

A. Introduction

- 1. **Title:** Automatic Underfrequency Load Shedding Requirements
- 2. **Number:** PRC – 006 – RFC – 01
- 3. **Purpose:** To establish *ReliabilityFirst* requirements for automatic underfrequency Load shedding (UFLS) to support NERC Reliability Standard PRC-006.
- 4. **Applicability:**
 - 4.1 **Distribution Provider**
 - 4.2 **Transmission Owners**
 - 4.3 **Load Serving Entity (all LSE’s regardless of size)**
 - 4.4 **Generator Owner (all generators with an individual nameplate rating or plants, including Wind Generating Stations, with an aggregate nameplate rating of 20 MVA or greater, connected at 69kV or above)**
 - 4.5 **Planning Coordinator**
- 5. **(Proposed) Effective Date:**

B. Requirements

- R1** Load Serving Entities shall furnish data in a pre-arranged format to their Distribution Providers and Transmission Owners with end-use Load connected to their Facilities in the *ReliabilityFirst* footprint as requested (within 45 days of request). These data shall include [*Violation Risk Factor: Medium*]:
 - R1.1** The Load Serving Entities’ forecasted Load magnitude and location for its next annual peak.
 - R1.2** Load characteristics necessary to set the UFLS relays per R2.6 in the pre-arranged format requested by the Distribution Providers and Transmission Owners with end-use Load connected to their Facilities (where applicable) (e.g. large motor Loads, etc.).
 - R1.3** Distributed generation characteristics necessary to set the UFLS relays per R2.6 in the pre-arranged format requested by the Distribution Providers and Transmission Owners with end-use Load connected to their Facilities (where applicable).
- R2** Each Distribution Provider and Transmission Owner with end-use Load connected to their Facilities in the *ReliabilityFirst* footprint shall implement an automatic UFLS program for their Facilities or shall participate with one or more Distribution Providers and Transmission Owners with end-use Load connected to their Facilities to collectively implement by mutual agreement a single UFLS program. The automatic UFLS program shall include the following requirements: [*Violation Risk Factor: High*]
 - R2.1** Have the capability of shedding at least 25 percent of connected Load determined from the forecasted annual peak hour.

- R2.2** Shed Load in a minimum of three steps.
- R2.2.1** If a Distribution Provider or Transmission Owner with end-use Load connected to their Facilities cannot comply with these sub-requirements for its Facilities due to a limited number of feeders or without reconfiguring their 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 shall be exempt from R2.2.
- R2.3** Size each step equally (the variance between steps shall be no more than two percent of forecasted annual peak hour Load) (additional Load shedding required per R4 or R5 is excluded from this requirement).
- R2.3.1** If a Distribution Provider or Transmission Owner with end-use Load connected to their Facilities cannot comply with these sub-requirements for its Facilities due to a limited number of feeders or without reconfiguring their 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 shall be exempt from R2.3.
- R2.4** The first set point shall be no lower than 59.3 Hz and not higher than 59.5 Hz. The last set point shall be no lower than 58.5 Hz and not higher than 58.7 Hz (additional Load shedding required per R4 or R5 is excluded from this requirement).
- R2.5** The difference between frequency set points shall be at least 0.2 Hz but no greater than 0.5 Hz (additional Load shedding required per R4 or R5 is excluded from this requirement).
- R2.6** Intentional relay time delay shall be no greater than ten cycles, with the following documented exceptions. The documentation shall consist of reports of misoperations or distributed generation issues or analysis of large motor Loads:
- R2.6.1** For installations where large motor Loads may be isolated, undercurrent supervision shall be used to avoid false operation during Fault isolation. If this is not available, planned total time delay may be increased to no greater than 29 cycles.
- R2.6.2** For installations where distributed generation may be isolated, undercurrent supervision shall be used to avoid false operation during Fault isolation. If this is not available, planned total time delay may be increased to no greater than 29 cycles.
- R2.7** Undervoltage inhibit (where applicable) shall be set as low as practical, but shall not be greater than 75 percent of nominal voltage.

- R2.8** Each Transmission Owner owning capacitor banks connected to the BES shall trip them as necessary to avoid excessive voltage during automatic UFLS events.
- R3** Each Planning Coordinator in coordination with the Distribution Providers and Transmission Owners with end-use Load connected to their Facilities in the ReliabilityFirst footprint, shall have a documented methodology to determine areas (or sub areas) of credible islanding. The methodology shall address at least the following to identify areas (or sub areas) of credible islanding [*Violation Risk Factor: Lower*]:
- Historical islanding scenarios
 - Areas with a limited number of connecting lines
 - System Operating Limit interfaces which define importing areas
 - A process to involve stakeholders in the analysis and results
- R3.1** Each Planning Coordinator shall make its credible island determination methodology available for inspection and technical review by those entities directly and materially affected by the reliability of ReliabilityFirst Bulk Electric System (BES), within 15 business days of the receipt of a request.
- R3.2** If entities directly and materially affected by the reliability of ReliabilityFirst BES provide written comments on the credible island determination 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 the credible island determination methodology and, if no change will be made, the reason why.
- R3.3** The Planning Coordinator shall use this methodology at least every five years to determine areas (or sub areas) of credible islanding within their area of responsibility.
- R3.4** The Planning Coordinator shall supply the results of the determination (within 30 days of completion of the process) to the Distribution Providers, Transmission Owners with end-use Load connected to their Facilities and Generator Owners in the ReliabilityFirst footprint of identified areas (or sub areas) of credible islanding.
- R4** Distribution Providers, Transmission Owners with end-use Load connected to their Facilities and Generator Owners in identified areas (or sub areas) of credible islanding (as determined in R3) shall participate in the appropriate engineering assessment that specifically address generation/Load imbalances in the area of credible islanding [*Violation Risk Factor: Lower*].
- R4.1** Distribution Providers and Transmission Owners with end-use Load connected to their Facilities shall utilize one or both of the following:

- R4.1.1** Install UFLS capability in the island area so as to cover potential generation/Load imbalances (the amount of Load to be shed in the island area and the corresponding Load shedding step sizes, relay trip and time delay settings shall be determined by appropriate engineering assessments that specifically address the islanding scenario).
- R4.1.1.1** Identified areas (or sub areas) of credible islanding with a forecasted annual peak Load of 1000 MW or less shall be exempt from any additional UFLS requirements.
- R4.1.1.2** Distribution Providers and Transmission Owners with end-use Load connected to their Facilities in the Reliability *First* footprint are not required to install UFLS greater than 50 percent of the forecasted annual peak Load in the identified areas (or sub areas) of credible islanding. If more than 50 percent UFLS is indicated then only the requirements in R2 apply.
- R4.1.1.3** Upon determination of a new credible island which requires mitigation as required in R4.1.1, the Distribution Providers and Transmission Owners with end-use Load connected to their Facilities shall have two years to comply with R4.1.1.
- R4.1.2** Apply other methods of balancing Load and resources.
- R4.1.2.1** Identified areas (or sub areas) of credible islanding with a forecasted annual peak Load of 1000 MW or less shall be exempt from any additional other methods of balancing Load and resources requirements.
- R4.1.2.2** Upon determination of a new credible island which requires mitigation as required in R4.1.2, the Distribution Providers and Transmission Owners with end-use Load connected to their Facilities shall have two years to comply with R4.1.2.
- R4.2** Generator Owners in the Reliability *First* footprint in identified areas (or sub areas) of credible islanding (as determined in R3) shall participate in the appropriate engineering assessments by the Planning Coordinator to possibly optimize unit trip setting changes to enhance the coordination within the potential area of credible islanding.

R5 If automatic underfrequency protection is installed, each Generator Owner’s unit shall not trip faster than the minimum tripping time delays in the following table:
[Violation Risk Factor: High]

<u>Frequency (Hz)</u>	<u>Minimum Time Delay (Sec)</u>
≥ 59.5	Automatic Frequency Dependent Tripping Not Permitted
<59.5 to > 59.2	2,700.0
≤59.2 to > 58.5	120.0
≤58.5 to > 58.2	15.0
≤58.2	Owner’s Discretion

R5.1 It is the sole responsibility of the Generator Owner to ensure that the time vs. frequency requirement listed in Table 1 is met. In those cases where a generator must be tripped for its own protection outside the specifications in the above Table 1, the Generator Owners may become compliant by arranging for Load shedding to be installed by mutual agreement, in addition to that required of Distribution Providers and Transmission Owners with end-use Load connected to their Facilities in R2.

R5.1.1 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.

R5.1.2 If the generator is located within a credible island, arrangement for additional Load shedding shall be within the credible island.

R6 Distribution Providers, Generator Owners or Transmission Owners owning non-Fault clearing tie-tripping schemes, islanding schemes, automatic load-restoration schemes, additional Load shedding schemes or any other schemes that are part of or impact the UFLS programs shall document such schemes in sufficient detail to allow modeling for dynamics simulations *[Violation Risk Factor: Lower]*.

R7 Each Planning Coordinator shall establish and maintain an UFLS database in a pre-arranged format *[Violation Risk Factor: Lower]*.

R7.1 The database shall be updated every 5 years or as required by changes in system conditions.

R7.2 The database shall include the areas of credible islanding determined in R3.3.

- R8** Distribution Providers, Transmission Owners and Generator Owners required to comply with the relevant sections of R2, R4, R5, or R6 shall populate the Planning Coordinator's UFLS database (within 45 days of request), in the pre-arranged format, as follows [*Violation Risk Factor: Lower*]:
- R8.1** Distribution Providers and Transmission Owners shall supply the following applicable information as implemented:
 - R8.1.1** Frequency trip points.
 - R8.1.2** Percent of forecasted peak hour Load dropped at each Trip Point.
 - R8.1.3** Relay operating time delay, intentional and unintentional.
 - R8.1.4** Circuit breaker operating time.
 - R8.1.5** UFLS relay undervoltage inhibit voltage level.
 - R8.1.6** Information describing any other schemes that are part of or impact the UFLS program.
 - R8.1.7** Any underfrequency trip set points, overvoltage trip set points and time delays of capacitor banks connected to the BES tripping.
 - R8.2** Generator Owners shall supply the following information as implemented:
 - R8.2.1** Underfrequency trip set points and time delays of generating units.
 - R8.2.2** Information describing any other schemes that are part of or impact the UFLS program.
- R9** All Planning Coordinators within ReliabilityFirst shall perform a joint assessment of the effectiveness of the design and implementation of the UFLS programs within ReliabilityFirst. This assessment shall include effects of neighboring areas. This assessment shall be conducted periodically (at least every five years or as required by changes in system conditions) and shall include, but not be limited to [*Violation Risk Factor: Lower*]:
- R9.1.** A review of the current frequency set points and timing.
 - R9.2.** Dynamic simulation of possible Disturbances that cause the Planning Coordinators' systems or portions of the Planning Coordinators' systems to experience significant imbalance between Load and generation.

- R9.3** Determination of the need to install underfrequency tripping of bulk power capacitor banks to avoid excessive voltage during automatic UFLS.
- R10** Coordination of UFLS programs shall be accomplished by the following requirements [*Violation Risk Factor: Lower*]:
 - R10.1** Planning Coordinators shall provide the data in the database required in R8 to neighboring Planning Coordinators within ReliabilityFirst.
 - R10.2** Planning Coordinators shall provide the data in the database required in R8 and assessment results required in R9 to neighboring entities responsible for UFLS assessment external to ReliabilityFirst.
 - R10.3** Planning Coordinators shall request UFLS data and assessment results from neighboring entities responsible for UFLS assessment external to ReliabilityFirst.

C. Measures

The following documentation will be used to determine compliance with the above requirements.

- M1** The Load Serving Entity shall have documentation showing that the information requested in R1 was supplied to its Distribution Provider and Transmission Owner when requested within the time period specified.
- M2** Every Distribution Provider and Transmission Owner in the ReliabilityFirst footprint shall have documentation showing they comply with all the requirements of R2.
- M3** The Planning Coordinator shall have documentation detailing processes to assess areas of credible islanding giving consideration to the items listed in R3. The Planning Coordinator shall have evidence that an assessment to determine if credible islands exist was performed within the past 5 years. The Planning Coordinator shall have documentation that the results of the assessment were supplied to the applicable Distribution Providers, Transmission Owners with end-use Load connected to their Facilities and Generator Owners in the ReliabilityFirst footprint.
- M4** Distribution Providers and Transmission Owners with end-use Load connected to their Facilities and Generator Owners in the ReliabilityFirst footprint in identified areas (or sub areas) of credible islanding (as determined in R3) shall have documentation of participation in the appropriate engineering assessment and documentation of installed UFLS capability as required in R4.
- M5** The Generator Owner shall have documentation that it complies with the frequency protection settings of generators or has made arrangements for additional Load shedding, if appropriate, as required in R5.
- M6** Distribution Providers, Generator Owners and Transmission Owners owning non-Fault clearing tie-tripping schemes, islanding schemes, automatic load-

restoration schemes or any other schemes that are part of or impact the UFLS programs shall have documentation of these schemes as required in R6 and evidence that this documentation was provided to the Planning Coordinator.

- M7** Planning Coordinator shall have evidence it established and maintained an UFLS database as required in R7.
- M8** The respective Distribution Providers, Transmission Owners and Generator Owners shall have evidence that the information as required in R8 was supplied to the Planning Coordinator to populate the UFLS Database.
- M9** The Planning Coordinator shall have evidence that the assessment of the design effectiveness and implementation of UFLS as required by R9 have been completed.
- M10** The Planning Coordinator shall have evidence that the data in the database and relevant study results have been exchanged with neighboring Planning Coordinators as required by R10.

D. Compliance

1 Compliance Monitoring Process

- 1.1** Compliance Monitoring Responsibility
Compliance Monitor: ReliabilityFirst
- 1.2** Compliance Monitoring Period and Reset
On request (within 45 calendar days)
- 1.3** Data Retention
5 years
- 1.4** Additional Compliance Information
None

2 Violation Severity Levels

Req. Number	VIOLATION SEVERITY LEVEL			
	LOWER	MODERATE	HIGH	SEVERE
R1		The Load Serving Entity did not send the information required in R1.2 and R1.3 to the Distribution Provider and Transmission Owner with directly connected end-use Load in the ReliabilityFirst footprint as requested		The Load Serving Entity did not send the information required in R1.1 to the Distribution Provider and Transmission Owner with directly connected end-use Load in the ReliabilityFirst footprint as requested
R2	The Distribution Provider and	The Distribution Provider and	The Distribution Provider and	The Distribution Provider and

	<p>Transmission Owner with end-use Load connected to their Facilities total UFLS is less than 25% but greater than or equal to 23% of the connected Load at the forecasted annual peak hour as required in R2.1; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities intentional relay time delays are greater than 10 cycles, but less than or equal to 12 cycles, except as allowed by R2.6.1 or R2.6.2, as required in R2.6</p>	<p>Transmission Owner with end-use Load connected to their Facilities total UFLS is less than 23% but greater than or equal to 21% of the connected Load at the forecasted annual peak hour as required in R2.1; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities UFLS program steps are not equal to within 2% of the forecasted annual peak hour Load as required in R2.3; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities intentional relay time delays are greater than 12 cycles, but less than or equal to 14 cycles, except as allowed by R2.6.1 or R2.6.2, as required in R2.6</p>	<p>Transmission Owner with end-use Load connected to their Facilities total UFLS is less than 21% but greater than or equal to 18% of the annual forecasted peak hour Load, as required in R2.1; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities difference between frequency set points is less than 0.2 Hz or greater than 0.5 Hz, as required in R2.5; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities undervoltage inhibit (where applicable) is set greater than 75 % of nominal voltage, as required in R2.7; OR Transmission Owners capacitor banks connected to the BES are not tripped as specified in R2.8; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities intentional relay time delays are greater than 15 cycles, but less than or equal to 20 cycles, as required in R2.6</p>	<p>Transmission Owner with end-use Load connected to their Facilities total UFLS is less than 18% of the annual forecasted peak hour Load, as required in R2.1; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities UFLS program contains less than three steps as required in R2.2, except as allowed by R2.2.1; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities first set point of the UFLS program is less than 59.3 Hz, or the last set point is less than 58.5 Hz or greater than 58.7 Hz, as required in R2.4; OR The Distribution Provider and Transmission Owner with end-use Load connected to their Facilities intentional relay time delays are greater than 20 cycles, as required in R2.6, except as allowed by R2.6.1 or R2.6.2, as required in R2.6</p>
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<p>R3</p>	<p>The Planning Coordinator did not make its credible islanding determination methodology available within 15 business days of the receipt of a request, as required in R3.1; OR The Planning Coordinator did not respond to comments on its credible islanding determination methodology within 45 calendar days of receipt of a written comment, as required in R3.2</p>	<p>The Planning Coordinator performed the assessment required in R3 but did not report the results to the Distribution Provider and Transmission Owner with end-use Load connected to their Facilities and Generator Owner in the ReliabilityFirst footprint affected by the credible islanding, as required in R3.4; OR The Planning Coordinator did not perform the assessment within 5 years of the previous determination, as required in R3.3</p>	<p>The Planning Coordinator in the ReliabilityFirst footprint failed to address one or more of the bullet point per R3 to identify areas (or sub areas) of credible islanding in the methodology</p>	<p>The Planning Coordinator did not perform the determination of credible islands as required in R3</p>
<p>R4</p>			<p>The Distribution Provider, Transmission Owner with end-use Load connected to their Facilities or Generator Owner in the ReliabilityFirst footprint did not participate in the appropriate engineering assessment that specifically address generation/Load imbalances in the area of credible islanding as required in R4</p>	<p>The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities did not document the installation of UFLS capability or application of other methods of balancing Load and resources as required in R4.1 or R4.2.</p>
<p>R5</p>		<p>Greater than 0% but less than or equal to 5% of a Generator Owner’s total MWs is tripped by UF protection sooner than the minimum time delays required in the Table 1 in R5 without using the mitigation technique suggested in R5.1</p>		<p>Greater than 5% of a Generator Owner’s total MWs is tripped by UF protection sooner than the minimum time delays required in the Table 1 in R5</p>
<p>R6</p>		<p>The Distribution Providers, Generator</p>		<p>The Distribution Providers, Generator</p>

		Owner or Transmission Owners owning schemes that effect the UFLS program as mentioned in R6 failed to document one of the schemes identified in R6 in sufficient detail for dynamics modeling		Owner or Transmission Owners owning schemes that effect the UFLS program as mentioned in R6 failed to document more than one of the schemes identified in R6 in sufficient detail for dynamics modeling
R7			The Planning Coordinator established and maintained the UFLS database required by R7 but areas of credible islanding were not included as required by R7.2	The Planning Coordinator has not established and maintained UFLS database as required by R7 OR The Planning Coordinator has established and maintained the UFLS database as required by R7 but has not been updated within the last 5 years or as required by changes in system conditions as required by R7.1
R8	The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities supplied the information but between 1% and 2% of the information submitted for any of the individual applicable sub requirements listed in R8.1 is incomplete OR The Distribution Providers, Transmission Owners with end-use Load connected to their Facilities and Generator Owners failed to supply the information within 45 days but not longer than 90 days from the	The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities supplied the information but greater than or equal to 2% but less than 3% of the information submitted for any of the individual applicable sub requirements listed in R8.1 is incomplete OR The Generator Owner supplied the information within 45 days from the request but failed to submit underfrequency trip set points and time delays for 1 generator as	The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities supplied the information and greater than or equal to 3% but less than 6% of the information submitted for any of the individual applicable sub requirements listed in R8.1 is incomplete OR The Generator Owner supplied the information within 45 days from the request but failed to submit underfrequency trip set points and time delays for more than 1	The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities supplied the information and greater than or equal to 6% of the information submitted for any of the individual applicable sub requirements listed in R8.1 is incomplete OR The Generator Owner failed to supply the information within 45 days from the request but failed to submit underfrequency trip set points and time delays for more than 1 generator as required by

	request	required by R8.2	generator as required by R8.2	R8.2 OR The Distribution Providers or Transmission Owners with end-use Load connected to their Facilities failed to supply the information within 90 days of the request
R9		The Planning Coordinator performed the assessment of the effectiveness of the design and implementation of the UFLS programs within its planning area, but the assessment was incomplete in one of the areas identified in R9.1 through R9.3.		Planning Coordinator performed the assessment of the effectiveness of the design and implementation of the UFLS programs within its planning area, but the assessment was incomplete in two or more of the areas identified in R9.1 through R9.3
R10		The Planning Coordinator did not provide the data and study results with neighboring Planning Coordinators as required in one of the areas identified in R10.1 through R10.3		The Planning Coordinator did not provide the data and study results with neighboring Planning Coordinators as required in two or more of the areas identified in R10.1 through R10.3

E. Definitions

The following are definitions of terms used in this Standard

Wind Generating Station - a collection of wind turbines at a single site electrically connected together and injecting energy into the grid at one point, sometimes known as a “Wind Farm.”

The following are definitions of terms used in this Standard

NOTE: These definitions were extracted from the February 12, 2008 NERC Glossary of Terms.

Facility - A set of electrical equipment that operates as a single Bulk Electric System Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)

Fault - An event occurring on an electric system such as a short circuit, a broken wire, or an intermittent connection.

Load - An end-use device or customer that receives power from the electric system.

System - A combination of generation, transmission, and distribution components.

F. IntraRegional Differences

None

G. Notes

Version History

Version	Date	Action	Change Tracking
PRC-006-RFC-01 1 st Draft	05/16/07 Thru 06/14/07	Posted for 1 st Comment Period	
PRC-006-RFC-01 2 nd Draft	10/29/07 Thru 11/27/07	Posted for 2 nd Comment Period	
PRC-006-RFC-01 3 rd Draft	04/18/08 Thru 05/19/08	Posted for 3 rd Comment Period	
PRC-006-RFC-01 4 th Draft	xx/xx/08 Thru xx/xx/08	Posted for 4 th Comment Period	