Master/Local Control Center Procedure No. 18

(M/LCC 18)

New England System Restoration Plan

References

1. NERC Operating Manual Electric System Restoration Reference Document
2. NERC Reliability Standard NUC-001 - Nuclear Plant Interface Coordination
3. NERC Reliability Standard EOP-005 - System Restoration from Blackstart Resources
4. NERC Reliability Standard EOP-006 - System Restoration Coordination
5. NERC Reliability Standard PRC-006-NPCC Automatic Underfrequency Load Shedding, Attachment C
6. NERC Evaluating Blackstart Documented Procedures Compliance Monitoring and Enforcement Program (CMEP) Practice Guide
7. NPCC Power System Restoration Reference Document
8. NPCC Regional Reliability Reference Directory #8 System Restoration
9. ISO New England Inc. Transmission, Markets, and Services Tariff (Tariff)
10. ISO New England Operating Procedure No. 1 - Central Dispatch Operating Responsibilities and Authority, Appendix A, Assignment of Responsibilities (OP-1A)
11. ISO New England Operating Procedure No. 12 - Voltage and Reactive Control, Appendix B, Voltage & Reactive Schedules (OP-12B)
12. Master/Local Control Center Procedure No.1 - Nuclear Plant Transmission Operations, Attachment C - Millstone Nuclear Power Station (Confidential) (M/LCC 1C)
13. Master/Local Control Center Procedure No. 1 - Nuclear Plant Transmission Operations, Attachment D - Seabrook Nuclear Power Station (Confidential) (M/LCC 1D)
14. Master/Local Control Center Procedure No. 6 – MCC Evacuation and BCC Operation, Attachment A - ISO New England Evacuation Procedure Telephone List (Confidential) (M/LCC 6A)
15. Master/Local Control Center Procedure No. 7 - Processing Outage Applications (M/LCC 7)
16. Department of Energy (DOE) Defense Critical Electrical Infrastructure (DCEI) letters to Transmission Owners

1. INTRODUCTION

This document, Master /Local Control Center Procedure No. 18 – New England System Restoration Plan (M/LCC 18) and the M/LCC 18 Attachments include strategies, guidelines, information and instructions that are to be used by ISO New England (ISO) and the Local Control Centers (LCCs) during implementation of the New England System Restoration Plan (the Plan) after a partial or total shutdown of the New England Bulk Electric System (BES), which generally consists of facilities operated at voltages of 100 kV or higher. The Plan (as represented in its entirety by M/LCC 18 as well as all M/LCC18 Attachments) is the single New England regional system restoration plan that serves as both:

- the Transmission Operator (TOP) restoration plan (as pertains to EOP-005) and
- the Reliability Coordinator (RC) restoration plan (as pertains to EOP-006).

NOTE
These same M/LCC 18 documents also serve as the TOP restoration plan for each Local Control Center (LCC).

Expeditious system restoration of the BES depends on independent actions and interactions by ISO, LCCs and Market Participants (MPs). The expanse of the blackout (locally limited or regionally widespread) will determine the response by ISO, each LCC and each MP, including the procedures and/or instructions which may need to be implemented.

The major objectives of the Plan are to:

1) Provide off-site ac power to the New England nuclear power stations

2) Interconnect all New England Transmission Operators (TOPs) (i.e., the LCCs)

3) Establish interconnections/synchronizations with contiguous Reliability Coordinator Areas (RCAs) that are normally synchronously connected to the New England RCA, advancing system restoration of the Eastern Interconnection

When these three objectives have been achieved and, in accordance with EOP-005, the choice of the next load to be restored is not driven by the need to control frequency or voltage, implementation of the Plan shall be considered to have been completed. ISO recognizes that, upon completion of the Plan, LCC local recovery actions may still be ongoing for the energization of remaining New England load. The local area recovery actions of each LCC are documented in their respective Local Area Recovery Instructions (LARIs), which are **not** part of the Plan. As necessary, ISO will continue to coordinate with each LCC when restoring load to remaining areas of New England, while each LCC implements its respective LARIs.[1]

Recognizing the numerous possible system blackout scenarios (depending on the expanse of the blackout, Resources available for system restoration, etc.), knowledge and application of the guidelines, information and instructions contained in this document and related Attachments are critically important. This procedure provides for coordinated actions of ISO and other entities identified in the Plan (including each LCC, TOPs, Transmission Owners (TOs) and MPs). Coordination is especially important with respect to the technical aspects of system restoration (i.e., Generator startups, load pickups, switching surges, voltages, frequency, synchronization of islands, etc.). ISO shall work with its affected LCCs and Generator Operators (GOPs), as well as neighboring RCAs, to monitor system restoration progress, coordinate system restoration, and take actions to restore the BES frequency within acceptable operating limits. ISO shall coordinate and authorize re-synchronizing islanded areas that bridge boundaries between the LCCs or between the ISO RCA and neighboring RCAs.

The ISO New England Inc. Transmission, Markets, and Services Tariff (Tariff) provides for ISO to enter into contractual arrangements with blackstart Generators that have the ability to be started without support from the transmission system. Blackstart Generators are an essential element of the Plan. The M/LCC18 suite of documents contains a full listing of all of the Designated Blackstart Resources (DBRs) in the Plan, including Primary Path DBRs (referenced in M/LCC 18 Attachment A) and Alternate Path DBRs (referenced in M/LCC 18 Attachments H and K). All DBRs in the Plan are considered material to the Plan and are listed in confidential document, M/LCC 18, Attachment O - Designated Blackstart Resources. Attachment O also includes a listing of other additional DBRs that are **not** part of the Plan but can be called upon, as needed, to support the system restoration strategies of the Plan.

A. Responsibilities

ISO and LCC responsibilities regarding Plan implementation are specified in this M/LCC 18 as well as in ISO New England Operating Procedure No. 1 Central Dispatch Operating Responsibilities and Authority, Appendix A, Assignment of Responsibilities (OP-1A). Responsibilities of MPs and TOs regarding Plan implementation are specified in OP-1A. This Section of the procedure provides an outline of the responsibilities of ISO and each LCC (including independent actions and interactions between these entities). Each LCC relationship to ISO is the same; therefore, each LCC's general responsibilities during system restoration are the same

1. ISO Responsibilities

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1 Energizations of Defense Critical Electric Infrastructure (DCEI) facilities is a top priority for Transmission Owners (TOs) and the TO should align recovery of these facilities with the restoration of load to support the Plan objectives. Restoration of DCEI facilities should not conflict with the Plan objectives. When possible, DCEI facilities should be excluded from under-frequency load shed plans. If unable to be excluded, DCEI facilities should be assigned the lowest priority for load shed.

a. Determining the extent of the blackout throughout the New England Reliability Coordinator Area/Balancing Authority Area (RCA/BAA) and each adjacent RC power system and informing each LCC of existing generation and transmission capabilities

b. Executing the responsibilities of the ISO Restoration Coordinator (which is the Lead Operations Shift Supervisor, or designee) which include the following:

   i. Establishing communications with a restoration coordinator in each LCC and each adjacent RC power system and providing a flow of information that promotes coordinated system restoration

      - The establishment of system restoration efforts will be coordinated and monitored in the Restoration Room located in the ISO MCC Control Room, behind the Operations Shift Supervisor workstation.

   ii. Monitoring, advising, approving actions (as appropriate) and helping coordinate with each LCC and each adjacent RC power system when performing any of the following:

      - Energizing any circuit identified in the Plan and any additional 345 kV circuit
      - Energizing an inter-LCC or inter-Area tie-line
      - Generator startup, load pickup, generation reserves adjustment and load shed

   iii. Maintaining records of work performed to support system restoration

   iv. Providing New England RCA/BAA status updates to each LCC and each adjacent RC

   v. Assigning support staff to survey blackstart Generators to determine the following:

      - Availability of the Generator
      - Amount of fuel available on-site (hours at full load operation)
      - Approximate time to have the Generator station manned

c. Assessing the need for additional support staff to aid in system restoration and, as necessary, assigning ISO personnel to assist the Restoration Coordinator in the execution of the Plan

d. Assigning scribes to key positions in the Control Room to assist System

Operators[2] to document events related to system restoration

e. Implementing the Plan (including necessary coordination with each LCC and each adjacent RC)

f. Assigning a Loader to assist with the loading function if the blackout is severe and ISO Generator dispatch responsibility has been temporarily shared with an LCC and the LCC that is assisting with the loading function has requested such assistance from ISO. Each assigned ISO Loader is responsible for:

   i. Following the technical guidelines which relate to Generator startups, interconnections/synchronizations and loadings

   ii. Communicating Generator dispatch instructions between the ISO and LCC such that:

      - ISO maintains overall Area coordination
      - Area load and generation are balanced
      - Area reliability concerns are met

   iii. Coordinating Generator operations with switching operations to optimize the efficacy of system restoration and recovery activities

g. In consultation with LCC restoration coordinator(s), the ISO Restoration Coordinator will determine when Generator dispatch is resumed by ISO based on an assessment of when reliable normal Generator dispatch by ISO can be resumed, taking into account the applicable considerations listed in Section H

h. Coordinating and authorizing the closing of an inter-LCC or inter-Area transmission line

   i. If this **cannot** be completed using the tie-lines identified in the Plan, ISO shall use its system restoration plan strategies to facilitate interconnection/synchronization

i. Once an inter-LCC or inter-Area tie-line is restored, overseeing and coordinating load pickup and Generator dispatch within the interconnected parties

j. Selecting priority for start-up power supply to generation facilities

k. Directing load shed, if necessary, to enable continued reliable system restoration of interconnected parties or the closing of an inter-LCC or inter-Area tie-line

2 Defined term per Glossary of Terms Used in NERC Reliability Standards.

l. Monitoring the New England BES transmission and generation facilities and, as practical, taking action to promote system reliability

m. Conducting regular meetings to keep ISO System Operators informed of system conditions and system restoration activities

2. LCC Responsibilities

   a. Determining the extent of the blackout within the LCC local area and informing ISO as soon as possible of existing generation and transmission capabilities. (ISO will determine the extent of the blackout within the New England RCA/BAA and each adjacent RC and inform each LCC.)

      i. Notifications regarding the New England Nuclear Power Stations must be made in accordance with:

         - M/LCC1 Nuclear Plant Transmission Operations
         - M/LCC1C Millstone Nuclear Power Station
         - M/LCC1D Seabrook Nuclear Power Station

      ii. Notifications must include, but are not limited to:

         - Loss of off-site ac power
         - Restoration of off-site ac power

      in accordance with Section E. Restoration of Off-Site ac Power to Nuclear Power Stations, of this document.

NOTE

If an LCC has verified it is an isolated island and LCC Resource dispatch does not conflict with the Plan objectives, the starting of Resources other than the area DBR does not need to be reported to the ISO. Once an LCC is tied to a neighbor, all starting instructions for Resources in the affected areas must be reported to ISO prior to dispatching the Resources.

   b. Assigning an LCC restoration coordinator to be responsible for the following:

      i. Establishing communications with the ISO Restoration Coordinator and the restoration coordinator at each adjacent LCC and providing a flow of information that promotes coordinated system restoration

      ii. Monitoring, advising, requesting approval (as appropriate) and helping coordinate with ISO and each adjacent LCC, when performing any of the following:

- Energizing any circuit identified in the Plan and any additional 345 kV circuit
- Energizing an inter-LCC or inter-Area tie-line
- Resource startup, load pickup, generation reserves adjustment and load shed

iii. Maintaining records of work performed to support system restoration

iv. Providing LCC status information updates to the ISO Restoration Coordinator

c. Assessing the need for additional support staff to assist in system restoration

d. Assigning scribes to key positions in the control room to help System Operators document events related to system restoration

e. Implementing applicable provisions of M/LCC 18 and Attachments as well as LARIs (including supporting necessary coordination with ISO and each adjacent LCC)

f. Assigning a loader to assist with the loading function if the blackout is severe and ISO generation dispatch responsibility must be temporarily shared with an LCC and ISO requests such assistance. Each assigned LCC loader is responsible for:

i. Following the technical guidelines which relate to Resource startups, synchronizations and loadings

ii. Coordinating Resource operations with switching operations to optimize the efficacy of system restoration and recovery activities

- If an LCC is sharing the Resource loading responsibility, that LCC can request that an ISO System Operator assist in the Resource loading, if needed

g. Monitoring transmission and generation facilities and, as practical, taking action to promote system reliability

h. Synchronizing inter-LCC or inter-Area tie-lines only with the authorization of ISO or in accordance with established ISO procedures, except as provided for in Section 1.A.2.i

i. If communications with ISO fail, energizing 345 kV circuits and inter-LCC or inter-Area tie-lines, if prudent to total system restoration and communications between the affected parties exist

j. Conducting regular meetings to keep the LCC operations staff informed of system conditions and system restoration activities

k. Prioritizing activities during system restoration that contribute to the completion of the Plan such that each LCC implementation of their LARI documents, which are not part of the Plan and which are considered secondary to the primary priority of performing the required functions, are meeting the stated objectives detailed in the Plan

B. Plan Implementation Criteria and System Assessment

The ISO Operations Shift Supervisor shall determine whether to implement M/LCC 18 if one or more of the following events occurs:

- A system disturbance results in a partial or complete blackout in which one or more areas of the New England BES shuts down and the use of DBRs is required to re-energize the shutdown area(s) of the New England BES
- Separation has occurred between the ISO RCA and one or more neighboring RCA(s) and the ISO Operations Shift Supervisor determines that implementation of the Plan is necessary to interconnect/synchronize with the RCA(s)
- An energized island has been formed on the BES within the New England RCA and the ISO Operations Shift Supervisor determines that implementation of the Plan is necessary to resynchronize that island with the remainder of the ISO RCA

If M/LCC 18 is implemented, the ISO Operations Shift Supervisor shall:

- Make an entry in the Control Room Event Logserver.
- Post a “Notice” to the ISO external website.

NOTE

M/LCC 18 Attachment Q - System Restoration Checklist (Confidential) is expected to be used by the ISO Operations Shift Supervisor and by the LCC System Operators during the stages of System Restoration.

- Following a complete or partial Blackout, use M/LCC 18 Attachment Q during the stages of System Restoration.

If M/LCC 18 is implemented, each LCC shall create a log entry to document this.

The ISO Restoration Coordinator and each applicable LCC restoration coordinator shall conduct a post-blackout-event system assessment. Based on this assessment, the ISO Restoration Coordinator shall determine the priority assigned to actions taken to achieve Plan objectives. The ISO Restoration Coordinator, in conjunction with the applicable LCC restoration coordinator(s), will coordinate the use of identified Plan Resources.

NOTE

Recognizing the nuclear power stations sensitivity to Coping Time during a complete loss of ac power, when both a Primary and Alternate Path are out-of-service at the same time, a Temporary Plan is required when the M/LCC 7 Processing Outage Applications (M/LCC 7) criteria **cannot** be met. Temporary plans do **no**t apply to paths for inter- or intra-area synchronization points. These paths are addressed by system restoration strategies (M/LCC 18 Attachment G).

The System Restoration paths detailed in Attachment A - System Restoration Flowchart, achieve all Plan objectives. As listed below, Primary Paths only include paths from identified DBRs to nuclear power stations.

Primary Paths	LCC(s) Involved
Stony Brook to Millstone	CONVEX
Westbrook to Seabrook	Maine, NH

In the event that the Primary Paths **cannot** be followed or if sufficient Resources are available to support multiple Plan objectives concurrently, Alternate Paths are detailed in Attachments H and K. Alternate Paths include paths from alternate source DBRs to nuclear power stations.

Alternate Paths	LCC(s) Involved
Millstone Alternate Path (Attachment H)	CONVEX
Seabrook Alternate Path (Attachment K)	NH

In addition, other system restoration paths can be evaluated and pursued using the system restoration strategies detailed in the Plan (including the use of Attachment G – System Restoration Strategies). ISO and the applicable LCCs shall use system restoration strategies to facilitate system restoration if the Plan **cannot** be executed as expected.

In addition to Plan documents, ISO and LCC restoration coordinators and System Operators should also refer to any Temporary Guides applicable to Plan implementation, such as those that may have been developed to address non-permanent outages of Plan facilities.

C. Potential Actions to Stabilize Remaining Electrical Island(s)

During a blackout event, electrical islands internal to New England may remain energized as New England separates from the Eastern Interconnection. It is imperative to immediately monitor and assess conditions within these islands and take any warranted actions, including shedding load or shutting down Resources, to stabilize their operations. Actions taken at LCC or Local Dispatch Centers to secure voltage, thermal or frequency conditions may include the switching of reactive devices, Resource dispatch actions, transmission switching or load shedding. As a guide, per the NERC Restoration Reference Document, shedding approximately six to ten percent (6-10%) of the load in the island will restore frequency in that island by 1 Hertz[3].

The ISO System Operators may need to suspend use of Electronic Dispatch orders and change to manual dispatch orders. Also, depending on the status of the tie-lines between RCAs or BAAs, ISO System Operators should appropriately select flat frequency or tie-line bias control to stabilize frequency. If the New England power system is electrically isolated, the flat frequency control mode should be implemented. If still synchronously tied to one or more BAAs, combinations of different control modes may have to be explored. Tie-line bias control should be selected if ISO is the smaller of the RCAs interconnected. If ISO is the larger of the synchronously connected RCAs, flat frequency control should be selected.

When flat frequency operation is used, the normal bias setting (approximately 1% of forecasted peak load) may be changed to a reduced value that approximates the expected actual frequency response of the remaining island. This reduced bias setting should minimize system frequency oscillations by preventing excessive Regulation change signals to Resources during islanding. Slower moving Regulation Resources should also be selected to prevent significant frequency excursions.

D. Avoiding Unplanned Connections of Electrical Islands

Circuit breakers of transmission circuits that opened during the blackout event, and whose terminals are energized within separate electrical islands, may automatically reclose. This action can be performed by automatic synchronism-check relays that were installed to supervise the steady-state angles across, and appropriate re-closure of, an open circuit whose terminals are synchronized during normal system conditions. The unintentional reclosing of two disconnected systems whose frequencies and voltages happen to match for a sufficient period of time, may be followed either by the trip of the circuit as the islands continue to pull away from each other or the de-energization of one or more of the recently connected islands. Also, there is a risk that circuits between electrical islands may be inadvertently closed during switching for system restoration.

To avoid unplanned connections between electrical islands, switching procedures should:

3 NERC Operating Manual August 2016; Electric System Restoration Reference Document by the North American Electric Reliability Council April 1993; updated July, 2003; VI. Restoration of the Transmission System and System Loads; B. Generation; 2. Load/Frequency Control in Area Islands.

- Contain steps such as inhibiting reclosing relays via Supervisory Control And Data Acquisition (SCADA) commands or the opening of disconnects on circuits that comprise a split between electrical islands
- Call for the notification of field personnel to alert them to events involving electrical islanding and increase awareness to the possible need for synchronizations before manual closures of breakers.

E. Restoration of Off-Site ac Power to Nuclear Power Stations

One of the most critical power requirements after a blackout is the assurance of reliable shutdown of nuclear Generators. The Nuclear Regulatory Commission (NRC) requires that these Generators have reliable on-site power sources (Emergency Generators) for shutdown operations. The expeditious restoration of alternative off-site ac power sources to nuclear power stations is imperative to promote the continued reliability of shutdown operations.

It is of the utmost importance during system assessment after a blackout to determine the status of the Emergency Generators at nuclear power stations in New England. The ISO Restoration Coordinator shall use this information to prioritize coordinated system restoration activities.

The Plan documents the Primary and Alternate paths for restoring off-site ac power to nuclear power stations, stressing the urgency to restore off-site power to nuclear Generators that have lost all off-site and on-site ac power. The agreements pertaining to how the off-site power requirements of nuclear power stations are fulfilled during System Restoration, including priority of system restoration, are contained in Master/Local Control Center Procedure No.1 - Nuclear Plant Transmission Operations (M/LCC 1) and the following M/LCC 1 Attachments:

Attachment C - Millstone Nuclear Power Station (Confidential) (M/LCC 1C)

Attachment D - Seabrook Nuclear Power Station (Confidential) (M/LCC 1D)

The loss of all off-site and on-site ac power at a nuclear power station is defined as a Station Blackout (SBO). Each nuclear Generator can maintain adequate core cooling without significant damage for the minimum SBO coping time listed in M/LCC 1 - Attachment C and D for the applicable nuclear power station. ISO and each applicable LCC shall be mindful of the amount of time that the New England nuclear Generators can maintain adequate core cooling during an SBO event and shall reassess system restoration priorities to take into consideration the requirements and urgency of the nuclear power station that is experiencing an SBO event.

Nuclear power stations are notified when a stable power system is established following a system restoration. This notification enables the nuclear power station to switch from the emergency on-site power sources back to the New England transmission system for continued reliability of shutdown operations**.**

F. Opening Circuit Breakers and Switches

In most cases, in-place substation procedures provide specific switching instructions to be followed in the event of a substation blackout. Some substations have equipment which automatically switches into a desired post-blackout configuration.

In general, capacitors and customer loads will be opened and disconnected from the 345/230/115 kV transmission system. Similarly, circuit breakers or switches on the 345/230/115 kV transmission system will be opened. On the 345 and 230 kV, step-down transformers will be opened on the high side to avoid the simultaneous energization of a 345 or 230 kV circuit along with a step-down transformer. Step-down transformers off the 115 kV system will be opened on either the high or low side.

Operators should have station and distribution capacitors opened in locations where customer load can effectively absorb charging from transmission lines. This will help prevent high voltage conditions on the transmission system and excessive under-excitation on Generators. Along these lines, operators should anticipate the use of any available reactors to help absorb charging and prevent high voltage.

G. Reviewing Load Tap Changer (LTC) Positions

During system collapse, LTCs on autotransformers could move toward/to extreme tap positions in an attempt to maintain sub-transmission or distribution voltage. Upon collapse, the LTCs would remain in these positions and subsequent re-energization of the autotransformers could result in excessively high or low voltages that could result in equipment or load damage. Consequently, LTC positions should be checked prior to energization of autotransformers. If LTC positions are substantially off nominal, taps should be moved to nominal positions before energizing autotransformers.

H. Generator Start Ups and MW Loadings

Generator MW loadings will be primarily dictated by minimum MW loading requirements to ensure Generator stability and the need to provide station service power to Generators without blackstart capability. ISO and LCC System Operators should balance restoring generation and load to restore the transmission system and meet the goals of the Plan with the added coordination and stability requirements of excessive on-line generation. As larger Generators are started, they will provide stronger sources of synchronized inertia and minimize excursions of frequency and voltage.

Stronger sources will facilitate circuit energizations, the provision of spinning reserve, and load pickups (including larger block sizes of load pickups).

ISO and LCC System Operators should provide on-line Generators with their minimum loading requirements. System Operators should also restore as much of the next cranked Generator's minimum loading as possible prior to starting the next cranked Generator. This load should be transferred by adjusting Generator loadings in the synchronized subsystem. This method of providing minimum load requirements to Generators is preferable to performing load pickups after a Generator has been synchronized and is **not** yet stable at its minimum loading.

Generator loadings should be minimized to prevent severe frequency excursions, or loss of the island, in the event of a Generator trip. Increasing island inertia is beneficial to stable operation. Energizing additional transmission elements, load, and generation will increase the island size and generation MW reserve in the island. These actions improve the likelihood an island will ride-through a frequency excursion caused by a system disturbance.

The ISO Restoration Coordinator shall determine the point during system restoration at which ISO will resume normal generation dispatch control, based on the following considerations:

- number of LCCs interconnected
- amount of synchronized reserve
- amount of transmission and load restored
- status of telecommunication and operating tools

I. Wind Plants and Solar Plants

Wind plants and solar plants have variable outputs that are a function of wind speed or irradiance, respectively. The variability of these outputs can be problematic during a system restoration, particularly when trying to stabilize or **synchronize islands**.

The following guidelines should be applied for both wind plants and solar plants during a system restoration:

- In electrical islands:
    - Disconnect wind plants and solar plants if their varying outputs cause unacceptable voltage or frequency deviations.
    - Disconnecting all wind plants and solar plants at once may cause the island to collapse if their output exceeds 5% of the island's generation capacity
    - Disconnect wind plants and solar plants in banks. Compensate with other generation or load shedding to maintain frequency.
- In blacked-out areas:

- Ensure wind plants and solar plants are disconnected and leave them out-of-service until the latter stages of system restoration.

J. Spinning Reserves

During initial stages of system restoration, few Generators are on-line and System Operators may **not** be able to provide spinning reserves. As system restoration progresses and more Generators are phased in, System Operators should establish and maintain enough spinning reserve as soon as possible to cover loss of the Generator generating the most MW. Eventually, spinning reserves should be adequate to cover loss of the largest generating Generator and have additional reserve for continuing Generator start-up demands.

K. Load Pickups

1. Load Block Sizes

Load restoration will require careful coordination to ensure that Generator governors are **not** overtaxed and do **not** overspeed or underspeed during load pickups.

- Until operational experience shows otherwise, loads based on normal operating values for time, date and season should be restored in block sizes that do **not** exceed 5% of total synchronized generating capability.
- When any Generator is operating with the governor in isochronous (isolated, island) mode in an island which also contains significant generation with the governors operating in droop (parallel, manual) mode:
  - Monitor the isochronous unit loading as new load is energized and as cold load decreases to:
    - Ensure no overload of the isochronous unit occurs before transferring load to a droop unit with available capacity.
    - Ensure cold load reduction does not threaten to trip the isochronous unit on reverse power.

In all cases, monitor system performance (voltage and frequency excursions) during load energization to assess whether smaller load block energization would be appropriate.

2. Frequency Increase Prior to Load Pick up, Automatic Underfrequency Load Shedding (UFLS)

Large frequency excursions are to be expected during system restoration. This is most likely during the initial stages of system restoration where island sizes are 500

MW or less and load restoration is close to 5% of synchronized capability. To minimize these excursions and prevent compounding them by the triggering of Automatic Underfrequency Load Shedding (UFLS) and other subsequent cascading problems, System Operators should employ the following methods:

- Increase frequency to at least 60.3 Hertz prior to load pickup; if frequency is expected to drop to less than 59.9 Hertz, increase frequency to **no** greater than 61.2 Hertz prior to load pickup
- Avoid the restoration of feeders with UFLS. (Initially avoiding UFLS is preferred, but may not be possible based on substation design).
- If UFLS feeders must be restored, restore the feeders set at the lowest available frequency setpoint. NERC Reliability Standard PRC-006-NPCC Automatic Underfrequency Load Shedding, Attachment C provides detailed information on UFLS parameters in the Eastern Interconnection.

As island sizes grow to several hundred MW and the ratio of load block sizes to synchronized generation decreases, smaller increases in frequency prior to load pickup may become appropriate. System Operators may restore the portion of load with UFLS that operate lower than 59.1 Hertz, provided that UFLS enabled feeders are diverse and UFLS actuation would **not** initiate a frequency excursion of a magnitude that would jeopardize system restoration action. These feeders may be restored in quantities that could be used to provide reserve for generation contingencies during system restoration.

Finally, as island/system sizes reach thousand(s) of MW, load block sizes should become a small percent of synchronized generation and increasing/maintaining frequency after, rather than prior, to load pickups should be sufficient. Full UFLS capability should be considered and restored as appropriate. This will provide backup protection for generation contingencies in these larger size islands/systems.

During system restoration, System Operators should observe analog/instantaneous recordings of frequency response to actual load pickups (if available) and tailor frequency increases and load block sizes to prevent excessive frequency excursions.

3. Cold Load Pickup

During system restoration, System Operators will be restoring feeder loads that have been de-energized for unusually long periods of time (commonly referred to as "cold load"). Cold load refers to the loss of diversity between cycling loads on a feeder. Upon re-energization of the load, simultaneous full demands of all the various load components can be encountered. Consequently, System Operators should anticipate cold load pickups that are 1.5 to 5 times greater than normal feeder loads. Also, the longer the de-energization period, the longer it will take for the cold load magnitude to decay to a more typical value. During system restoration, System

Operators will be required to modify load pickups depending upon the cold load observed.

L. Salient Electrical Concerns During System Restoration

Reliable frequency and voltage performance (both transient and steady state) and reliable circuit energizations are major concerns during system restoration, especially during initial stages. The following general guidelines address these concerns.

1. Transmission Line Charging

NOTE The charging values referenced below are typical charging values. A more complete and specific set of 345 kV transmission line nominal charging values is contained in Attachment C - Charging of 345 kV Circuits in New England. These values may be used when and if system restoration strategies are employed, using Attachment G – System Restoration Strategies
NOTE Cables will not be energized using Rules of Thumb. Cable energizations will be evaluated by support engineering prior to energization

Anticipate the introduction of shunt MVAr charging from line energizations and ensure that adequate reactive control exists prior to line energizations. The following are typical charging values:

For overhead lines:

- 0.88 MVAr/mile for 345 kV
- 0.28 MVAr/mile for 230 kV
- 0.07 MVAr/mile for 115 kV

These figures show charging to be a critical concern on the 345 kV, a significant factor on the 230 kV but much less of a concern on the 115 kV. Charging on cables is much higher than that of overhead lines. These cable charging values, combined with a greater likelihood of switching surge difficulties and pressurization problems for fluid-filled pipe-type cables, underscore the need to delay the energization of cables until later stages of system restoration. Cable energizations will be evaluated by support engineering prior to energization. A list of shunt devices within New England that may be of benefit during system restoration are provided in ISO New England Operating Procedure No. 12 - Voltage and Reactive Control, Appendix B - Voltage & Reactive Schedules (OP-12B).

2. Voltage Schedules at Generators

Voltage limits during system restoration are detailed in Attachment P, Restoration Voltage Limits. ISO and LCC System Operators should work to maintain voltage schedules below normal levels during system restoration. This will help combat charging from lightly loaded transmission lines and consequential high voltage and excessive switching surges. Lower voltage schedules will reduce transmission line MVAr charging (which is a function of voltage squared) and promote leading operation of Generators and thus the absorption of transmission line MVAr charging. As island/system sizes increase and significant real power MW flows start to occur on transmission circuits, normal voltage schedules at generating stations may become preferable. In any case, decisions on voltage schedules should be based on actual system voltage levels and Generator reactive loadings versus their leading reactive power limits. Generators are less stable while absorbing reactive power and GOPs are less familiar with operating in this condition; therefore, other options for absorbing reactive power or reducing the amount of reactive power that has to be absorbed should be exercised to restore leading reactive reserve on Generators.

3. Circuit Energizations

Perform circuit energizations in a deliberate manner. Prior to and after energization, check:

- The status of all associated facilities,
- Synchronism, and
- Reactive conditions.

Switching surges caused by inrush current on lines and transformers should be considered for 345 kV. Excessive switching surges are **not** anticipated for energizations on elements with voltages less than 345 kV.

In the early stages of system restoration, 345 kV line or 345/115 kV transformer energizations should be performed with a source that has a total capability of 150 MVA or more (could be one or more synchronized Generators); the specifics on this determination are addressed in Attachment G – System Restoration Strategies. The number and type of facilities that could be energized reliably will depend on line length or transformer characteristics. Energizations of a 345 kV element that is performed outside of the studied Primary or Alternate Paths shall be evaluated by ISO and the applicable LCC(s) System Operators using Attachment G – System Restoration Strategies. As system restoration progresses and the total capability of synchronized sources builds up to several hundred MVA spread out over the system, the possibility of excessive switching surges decreases substantially.

The simultaneous energization of a 345 kV transmission line and a 345 kV step-down transformer should be avoided. In cases where this is **not** possible (**no** breaker between the line and transformer), the energization of these circuits should be performed with a strong nearby source or in later stages of system restoration when sources are strong.

In general, a reactor connected to the tertiaries of 345 kV step-down transformers should be closed-in prior to energization of the transformers. This will help prevent excessively high switching and steady state voltages. Prior to switching, System Operators should confirm that the reactor will be beneficial and sufficient reactive reserve is available to maintain voltages after energization. In cases where multiple reactors are available, System Operators should decide how many reactors can/should be energized along with the 345 kV step-down transformer.

NOTE

The term Remedial Action Scheme (RAS) and its definition has been adopted by NPCC in place of the term Special Protection System (SPS). For existing documentation, the terms Remedial Action Scheme (RAS) or Special Protection System (SPS) may be used until such time as the terminology is changed by the Transmission Owner on equipment and schematics used in operations and in the field. However, a subset of SPSs were not recognized as RAS and instead became Automatic Control Schemes (ACS)

Remedial Action Schemes (RAS) or Automatic Control Schemes (ACS) that were armed prior to a blackout event may remain armed following the event. System Operators should be aware of which RASs/ACSs should remain armed following an event. If an RAS/ACS could cause an undesired outcome or action, it is recommended the RAS/ACS be disarmed.

4. Synchronizations

Generating stations are the preferred locations for synchronizing Generators, islands or systems together. These stations have synchronizing equipment which is needed for regular Generator phasing. Also, station operators should be versed in synchronizing techniques. In the Plan, some synchronizations are planned at transmission stations. For these cases, the necessary means to match frequency (including synchronizing equipment, operator knowledge and communication links to predefined generating stations) have been considered.

At the circuit breaker where electrical islands will be synchronized, the voltage magnitude of the two systems must be matched as closely as possible. Rules of Thumb for system restoration are contained in Attachment G – System Restoration Strategies. A rule of thumb would be to close the circuit breaker with **not** more than 3% voltage difference between the two islands. The island with the dynamic voltage control device closest to the synchronizing location should change the voltage. The frequency of the two systems must also be matched as closely as possible. The difference should be **no** greater than 20º of relative phase angle rotation per second, or a synchroscope rotation of **not** more than one (1) full revolution in 18 seconds. The smaller island frequency should be controlled and run at a slightly higher frequency. Finally, the sync-scope phase should be as close to the 12 o'clock position as possible and certainly within +/-3 minutes (or about +/- 20º) of vertical upon breaker closure.

M. Inter-Island Ties

The synchronization/energization of inter-island ties should occur during fairly early stages of system restoration. This should minimize problems associated with needing to synchronize many small islands or trying to match frequencies of two large islands. It would also promote the most effective use of available Resources to restore the system in the least amount of time. Synchronization/energization of inter-island ties during system restoration shall always be performed in accordance with M/LCC 18 and:

(1) only with the authorization of ISO; or

(2) if communications with ISO fail, if prudent to total system restoration and communications between the affected parties exist

Attachment D lists the Inter-LCC Ties operating at 115 kV and above. ISO and LCC System Operators should complete Attachment N – Interconnection/Synchronization Checklist for interconnection/synchronization criteria during a system restoration event.

N. Inter-RCA/BAA Ties

Restoration of the Eastern Interconnection is a priority objective of the Plan. The same reasons for early establishment of inter-LCC ties apply to synchronous inter-RCA/BAA ties. However, the lack of direct control over switching operations in other RCA/BAAs and their overall status/reliability should be considered before establishing ties. ISO System Operators should complete Attachment N – Interconnection/Synchronization Checklist for interconnection/synchronization criteria during a system restoration event.

Reliable operation of most HVdc converters requires that strong ac systems exist. For this reason, System Operators should **not** attempt to energize HVdc ties during early phases of system restoration unless it is known that their design will allow reliable operation with weak ac systems. Interconnection/synchronization of inter-RCA-BAA ties during system restoration shall always be performed in accordance with M/LCC 18 and:

(1) only with the authorization of ISO; or

(2) if communications with ISO fail, if prudent to total system restoration and communications between the affected parties exist.

Attachment E lists the Inter-RCA/BAA Ties and guidelines for when the HVdc ties can be reliably restored. Attachment E also includes indications as to whether a given Inter-RCA/BAA Tie is an interconnection point on a Primary or Alternate Path of the Plan as well as indications as to which side of the border the substation is located, where the interconnection will take place.

O. Reporting Requirements During System Restoration

The ISO Restoration Coordinator shall establish communications with LCC restoration coordinators and with the restoration coordinators of each adjacent RC power system to facilitate a flow of information that will promote coordinated system restoration. The ISO Restoration Coordinator shall be the primary contact for disseminating information regarding system restoration to the restoration coordinators of neighboring RCs, and to the LCC restoration coordinators. During system restoration, the ISO Restoration Coordinator shall monitor the progress of system restoration and provide periodic reports to LCCs and each adjacent RC power system, as necessary and appropriate.

NOTE

Refer to M/LCC 6, Attachment A - ISO New England Evacuation Procedure Telephone List (Confidential) for Contact information for neighboring RCs.

Each LCC restoration coordinator shall establish communications with the ISO Restoration Coordinator and the restoration coordinators of adjacent LCCs to provide a flow of information that promotes coordinated system restoration and to monitor, advise and help coordinate with the ISO and adjacent LCCs. Each LCC restoration coordinator shall monitor the progress of system restoration in its area and provide periodic reports to the ISO Restoration Coordinator and the restoration coordinators of neighboring LCCs, as necessary and appropriate.

ISO and LCC restoration coordinators shall share information regarding the progress of system restoration or any issues regarding system restoration as necessary and appropriate to promote reliability and keep appropriate entities informed within the limits of the Tariff, Attachment D - ISO New England Information Policy

Revision History

Rev. No.	Date	Reason	Owner
- -	02/28/24	For previous revision history, refer to Rev 10 available through Ask ISO	Jospeh Koltz
Rev 11	02/28/24	Annual review by procedure owner; Removed duplicate language in section 1.B; This revision is **not** the result of any permanent planned or unplanned BES modification; This revision does **not** change the ability, through roles or specific tasks, of one or more entities identified in the Plan, to implement the approved Plan; This revision does **not** impact the ability of ISO-NE to monitor and direct system restoration efforts.	Joseph Koltz

2. ATTACHMENTS

Attachment A - System Restoration Flowchart (Confidential)

Attachment B - Retired (01/04/16)

Attachment C - Charging of 345 kV Circuits in New England

Attachment D - Inter-Local Control Center Ties Operating at 115kV and Above

Attachment E - Inter-Reliability Coordinator Area / Balancing Authority Area Ties

Attachment F - Retired (01/27/14)

Attachment G - System Restoration Strategies

Attachment H - Millstone Alternate Path (Confidential)

Attachment I - Retired (12/31/99)

Attachment J - Retired (07/03/19)

Attachment K - Seabrook Alternate Path (Confidential)

Attachment L - RCA/BAA Interconnection/Synchronization Alternate Path (Confidential)

Attachment M - Paths to Alternative Cranked Generators (Confidential)

Attachment N - Interconnection/Synchronization Checklist

Attachment O - Designated Blackstart Resources (Confidential)

Attachment P - System Restoration Voltage Limits

Attachment Q - System Restoration Checklist (Confidential)