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 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 our industry’s response to the Severe Impact Resilience Task Force (SIRTF) Recommendations.

The Reliability Guideline applies primarily to Balancing Authorities and to Generator Operators. The applicability of this document to Balancing Authorities is to provide a resource for coordination and training guidelines for generators operators should all communications be interrupted, particularly during a severe impact event. See Appendix (Training) below.

The Reliability Guideline outlines a coordinated operations strategy for generating units to stabilize system frequency when centralized guidance is not possible. It is designed to keep frequency within allowable limits and continued safe operation of generators while maintaining acceptable frequency control.

The Reliability Guideline is not meant to prevent generating unit operators from taking actions necessary to protect the equipment under their supervision from permanent damage. Protective equipment should not be bypassed or rendered inoperable in order to follow this guide. Safety of personnel and prevention of permanent 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 permanent damage is allowed to occur to system equipment.

Assumptions:

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

A. 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.

B. Generating Unit Status – some generating capacity remains in service or can be brought into service locally at the plant 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.)

C. Instrumentation – Generating units are equipped with 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. Alternatively, nomograms or other job aids that convert generator speed to frequency can be used.

D. Situation Awareness – The on-site generating unit(s) operator recognize that frequency is abnormal and a unique situation is occurring.

Guideline Details:

If communications between the on-site generating unit(s) operator and the System Operator is lost, the primary system information available to the on-site generating unit(s) operator will be 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. Still, any constant frequency operations strategy must function equally well with an intact grid or under island conditions.

In order to maintain stable system operations with either 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, this can only be done by the on-site generating unit(s) operator controlling to frequency. This guide proposes the following structure to achieve frequency control for the following Interconnections:

**Eastern Interconnection**

**Deadband** (Green Zone) – as long as frequency stays reasonably close to 60.00 Hz, no control actions should be taken by generating units. This deadband should be +/- 50 milliHertz (59.95 Hz to 60.05 Hz - See Chart 1 below).

**Selective Response** (Yellow Zone) – as frequency moves outside the deadband boundaries but remains within reasonable operational limits it should be corrected by maneuvering generating units in a gradual manner. For the Eastern Interconnection, the Selective Response band should be beyond +/- 50 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. On-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency enters 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 frequency exceeds reasonable operational limits all units capable of responding should rapidly maneuver 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. 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 will be required.

- **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 offline. Generally, smaller units with minimal impacts to transmission should be taken offline first, so that as much capacity as possible remains online. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken offline as needed.

- **Low Frequency** – Emergency Response will consist of loading all available hydro generation, followed by commitment of quick start generating units (primarily combustion turbines) and, finally, under frequency load shedding.
  - **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

For information, under frequency load shed relays start to operate automatically when frequency declines to 59.50 Hz. Roughly ten 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 on-site generating unit(s) operator to separate from the synchronized grid in order to protect generating unit equipment. This
typically takes place 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 under frequency load shedding relays is completed at roughly 58.00 Hz.

If possible, a unit removed from the transmission system by the on-site generating unit(s) operator should continue operation on a self-supporting basis carrying its own station service. 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. Maintaining generating units in hot standby mode will reduce the time required to restore the electrical system to normal operation.

The on-site generating unit(s) operator should make regular attempts to reestablish communications with the System Operator to convey the status of their generating units and always follow their Black Start Plans. This should include attempts to contact the Balancing Authority, Transmission Operator and/or Reliability Coordinator.
1. 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.

2. It is recommended that generating units calibrate plant frequency equipment on an annual basis.
ERCOT Interconnection

Deadband (Green Zone) – as long as frequency stays reasonably close to 60.00 Hz, no control actions should be taken by generating units. This deadband should be +/- 70 milliHertz (59.93 Hz to 60.07 Hz - See Chart 2 below). This dead-band is the “Secondary Control” dead-band and should not be confused with governor dead-band of the turbine governor. Turbine governor dead-bands are as required by ERCOT.

Selective Response (Yellow Zone) – as frequency moves outside the dead-band boundaries but remains within reasonable operational limits it should be corrected by maneuvering generating units 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. On-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency enters the dead-band.

Full Response (Red Zone) – when frequency exceeds reasonable operational limits all units capable of responding should rapidly maneuver 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. 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 will be required.

- **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 offline. Generally, smaller units with minimal impacts to transmission should be taken offline first, so that as much capacity as possible remains online. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken offline 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 will consist of loading all available hydro generation, followed by commitment of quick start generating units (primarily combustion turbines) and, finally, under frequency load shedding.
  - **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.

For information, under frequency load shed relays start to operate automatically 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 declines to 58.90 Hz with a final system load shedding of 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 on-site generating unit(s) operators to separate from the synchronized grid in order to protect generating unit equipment. This typically takes place 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 under frequency load shedding relays is completed at roughly 58.40 Hz. Off frequency operations of steam turbines should be limited to 9 minutes below 59.40 Hz. Thirty seconds below 58.40 Hz and two seconds below 58.00 Hz.

If possible, a unit removed from the transmission system by the on-site generating unit(s) operator should continue operation on a self-supporting basis carrying its own station service. 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. Maintaining generating units in hot standby mode will reduce the time required to restore the electrical system to normal operation.

On-site generating unit(s) operator should make regular attempts to reestablish communications with the System Operator to convey the status of their generating units and always follow their Black Start Plans. This should include attempts to contact the Balancing Authority, Transmission Operator and/or Reliability Coordinator.
**Reliability Guideline:** Generating Unit Operations During Complete Loss of Communications

**Notes:**

1. 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.

2. It is recommended that generating units calibrate plant frequency equipment on an annual basis.
Western Interconnection

Deadband (Green Zone) – as long as frequency stays reasonably close to 60.00 Hz, no control actions should be taken by generating units. This deadband should be +/- 50 milliHertz (59.95 Hz to 60.05 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 frequency moves outside the deadband boundaries but remains within reasonable operational limits it should be corrected by maneuvering generating units 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. On-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency enters the deadband.

Full Response (Red Zone) – when frequency exceeds reasonable operational limits all units capable of responding should rapidly maneuver 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. 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 will be required.

- **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 offline. Generally, smaller units with minimal impacts to transmission should be taken offline first, so that as much capacity as possible remains online. Use operational judgment to minimize any adverse impacts. Subsequent generation should be taken offline as needed. Note that turbine overspeed trips typically engage at 61.20 Hz.

- **Low Frequency** – Emergency Response will consist of loading all available hydro and pumped storage hydro generation, followed by commitment of quick start generating units (primarily combustion turbines) and, finally, under frequency load shedding.
  - Hydro – all hydro and pumped storage 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.

For information, under frequency load shed relays start to operate automatically 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 May 24, 2011 WECC Off-Nominal Frequency Load Shedding Plan.

It is preferred that online generators that protect for off-nominal frequency operation should have relaying protection that accommodates, at a minimum, underfrequency and overfrequency operation for the time frames specified in the following table:

<table>
<thead>
<tr>
<th>Underfrequency Limit</th>
<th>Overfrequency Limit</th>
<th>Minimum Time(^{NOTE 1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;59.4 Hz</td>
<td>&lt; 60.6 Hz</td>
<td>N/A (continuous operation)</td>
</tr>
<tr>
<td>(\leq)59.4 Hz</td>
<td>(\geq)60.6 Hz</td>
<td>3 minutes</td>
</tr>
<tr>
<td>(\leq)58.4 Hz</td>
<td>(\geq)61.6 Hz</td>
<td>30 seconds</td>
</tr>
<tr>
<td>(\leq)57.8 Hz</td>
<td>(\geq)61.7 Hz</td>
<td>7.5 seconds</td>
</tr>
<tr>
<td>(\leq)57.3 Hz</td>
<td></td>
<td>45 cycles</td>
</tr>
<tr>
<td>(\leq)57.0 Hz</td>
<td>(\geq)61.7 Hz</td>
<td>Instantaneous trip</td>
</tr>
</tbody>
</table>

\(^{NOTE 1}\): Minimum Time is the time the generator should stay interconnected and producing power.

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 typically takes place 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 under frequency load shedding relays is completed at roughly 58.30 Hz.

If possible, a unit removed from the transmission system by the on-site generating unit(s) operator should continue operation on a self-supporting basis carrying its own station service. 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. Maintaining generating units in hot standby mode will reduce the time required to restore the electrical system to normal operation.
On-site generating unit(s) operator should make regular attempts to reestablish communications with the System Operator to convey the status of their generating units and always follow their Black Start Plans as necessary. This should include attempts to contact the Balancing Authority, Transmission Operator and/or Reliability Coordinator.

**Western Interconnection Generator Frequency Operating Guide**

**Notes:**

1. 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.

2. It is recommended that generating units calibrate plant frequency equipment on an annual basis.
Quebec Interconnection

Deadband (Green Zone) – as long as frequency stays reasonably close to 60.00 Hz, no control actions should be taken by generating units. This deadband should be +/- 50 milliHertz (59.95 Hz to 60.05 Hz - See Chart 4 below).

Selective Response (Yellow Zone) – as frequency moves outside the deadband boundaries but remains within reasonable operational limits it should be corrected by maneuvering generating units 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. On-site generating unit(s) operator should carefully observe frequency during Selective Response and cease maneuvering their units when frequency enters the deadband.

Full Response (Red Zone) – when frequency exceeds reasonable operational limits all units capable of responding should rapidly maneuver 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. 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 will be required.

- **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 increase to 60.30 Hz.
  - **Unit Tripping** – when frequency increases to 60.50 Hz, plants with multiple units should trip generation offline. Variable hydro generation should be taken offline first and run-off-the-river units second. Use operational judgment to minimize any adverse impacts and to adequately manage hydraulic resource. Subsequent generation should be taken offline as needed. Note that over frequency generation tripping engages roughly at 60.5 Hz.

- **Low Frequency** – Emergency Response will consist of loading all available hydro and pumped storage hydro generation, followed by commitment of quick start generating units (primarily combustion turbines) and, finally, under frequency load shedding.
  - **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.

For information, under frequency load shed relays start to operate automatically 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 under frequency load shedding relays is completed at roughly 57.00 Hz.

If possible, a unit removed from the transmission system by the on-site generating unit(s) operator should continue operation on a self-supporting basis carrying its own station service. 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.

On-site generating unit(s) operator should make regular attempts to reestablish communications with the System Operator to convey the status of their generating units and always follow their Black Start Plans as necessary. This should include attempts to contact the Balancing Authority, Transmission Operator and/or Reliability Coordinator.
QUÉBEC INTERCONNECTION
GENERATOR FREQUENCY OPERATING GUIDE

1. On-site generator unit(s) operator should ONLY use this guide when all communication (data and voice) has been lost between the generator and Balancing Authority and Transmission Operator.
2. When frequency is in green zone, let governor action control unit output.
3. When frequency is in yellow zone, manually load/unload unit in gradual increments to avoid overcorrecting. (Note: generally 1% of unit rating per minute)
4. When frequency is in red zone, manually load/unload unit as quickly as possible.

In situations of severe under/over speed or severe under/over voltage, take standard precautions to protect your unit!

Chart 4 – Quebec Interconnection Generator Frequency Operating Guide

Notes
1. It is recommended that generating units calibrate plant frequency equipment on an annual basis.

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>
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<tr>
<td>11/19/2013</td>
<td>1.0</td>
<td>Initial Version – “Generating Unit Operations During Complete Loss of Communications”</td>
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</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. On-site generator unit(s) operators are encouraged to consult with their Balancing Authority in reference to this guideline and training.

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 59Hz, which was the first step of under frequency load shedding (UFLS) in this area. The UFLS caused frequency to overshoot to approximately 61.5Hz. 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 will be larger and changes in frequency will be 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) over-frequency trip settings.
- Identify and test your generator(s) most frequency responsive 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.
- 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 total loss of communications.
- Walk through the steps needed to isolate a generator from the grid while supplying its own auxiliaries.