Reliability Coordinator Area Restoration Plan

Western Interconnection

Effective 12/03/2019

PREPARED AND MAINTAINED BY

SPP RELIABILITY COORDINATION STAFF

Change History

Date	Change
12/3/2019	Initial Version Effective

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Section 1 – Scope

The scope of this plan starts when Blackstart Resources are utilized to re-energize an area of the Bulk Electric System (BES), separation has occurred between neighboring Reliability Coordinators, or an energized island has been formed on the BES within the Reliability Coordinator Area. The scope and objective of the Reliability Coordinator's restoration plan ends when all of its Transmission Operators are interconnected and its Reliability Coordinator Area (RC Area) is connected to all of its neighboring Reliability Coordinator Areas.

Section 2 – RC Area Restoration Strategy

The high level strategy to be employed by the SPP Reliability Coordinator in a restoration situation will be highly dependent upon the nature and extent of the event. This document will serve to provide general guidelines to use in assessing and responding to several types of restoration situations. There are two basic methods of restoring a transmission system: Build and interconnect an energized island or incrementally pick up load in the blackout area by working from a portion of the system that is still energized. Depending upon the nature and extent of the event, one general method or the other may provide benefits such as speed in restoring load or limiting exposure to instability. The nature of the restoration may result in one or several TOP's or BA's within the SPP RC footprint being synchronized with neighboring RC footprint areas prior to synchronizing with other TOP's or BA's within the SPP RC area. The SPP RC and the neighboring RC shall be informed of and coordinate the synchronization with each other's systems.

1. Assessment

   The RC will establish communications with its Transmission Operators and Balancing Authorities and neighboring Reliability Coordinators in order to determine the extent of the blackout for the SPP RC Area. If nuclear stations within the SPP RC footprint have lost access to offsite power, the RC shall coordinate with the affected TOP's to give high priority to restoration of offsite power to the affected nuclear stations. Notification of the event shall be made to additional support staff and management as soon as practical. Staffing plans should include the need to preserve relief staff for the estimated duration of the restoration activities. TOPs should be wary of any distributed energy resources connected to their system and take necessary actions to prevent them from causing harm to restoration activities.

2. Initiate Restoration Activities

   Depending upon the nature and extent of the blackout, the RC will coordinate with TOPs to begin their restoration processes. Listed below are several types of scenarios that may be experienced in a blackout scenario along with a high level strategy for proceeding with restoration.

   a. <u>Partial or Complete System of a Balancing Authority/Transmission Operator</u>

      A disturbance may occur leaving either an energized island or subset of load being disconnected from the rest of the synchronized Bulk Electric System. If the energized island is stable, or the resulting system will be stable, restoration should focus on restoring interconnection of the island with the rest of the energized system.

      The restoration of the blackout area may involve starting a blackstart resource, if available, within the blackout area in order to create a stable island. Alternatively, restoration of the blackout area may involve energizing a cranking path to a non-blackstart generator within the

blackout area from the energized system. A third alternative is to restore load in the blackout area by energizing transmission facilities from the energized system. The method to restore service to the blackout area will be dependent upon assessment and coordination between the impacted TOP(s) and the RC.

b. Partial or Complete SPP RC Area

A blackout may occur leaving the complete SPP RC area blacked out, an energized island or several islands within the SPP RC Area, or some portion of the SPP RC area blacked out and the rest of the RC area synchronized to the rest of the Western Interconnection. Any of the extensive events mentioned above will require a large amount of communication and coordination as there are many TOP's within the SPP RC Area.

The high level strategy for restoring a completely dark SPP RC Area is to initiate the individual TOP restoration plans. These plans include the startup of the blackstart resources, if available, within the individual TOP systems, restoration of stabilization load, energization of cranking paths to non-blackstart generators, and establishment of stable islands. These islands may then be interconnected with each other, or the energized Interconnection when possible.

The high level strategy for restoring a partially blacked out SPP RC Area is highly dependent upon the extent and status of the blacked out system as well as the proximity to an energized system. Depending upon assessment and extent, the TOP's and RC may elect to utilize either the strategy of building an island within the blacked out area, restoring load and cranking paths from the energized system, or some combination of these options.

Section 3 – Roles and Responsibilities

The SPP Reliability Coordinator has the overall responsibility to coordinate the restoration plans of the Transmission Operators within the SPP RC Area. The SPP Reliability Coordinator will work with Balancing Authorities and Transmission Operators to implement the SPP RC Restoration Plan and make changes as conditions warrant. The SPP Reliability Coordinator shall inform each Balancing Authority and Transmission Operator of the status of the SPP RC Area and of other neighboring RC Areas. The SPP Reliability Coordinator will inform each Balancing Authority and Transmission Operator of the general restoration plan for the area.

With the assistance of the SPP Reliability Coordinator, each Transmission Operator will execute its restoration plan and advise the SPP Reliability Coordinator of restoration progress. Each Transmission Operator will determine the specific load to reestablish within its area to maintain the generation and load balance until the authority has been transferred back to the Balancing Authority in accordance with the SPP RC's criteria in Section 8.

Each Transmission Operator shall provide the necessary information for the RC to review and approve a proposed interconnection before interconnecting to other islands or energized systems. In general, the resulting island shall be a stable island or the interconnection should not be approved. If the resulting island is not stable, the connection should not be made. The Transmission Operators and Reliability Coordinator shall coordinate energy scheduling between interconnected transmission systems until authority is transferred back to the Balancing Authority.

The SPP Reliability Coordinator will continually review the status of the recovery effort and coordinate adjustments in the restoration plan as appropriate.

The SPP Reliability Coordinator will determine and notify Balancing Authorities and Transmission Operators, neighboring Reliability Coordinators and other pertinent parties when the recovery effort is complete.

Section 4 – Operating Processes

The operating processes that are to be used when restoring the interconnection shall ensure the operational reliability of the interconnections. These processes include identification and mitigation of System Operating Limits (SOL) and Interconnection Reliability Operating Limits (IROL). The following processes must be followed during restoration activities, especially while re-synchronizing islands or energizing facilities.

Considerations Before Synchronization

Before synchronizing two islands together, there are several items to be checked and verified. These items/considerations are discussed below and should be entered on the Interconnection Checklist found in Attachment 3 where applicable. If an island is synchronizing with a very large island, or the Western Interconnection, some fields may not be required. The Reliability Coordinator shall review and must approve any interconnections between Transmission Operator areas prior to synchronization.

Synchronization Process/Interconnection Checklist

See the Interconnection Checklist found in Attachment 3. These interconnection guidelines listed below are subject to the Reliability Coordinator's discretion.

1. Trained personnel are on site (power plants and substations) to perform/assist with synchronization efforts (if practical).
2. Reliable communications have been established with all operating personnel involved and appropriate contact information shared with affected parties. (Lines 1 – 9)

3. Determine the Frequency range of the two islands. Frequency of each island should be 60.0 +/- 0.2 Hz over 10 minutes but preferably 60.0 +/- 0.05 Hz . (Line 10)
4. Determine the voltage range at the interconnection location. The voltage magnitude difference between islands at the interconnection point is preferred to be within +/- 2% (0.02pu) over 10 minutes or be acceptable to the Reliability Coordinator and the impacted TOPs. An alternative interconnection point may be required if voltage cannot be adjusted to within acceptable range. (Line 11)
5. Determine that the slip frequency is low as indicated by a slow, steady moving synchroscope needle.
6. Determine the total online, synchronized capacity of each island. Particular attention should be paid to lowered capacities due to use of alternative fuels. (Line 12)
7. Determine the total amount of Unloaded Capacity in each island. This is the difference between the current total output of all generation within the island and the total capacity calculated in Line 12. (Line 13).
8. Determine the Most Severe Single Contingency in each island. Typically this is a single generating unit, but due to abnormal transmission configurations, several units may be connected to the island via a single element. (Line 17)
9. Determine the total amount of Governor Reserves in each island. This value, if not able to be directly calculated, may be estimated per the following:
    a. Determine Unloaded Capacity on the largest generator (or Most Severe Single Contingency) in the island.
    b. Subtract Unloaded Capacity on the largest generator (or Most Severe Single Contingency) from the total Unloaded Capacity of the island found on Line 13.
    c. Governor Reserve estimate is equal to 20% of the remaining Unloaded Capacity. (Line 14)
10. Determine if any load in each island has been restored that is protected by Under Frequency Load Shed schemes. (Line 15)
11. Determine the Total Dynamic Reserves of each island (Line 14 + Line 15).

12. Identify the primary synchronization location that will be used. Specifically the individual breaker that will be used must be identified. (Line 19) A secondary synchronization location must be identified that can be synced as soon as possible after an initial synchronization of the primary location.
13. Identify the secondary synchronization location that will be used. Specifically the individual breaker that will be used must be identified. (Line 19a)
14. Check any relays or protection systems that might improperly interfere with synchronization efforts. Examples are impedance relays that do not have out-of-step blocking may trip lines due to power swings. Check for any lock-out relays that may prohibit interconnection. (Line 20 and Line 21)
15. Identify the unit that will be set to Frequency control prior to synchronization. Before interconnection, actions should be taken to ensure no more than one unit is on isochronous control (0% droop). (Line 22)
16. Determine the AGC control modes (if applicable) that will be used after the interconnection is complete.
17. Determine the Total Online Capacity of the resulting island. (Line 25)
18. Determine the Total Unloaded Capacity of the resulting island. (Line 26)
19. Identify the Most Severe Single Contingency of the resulting island. (Line 30)
20. Determine the Total Governor Reserves of the resulting island. This value, if not able to be directly calculated, may be estimated per the following:
    a. Determine Spinning Reserve Capacity on the largest generator (or Most Severe Single Contingency) in the island.
    b. Subtract Spinning Reserve capacity on the largest generator (or Most Severe Single Contingency) from the total Spinning Reserves of the island found on Line 26.
    c. Governor Reserve estimate is equal to 20% of the remaining Spinning Reserve. (Line 27)
21. Determine the total load in the resulting island that has been restored that is protected by Under Frequency Load Shed schemes. (Line 28)
22. Determine the Total Dynamic Reserve of the resulting island. (Line 29)

23. The Total Dynamic Reserve of the resulting island shall be equal to or exceed the size of the Most Severe Single Contingency in Line 30.
24. Determine the scheduled interchange (if any) between the two interconnecting islands. Flow should be maintained near zero until at least two tie lines have been established between the islands. (Line 32)
25. The Reliability Coordinator must review and provide approval of the proposed interconnection prior to synchronization.
26. After synchronization is complete, the RC shall notify all affected TOP's and BA's that the synchronization is complete.

Additional Synchronization Considerations

1. The status of any reactive devices (capacitors, reactors, static VAr compensators - SVCs) should be determined prior to synchronization.
2. Ferroresonance may occur when energizing a line or while energizing a transformer from an unloaded line.
3. Synchroscopes should be monitoring the appropriate breaker used to synchronize two systems together.
4. For substations, the need for adequate DC and AC power sources to breakers should be checked. For example, will an auxiliary generator be needed?
5. Preferably energize the tie point with the highest thermal capability first.
6. Breakers used for synchronization should be field checked to be open (if practical).
7. The synchronization location has a functioning synchroscope or other synchronizing equipment.
8. Personnel at the point of synchronization should be prepared to immediately open the synchronization breaker if problems develop (overloads, frequency swings, low voltages, etc.).
9. As previously stated, other tie points between two systems should be closed as soon as practical and loading on tie-lines should be no more than 50-70% of their emergency rating.

10. As systems are synchronized within SPP, it is extremely important that all affected systems be notified.

Load Recovery Guidelines

It is important for SPP Transmission Operators to recover customer load as quickly as possible; however, it is imperative to maintain an acceptable balance of load and generation to maintain the integrity of the restoration and recovery efforts. It is also important to make sure voltage on unloaded or lightly loaded transmission lines is maintained within acceptable limits. The following guidelines should be considered in restoring load to an area to maintain system integrity and are based on information contained in the NERC Electric System Restoration reference document:

1. Before the load restoration begins ensure the following:
   a) Area frequency is between 59.75 and 61 Hz and
   b) Voltages on the transmission corridors established are within +/- 10% of nominal voltage
2. Note the available generation resource information:
   a) Generator minimum load requirement
   b) Generator reactive capability
   c) Duration of time the generator can tolerate at less than minimum load level
   d) Generator ramp capabilities
   e) Mutually agree with SPP and Transmission Operators on the amount of generation to hold in reserve in case of problems as the restoration progresses. At a minimum, it is recommended to maintain no less than 20% of each generator capacity available as unloaded capacity to assist in the load recovery process.
3. Determine the amount of load to recover and what generation resource to use. It is recommended to recover a load amount not to exceed 5% of available on-line generation capability at one time.

4. Ensure all parties involved are prepared to reconnect customer load
5. At the generator, prepare to raise the generation level up to the amount of load to be recovered. As the generation is raised, voltages and frequency are likely to rise. As the generator output increases, recover customer load incrementally to maintain voltage levels between 90% and 110% of nominal level and frequency between 59.75 and 61 Hz.
6. When the load recovery is complete, evaluate the current system conditions for voltage and frequency and make small adjustments as necessary to achieve voltage levels between 90% and 110% and frequency between 59.75 and 61 Hz. Units not assigned to regulate frequency should be constantly redispatched to keep each regulating unit's energy at the middle of its regulating range.
7. Continue the load restoration effort repeating steps 4 through 6 until all load is recovered or until all available generation is utilized maintaining a sufficient amount of generation reserve considering the circumstances.

Section 5 – TOP Restoration Plan Requirements

Each Transmission Operator shall have a restoration plan approved by the SPP Reliability Coordinator. The restoration plan shall allow for restoring the Transmission Operator's System following a Disturbance in which one or more areas of the Bulk Electric System (BES) shuts down and the use of Blackstart Resources is required to restore the shut down area to service, to a state whereby the choice of the next Load to be restored is not driven by the need to control frequency or voltage regardless of whether the Blackstart Resource is located within the Transmission Operator's System.

In order for the SPP Reliability Coordinator to approve the TOP's restoration plan, the restoration plan shall be submitted to SPP at RestorationPlans@spp.org and include the following:

1. Identification of the strategy for system restoration that is coordinated with the Reliability Coordinator's high level strategy for restoring the Interconnection found in the SPP Reliability Coordinator Area Regional Restoration Plan.

2. A description of how all Agreements or mutually agreed upon procedures or protocols for off-site power requirements of nuclear power plants, including priority of restoration, will be fulfilled during System restoration.

3. Procedures for restoring interconnections with other Transmission Operators under the direction of the Reliability Coordinator.

4. Identification of each Blackstart Resource, if required to implement the TOP's plan, and its characteristics including but not limited to the following: the name of the Blackstart Resource, location, megawatt and megavar capacity, and type of unit.

5. Identification of Cranking Paths and initial switching requirements between each Blackstart Resource, or interconnection point, and the next unit(s) to be started.

6. Identification of acceptable operating voltage and frequency limits during restoration.

7. Operating Processes to reestablish connections within the Transmission Operator's System for any areas that have been restored and are prepared for reconnection.

8. Operating Processes to restore Loads required to restore the System, such as station service for substations, units to be restarted or stabilized, the Load needed to stabilize generation and frequency, and provide voltage control.

9. Operating Processes for transferring authority back to the Balancing Authority in accordance with the guidelines found in the SPP Reliability Coordinator Area Regional Restoration Plan.

10. A list of GOPs identified in the TOP restoration plan. GOPs included in this list will be required to attend SPP system restoration training at least once every two calendar years.

TOP restoration plans shall be reviewed annually and provided to the RC based on the frequency criteria found in the *SPP RC and BA NERC Compliance Submission Guide* document.

Section 6 – Neighboring RC Coordination

Dependent upon nature and extent of the disturbance, one or more TOP's or BA's in the SPP RC footprint may be synchronized with or attempting to interconnect with a neighboring RC footprint. SPP RC shall be contacted and will coordinate with the neighboring RC to facilitate the synchronization. The SPP RC shall be aware of and familiar with neighboring RC Restoration Plans. SPP shall review the neighboring RC Restoration Plans on an annual basis in order to ensure that the SPP RC Restoration Plan and the neighboring RC restoration plan do not conflict.

Section 7 – Reporting Requirements and Information Sharing

Reliable communication between the Balancing Authorities/Transmission Operators and the SPP Reliability Coordinator will be the key to a safe and timely restoration following a collapse of the SPP RC Area. As part of the initial assessment following a network disturbance or after a partial or complete blackout, communication facilities shall be tested and verified. Balancing Authorities and Transmission Operators shall establish communication with neighboring Balancing Authorities and Transmission Operators as well as with the SPP Reliability Coordinator. Balancing Authorities and Transmission Operators shall establish contact with power stations operating within their boundaries. SPP RC shall be the primary contact for disseminating information regarding restoration

to neighboring Reliability Coordinators, and to Transmission Operators, and Balancing Authorities within the SPP RC Area.

1. The SPP Reliability Coordinator shall poll each Balancing Authority and/or Transmission Operator. If primary communication channels are unavailable, the polling may be performed via the SPP Emergency Communication Network (satellite phones). The SPP Reliability Coordinator shall document each Balancing Authority/Transmission Operator's initial assessment of its area. The Reliability Coordinator will establish a specific time to poll each Balancing Authority/Transmission Operator and inform others of that time. Polling will take place as requested by the Reliability Coordinator with each Balancing Authority/Transmission Operator. Each Balancing Authority and Transmission Operator will be ready to report required data to the SPP Reliability Coordinator at each poll. Attachment 2 shows a possible form to use for reporting the required data.
2. Balancing Authorities and Transmission Operators will provide the SPP Reliability Coordinator with updates regarding significant changes that occur outside the normal polling times.
3. The SPP Reliability Coordinator shall poll surrounding Reliability Coordinators for an assessment of their area. SPP and neighboring RC's shall establish a specific time and frequency of communication to share status updates and information. SPP will communicate with neighboring RC's with updates regarding significant changes that occur outside the normal contact times.
4. The SPP Reliability Coordinator shall notify appropriate SPP personnel and appropriate regulatory and governmental bodies.
5. Each Balancing Authority and Transmission Operator shall notify appropriate personnel within their organization and mobilize for area recovery.
6. Each Balancing Authority and Transmission Operator shall notify appropriate regulatory and governmental bodies.

Considerations

In the absence of primary communication methods, the SPP Emergency Communication Network shall be used initially to convey appropriate information. The SPP Emergency Communication Network is comprised of Satellite Phones. Priority should be given to establishing voice communication paths prior to re-establishing data communication paths.

Section 8 – Criteria for Transferring Operations Back to the Balancing Authority

As the restoration activities proceed, the SPP Reliability Coordinator, in conjunction with affected Balancing Authorities and Transmission Operators, will assess the ability of a Balancing Authority to resume its authority. In order for the SPP Reliability Coordinator and Transmission Operator(s) to transfer operations and authority back to a Balancing Authority, the Balancing Authority must:

1. Carry at least enough Contingency Reserve to cover the Most Severe Single Contingency of the Balancing Authority, or possess enough transmission import capability to receive Contingency Reserve assistance from a neighboring Balancing Authority when the combined Contingency Reserve of the interconnected Balancing Authorities is sufficient to cover the Most Severe Single Contingency of the interconnected Balancing Authorities.

2. Carry at least enough Regulating Reserve to maintain a stable frequency.

3. Ensure that there are sufficient energized portions of the Balancing Authority Area within the same electrical island for the Balancing Authority to maintain reliable balancing operations.

Once the above criteria are met, a Balancing Authority will initiate a call with all Transmission Operators included in the Balancing Authority Area to coordinate the transition of operations and authority back to the Balancing Authority. Transmission Operators will not transfer operations and authority back to a Balancing Authority until the Balancing Authority agrees to such transfer.

Section 9 – Reliability Coordinator Restoration Plan Review and Distribution Requirements

The SPP RC Restoration Plan will be reviewed on an annual basis to ensure the plan maintains effectiveness and accuracy. It is the responsibility of SPP Staff to review and update the plans as required and to bring such proposed updates to the Western Reliability Working Group (WRWG) for their review and approval. The annual review and any proposed updates are to be submitted to the WRWG no later than April 1.

The Reliability Coordinator shall distribute its most recent Reliability Coordinator Area restoration plan to each of its Transmission Operators and neighboring Reliability Coordinators within 30 calendar days of creation or revision.

Attachments

Attachments to this document are available at the URL below. A valid user account is required to access these documents.

Location:

https://xfer.spp.org/EFTClient/Account/Login.htm

'Studies' \ 'Report Tools' \ 'Procedures'

Attachment 1 - Contacts

Document Name: 'SPP RC PSR WI Attachment 1'

Attachment 2 - SPP Restoration System Status Form

Document Name: 'SPP RC PSR WI Attachment 2'

Attachment 3 - Interconnection Checklist

Document Name: 'SPP RC PSR WI Attachment 3'

Attachment 4 -

SPP RC System Restoration Drill Required Entity Participation

Document Name: 'SPP RC PSR WI Attachment 4'