



TRANSMISSION

SEVERE LOADING MITIGATION

REFERENCE GUIDE



Revision Chart

Modifications will be documented in the following chart. There are no exceptions.

Version	Revised By	Description of Modifications	Revision Date	Effective Date
1.0	Jason Bulloch	Initial draft creation based on information provided by SPP Operation’s Management and Functional Coordinators.	11/14/2021	
2.0	Jason Bulloch	Changes made per participant comments from the October ORWG. These changes clarify the actions taken prior to extreme conditions.	12/2/2021	
3.0	Jason Bulloch	Changes made per comments from the December ORWG. These changes include: <ol style="list-style-type: none"> 1) Adjusting language for SPP RC actions when Ambient Adjusted Ratings raise and lower. 2) Stating that TOPs may request SPP perform a cascade analysis study prior to the Severe Loading Threshold exceedance. 3) Changing “Pre-Contingent loading” back to “Real-time loading”. 4) Updated language to provide more clarity in defining a Wide Area Cascade event. 	1/6/2022	3/01/2022

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Purpose

This document provides guidance to the SPP Eastern Reliability Coordinator¹ (RC) to follow under severe System Operating Limit (SOL) exceedances, which could include pre-contingent load shed. SPP RCs have Congestion Management procedures to follow when under normal loading conditions. This document is supplemental to the standard Congestion Management procedures and used as a reference guide when taking urgent action for extreme loading events. Extreme loading events can occur when events like units tripping offline or sudden wind generation spikes occur requiring immediate action. The document defines scenarios requiring extreme mitigation measures such as pre-contingent load shed, as well as defining scenarios where post-contingent load shed may be acceptable. Using operator judgment, SPP RCs may deviate from this approach as deemed necessary in real-time operations.

Background

The SPP RC ensures reliable delivery of electricity to consumers by protecting the Bulk Electric System (BES) from current and future hazardous conditions. The level and urgency of actions SPP RCs take varies depending on the assessed risk of the event on the BES. When a congestion event's area of impact to the BES cannot be determined or affects a wide area of the BES, SPP RCs may act with even greater urgency in protecting the BES, including instruction of pre-contingent load shed.

Congestion Management

SPP RC utilizes the Market System, Operating Instructions and Transmission Loading Relief (TLR) to manage transmission system congestion and prevent or mitigate SOL and Interconnection Reliability Operating Limit (IROL) exceedances, as necessary. Transmission congestion mitigation actions include:

¹ The SPP Reliability Coordinator function divides RC responsibilities between an East RC desk and a West RC desk. The SPP East RC desk is responsible only for facilities in the Eastern Interconnection, and the SPP West RC desk is responsible only for facilities in the Western Interconnection. References to “the SPP RC” in this document apply to the SPP East RC desk only.

- Generation re-dispatch utilizing Congestion Management Event (CME) activation or thru RC Operating Instruction.
- Transmission Loading Relief (TLR)
- Issuing Out-of-Merit Energy (OOME) instruction
- Instructing transmission reconfigurations
- Pre-contingent load shed as necessary

SPP RC manages SOLs based on the transmission limits established by the Transmission Owners or as determined by system studies. The RC takes preventive measures and mitigation actions to ensure SOLs and IROLs are within specified limits. Some circumstances may cause SOL exceedances and, in some cases, reach a severe level, typically due to sudden transmission system or generation changes. These studies are known as Severe Loading Studies. This document refers to this threshold as the Severe Loading Threshold as defined in the SPP SOL Methodology.

Note: To minimize the duration of severe SOL exceedances and improve the likelihood of study convergence, SPP has established internal guidelines to initiate Severe Loading studies prior to the Severe Loading Threshold. While this loading level may be the initial point for performing a system cascade analysis study, the RC may not escalate actions to load shed until the Severe Loading Threshold is reached.

Managing IROL Exceedances

To mitigate or prevent an IROL exceedance, the SPP RC will initiate mitigating actions to ensure that the loading does not exceed the established IROL for more than 30 consecutive minutes. SPP RC or Shift Engineer (SE) will perform studies, with no intentional delay, to identify mitigation options that would alleviate or prevent an IROL exceedance most efficiently and with minimal service interruption. ² The RC will coordinate with the TOP(s) the most efficient and

² There may be times when the loading is relieved before the SPP RC can perform a severe loading study; in this case, the RCs will maintain awareness of the exceedance and perform studies as necessary if loading approaches the Severe Loading Threshold.

effective mitigation approach. Under all circumstances, the SPP RC takes all necessary mitigation actions to mitigate the congestion, including pre-contingent load shed.

IMPORTANT! As a general guide line, if necessary, pre-contingent load shed will be limited to half of the post-contingent load at risk.

Managing SOL Exceedances

Real-time SOL Congestion Management Procedure

To mitigate or prevent a real-time SOL exceedance (Pre-contingent exceedance), the SPP RC will initiate mitigation actions with no intentional delay to ensure that the real-time loading does not exceed the monitored element's normal (NORM) rating for more than 30 consecutive minutes or no more than the Short-Term rating's time limits, if identified as greater than 30 minutes. For any real-time exceedance over the emergency rating, the SPP RC will take immediate action to bring loading back to the emergency rating as soon as possible, and to the normal rating within 30 minutes. The RC will coordinate the most effective mitigation approach with the TOP(s). Under all circumstances, the SPP RC takes the necessary actions to mitigate the congestion, including pre-contingent load shed.

IMPORTANT! If the TO/TOP states that the transmission element should operate at an Ambient Adjusted Rating then the most recently communicated rating will be used to monitor the constraint until the TO/TOP informs the SPP RC otherwise. The SPP RC should consider the impact to the BES when considering using a higher rating.

Post-contingent SOL Congestion Management Procedure

To mitigate or prevent a post-contingent SOL exceedance, the SPP RC will initiate mitigation actions with no intentional delay to ensure that the post-contingent loading does not exceed the emergency rating (EMER) of the Monitored element. If the actions taken do not prevent exceedance above the Severe Loading Threshold, then the SPP RC or Shift Engineer (SE) will run studies to identify any cascade risks to the BES. Utilizing the Severe Loading Studies, if the SPP

RC establishes any of the following two outcomes, the event is considered to be a cascading wide-area event : ³

1. Area voltage collapse with no clear area of containment.
2. Cumulative results of cascade analysis study iterations have five transmission facilities' monitored elements with loading greater than the Severe Loading Threshold. This loading can occur in the first iteration of cascade analysis studies run or across as many as five iterations.

The SPP RC will contact the TOP(s) if the transmission line rating is exceeded for an extended period to confirm the transmission equipment rating and inquire about adjusted ratings in real-time. If the TOP provides an Ambient Adjusted Rating different from the current rating, then the Ambient Adjusted Rating will be used until the TOP notifies the SPP RC of any needed changes. If the loading is still over the Severe Loading Threshold, based on the line rating confirmed by the TOP, then SPP RC will use any level of mitigation necessary to relieve the loading. The SPP RC may consider pre-contingent load shed during Severe Loading events if BES cascading risk has been determined or if a large amount of post-contingent load is at risk ($\geq 200\text{MW}$).

Post-contingent SOL Exceedance With Cascade Risk and Wide Area Impacts

If a Severe Loading study's outcome meets the cascading requirement as outlined above, then the event is considered cascading with wide-area impact. The SPP RC takes mitigating actions to alleviate congestion, which can include pre-contingent load shed, and has the responsibility to relieve the congestion within 30 minutes of identifying cascade risk.

³ If the Severe Loading Study results in a lack of convergence, then the SPP RC will work to identify the reason for the study's convergence issues and may use operator judgment to determine the cascading risks.

Post-contingent SOL Exceedance Without Cascade Risk

If the study does not meet any of the above two criteria for establishing a cascading wide-area impact event, then the SPP RC will evaluate the total megawatts of load at risk post-contingent. ⁴

Impacted Load Greater Than or Equal to 200 Megawatts

If the SPP RC has established that there is 200 megawatts or more of post-contingent load at risk, the SPP RC will take mitigating action, which could include pre-contingent load shed, and has the responsibility to relieve the congestion within 30 minutes of identifying the load at risk.

IMPORTANT! As a general principle, if necessary, a pre-contingent load shed with a defined amount of load at risk may be limited to half of the post-contingent load at risk.

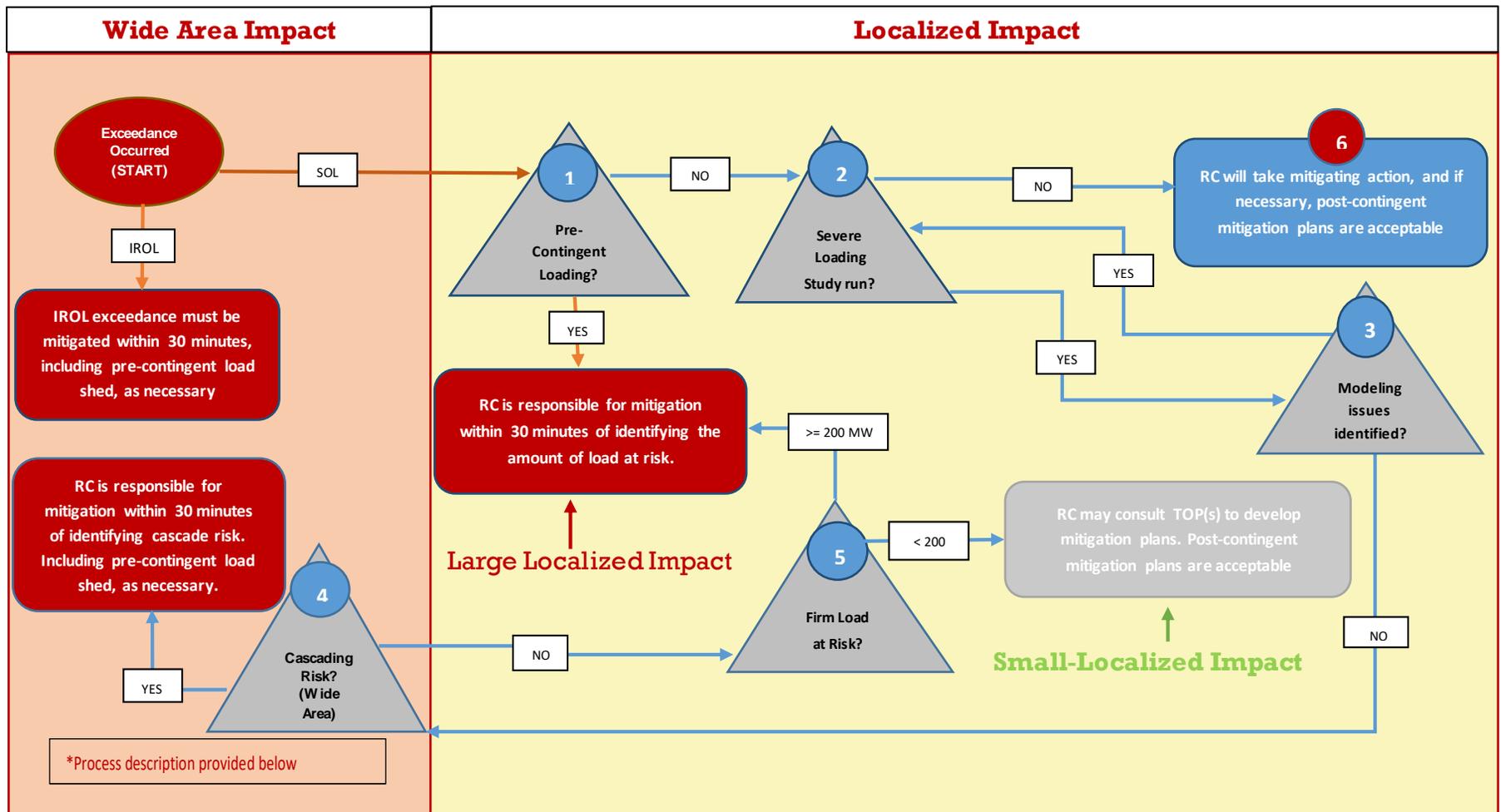
Impacted Load is Less Than 200 Megawatts

After exhausting all mitigation approaches prior to pre-contingent load shed and establishing that less than 200 megawatts of post-contingent load are at risk, then the SPP RC may consult TOP(s) to develop post-contingent mitigation plans. If more than one TOP is impacted, then impacted TOPs must reach consensus. The RC will resolve any conflict by implementing the most conservative mitigation approach.

⁴ Two criteria include: 1) Area voltage collapse with no clear area of containment. 2) Cumulative results of cascade analysis study iterations have five transmission facilities' monitored elements with loading of greater than the Severe Loading Threshold.

Appendix A

The below flowchart displays a high-level flow of the SPP Transmission Severe Loading Mitigation plan in the Eastern interconnect.



STEP	Description
1	SPP RC is alerted to SOL exceedance on a transmission constraint. If the SOL exceedance is pre-contingent, the SPP RC must mitigate loading within 30 minutes of the alert. If post-contingent, the RC will perform Severe Loading Study with no intentional delay. (step 2)
2	If the post-contingent SOL exceedance is equal to or greater than the Severe Loading Threshold, the RC will perform Severe Loading Study with no intentional delay. If loading is less than the Severe Loading Threshold, the RC will take mitigating actions but load shed may be part of a post-contingent mitigation plan. (step 6)
3	If the SPP RC confirms erroneous modeling differences with the TOP, then the Severe Loading Study should be rerun (step 2) with the corrected modeling changes. If no modeling differences are identified, then the RC will need to assess if the event is a wide-area cascading event. (step 4)
4	SPP RC will assess Severe Loading Studies and identify if cascading impacts 5 or more transmission elements. If cascading outages impact less than 5 transmission elements, then the SPP RC will assess the amount of load at risk. (step 5) If the cascading assessment impacts 5 or more transmission elements or if the solution fails to converge without resolution from (step 3) , then the SPP RC is responsible for taking mitigating actions necessary to control loading on the constraint, including pre-contingent load shed. The actions will be taken with no intentional delay.
5	If load at risk as result of transmission element(s) loss is determined to be less than 200 megawatts, then the SPP RC will consider the event to have localized impact and the RC has the discretion to consult with the TOP(s) on whether to shed load pre-contingent. If the load impacted is greater than OR equal to 200 megawatts, then the SPP RC has the responsibility to shed load pre-contingent. The SPP RC may take into consideration the ratio of load shed pre-contingent compared to the amount at risk. Note: If the impact is < 200 MW but two or more TOPs are affected, the RC will seek consensus from impacted TOPs on a mitigation approach. If no consensus is reached, then the RC will implement the most conservative mitigation approach as determined by the RC.
6	SPP RC will perform all mitigation steps available to them, the exception being pre-contingent load shed. Should the post-contingent exceedance persist for a long duration (>30-minutes), but is not exceeding the Severe Loading Threshold, SPP RC will be in contact with the TOP(s) to discuss post-contingent mitigation plans. The TOP may request SPP perform a cascade analysis study prior to a severe loading threshold exceedance.