

**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:** 1<sup>st</sup> day of the 1<sup>st</sup> 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 provide its credible island determination to the Transmission Owners and Distribution Providers that are within its area of responsibility, and to adjacent Planning Coordinators, within 30 days of the determination.
- 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, unless generation protection in the credible island warrants a higher limit, and shall not exceed 60.5 Hz for greater than 30 seconds, cumulatively per event.
  - 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.
  - 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 15 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 why.

**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 R4. [*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 program design changes in each island in its footprint and provide an assessment report to the entities associated with each island. [*Violation Risk Factor: Lower*] [*Time Horizon: Long-term Planning*]

**R6.1.** Perform an assessment of the expected performance of the UFLS program, reactive power device tripping scheme, any related protective schemes or balancing methods in each island at least every five calendar years.

- R6.2.** Prepare a report of the assessment results and provide the report to the entities associated with each UFLS program, reactive power device tripping scheme, related protective scheme, or balancing method within 30 days. The entities may include Distribution Providers, Transmission Owners, Generator Owners, Transmission Planners, Planning Coordinators, adjacent Planning Coordinators, the MRO, or NERC.
- R7.** 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 in the MRO approved format. *[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
- R8.** 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 the device or protection scheme data to its Planning Coordinator in the MRO approved format. *[Violation Risk Factor: Lower]* *[Time Horizon: Long-term Planning]*
- R8.1.** Provide data on any applicable new reactive power device before it is placed in service and any existing reactive power device. Also provide any change in the device data within 60 days.
- R8.2.** Provide data on any applicable system protection scheme or load and resource balancing method before it is placed in service and provide any change in the scheme or method within 60 days.
- R9.** Each Generator Owner shall provide 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 in the MRO approved format. *[Violation Risk Factor: Lower]* *[Time Horizon: Long-term Planning]*

- R9.1.** Provide the off-nominal frequency response capability limits of each new generation unit before it is placed in service, and for each existing unit. Also provide any changes in data within 60 days.
  - R9.2.** Provide the settings and time delays of any frequency excursion for each new protection relay before they are placed in service, and for each existing relay. Also provide any changes in the relay data within 60 days.
  - R9.3.** Provide information documenting any other new schemes that may impact the UFLS programs in the MRO footprint before it is placed in service, and for each existing scheme. Also provide any changes in the scheme data within 60 days.
- R10.** 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

If a generator must be tripped for its own protection outside the specifications in the above Table 1, then Generator Owner may become compliant by arranging for 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 in R7.

This additional Load shedding shall be equal to or greater than the generator MW dispatch, instituted at the same frequency and time as the generator would be expected to trip within the same credible island.

- R11.** 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. *[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 25 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.

- R12.** Each Planning Coordinator shall update its UFLS program database in the MRO approved format 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 as listed in R9
- The tripping schemes

- R13.** The Planning Coordinator shall provide the UFLS database to MRO or NERC 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 a documented methodology for design and performance of its UFLS program that includes the elements in R3.1.
- M4.** Each Planning Coordinator shall provide evidence of the distribution of the methodology within 15 business days of a request per R3.2.
- M5.** Each Planning Coordinator shall provide evidence that comments were responded to with the required elements per R3.3 within 45 calendar days of receipt.
- M6.** 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.

- M7.** 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.
- M8.** Each Planning Coordinator shall provide a valid assessment report of expected UFLS program performance in each island, and evidence (such as U.S. mail, memos, or email) of distribution to applicable entities (see R6.2).
- M9.** Each Distribution Provider or Transmission Owner that owns UFLS relay(s) shall provide evidence that it provided new and updated UFLS data elements in the MRO approved format to its Planning Coordinator per R7.
- M10.** 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 in the MRO approved format following the timing requirements in R8.
- M11.** 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 in the MRO approved format, following the timing requirements in R9.
- M12.** 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 R10.
- M13.** 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 prior to the next projected peak season per R11.
- M14.** Each Planning Coordinator shall provide evidence that it updated its UFLS program database elements in the MRO approved format within 15 months of the previous update per R12.
- M15.** The Planning Coordinator shall provide evidence that it provided the UFLS database to MRO or NERC within 30 calendar days of their request per R13.

## **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.)
- Triggered Investigations (Notification of an investigation must be made within 60 days of an event or complaint of noncompliance. The entity will have up to 30 days to prepare for the investigation. An entity may request an extension of the preparation period and the extension will be considered by the Compliance Monitor on a case-by-case basis.)
- The Performance-Reset Period shall be 12 months from the last finding of noncompliance.

#### **1.1. Data Retention**

Current plan available at all times. Annual review must have been performed within the past 15 months.

If an entity is found non-compliant the entity shall keep 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 triggered investigation shall be 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 shall keep the last periodic audit report and all requested and submitted subsequent compliance records.

#### **1.2. 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 of the criteria in its methodology.
2	The Planning Coordinator provided credible island determinations to the Transmission Owners and Distribution Providers 31 – 45 days after determination as described in R2.2.	The Planning Coordinator provided credible island determinations to the Transmission Owners and Distribution Providers 46 – 60 days after determination as described in R2.2.	The Planning Coordinator provided credible island determinations to the Transmission Owners and Distribution Providers 61 - 75 days after determination as described in R2.2.	<p>The Planning Coordinator did not include or provide an explanation for 5 of the criteria in its methodology and confirm credible islanding determinations 60 months from the last evaluation as described in R3.1.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided credible island determinations to the Transmission Owners and Distribution Providers more than 75 days after determination as described in R2.2.</p>

<p><b>3</b></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.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided its methodology 16 – 30 days after a request.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided a written response to the commenting entity 46 – 60 days after a request.</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.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided its methodology 31 – 45 days after a request</p> <p><b>OR</b></p> <p>The Planning Coordinator provided a written response to the commenting entity 61 – 75 days after a request.</p>	<p>The Planning Coordinator provided its methodology more than 45 days after a request</p> <p><b>OR</b></p> <p>The Planning Coordinator provided a written response to the commenting entity more than 76 days after a request.</p>	<p>The Planning Coordinator’s methodology did not include frequency set points, timing delays and/or did not meet load shed.</p> <p><b>OR</b></p> <p>The Planning Coordinator does not have documented methodology for the performance of its UFLS program.</p>
<p><b>4</b></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 collect characteristics data and update its UFLS program within 12 months from the last evaluation.</p>

5				The Planning Coordinator did UFLS program, and update it within 15 months of the last r
6	<p>The Planning Coordinator performed the assessment but did not include 1 of the performance elements as required in R6.1.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided the assessment report to the associated entities in 31 - 45 days as required in R6.2.</p>	<p>The Planning Coordinator performed the assessment but did not include 2 of the performance elements as required in R7.1.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided the assessment report to the associated entities in 46 - 60 days as required in R6.2.</p>	<p>The Planning Coordinator performed the assessment but did not include more than 2 of the performance elements as required in R6.1.</p> <p><b>OR</b></p> <p>The Planning Coordinator provided the assessment report to the associated entities in 61 - 75 days as required in R6.2.</p>	<p>The Planning Coordinator did periodic assessment of the exp performance of the UFLS pro every 5 calendar years as requ</p> <p><b>OR</b></p> <p>The Planning Coordinator pro assessment report to the assoc more than 75 days from the re required in R6.2.</p>
7	<p>The Distribution Provider or Transmission Owner did not provide 1 or 2 of the elements.</p> <p><b>OR</b></p> <p>The data was not submitted in the MRO approved format.</p>	<p>The Distribution Provider or Transmission Owner did not provide 3 or 4 of the elements.</p>	<p>The Distribution Provider or Transmission Owner did not provide 5 of the elements.</p>	<p>The Planning Coordinator did the data within 15 months of t submittal.</p>

<p><b>8</b></p>	<p>The Distribution Provider or Transmission Owner provided the data as required in R8.1 or R8.2 61 – 75 days from the date of change.</p> <p><b>OR</b></p> <p>The data as required in R8.1 or R8.2 was not submitted in the MRO approved format.</p>	<p>The Distribution Provider or Transmission Owner provided the data as required in R8.1 or R8.2 76 – 90 days from the date of change.</p>	<p>The Distribution Provider or Transmission Owner provided the data as required in R8.1 or R8.2 90 – 105 days from the date of change.</p>	<p>The Distribution Provider or Transmission Owner provided the data as required in R8.1 or R8.2 more than 105 days from the date of change.</p> <p><b>OR</b></p> <p>The Distribution Provider or Transmission Owner did not supply information prior to placing new equipment in service.</p>
<p><b>9</b></p>	<p>The Generator Owner provided the data as required in R9.1, R9.2 or R9.3 61 – 75 days from the date of change.</p> <p><b>OR</b></p> <p>The data as required in R9.1, R9.2 or R9.3 was not submitted in the MRO approved format.</p>	<p>The Generator Owner provided the data as required in R9.1, R9.2 or R9.3 76 – 90 days from the date of change.</p>	<p>The Generator Owner provided the data as required in R9.1, R9.2 or R9.3 90 – 105 days from the date of change.</p>	<p>The Generator Owner provided the data as required in R9.1, R9.2 or R9.3 more than 105 days from the date of change.</p> <p><b>OR</b></p> <p>The Generator Owner did not supply information prior to placing new equipment in service.</p>

<p><b>10</b></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>
<p><b>11</b></p>				<p>The Distribution Provider, Transmission Owner, or Generation Owner did not implement its portion of the UFLS or related protective scheme prior to the next peak season.</p>
<p><b>12</b></p>	<p>The Planning Coordinator did not include 1 of the criteria in its UFLS database.</p> <p><b>OR</b></p> <p>The data was not submitted in the MRO approved format.</p>	<p>The Planning Coordinator did not include 2 of the criteria in its UFLS database.</p>	<p>The Planning Coordinator did not include 3 or more of the criteria in its UFLS database.</p>	<p>The Planning Coordinator did not update its UFLS database within 15 months of the last update.</p>
<p><b>13</b></p>	<p>The Planning Coordinator provided its database 31 – 45 days after a request.</p>	<p>The Planning Coordinator provided its database 46 – 60 days after a request.</p>	<p>The Planning Coordinator provided its database 60 – 75 days after a request.</p>	<p>The Planning Coordinator provided its database more than 75 days after a request.</p>

**Version History**

<b>Version</b>	<b>Date</b>	<b>Action</b>	<b>Change Tracking</b>