

A. Introduction

1. **Title:** Automatic Underfrequency Load Shedding Requirements
2. **Number:** **PRC-006-MRO-01**
3. **Purpose:** The purpose of this standard is to develop, coordinate, implement and document Automatic Underfrequency Load Shedding (UFLS) requirements to provide last resort system preservation measures to mitigate unwanted low frequency conditions.
4. **Applicability:**
 - 4.1. Planning Coordinator (PC)
 - 4.2. Distribution Provider (DP)
 - 4.3. Transmission Owner (TO)
 - 4.4. Generator Owner (GO)
5. **Effective Date:** 1st day of the 1st quarter one year following last appropriate Regulatory Approval, financial sanctions will become effective. Note: the implementation time frame for R9 and R10.

B. Requirements

- R1.** Each Planning Coordinator shall develop and maintain a documented methodology to determine areas of credible islanding within its area. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- The methodology shall include the following elements or an explanation why they were not included:
- Historical islanding events
 - Historical severe disturbance events
 - Any network islanding scheme
 - Identity of the connecting elements for credible islands
 - Identity of exempt critical loads within each credible island
 - Identity of exempt credible islands
 - How the registered entities and stakeholders, including adjacent entities, will assist in the UFLS development, including studies and analyses, and provide concurrence
- R2.** Each Planning Coordinator shall use its methodology to determine credible islands within its area of responsibility and identify the credible islands that must have UFLS programs. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- R2.1.** Each Planning Coordinator shall evaluate and confirm credible islanding within their area of responsibility every calendar year and within 15 months of the last evaluation.

- R2.2.** Each Planning Coordinator shall make its credible island determination available for inspection and technical review by those entities directly and materially affected by the reliability of the MRO Bulk Electric System (BES), within 30 days of the determination.
- R2.3.** If entities directly and materially affected by the reliability of the MRO BES provide written comments on its credible island determination, the Planning Coordinator shall provide a written response to that commenting entity within 45 calendar days of receipt of those comments. The response shall indicate whether a change will be made to its credible island determination and, if no change will be made, the reason.
- R3.** Each Planning Coordinator shall have a documented methodology for design and performance of its UFLS program. [*Violation Risk Factor: Lower*] [*Time Horizon: Long-term Planning*]
- R3.1.** The methodology shall include the following elements:
- Frequency set points and timing delays
 - A minimum of 30% percent of its total connected forecasted annual peak hour Load assigned to trip in each designated island
 - Frequency decline shall be arrested at no less than 58.0 Hz, unless generation protection in the credible island warrants a lower limit, the frequency shall not remain below 58.5 Hz for greater than 10 seconds, cumulatively per event, and shall not remain below 59.5 Hz for greater than 30 seconds, cumulatively per event.
 - Frequency overshoot resulting from operation of UFLS relays shall not exceed 61.0 Hz and shall not exceed 60.5 Hz for greater than 30 seconds, cumulatively per event. A higher limit may be allowed if it is within the limits stated in IEEE standard C37.106.
 - Bulk Electric System voltage during and following UFLS operations shall be controlled such that the per unit Volts per Hz (V/Hz) will not exceed 1.18 for longer than 2 seconds, cumulatively, and will not exceed 1.10 for longer than 45 seconds, cumulatively. A higher limit may be allowed if it is within the limits stated in IEEE standard C37.102.
 - Undervoltage inhibit shall not be greater than 75 percent of nominal voltage
 - Evaluate and discuss any network islanding schemes, automatic load restoration schemes, network tie tripping schemes, generating unit frequency excursion protection

tripping scheme, and other methods of load and resource balancing, including any recognized potential effects on adjacent Planning Coordinators.

- Evaluate applicable reactive power device tripping scheme designs for proper coordination with the proposed UFLS Program designs to avoid excessive BES bus voltage during automatic UFLS events.
- Exemption criteria, such as for small DPs and TOs.
- Off-nominal frequency relay types used
- Simulation methods used
- Maximum breaker interrupting times

R3.2. Each Planning Coordinator shall make its design and performance methodology available for inspection and technical review by those entities directly and materially affected by the reliability of the MRO Bulk Electric System (BES), within 30 business days of the receipt of a request.

R3.3. If entities directly and materially affected by the reliability of the MRO BES provide written comments on its design and performance methodology, the Planning Coordinator shall provide a written response to that commenting entity within 45 calendar days of receipt of those comments. The response shall indicate whether a change will be made to its design and performance methodology and, if no change will be made, the reason.

R4. Each Distribution Provider shall review, and if necessary make revisions to, its portion of the UFLS program each calendar year and within 15 months of the last evaluation to agree with the overall UFLS program and the design and performance methodology in R3. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

The review shall include the following:

- Collect information as needed regarding the characteristics and criticality of the end use Load that is in each island and connected to its facilities from the associated Load Serving Entities.
- Update the UFLS program load data in each island to reflect next year's projected peak hour Loads.

R5. Each Planning Coordinator shall review its UFLS program each calendar year and within 15 months of the last review and if the updated UFLS program in any island does not agree with the design methodology, then the UFLS program shall be revised to agree with the design methodology. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

- R6.** Each Planning Coordinator shall periodically perform an assessment of the expected performance of UFLS programs and related reactive power device tripping schemes, protective schemes or balancing methods in each island in its footprint at least every five calendar years. *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*
- R7.** Each Planning Coordinator shall provide the report to the entities associated with each UFLS programs and related reactive power device tripping schemes, protective schemes, or balancing methods within 30 days. The entities may include Distribution Providers, Transmission Owners, Generator Owners, Transmission Planners, Planning Coordinators, adjacent Planning Coordinators, the MRO, or NERC. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- R8.** Each Distribution Provider or Transmission Owner that owns UFLS relay(s) shall provide new and updated UFLS data to its Planning Coordinator(s) every calendar year and within 15 months of the last submittal. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- This information shall include:
- Point where each load, as a part of the UFLS program, is ultimately interconnected to the transmission system
 - Percentage of peak load tripped at the transmission interconnection location for each load step
 - Frequency trip points for each UFLS step
 - Relay operating time delay for each UFLS step
 - Nominal circuit breaker operating time
 - UFLS relay undervoltage-inhibit voltage level
- R9.** Each Distribution Provider or Transmission Owner shall provide pertinent data for any applicable reactive power devices, system protection schemes, and/or balancing methods (load/resource) that may impact the UFLS programs in the MRO footprint to its Planning Coordinator more than 60 days prior to implementation. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- R10.** Each Generator Owner shall provide (existing or planned) the off-nominal frequency capability limits of its generating units; the settings and time delays of protective relays; and, other schemes that may impact the UFLS program(s) in the MRO footprint to its Planning Coordinator more than 60 days prior to implementation. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*
- R11.** Each Generator Owner with automatic underfrequency protection relays installed in the MRO footprint shall have relay trip settings that are equal

to or slower than the minimum tripping time delays in the following table:
[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]

Table 1	
Frequency (Hz)	Minimum Time Delay (Sec)
≥ 59.5	Automatic Tripping Not Permitted
≤ 59.5 to > 59.3	2,700
≤ 59.3 to > 59.0	300
< 59.0 to > 58.4	80
≤ 58.4 to > 58.0	30
≤ 58.0 to > 57.6	7.5
≤ 57.6	0

R11.1. If a generator must be tripped for its own protection outside the specifications in the above Table 1, the Generator Owner shall arrange for additional automatic Load shedding to be installed by mutual agreement, in addition to that required of Distribution Provider or Transmission Owner with end-use Load connected to their Facilities. This additional automatic Load shedding shall be within the same credible island and instituted at the same frequency and time as the generator would be expected to trip, and an amount agreed upon by the Distribution Provider, Generation Owner and Planning Coordinator.

R12. Each Distribution Provider, Transmission Owner, and Generation Owner shall implement its portion of the UFLS Program or related protective scheme prior to the next projected peak season as specified by the Planning Coordinator. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

If a Distribution Provider or Transmission Owner with end-use Load connected to their facilities cannot comply with this requirement for its facilities due to having less than or equal to 30 feeders and have not aggregated their Load with other Distribution Providers or Transmission Owners to implement a collective UFLS program, that Distribution Provider or Transmission Owner respectively shall still implement a UFLS program but may request an exemption from the Planning Coordinator for the minimum number of steps and the minimum and maximum frequency set points.

R13. Each Planning Coordinator shall update its UFLS program database every calendar year and within 15 months of the last update. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

The database shall include:

- Credible islands
- UFLS program information (location, size, setting, time duration)

- Applicable generation unit frequency information (e.g. performance limits, inertia and frequency excursion protection scheme information)
- Applicable reactive power device information
- The tripping schemes

R14. The Planning Coordinator shall provide the UFLS database to MRO or NERC in their format within 30 calendar days of their request. [*Violation Risk Factor: Lower*] [*Time Horizon: Long-term Planning*]

C. Measures

- M1.** Each Planning Coordinator shall provide a credible islanding methodology document that includes the elements in R1 or shall provide an explanation of why the omitted elements were not included.
- M2.** The Planning Coordinator shall provide documentation detailing its determination of credible islands within the previous 15 months, specifying those that require UFLS, and that such evaluation was provided to applicable (see R2.2) Transmission Owners, Distribution Providers and adjacent Planning Coordinators within 30 days of the determination.
- M3.** Each Planning Coordinator shall provide evidence that comments were responded to per R2.3 within 45 calendar days of receipt.
- M4.** Each Planning Coordinator shall provide a documented methodology for design and performance of its UFLS program that includes the elements in R3.1.
- M5.** Each Planning Coordinator shall provide evidence of the distribution of the methodology within 30 business days of a request per R3.2.
- M6.** Each Planning Coordinator shall provide evidence that comments were responded to per R3.3 within 45 calendar days of receipt.
- M7.** Each Distribution Provider shall provide evidence (such as email, US Mail, worksheets, etc.) that it reviewed its UFLS program in the previous 15 months, and made revisions as necessary per R4.
- M8.** Planning Coordinator shall provide evidence that it reviewed the UFLS plan for each island in its footprint in the previous 15 months, and compared it with the overall UFLS plan to ensure consistency per R5.
- M9.** Each Planning Coordinator shall provide evidence that a valid assessment of expected UFLS program performance was performed per R6.
- M10.** Each Planning Coordinator shall provide evidence (such as U.S. mail, memos, or email) that a valid assessment report was distributed to applicable entities per R7.
- M11.** Each Distribution Provider or Transmission Owner that owns UFLS relay(s) shall provide evidence that it provided new and updated UFLS data elements to its Planning Coordinator per R8.

- M12.** Each Distribution Provider or Transmission Owner with reactive power devices, system protection schemes, or load and resource balancing methods that may impact the UFLS programs in the MRO footprint shall provide evidence that the data pertaining to those devices was provided to its Planning Coordinator per R9.
- M13.** Each Generator Owner shall provide evidence that it supplied the off-nominal frequency capability limits of its generating units and any frequency excursion protection system data that may affect the UFLS program(s) in the MRO footprint to its Planning Coordinator per R10.
- M14.** Each Generator Owner with automatic underfrequency protection relays installed in the MRO footprint shall provide evidence that its relay trip settings are equal to or slower than the minimum tripping time delays as specified in the table in R11.
- M15.** Each Distribution Provider, Transmission Owner, and Generation Owner with UFLS responsibility shall provide evidence (or an exemption document) that it implemented its portion of the UFLS Program or related protective scheme per R12.
- M16.** Each Planning Coordinator shall provide evidence that it updated its UFLS program database elements within 15 months of the previous update per R13.
- M17.** The Planning Coordinator shall provide evidence that it provided the UFLS database to MRO or NERC within 30 calendar days of their request per R14.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Compliance monitor: MRO

1.2. Compliance Monitoring Period and Reset Time Frame

One or more of the following methods will be used to assess compliance:

- Self-certification (Conducted annually according to schedule.)
- Spot Check Audits (Conducted anytime with up to 30 days notice given to prepare.)
- Periodic Audit (Conducted once every three years according to schedule.)
- Compliance Violation Investigations
- The Performance-Reset Period shall be 12 months from the last finding of noncompliance.
- Self Report

1.3. Data Retention

Current plan is available at all times.

If an entity is found non-compliant the entity keeps information related to the noncompliance until found compliant or for two years plus the current year, whichever is longer.

Evidence used as part of a Compliance Violation Investigation is retained by the entity being investigated for one year from the date that the investigation is closed, as determined by the Compliance Monitor.

The Compliance Monitor keeps the last periodic audit report and all requested and submitted subsequent compliance records.

1.4. Additional Compliance Information

None

2. Violation Severity Levels

R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
1	The Planning Coordinator did not include or provide an explanation for 1 of the criteria in its methodology.	The Planning Coordinator did not include or provide an explanation for 2 of the criteria in its methodology.	The Planning Coordinator did not include or provide an explanation for 3 or 4 of the criteria in its methodology.	The Planning Coordinator did not include or provide an explanation for 5 or more of the criteria in its methodology.
2	<p>The Planning Coordinator made its credible island determinations available 31 – 45 days after the determination was made as described in R2.2</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity 46 – 60 days after a request as described in R2.3.</p>	<p>The Planning Coordinator made its credible island determinations available 46 – 60 days after the determination was made as described in R2.2.</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity 61 – 75 days after a request as described in R2.3.</p>	<p>The Planning Coordinator made its credible island determinations available 61 - 75 days after the determination was made as described in R2.2.</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity more than 76 days after a request as described in R2.3.</p>	<p>The Planning Coordinator did not evaluate and confirm credible islanding more than 15 months from the last evaluation as required in R2.1.</p> <p>OR</p> <p>The Planning Coordinator made its credible island determinations available more than 75 days after the determination was made as described in R2.2.</p>

<p>3</p>	<p>The Planning Coordinator’s methodology did not include exemption criteria, Off-nominal frequency relay types, simulation methods used, and/or maximum breaker interrupting times as described in R3.1.</p> <p>OR</p> <p>The Planning Coordinator made its methodology available 31 – 45 days after a request as described in R3.2.</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity 46 – 60 days after a request as described in R3.3.</p>	<p>The Planning Coordinator’s methodology did not include the frequency and/or voltage characteristics, and/or evaluations of other schemes and potential effect on adjacent Planning Coordinators as described in R3.1.</p> <p>OR</p> <p>The Planning Coordinator made its methodology available 46 - 60 days after a request as described in R3.2.</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity 61 – 75 days after a request as described in R3.3.</p>	<p>The Planning Coordinator made its methodology available more than 60 days after a request as described in R3.2.</p> <p>OR</p> <p>The Planning Coordinator provided a written response to the commenting entity more than 76 days after a request as described in R3.3.</p>	<p>The Planning Coordinator’s methodology did not include frequency set points and timing delays and/or did not meet the 30% load shed as described in R3.1.</p> <p>OR</p> <p>The Planning Coordinator does not have a documented methodology for design and performance of its UFLS program as described in R3.</p>
<p>4</p>		<p>The Distribution Provider did not collect characteristics data or criticality of End-use Load from the Load Serving Entities.</p>		<p>The Distribution Provider did not review and update its UFLS program more than 15 months from the last evaluation</p>

5				The Planning Coordinator did not review its UFLS program, and update it as needed, within 15 months of the last review.
6	The Planning Coordinator performed the assessment but did not include 1 of the performance elements.	The Planning Coordinator performed the assessment but did not include 2 of the performance elements.	The Planning Coordinator performed the assessment but did not include more than 2 of the performance elements.	The Planning Coordinator did not perform a periodic assessment of the expected performance of the UFLS program at least every 5 calendar years.
7	The Planning Coordinator provided the assessment report to the associated entities in 31 - 45 days.	The Planning Coordinator provided the assessment report to the associated entities in 46 - 60 days.	The Planning Coordinator provided the assessment report to the associated entities in 61 - 75 days.	The Planning Coordinator provided the assessment report to the associated entities more than 75 days from the request.
8	The Distribution Provider or Transmission Owner did not provide 1 or 2 of the elements.	The Distribution Provider or Transmission Owner did not provide 3 or 4 of the elements.	The Distribution Provider or Transmission Owner did not provide 5 of the elements.	The Planning Coordinator did not provide the data within 15 months of the last submittal.

<p>9</p>	<p>The Distribution Provider or Transmission Owner provided the data 61 – 75 days from the date of change.</p>	<p>The Distribution Provider or Transmission Owner provided the data 76 – 90 days from the date of change.</p>	<p>The Distribution Provider or Transmission Owner provided the data 90 – 105 days from the date of change.</p>	<p>The Distribution Provider or Transmission Owner provided the more than 105 days from the date of change.</p> <p>OR</p> <p>The Distribution Provider or Transmission Owner did not supply information prior to placing new equipment in service.</p>
<p>10</p>	<p>The Generator Owner provided the data 61 – 75 days from the date of change.</p>	<p>The Generator Owner provided the data 76 – 90 days from the date of change.</p>	<p>The Generator Owner provided the data 90 – 105 days from the date of change.</p>	<p>The Generator Owner provided the data more than 105 days from the date of change.</p> <p>OR</p> <p>The Generator Owner did not supply information prior to placing new equipment in service.</p>
<p>11</p>	<p>The Generator Owner did not meet 1 of the criteria listed in Table 1 and did not arrange for additional load shedding.</p>	<p>The Generator Owner did not meet 2 of the criteria listed in Table 1 and did not arrange for additional load shedding.</p>	<p>The Generator Owner did not meet 3 of the criteria listed in Table 1 and did not arrange for additional load shedding.</p>	<p>The Generator Owner did not meet more than 3 of the criteria listed in Table 1 and did not arrange for additional load shedding.</p>

12				The Distribution Provider, Transmission Owner, or Generation Owner did not implement its portion of the UFLS program or related protective scheme prior to the next peak season.
13	The Planning Coordinator did not include 1 of the criteria in its UFLS database.	The Planning Coordinator did not include 2 of the criteria in its UFLS database.	The Planning Coordinator did not include 3 or more of the criteria in its UFLS database.	The Planning Coordinator did not update its UFLS database within 15 months of the last update.
14	The Planning Coordinator provided its database 31 – 45 days after a request.	The Planning Coordinator provided its database 46 – 60 days after a request.	The Planning Coordinator provided its database 60 – 75 days after a request.	The Planning Coordinator provided its database more than 75 days after a request.

Version History

Version	Date	Action	Change Tracking