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, 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

4.2. Distribution Provider

4.3. Transmission Owner

4.4. Generator Owner

5. Effective Date: 1st day of the 1st quarter one year following last appropriate Regulatory Approval, financial sanctions will become effective.

B. Requirements

R1. Each Planning Coordinator shall develop and maintain a documented methodology to determine areas of credible islanding, with registered entities and stakeholders. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

The methodology shall consider the following at a minimum:

- How the registered entities and stakeholders, along with adjacent entities, will assist in the UFLS development, including studies and analyses, and provide concurrence
- 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

R2. A Planning Coordinator will make its methodology available to MRO or NERC within 15 business days of a request.

R3. 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]*

R3.1. Each Planning Coordinator shall evaluate and confirm credible islanding within their area of responsibility at least every five years or when significant network changes occur.

R3.2. Each Planning Coordinator shall provide its credible island determination to the TOs and DPs that are within its area of responsibility, and to adjacent PCs, within 30 days of the determination.

R4. 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]*

The methodology will include the following elements as a minimum:

- 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. The frequency shall not remain below 58.5 Hz for greater than 30 seconds, cumulatively, and shall not remain below 59.5 Hz for greater than 30 seconds, cumulatively.
- Frequency overshoot resulting from operation of UFLS relays shall not exceed 61.0 Hz for any duration and shall not exceed 60.5 Hz for greater than 30 seconds, cumulatively.
- 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
- Maximum breaker interruptible times
- 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. Include any potential effects on adjacent Planning Coordinator.
- Evaluate the proposed 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
- A list of off-nominal frequency relays types

- Simulation methods [e.g. steady state, transient dynamic, dynamic, equivalent system and modeling software]
    - Dynamic simulation of possible Disturbances that cause the Planning Coordinators' systems or portions of the Planning Coordinators' systems to experience imbalance between Load and generation.

R5. Each Planning Coordinator shall review its UFLS program annually, and if necessary, revise its UFLS program to agree with its design and performance methodology. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

The annual review will include the following:

- Collect information annually 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 annually to reflect next year's projected peak hour Loads and annually review whether the updated UFLS program agrees with its design methodology.
- 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.

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 years or whenever system changes occur.

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, and NERC.

R7. Each Distribution Provider or Transmission Owner that owns UFLS relay(s) shall annually provide new and updated UFLS data to its Planning Coordinator(s), upon request, in the MRO approved format. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

This information will include as a minimum:

- 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 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]*

R8.1. 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 30 days.

R8.2. Provide the settings and time delays of any frequency excursion for each new protection relays before they are placed in serviced, and for each existing relay. Also provide any changes in the relay data within 30 days.

R8.3. 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 30 days.

R9. Each Generator Owner with automatic underfrequency protection relays installed in the MRO footprint shall have relay trip settings that are slower than the minimum tripping time delays in the following table: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

[MRO] 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
≤58.2	0

If a generator must be tripped for its own protection outside the specifications in the above Table 1, then Generator Owners may become compliant by arranging for Load shedding to be installed by mutual agreement, in addition to that required of Distribution Providers with end-use Load connected to their Facilities in R3.

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.

R10. 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]*

R10.1. Provide the following 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 30 days.

R10.2. 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 30 days.

R11. Each Distribution Provider, Transmission Owner, and Generation Owner shall implement the UFLS Program or related protective scheme as required; provide data and report implementation to its Planning Coordinator. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

R12. Each Planning Coordinator shall update its UFLS program database in the MRO approved format when data changes occur. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

R12.1. The database shall include at a minimum:

- Credible islands
- UFLS program information (location, size, setting, time duration)
- Relevant generation unit frequency performance limits and frequency excursion protection scheme information
- Relevant reactive power device information as listed in R8
- The tripping schemes

R12.2. The Planning Coordinator shall provide the UFLS database to applicable entities, MRO and NERC within 30 calendar days of a request.