Reliability Guideline
Generating Unit Operations during Complete Loss of Communications

Preamble
It is in the public interest for the North American Electric Reliability Corporation (NERC) to develop guidelines that are useful for maintaining or enhancing the reliability of the Bulk Electric System (BES). The Technical Committees of NERC; Operating Committee (OC), Planning Committee (PC) and the Critical Infrastructure Protection Committee (CIPC) per their charters are authorized by the NERC Board of Trustees (Board) to develop Reliability (OC and PC) and Security Guidelines (CIPC). These guidelines establish a voluntary code of practice on a particular topic for consideration and use by BES users, owners, and operators. These guidelines are coordinated by the technical committees and include the collective experience, expertise and judgment of the industry. The objective of this reliability guideline is to distribute key practices and information on specific issues critical to maintaining the highest levels of BES reliability. Reliability guidelines are not to be used to provide binding norms or create parameters by which compliance to standards is monitored or enforced. While the incorporation of guideline practices are strictly voluntary, reviewing, revising, or developing a program using these practices is highly encouraged to promote and achieve the highest levels of reliability for the BES.

Purpose
This Reliability Guideline provides a strategy for power plant operations in the case of complete loss of communications (both data and voice) between the on-site generating unit(s) operator and the System Operator for the Balancing Area, Transmission Operator and Reliability Coordinator.

This Reliability Guideline was developed as requested by the NERC OC as part of the industry’s response to the Severe Impact Resilience Task Force (SIRTF) Recommendations.

The Reliability Guideline applies primarily to Balancing Authorities, Transmission Operators, Generator Operators and on-site generating unit(s) operators. The intent of this document is that Balancing Authorities and Transmission Operators, in accordance with their Reliability Coordinator, provide guidance for the coordination and training of the on-site generating unit(s) operators should all communications be interrupted, particularly during a severe impact event.

The applicable Balancing Authority, Transmission Operator or Reliability Coordinator may require a generator or group of generators to deviate from the guidance provided in this Reliability Guideline due to their electrical interconnection point to the Bulk Electric System. Therefore, it is important that Generator Operators coordinate the development of procedures and training with input and concurrence from their applicable Balancing Authority, Transmission Operator and Reliability Coordinator (see Appendix: Training).

The Reliability Guideline outlines a coordinated operations strategy for the on-site generating unit(s) operator to stabilize system frequency when centralized guidance is not possible. The strategy is designed
to keep frequency within allowable limits and continue safe operation of generators while maintaining acceptable frequency control. The Reliability Guideline is not applicable to generation connected to asynchronous loads or systems not normally part of one of the Interconnections. This guideline was written originally for staffed synchronous generation, however, the guidance may be applied to non-synchronous generation that has manual control capabilities and is capable of responding.

The Reliability Guideline is not meant to have the on-site generating unit(s) operator operate outside of the generator(s) limits or prevent the on-site generating unit(s) operator from taking actions necessary to protect the equipment under their supervision from damage including, if necessary, taking a unit off line in a safe manner. Protective equipment should not be bypassed or rendered inoperable in order to follow this guideline. Safety of personnel and prevention of damage to system equipment are the first responsibilities of electric system operators at all levels. Short-term instabilities and power grid outages can only be made worse if damage is allowed to occur to system equipment.

This Guideline does not create binding norms, establish mandatory Reliability Standards or create parameters by which compliance with Reliability Standards are monitored or enforced. In addition, the Reliability Guideline is not intended to take precedence over any Regional procedure.

Assumptions
The basic assumptions made in the development of this guideline are as follows:

1. **Loss of Communications** – all data and voice communications, both primary and backup, are lost between the on-site generating unit(s) operator and the System Operator for the Balancing Area, Transmission Operator and Reliability Coordinator.
2. **Generating Unit Status** – some generating capacity remains in service or can be brought into service locally at the on-site generating unit(s) operator’s discretion, to serve the load over the period of lost communications. (This does not imply that steam units not already in service should be brought into service.)
3. **Instrumentation** – Generating unit(s) are equipped with turbine speed sensors capable of one RPM increments and sometimes frequency metering devices capable of displaying (and optionally recording) system frequency on both narrow (roughly 59.95 Hz to 60.05 Hz) and wide (roughly 58.0 Hz to 62.0 Hz) ranges. Nomograms or other job aids that convert generator speed to frequency can be used.
4. **Situation Awareness** – The on-site generating unit(s) operator recognizes that turbine speed, therefore frequency is abnormal and a unique situation is occurring.

Guideline Details
If all communications between the on-site generating unit(s) operator and the System Operator are lost, one data point that is generally available to the on-site generating unit(s) operator is turbine speed that is proportional to frequency as measured locally by plant instrumentation. It may not be possible for the on-site generating unit(s) operator to determine if the grid remains intact or if the plant is operating as part of
a local island. There may be clues that a disturbance has occurred. However, any constant frequency operations strategy must function equally well with an intact grid or under island conditions.

In order to maintain stable system operations either with an intact grid or as part of an island, it is necessary to maneuver generation output to match changes in system demand. Without communications from the System Operator, the on-site generating unit(s) operator can only do this by controlling to frequency. Generator Operators should coordinate with their applicable Balancing Authority, Transmission Operator and Reliability Coordinator the development of procedures and training specific to each on-site generating unit(s) operator for complete loss of communication to incorporate any local actions that may deviate from the guidance provided in this document. Such procedures should include steps requiring periodic checks of communication status following the initial loss and steps requiring attempts to reestablish communication and potential alternate communication methods. This guideline proposes a structured approach to achieve frequency control for each of the following Interconnections:

- Eastern Interconnection
- ERCOT Interconnection
- Western Interconnection
- Quebec Interconnection
Eastern Interconnection

Deadband (Green Zone) – as long as the frequency trend stays reasonably close to 60.00 Hz, no manual control actions should be taken by generating unit(s). This Deadband should be +/- 100 milliHertz (59.90 Hz to 60.10 Hz - See Chart 1 below). This Deadband is the “Secondary Control” deadband and should not be confused with governor deadband of the turbine governor.

Selective Response (Yellow Zone) – as the frequency trend moves outside the Deadband boundaries but remains within reasonable operational limits, frequency should be corrected by maneuvering generating unit(s) in a gradual manner. For the Eastern Interconnection, the Selective Response band should be beyond +/- 100 milliHertz but less than +/- 200 milliHertz (59.80 Hz to 60.20 Hz). The generation ramp rate recommended for Selective Response is roughly one percent of the unit rating per minute. The on-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency is returned to within the Deadband. It should be noted that a sustained frequency less than 59.90 Hz or greater than 60.10 Hz in the Eastern Interconnection is an indication that a disturbance has occurred.

Full Response (Red Zone) – when the frequency trend exceeds reasonable operational limits, all units capable of responding should rapidly maneuver within their maximum capability to balance load with generation. Full Response should be triggered when frequency is less than 59.80 Hz or greater than 60.20 Hz. If frequency continues to exceed the Full Response limits, all available generation at the plant should be maneuvered to the appropriate unit operating limits (i.e. fully loaded in the case of low frequency or at minimum load in the case of high frequency). In particular, all available generating capacity at the plant should be deployed to halt frequency decline when the frequency drops below the Full Response limit. The on-site generating unit(s) operator(s) should carefully observe frequency during Full Response operation and reduce the ramp rate of their units when frequency reaches the Selective Response region.

Emergency Response – if the frequency trend continues to deteriorate, emergency measures may be required in accordance with actions developed in consultation with applicable Balancing Authority, Transmission Operator and Reliability Coordinator.

- **High Frequency** – high frequency Emergency Response will consist of maneuvering all available generation to its lowest stable operating point, followed by tripping of selected units.
  - **Low Minimums** – all generation should be maneuvered to its lowest stable minimum load operating point (with auxiliary fuel firing, if required) when frequency increases to 60.30 Hz.
  - **Unit Tripping** – when frequency increases to 60.50 Hz, plants with multiple units should trip generation off line. Generally, smaller units with minimal impacts to operations should be taken off line first, so that as much capacity as possible remains on line. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken off line as needed.
- **Low Frequency** – Emergency Response may consist of loading all available hydro generation, followed by commitment of quick-start generating unit(s) (primarily combustion turbines).
- **Hydro** – all hydro generation should be loaded when frequency declines to 59.70 Hz
- **Quick-Start** – all quick-start generation resources should be committed when frequency drops below 59.60 Hz

On-site generating unit(s) operators should be aware that underfrequency load shed relays start to operate automatically to disconnect customer load when frequency declines to 59.50 Hz. Roughly 10 percent of system load is typically shed at this point (note that specific frequencies and load percentages vary depending upon specific Regional requirements). Additional load is typically shed as frequency continues to decline. The amount of load actually shed in any particular island will vary.

**Blackout Conditions** – if conditions continue to deteriorate, it will be necessary for the on-site generating unit(s) operator to separate from the synchronized grid in order to protect generating unit equipment. This separation takes place on a sliding time scale, typically at roughly 58.00 Hz. (Note that this is based on turbine manufacturer’s recommendations that operation below this frequency can result in significant fatigue failure of the turbine blades and may vary with specific turbine design).

While it is desirable to maintain service continuity, it is unacceptable to allow generating unit equipment to suffer major damage that would impede the restoration of service after a major disturbance. However, it is important that units not be prematurely tripped when frequency is declining, since such action will cause system frequency to decline further and adversely affect other generators in the island. It is recommended that unless frequency is declining rapidly, units should remain connected to the system until the operation of automatic underfrequency load shedding relays is completed at roughly 58.00 Hz.

If a unit is removed from the Transmission system by the on-site generating unit(s) operator and cannot continue operation on a self-supporting basis, the on-site generating unit(s) operator should shut down the plant in an organized manner in preparation for restart. Such operation should be continued until a request to re-synchronize the generating unit to the Transmission system can be communicated to and approved by the System Operator. The on-site generating unit(s) operator should maintain generating unit(s) in a state whereby the unit can be restarted quickly to reduce the time required to restore the electrical system to normal operation.

The on-site generating unit(s) operator should make regular attempts to restore communications with the System Operator to convey the status of their generating unit(s) and always follow their Transmission Operator’s restoration plans. This should include attempts to contact the applicable Balancing Authority, Transmission Operator and/or Reliability Coordinator.
Chart 1: Eastern Interconnection Generator Frequency Operating Guideline

**Notes:**

- Nuclear generating plants are expected to stay on line at a sustainable, stable output level as long as possible. Under no circumstances should this Reliability Guideline be interpreted as requiring nuclear generating plants to operate in a manner that will violate their regulatory requirements, endanger public safety or adversely impact the integrity of plant equipment.

- Calibration of turbine speed and frequency measuring equipment should be included as part of the each generator’s annual maintenance plan.
ERCCOT Interconnection

Deadband (Green Zone) – as long as the frequency trend stays reasonably close to 60.00 Hz, no manual control actions should be taken by generating unit(s). This Deadband should be +/- 100 milliHertz (59.90 Hz to 60.10 Hz - See Chart 2 below). This Deadband is the “Secondary Control” deadband and should not be confused with governor dead-band of the turbine governor. Turbine governor deadbands are established by ERCOT.

Selective Response (Yellow Zone) – as the frequency trend moves outside the Deadband boundaries but remains within reasonable operational limits, frequency should be corrected by maneuvering generating unit(s) in a gradual manner. For the ERCOT Interconnection, the Selective Response band should be +/- 200 milliHertz (59.80 Hz to 60.20 Hz). The generation ramp rate recommended for Selective Response is roughly one percent of the unit rating per minute. The on-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency is returned to within the Deadband.

Full Response (Red Zone) – when the frequency trend exceeds reasonable operational limits, all units capable of responding should rapidly maneuver within their maximum capability to balance load with generation. Full Response should be triggered when frequency is less than 59.80 Hz or greater than 60.20 Hz. If frequency continues to exceed the Full Response limits, all available generation at the plant should be maneuvered to the appropriate unit operating limits (i.e. fully loaded in the case of low frequency or at minimum load in the case of high frequency). In particular, all available generating capacity at the plant should be deployed to halt frequency decline when the frequency drops below the Full Response limit. The on-site generating unit(s) operator should carefully observe frequency during Full Response operation and reduce the ramp rate of their units when frequency reaches the Selective Response region.

Emergency Response – if the frequency trend continues to deteriorate, then emergency measures may be required in accordance with actions developed in consultation with applicable Balancing Authority, Transmission Operator and Reliability Coordinator.

- **High Frequency** – high frequency Emergency Response will consist of maneuvering all available generation to its lowest stable operating point, followed by tripping of selected units.
  - **Low Minimums** – all generation should be maneuvered to its lowest stable minimum load operating point (with auxiliary fuel firing, if required) when frequency increases to 60.50 Hz.
  - **Unit Tripping** – when frequency increases to 62.50 Hz, plants with multiple units should trip generation off line. Generally, smaller units with minimal impacts to operations should be taken off line first, so that as much capacity as possible remains on line. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken off line as needed. Note that turbine overspeed trips typically engage at 63.00 Hz with auxiliary governor action beginning at 61.80 Hz.
- **Low Frequency** – Emergency Response may consist of loading all available hydro generation, followed by commitment of quick-start generating unit(s) (primarily combustion turbines)
- **Hydro** – all hydro generation should be loaded when frequency decreases to 59.50 Hz
- **Quick-Start** – all quick-start generation resources should be committed when frequency drops below 59.50 Hz.

On-site generating unit(s) operators should be aware that underfrequency load shed relays start to operate automatically to disconnect customer load when frequency declines to 59.30 Hz. Roughly five percent of system load is typically shed at this point. An additional 10% of system load is shed if frequency continues to decline and reaches 58.90 Hz. The final step of load shedding is 10 percent when frequency declines to 58.50 Hz. The amount of load actually shed in any particular island will vary.

**Blackout Conditions** – if conditions continue to deteriorate, it will be necessary for the on-site generating unit(s) operator to separate from the synchronized grid in order to protect generating unit equipment. This separation takes place on a sliding time scale, typically at roughly 58.00 Hz. (Note that this is based on turbine manufacturer’s recommendations that operation below this frequency can result in significant fatigue failure of the turbine blades and may vary with specific turbine design).

While it is desirable to maintain service continuity, it is unacceptable to allow generating unit equipment to suffer major damage that would impede the restoration of service after a major disturbance. However, it is important that units not be prematurely tripped when frequency is declining, since such action will cause system frequency to decline further. It is recommended that unless frequency is declining rapidly, units should remain connected to the system until the operation of automatic underfrequency load shedding relays is completed at roughly 58.40 Hz. Off-frequency operations of steam turbines should be limited to nine minutes below 59.40 Hz, 30 seconds below 58.40 Hz and two seconds below 58.00 Hz. Please note that these time limitations are cumulative during the entire service-life of a generator.

If a unit is removed from the Transmission system by the on-site generating unit(s) operator and cannot continue operation on a self-supporting basis, the on-site generating unit(s) operator should shut down the plant in an organized manner in preparation for restart. Such operation should be continued until a request to re-synchronize the generating unit to the transmission system can be communicated to and approved by the System Operator. The on-site generating unit(s) operator should maintain generating unit(s) in a state whereby the unit can be restarted quickly to reduce the time required to restore the electrical system to normal operation.

The on-site generating unit(s) operator should make regular attempts to restore communications with the System Operator to convey the status of their generating unit(s) and always follow their Transmission Operator’s restoration plans. This should include attempts to contact the applicable Balancing Authority, Transmission Operator and/or Reliability Coordinator.
Reliability Guideline: Generating Unit Operations During Complete Loss of Communications
Approved by the Operating Committee: December 11, 2018

Chart 2: ERCOT Interconnection Generator Frequency Operating Guideline

Notes:

- Nuclear generating plants are expected to stay on line at a sustainable, stable output level as long as possible. Under no circumstances should this Reliability Guideline be interpreted as requiring nuclear generating plants to operate in a manner that will violate their regulatory requirements, endanger public safety or adversely impact the integrity of plant equipment.

- Calibration of turbine speed and frequency measuring equipment should be included as part of each generator’s annual maintenance plan.

- In the event of a conflict between this guideline and the ERCOT governing documents, then the ERCOT governing documents will control.
Western Interconnection

Deadband (Green Zone) – as long as the frequency trend stays reasonably close to 60.00 Hz, no manual control actions should be taken by generating unit(s). This Deadband should be +/- 100 milliHertz (59.90 Hz to 60.10 Hz - See Chart 3 below). This Deadband is the "Secondary Control" deadband and should not be confused with governor deadband of the turbine governor.

Selective Response (Yellow Zone) – as the frequency trend moves outside the deadband boundaries but remains within reasonable operational limits, frequency should be corrected by maneuvering generating unit(s) in a gradual manner. For the Western Interconnection, the Selective Response band should be +/- 200 milliHertz (59.80 Hz to 60.20 Hz). The generation ramp rate recommended for Selective Response is roughly one percent of the unit rating per minute. The on-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency is returned to within the Deadband.

Full Response (Red Zone) – when the frequency trend exceeds reasonable operational limits, all units capable of responding should rapidly maneuver within their maximum capability to balance load with generation. Full Response should be triggered when frequency is less than 59.80 Hz or greater than 60.20 Hz. If frequency continues to exceed the Full Response limits, all available generation at the plant should be maneuvered to the appropriate unit operating limits (i.e. fully loaded in the case of low frequency or at minimum load in the case of high frequency). In particular, all available generating capacity at the plant should be deployed to halt frequency decline when the frequency drops below the Full Response limit. The on-site generating unit(s) operator should carefully observe frequency during Full Response operation and reduce the ramp rate of their units when frequency reaches the Selective Response region.

Emergency Response – if the frequency trend continues to deteriorate, then emergency measures may be required in accordance with actions developed in consultation with applicable Balancing Authority, Transmission Operator and Reliability Coordinator.

- **High Frequency** – high frequency Emergency Response will consist of maneuvering all available generation to its lowest stable operating point, followed by tripping of selected units.
  - **Low Minimums** – all generation should be maneuvered to its lowest stable minimum load operating point (with auxiliary fuel firing, if required) when frequency increases to 60.50 Hz.
  - **Unit Tripping** – when frequency increases to 60.60 Hz, plants with multiple units should trip generation off line. Generally, smaller units with minimal impacts to operations should be taken off line first, so that as much capacity as possible remains on line. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken off line as needed. Note that turbine overspeed trips typically engage at 61.20 Hz.
- **Low Frequency** – Emergency Response may consist of loading all available hydro and pumped storage hydro generation, followed by commitment of quick-start generating unit(s) (primarily combustion turbines).
- **Hydro** – all hydro and pumped storage hydro generation should be loaded when frequency declines to 59.70 Hz.

- **Quick-Start** – all quick-start generation resource(s) should be committed when frequency drops below 59.60 Hz.

On-site generating unit(s) operators should be aware that underfrequency load shed relays start to operate automatically to disconnect customer load when frequency reaches 59.50 Hz. Roughly, 4,200 MW of system load is shed at this point (note that specific frequencies and load percentages vary depending upon specific Regional requirements). Additional load is shed as frequency continues to decline. The amount of load actually shed in any particular island is per the WECC Off-Nominal Frequency Load Shedding Plan.

**Blackout Conditions** – if conditions continue to deteriorate, it will be necessary for the on-site generating unit(s) operator to separate from the synchronized grid in order to protect generating unit equipment. This separation takes place on a sliding time scale, typically at roughly 58.00 Hz. (Note that this is based on turbine manufacturer’s recommendations that operation below this frequency can result in significant fatigue failure of the turbine blades and may vary with specific turbine design).

While it is desirable to maintain service continuity, it is unacceptable to allow generating unit equipment to suffer major damage that would impede the restoration of service after a major disturbance. However, it is important that units not be prematurely tripped when frequency is declining, since such action will cause system frequency to decline further. It is recommended that unless frequency is declining rapidly, units should remain connected to the system until the operation of automatic underfrequency load shedding relays is completed at roughly 58.30 Hz.

If a unit is removed from the transmission system by the on-site generating unit(s) operator and cannot continue operation on a self-supporting basis, the on-site generating unit(s) operator should shut down the plant in an organized manner in preparation for restart. Such operation should be continued until a request to re-synchronize the generating unit to the transmission system can be communicated to and approved by the System Operator. The on-site generating unit(s) operator should maintain generating unit(s) in a state whereby the unit can be restarted quickly to reduce the time required to restore the electrical system to normal operation.

The on-site generating unit(s) operator should make regular attempts to restore communications with the System Operator to convey the status of their generating unit(s) and always follow their Transmission Operator’s restoration plans. This should include attempts to contact the applicable Balancing Authority, Transmission Operator and/or Reliability Coordinator.
Notes:

- Nuclear generating plants are expected to stay on line at a sustainable, stable output level as long as possible. Under no circumstances should this Reliability Guideline be interpreted as requiring nuclear generating plants to operate in a manner that will violate their regulatory requirements, endanger public safety or adversely impact the integrity of plant equipment.

- Calibration of turbine speed and frequency measuring equipment should be included as part of each generator’s annual maintenance plan.
Quebec Interconnection

Deadband (Green Zone) – as long as the frequency trend stays reasonably close to 60.00 Hz, no manual control actions should be taken by generating unit(s). This Deadband should be +/- 50 milliHertz (59.95 Hz to 60.05 Hz - See Chart 4 below). This Deadband is the “Secondary Control” deadband and should not be confused with governor deadband of the turbine governor.

Selective Response (Yellow Zone) – as the frequency trend moves outside the Deadband boundaries but remains within reasonable operational limits, frequency should be corrected by maneuvering generating unit(s) in a gradual manner. For the Quebec Interconnection, the Selective Response band should be +/- 300 milliHertz (59.70 Hz to 60.3 Hz). The generation ramp rate recommended for Selective Response is roughly one percent of the unit rating per minute. The on-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency is returned to within the Deadband.

Full Response (Red Zone) – when the frequency trend exceeds reasonable operational limits, all units capable of responding should rapidly maneuver within their maximum capability to balance load with generation. Full Response should be triggered when frequency is less than 59.70 Hz or greater than 60.30 Hz. If frequency continues to exceed the Full Response limits, all available generation at the plant should be maneuvered to the appropriate unit operating limits (i.e. fully loaded in the case of low frequency or at minimum load in the case of high frequency). In particular, all available generating capacity at the plant should be deployed to halt frequency decline when the frequency drops below the Full Response limit. The on-site generating unit(s) operator should carefully observe frequency during Full Response operation and reduce the ramp rate of their units when frequency reaches the Selective Response region.

Emergency Response – if frequency continues to deteriorate, then emergency measures may be required in accordance with actions developed in consultation with applicable Balancing Authority, Transmission Operator and Reliability Coordinator.

- **High Frequency** – high frequency Emergency Response will consist of maneuvering all available generation to its lowest stable operating point, followed by tripping of selected units.
  - **Low Minimums** – all variable hydro generation should be maneuvered to its lowest stable minimum load operating point when frequency increases to 60.30 Hz.
  - **Unit Tripping** – when frequency increases to 60.50 Hz, plants with multiple units should trip generation off line. Variable hydro generation should be taken off line first and run-of-the-river units second. Use operational judgment to minimize any adverse impacts and to adequately manage hydraulic resource. Subsequent generation should be taken off line as needed. Note that over frequency generation tripping engages roughly at 60.9 Hz.
- **Low Frequency** – Emergency Response may consist of loading all available hydro and pumped storage hydro generation, followed by commitment of quick-start generating unit(s) (primarily combustion turbines).
- **Variable Hydro** – all variable hydro generation should be loaded when frequency declines to 59.70 Hz.
- **Quick-start** – all quick-start generation resources should be committed when frequency drops below 59.70 Hz.
- **Run-of-the-river Hydro** – all run-of-the-river hydro generation should be loaded at maximum when frequency drops below 59.60 Hz.

On-site generating unit(s) operators should be aware that underfrequency load shed relays start to operate automatically to disconnect customer load when frequency reaches 59.00 Hz. Roughly, 500 MW of load is typically shed at this point (based on peak load conditions). An additional 800 MW of load is typically shed as frequency continues to decline by 500 milliHertz thresholds until it reaches the last step at 57.00 Hz.

**Blackout Conditions** – if conditions continue to deteriorate, it will be necessary for the on-site generating unit(s) operator to separate from the synchronized grid in order to protect generating unit equipment.

While it is desirable to maintain service continuity, it is unacceptable to allow generating unit equipment to suffer major damage that would impede the restoration of service after a major disturbance. However, it is important that units not be prematurely tripped when frequency is declining, since such action will cause system frequency to decline further. It is recommended that unless frequency is declining rapidly, units should remain connected to the system until the operation of automatic underfrequency load shedding relays is completed at roughly 57.00 Hz.

If a unit is removed from the transmission system by the on-site generating unit(s) operator and cannot continue operation on a self-supporting basis, the on-site generating unit(s) operator should shut down the plant in an organized manner in preparation for restart. Such operation should be continued until a request to re-synchronize the generating unit to the transmission system can be communicated to and approved by the System Operator.

The on-site generating unit(s) operator should make regular attempts to restore communications with the System Operator to convey the status of their generating unit(s) and always follow their Transmission Operator’s restoration plans. This should include attempts to contact the Balancing Authority, Transmission Operator and/or Reliability Coordinator.
Chart 4: Quebec Interconnection Generator Frequency Operating Guideline

Notes:

- Calibration of turbine speed and frequency measuring equipment should be included as part of each generator’s annual maintenance plan.

Related Documents and Links:
EPRI Power System Dynamics Tutorial
## Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Version Number</th>
<th>Reason/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/11/2014</td>
<td>1.0</td>
<td>Initial Version – “Generating Unit Operations During Complete Loss of Communications”</td>
</tr>
<tr>
<td>06/9/2015</td>
<td>2.0</td>
<td>Revision to address unintended consequences on the transmission system that could result from uncoordinated voluntary generator movements driven by frequency alone.</td>
</tr>
<tr>
<td>7/13/2018</td>
<td>Draft 3.0</td>
<td>Revision for usability improvements identified in periodic review.</td>
</tr>
<tr>
<td>9/21/2018</td>
<td>3.0</td>
<td>Incorporation of comments on Draft 3.0</td>
</tr>
</tbody>
</table>
Appendix: Training

**Introduction** - This appendix outlines suggested additional reading as well as provides a set of tasks the on-site generating unit(s) operator could consider as part of ongoing training and for participation in area restoration drills and seminars. Generator Operators may have a fleet of generators that crossover a number of Balancing Authorities and Transmission Operators footprints. Generator Operators should coordinate with each applicable Balancing Authority, Transmission Operator and Reliability Coordinator to develop guidelines and training specific to each generating unit operator for complete loss of communications.

Send comments and suggestions to balancing@nerc.com.

**Additional Reading** - A valuable resource available for training is the *EPRI Power System Dynamics Tutorial*. The tutorial can be downloaded for free at the link above. The parts of the tutorial that deal most directly to frequency control are:

- Section 4
- Section 8
- Section 11.3

**Scenario** - The tasks that follow are suggested as part of initial “emergency” training for the on-site generating unit(s) operator as well as refresher training during restoration drills. The tasks were developed after reviewing a few actual scenarios where generators found themselves in an island following a disturbance. While communications were still available to the Balancing Authority, the scenario still demonstrates the dynamics that can be observed following a disturbance. Since the most likely situation where an on-site generating unit(s) operator would need to take action and not have communications is following a disturbance or coordinated attack, the situation below is valid for comparison.
The frequency graph from a storm-created island in 2010 shows what took place within about 30 seconds. The storm left approximately 55 MWs of load in the area connected to 45 MWs of generation. This caused frequency to decline to 59 Hz, which was the first step of underfrequency load shedding (UFLS) in this area. The UFLS caused frequency to overshoot to approximately 61.5 Hz. Unfortunately, 18 MW of hydro generation tripped automatically at 61.5 Hz. This left an insufficient amount of generation in the area that caused a more rapid decline in frequency, which the next step of UFLS was unable to arrest.

The reality is that in some cases as outlined above, there is little for the on-site generating unit(s) operator to do. Knowing and coordinating the UFLS and generator trip setpoints in the area can help generators ride through local disturbances. For islands caused by major events, the islands may be larger and changes in frequency slower. The tasks below are intended to help the on-site generating unit(s) operator prepare for such events. It is suggested the tasks should be reviewed annually.

**Tasks**

- Discuss training activities and the guideline with your Balancing Authority.
- Identify your local load serving entity’s under-frequency load shedding trip points.
- Identify your generator(s) overfrequency trip settings.
- Identify and test the generator(s) governor frequency control modes.
- Identify the ratings of the Transmission lines emanating from your station and the plant limitations if one or more lines are out of service.
- Discuss what steps the on-site generating unit(s) operator should take if controlling to voltage.
- List and discuss the symptoms of possible islanding.
• Identify and test possible alternate communication paths with your Balancing Authority, Transmission Operator and Reliability Coordinator (to include communications through other entities).

• If at a multi-unit station, discuss the frequency control strategy to be followed during islanding, restoration or complete loss of communications.

• Walk through the steps needed to isolate a generator from the grid while supplying its own auxiliaries.