    - Shunt reactive device switching
    - Series capacitor switching phase shifter adjustment
    - Line and/or load tripping
    - DC line ramping or tripping
    - Area separation schemes
- For common tower and common adjacent circuits Credible MCs, in power flow and voltage stability analysis, the two circuits will be modeled as a common loss.
- For stuck/failed breaker Credible MCs, in power flow and voltage stability analysis, clear all circuits that would open due to the stuck failed breaker.

3.1.2 Voltage Stability Limits

Paths are screened for voltage stability limits if previous studies have shown the path is sensitive to voltage stability problems or if the path has not been previously studied, using the following methodology:

- The contingencies that need to be considered for determining voltage stability limits are described in section **3.1.6** and **3.1.7**.
    - Every studied path or Flowgate must meet criteria for all the Contingencies stated.
        - For outage studies (planned or unplanned) a reduced Contingency list of the worst performing Contingencies may be used to reduce study time.
        - If the path is historically not voltage stability limited, voltage stability screening will be conducted when there are major transmission changes that could impact the results, or if voltage stability screening is warranted in the judgment of TOT.
- RAS if applicable are modeled, including but not limited to:
    - Generation dropping
    - Shunt reactive device switching
    - Series capacitor insertion
    - Phase shifter adjustment
    - Line and/or load tripping
    - DC Line ramping or tripping
    - Area separation schemes

- BPA follows the Peak RC voltage stability analysis documented in the "Guide to WECC/NERC Planning standards I.D.: Voltage Support and Reactive Power" to ensure positive reactive margin is maintained for all Contingencies studied.
- If an unplanned outage occurs on a voltage stability limited path, BPA Dispatchers have 30 minutes to identify and implement a SOL.
    - SOLs are based upon these new system conditions and to protect for the next worst contingency. The SOL is determined from Seasonal and Outage Planning studies performed by TOT, or use of engineering judgment.
- BPA applies the following additional margin for determining the SOL on a voltage stability limited path:
    - 5.0% for a Single Contingency
    - 2.5% for a Credible Multiple Contingency
- For common tower and common adjacent circuits Credible MCs, in power flow and voltage stability analysis; the two circuits will be modeled as a common loss.
- For stuck/failed breaker Credible MCs, in power flow and voltage stability analysis; clear all circuits that would open due to the stuck failed breaker.

3.1.3 Transient Stability Limits

Paths are screened for transient stability limits if previous studies have shown that the path is sensitive to transient stability, or the path has not been studied before, using the following methodology:

- There are two approaches for transient stability studies:
    1. Transient Stability limited paths
        a. The Contingency list used for transient stability studies is a subset of the Contingencies used for thermal and voltage stability studies. They are chosen based on the following criteria:
            i. Any contingency that would set the SOL based on voltage stability criteria.
            ii. Additional contingencies based on historical system response, previous study responses or the judgment of TOT.
    2. Thermal or Voltage stability limited paths:
        a. Transient stability screening will be conducted when there are major transmission changes that could impact the results, or if transient stability screening is warranted in the judgment of TOT.
- Remedial Action Schemes (RAS), if applicable, are modeled and include but are not limited to:
    - Generation dropping

    - Shunt reactive device switching
    - Resistive brake insertion
    - Series capacitor insertion
    - Line and/or load tripping
    - DC line ramping or tripping
    - Area separation schemes
- Each Contingency is run for a 30-second simulation.
- If the unplanned outage occurs on a transient stability limited path, BPA Dispatchers have 30 minutes to identify and implement a SOL.
    - SOLs are based upon these new system conditions and to protect for the next worst Contingency. The SOL is determined from Seasonal and Outage Planning studies performed by TOT, or use of engineering judgment.
- Results are compared to the criteria in Appendix 1 – TPL-001-0.1System Performance Under Normal Conditions and Appendix 2 – TPL-001-WECC-RBP-2.1
    - Acceptability is based on, but not limited to:
        - Maximum first swing voltage dip and duration
        - Low frequency dip
        - System damping
    - Voltage and frequency dip and duration results must meet the criteria specified in Appendix 2 – TPL-001-WECC-RBP-2.1
    - Transient stability simulations must show positive damping (i.e. damping greater than zero percent) within a 30 second time frame as specified in PeakRC's System Operating Limits Methodology for the Operations Horizon.
- For transient stability, assume a Fault on one line; apply appropriate relay timing, and then trip the adjacent circuit along with the last breaker opening on the Faulted circuit.
- For transient stability, assume a Fault on one line; apply appropriate relay timing, then trip all circuits that would be cleared as a result of the stuck/failed breaker and timed in accordance with the appropriate breaker failure relaying.

3.1.4 Overall Performance Criteria

All SOLs must meet these minimum criteria:

- All Facilities are operating within their acceptable post-contingency thermal, frequency and voltage ratings.
- Cascading outages do not occur

- Uncontrolled system separation does not occur
- The system demonstrates transient and voltage stability.
- Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding) is allowed. The planned removal of certain generators and/or the curtailment of contracted firm electric power transfers may be necessary to maintain the overall security of the interconnected transmission system.
- Interruption of firm transfer, load, or system reconfiguration is permitted through manual control, automatic control, or protection actions.
    - To prepare for the next Contingency; system adjustments are permitted, including changes to generation, load, and the transmission system topology when determining limits.
- A generator producing more than its nameplate rating is not an indicator of an SOL exceedance (although generator nameplate ratings must be respected when performing studies).
- BPA may use SOLs established in previous studies or perform new Seasonal and Outage Planning studies as the expected system conditions warrant in order to ensure acceptable BES performance, establish or update SOLs, or develop plans, processes, and procedures necessary to ensure acceptable BES performance.
- If agreement on the value of the SOL among impacted TOPs cannot be reached, the TOPs shall default to the most conservative value for use until the issue is resolved.
- For any transient or voltage stability SOL that, while not qualifying as an IROL, has been identified by BPA as; (a) impacting more than one TOP; or (b) having significant impact beyond a localized load pocket within BPA's Area, BPA, in coordination with impacted TOPs, shall develop and document plans, processes, and procedures to mitigate SOL exceedances within a predefined time duration. If TOPs cannot agree on predefined time duration, then a default 30-minute time duration shall be used. TOPs shall coordinate such plans, processes, and procedures with the Peak RC.

3.1.5 Pre-Contingency Analysis

In the pre-contingency state, under conditions that reflect current or expected system conditions and system topology; all Facilities shall be within their Facility Rating, thermal limits, system voltage limits, transient stability limits, and voltage stability limits.

3.1.6 Analysis for Single Contingency

Following a Single Contingency; all Facilities shall be operating within their Facility Rating, thermal limits, system voltage limits, transient stability limits, and voltage stability limits. In addition, cascading outages or uncontrolled separation shall not occur.

BPA studies Single Contingencies that directly impact the SOL of a given path or Flowgate. The Single Contingencies are generally in the immediate vicinity of the path or Flowgate.

A Single Contingency is defined as any of the following

- All N-1 transmission lines (115kV and above), generators, transformers (non-generator step-up and low side at 115kV or above) for next and current day studies.
- N-1 transmission lines, generators, transformers (non-generator step-up and low side at 115kV or above), or shunt devices relevant to the path/Flowgate.
- Single pole block, with normal clearing, in a monopolar or bipolar high voltage direct current system as applicable.

In determining the system's response to a Single Contingency, the following shall be acceptable:

- 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.
- Interruption of other network customers, only if the system has already been adjusted, or is being adjusted, following at least one prior outage, or if the real-time operating conditions are more adverse than anticipated in the corresponding studies (e.g. load greater than studied).
- System reconfiguration may occur through manual or automatic control or protection actions.
- To prepare for the next Single Contingency; system adjustments may be made, including but not limited to, changes to generation, uses of the transmission system, and transmission system topology, as required.

3.1.7 Analysis for Credible Multiple Contingency (MC)

BPA shall assess whether any of the MCs that have been determined by its Planning Coordinator (PC) to result in stability limits (provided to the Peak RC per FAC-014-R6) are Credible and thus applicable in the Operating Horizons. The TOP shall modify applicable SOLs (including SOLs that qualify as IROLs) based on the revised list of Credible MCs.

Following a Credible MC, all Facilities shall be operating within their Facility Rating, thermal limits, system voltage limits, transient stability limits, and voltage stability limits. In addition, cascading outages or uncontrolled separation shall not occur.

The following types of contingencies will be considered to be Credible Multiple Contingencies:

- BES common tower lines
- Common adjacent circuits: applies to only adjacent transmission circuits where both circuits are greater than or equal to 300 kV based on TPL-001-WECC RBP regional criterion. Does not apply to adjacent transmission circuits that share a common right-of-way for a total of three miles or less, including – but not limited to – substation entrances, pinch points, and river crossings. Re-visit or eliminate when WECC modifies TPL-001-WECC RBP
- 500kV Breaker Failure (BFR's)
- Bipole block, with normal clearing, in a bipolar high voltage direct current system as applicable.
- Any Regionally Critical MC, as per the Peak RC Instructions document "Regionally Critical Multiple Contingencies"

The Study Engineer will determine which specific Credible Multiple Contingencies are relevant to the particular study they are performing. Only those specific Credible Multiple Contingencies need to be considered in the study.

The Study Engineer may deem additional multiple contingencies beyond those listed above to be credible based upon specific conditions or circumstances (for example, additional multiple generator losses).

The Credible MC list is utilized by BPA's TOT for studies that are applicable within the Operations Horizon. The comprehensive list of Credible MCs applicable to BPA will be provided per Peak RC Instructions "Credible Contingency (SEASONAL)".

Following any of the Credible MCs, the following may not occur:

- Voltage instability
- Cascading outages
- Uncontrolled separation

In determining the system's response to a Credible MC, the following shall be acceptable:

- Depending on system design and expected system impacts, the following may be necessary to maintain the overall security of the interconnected transmission systems:
    - Controlled interruption of electric supply to customers (load shedding).
    - Planned removal from service of certain generators.
    - Curtailment of contracted firm (non-recallable reserved) electric power transfers.
- System topology changes are allowed.

- Interruption of firm transfer, load or system reconfiguration is permitted through manual or automatic control or protection actions.
- To prepare for the next Contingency; system adjustments are permitted, including changes to generation, load and the transmission system topology when determining limits.

BPA shall not consider inability to prevent or mitigate adverse impacts of an MC as an acceptable reason for changing credibility of the MC at any time in the Operations Horizon. BPA will coordinate in the determination of Credible MCs where multiple TOPs operate Facilities. If agreement on MC credibility cannot be reached by the TOPs that operate the Facilities, then the MC shall be considered Credible by all until agreement is reached.

3.1.8 Study Model

BPA utilizes WECC seasonal base cases for establishing and calculating path SOLs. These cases are updated to include expected system topology, expected generation, and load demand patterns based on known and reported Facility outages.

BPA reviews and validates its portion of the WECC operating base cases for accuracy prior to case approval and prior to each operating season.

3.2 Reliability Criteria and Guidelines

The following criteria and guidelines will be applied in determining acceptable system response following single and Credible MCs:

3.2.1 Criteria and Guidelines for Post-Contingency Steady State Assessment

Following a single or Credible MC, the flow on all Facilities must be within their Thermal Ratings. In addition, voltage instability, cascading outages and uncontrolled separation must not occur.

For single and multiple contingencies, the steady-state pre and post-contingency voltage performance that will be applied will be the voltage limits specified in the voltage limits tables posted to the Peak RC website.

In the post-Contingency steady-state assessment; system configuration through manual or automatic control or special protection scheme actions is allowed if it has been proven that adjustments can be done in a timely manner and will be sufficient to prevent the system from equipment damage, voltage collapse, cascading outages or uncontrolled separation. This includes automatic voltage regulators, automatic fast-switched shunt capacitors, and special protection scheme actions.

3.2.2 Criteria and Guidelines for Post-Transient and Voltage Stability Assessment

BPA performs transient stability simulations utilizing the WECC approved seasonal case for Transmission Paths and load areas that that are known to have been post-transient stability limited or voltage stability limited.

Following single or Credible MC, transient instability, cascading outages and uncontrolled separation must not occur.

When performing voltage stability analysis, flows will be adjusted to provide a minimum 5% margin for the most limiting single Contingency and a minimum 2.5% margin for the most limiting double Contingency.

3.2.3 Criteria and Guidelines for Transient Stability Assessment

BPA performs transient stability simulations utilizing the WECC approved, seasonal case for areas that are known to have been transient stability limited. BPA performs transient stability simulations from the initiation of the Disturbance to 30 seconds afterwards. Following single or Credible MCs, transient instability, cascading outages and uncontrolled separation must not occur. In addition, the following Planning criteria should be evaluated as potential operating criteria: See Appendix 1 – TPL-001-0.1System Performance Under Normal Conditions and Appendix 2 – TPL-001-WECC-RBP-2.1.

In the transient stability assessment, only system reconfigurations through automatic, fast-switched shunt capacitors and special protection scheme actions are allowed. Other automatic actions may be included.

For transient stability, BPA will apply a 5% margin for SC and 2.5% margin for Credible MCs.

3.2.4 Exception to the Criteria

Exception to the above criteria is allowed with permission of the owner of the impacted Facilities and if there is no wide-spread impact and do not conflict with the Peak RC SOL Methodology for the Operations Horizon and applicable NERC Reliability Standards.

3.2.5 Use of Engineering Judgment

In situations where there is not enough time to run a study and there are no previous SOL's in BPA's Dispatcher's Standing Orders; then engineering judgment will be used per BPA's Use of Engineering Judgment guide to establish an SOL until a study can be run.

3.3 BPA Communication and Coordination

Communication and sharing of SOLs and any other limits required by the Peak RC SOL Methodology or deemed necessary by BPA for coordination to ensure reliable BES performance; will be provided to the operationally affected parties and Peak RC.

Seasonal studies are coordinated with Northwest Operational Planning Study Group and the Peak RC per Peak RC Instructions document "Posting seasonal study plans, reports and procedures". In all other horizons BPA shares study results with impacted TOPs as appropriate, and with the Peak RC. This includes study results that indicate a potential IROL condition.

If the SOL for a path was set based on the use of the ByLine tool, BPA will provide the following data to the RC:

- Limiting element
- Pre-contingency flow on the limiting element
- Post contingency flow on the limiting element (effectively the emergency rating)
- The assumed ambient air temperature

If any sub-100kV Facilities are known or determined to significantly impact the BES, BPA shall communicate this information to affected parties and to the Peak RC. In addition, BPA will provide other supporting data used to establish SOLs as requested by Peak RC.

BPA provides RAS/Special Protection System scheme descriptions per the Peak RC's Data Requests.

3.4 System Voltage Limits

BPA has established operating voltage criteria for the BPA TOP footprint as specified in the table provided per Peak RC Instructions document "Voltage Limits (Steady State)".

3.5 List of Credible Multiple Contingency Outages for the Operations Horizon

BPA will provide lists of initial and subsequently revised Single Contingencies that result in the loss of multiple Facilities, or instability, and of Credible MCs, to the Peak RC and other TOPs per Peak RC Instructions document "Credible Contingency (SEASONAL)".

4.0 Version History and Signatures

Version	Issue Date	Action/Changes	Prepared By	Date Reviewed	Approved By Signature	Date Signed
1.0	8/24/09	Updated date of document and added language to clarify consistency with RC SOL Methodology	Signed MRV Mike Viles		Signed EGE *Edison G. Elizeh*	8/24/09
1.1	11/02/09	Revised Document title and 2nd bullet under 1.a.	Mike Viles		Edison G. Elizeh	
1.2	11/14/09	Added language to address study model used	Mike Viles		/s/ Edison G. Elizeh	11/16/09
2.0	09/08/10	Updated document to reflect studied contingencies, margins, and requirements for establishing SOLs.	Mike Viles		/s/ Edison G. Elizeh	09/08/10
2.1	07/18/11	Updated document to reflect SOL 30 minute threshold	/s/ James O'Brien		/s/ John S. Kerr for Melvin Rodrigues	07/18/10
2.2	09/30/11	Removed "transformer" from 1.a. 4th sub-bullet	/s/ James O'Brien		/s/ Melvin Rodrigues	10/3/11
2.3	10/20/11	Removed "A double pole loss of the PDCI is considered an N-1 contingency" from 1.a.1st sub-bullet. Added " PDCI bi-pole loss as 1.a. 5th sub-bullet.	James O'Brien		Melvin Rodrigues	10/20/11
2.4	8/23/12	Section 1, removed "WECC does not have Irols so they are not identified as a subset of SOLs in this methodology."	John Anasis		Margaret I. Albright	8/27/12
3.0	2/28/14	Updated the entirety per Peak RC SOL Methodology for the Operations Horizon effective 3/3/14	/s/John Anasis	2/28/14	/s/ Margaret Albright	2/28/14
3.1	4/16/14	Minor spelling corrections. Corrected MC definitions. Added monitoring steady state Voltage. Added Appendix TPL-001-0.1 System Performance Under Normal Conditions	/s/ John Anasis	4/16/14	/s/ Margaret Albright	4/16/14
3.2	8/28/15	Minor spelling and clarity corrections. Added "Stability" to the title of 3.1.2, removed reference 0.0% margin and	/s/ Audrey Stevenson /s/ John	8/26/15 8/26/15	/s/ Jerry L. Jackson II /s/ Margaret	8/26/15

		removed transient voltage paragraph. Specified which Peak RC documents are referenced as instructions. Changed definitions of common adjacent circuits. Clarified transient studies. Removed 2 Palo Verde contingency and added Peak RC Regionally Critical MCs.	Anasis		Albright	
3.3	9/15/15	Addition to section 3.1.3 to add clarity regarding system damping performance.	/s/Audrey Stevenson /s/ John Anasis	9/11/15	/s/ Margaret Albright /s/Jerry L. Jackson II	9/11/15

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Appendix 1 – TPL-001-0.1System Performance Under Normal Conditions

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 (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 2. Transmission Circuit 3. Transformer 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) 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 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.

Appendix 2 – TPL-001-WECC-RBP-2.1

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.		

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.*

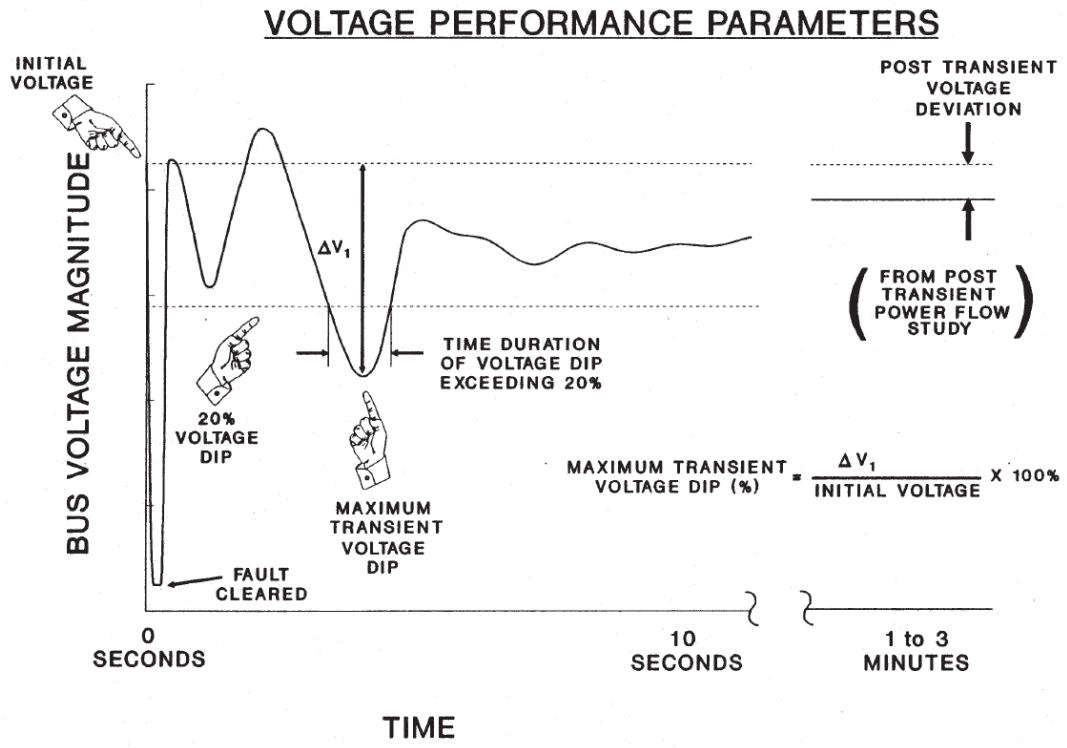
3. *If it can be demonstrated that post-transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) shall cooperate in mutually resolving the problem.*

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.*


VOLTAGE PERFORMANCE PARAMETERS
INITIAL VOLTAGE
POST TRANSIENT VOLTAGE DEVIATION
BUS VOLTAGE MAGNITUDE
ΔV1
FROM POST TRANSIENT POWER FLOW STUDY
TIME DURATION OF VOLTAGE DIP EXCEEDING 20%
20% VOLTAGE DIP
MAXIMUM TRANSIENT VOLTAGE DIP
MAXIMUM TRANSIENT VOLTAGE DIP (%) = ΔV1 / INITIAL VOLTAGE X 100%
FAULT CLEARED
0 SECONDS
10 SECONDS
1 to 3 MINUTES
TIME