

A. Introduction

1. **Title: Automatic Underfrequency Load Shedding Requirements**
2. **Number: PRC-006-SERC-01**
3. **Purpose: To establish SERC requirements for automatic underfrequency load shedding (UFLS)**
4. **Applicability:**
 - 4.1 **Distribution Provider (that participates in a UFLS scheme)**
 - 4.2 **Transmission Owners**
 - 4.3 **Load Serving Entity (that participates in a UFLS scheme)**
 - 4.4 **Generator Owner**
 - 4.5 **Transmission Planner**
5. **(Proposed) Effective**

B. Requirements

- R1** Each Transmission Planner in the SERC Region shall determine appropriate islands to study as a design basis for UFLS. These islands shall be chosen from system studies, actual system operations, or other islands as deemed appropriate by the Transmission Planner. Islands identified to form a design basis for UFLS shall include at least the following: [*Violation Risk Factor: Medium*]
- R1.1.** A single island that includes all of the SERC Region to verify that all SERC UFLS schemes meet the performance requirements when acting together.
 - R1.2** A single island for each SERC Sub-region to verify that all UFLS schemes within the SERC Sub-region meet the performance requirements when acting together.
- R2** Each Transmission Planner in the SERC Region shall design an automatic UFLS scheme (percent of load to be shed, frequency set points, and time delays) that meets the following minimum requirements: [*Violation Risk Factor: High*]
- R2.1** Have the capability of shedding at least 30 percent of the Peak Demand (MW) physically located within its transmission planning area.
 - R2.2** Shed load with a minimum of three frequency set points.
 - R2.3** The highest frequency set point with time delay of less than one second shall be no lower than 59.3 Hz and not higher than 59.5 Hz.
 - R2.4** The lowest frequency set point shall be no lower than 58.4 Hz
 - R2.5** The difference between frequency set points shall be at least 0.2 Hz but no greater than 0.5 Hz.

R2.6 Time delay (from frequency reaching the set point to the trip signal) shall be at least 6 cycles

R3 Each Transmission Planner in the SERC Region shall design its UFLS scheme to meet performance requirements R3.1.1 through R3.1.4 for each identified island (if any) in its footprint. The Transmission Planner shall design its UFLS scheme such that when combined with all of the other UFLS schemes in the SERC Region, the composite will meet performance requirements R3.1.1 through R3.1.4 for the SERC Region considered as an island. The Transmission Planner shall design its UFLS scheme such that when combined with all of the other UFLS schemes in its SERC Sub-region, the composite will meet performance requirements R3.1.1 through R3.1.4 for the SERC Sub-region considered as an island. [*Violation Risk Factor: High*]

R3.1 These performance requirements shall be satisfied for underfrequency conditions resulting from an imbalance between load and generation of 25% for all design basis islands (generation equals 75% of load). **[Note: The requirements below were based on the draft NERC UFLS Regional Reliability Standard Characteristics which is still under review. If those requirements change, these will change accordingly.]**

R3.1.1 Frequency decline shall be arrested at no less than 58.0 Hz.

R3.1.2 Frequency shall not remain below 58.5 Hz for greater than 10 seconds, cumulatively, and shall not remain below 59.5 Hz for greater than 30 seconds, cumulatively. **[Note: the SERC UFLS Standard Drafting Team requested these criteria be changed by NERC]**

R3.1.3 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. **[Note: the SERC UFLS Standard Drafting Team requested these criteria be changed by NERC]**

R3.1.4 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. **[Note: the SERC UFLS Standard Drafting Team requested these criteria be changed by NERC]**

R3.2 Transmission Planners shall verify UFLS schemes are coordinated by performing dynamic simulations that demonstrate that the performance requirements of R3.1 are met. Joint dynamic studies by multiple Transmission Planners can be used to meet this requirement.

R3.2.1 If the aggregation of the Transmission Planners' UFLS schemes for an identified island or SERC Sub-region as an island or SERC Region as an island fails to meet all the requirements in R3.1, an individual Transmission Planner in that island can demonstrate that its UFLS scheme meets the requirements of R3.1 by performing dynamic simulations that apply its UFLS scheme on its individual system as an island or on the island that failed.

- R4** Each Transmission Planner in the SERC Region is responsible for assessing its UFLS scheme, as designed, at least once every five years by performing dynamic simulations that demonstrate that the performance requirements of R3.1 are being met. Joint dynamic studies by multiple Transmission Planners can be used to meet this requirement [*Violation Risk Factor: Medium*]
- R4.1.** Each Transmission Planner in the SERC Region shall perform a dynamic simulation within one year for any of the following situations:
- new islands are identified
 - material design changes are made to the scheme parameters defined in R2
 - material changes to the boundaries of a specified island are identified
- R4.2** Each Transmission Planner in the SERC Region shall provide the study results to SERC or NERC within 30 calendar days of a request.
- R5** Each Transmission Owner in the SERC Region shall be responsible for implementing the UFLS scheme developed by the Transmission Planner for the Transmission Owner's area. The Transmission Owner may trip load at the transmission level. However, the Transmission Owner may coordinate with Distribution Providers and Load Serving Entities serving the connected load to implement the automatic UFLS scheme. Transmission Owners may participate with other Transmission Owners to implement the UFLS scheme developed by the Transmission Planner responsible for their collective systems. [*Violation Risk Factor: High*]

R5.1 Each Transmission Owner in the SERC Region shall own, install, and set UFLS equipment, except those portions of the UFLS scheme implemented by the Distribution Providers and Load Serving Entities.

The percent load shedding implemented shall be based on the actual or estimated demand of the Transmission Owner at the time coincident with the previous year actual Peak Demand of the applicable Balancing Authority. The Transmission Owner shall implement the UFLS scheme to meet the following requirements:

R5.1.1 The amount of load in each load shedding step

(including those portions of the UFLS scheme which the Distribution Providers and Load Serving Entities agree to implement) shall be within minus 1.0 and plus 2.0 of the percentage specified by the Transmission Planner. (For example, if the specified percentage step load shed is 12%, the allowable range is 11% to 14 %.)

R5.1.2 The amount of total UFLS load of all steps combined (including those portions of the UFLS scheme which the Distribution Providers and Load Serving Entities agree to implement) shall be within minus 1.0 and plus 3.0 of the percentage specified by the Transmission Planner for the total UFLS load in the UFLS scheme.

R5.2 The Distribution Providers and Load Serving Entities that participate in the UFLS scheme shall own, install, and set the associated UFLS equipment. The amount of load in each load shedding step and the total UFLS load of all steps combined which the Distribution Providers and Load Serving Entities agree to implement must be with plus or minus 10% of the agreed to load in MW.

R6 In those cases where a generator has an underfrequency setting that does not coordinate with the performance requirements of R3.1.1 and R3.1.2, the Generator Owner shall arrange for load shedding to be installed in addition to that required by the UFLS scheme. Coordination with R3.1.1 and R3.1.2 means that the generator is not tripped in less than 10 seconds for frequencies between 58.0 and 58.5 Hertz, is not tripped in less than 30 seconds for frequencies between 58.5 and 59.5 Hertz, and is not tripped for frequencies between 59.5 and 60.0 Hertz. [*Violation Risk Factor: Medium*]

R6.1 This additional load shedding shall be equal to or greater than the maximum generator MW that could be tripped due to an underfrequency condition.

R6.2 This additional load shedding shall be instituted at the same time as the generator would trip.

R6.3 This additional load shedding shall be located within the same SERC Sub-region and any islands as the generator. The Transmission Planner identifies islands as part of the development of the UFLS scheme.

R7 Each Generator Owner, Transmission Owner, and any other entity which participates in a UFLS scheme in the SERC Region shall provide UFLS data for the SERC UFLS database. This data shall be provided to the SERC Region at least once every five years or within 30 calendar days of a request by the SERC Region. [*Violation Risk Factor: Lower*].

R7.1 Entities that own, install, and set UFLS equipment shall supply the following information, as implemented in the field:

- R7.1.1** Underfrequency trip set points (Hz).
- R7.1.2** Total time delay associated with each set point (sec). This includes the time from when frequency reaches the set point and ends when the breaker opens.
- R7.1.3** Amount of previous year actual or estimated load associated with each set point, both in percent and in MW. The percentage and the Load demand (MW) shall be based on the time coincident with the previous year actual Peak Demand for the applicable Balancing Authority.
- R7.2** The Generator Owner shall supply the following information as implemented in the field:
- R7.2.1** Generator protection underfrequency trip set points (Hz) where applicable.
- R7.2.2** Indicate whether trip is manual or automatic.
- R7.2.3** Time delay (from initiation to trip signal) associated with each set point (sec). This includes the time from when frequency reaches the set point and ends when the signal is generated to trip the breaker.
- R7.2.3.1** For manual actuation, provide time based on plant specific guidance
- R7.2.3.2** For automatic actuation, provide time based on actual protection scheme design
- R7.2.4** Maximum generator MW that could be tripped due to an underfrequency condition.
- R7.2.5** Provide the data specified in R7.1 for any additional UFLS required by R6.
- R8** Coordination of UFLS programs with external entities shall be facilitated by the following requirements: [*Violation Risk Factor: Lower*]
- R8.1** Transmission Planners shall provide when requested a description of the UFLS schemes and the results of the UFLS study required in R3 and R4 to neighboring entities responsible for UFLS assessment external to SERC.
- R8.2** Transmission Planners shall provide requested data to neighboring entities within 30 calendar days of the request.
- R8.3** Transmission Planners shall request a description of the UFLS schemes and the results of the UFLS study from all neighboring

entities responsible for UFLS assessments external to SERC.

C. Measures

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

- M1:** Each Transmission Planner shall maintain documentation of the islands selected and why those islands were chosen as the design basis for the UFLS scheme for its area.
- M2:** Each Transmission Planner shall maintain documentation that the UFLS scheme for its area meets the design requirements specified in R2.1 through R2.6.
- M3:** Each Transmission Planner shall maintain documentation that its UFLS scheme meets the performance requirements in R3.
- M4:** Each Transmission Planner shall maintain documentation that dynamic simulations were performed and that study results were provided as required by R4.
- M5:** Each Transmission Owner shall provide evidence, upon request of the Compliance Monitor, demonstrating that it has implemented a UFLS scheme per Requirement R5. This evidence shall include documentation of how the installed scheme implements the requirements of the UFLS design provided by the Transmission Planner. Where implementation includes equipment installed by other Transmission Owners, Distribution Providers, or Load Serving Entities, the Transmission Owner shall include documentation of how these installations support its meeting Requirement R5.
 - M5.1:** Each Distribution Provider or Load Serving Entity that participates in the UFLS scheme shall provide evidence, upon request of the Compliance Monitor, demonstrating that it has implemented its agreed to portion of the UFLS scheme per Requirement R5.2.
- M6:** The Generator Owner shall maintain documentation demonstrating one of the following:
 - M6.1:** The generating unit will not be tripped, automatically or manually, for underfrequency excursions (i.e., below 60 Hz) less severe than those described in Requirements R3.1.1 and R3.1.2.
 - M6.2:** An automatic underfrequency load shedding scheme meeting the requirements of R6 has been installed.
- M7:** Maintain documentation that the following data was provided to SERC as described in R7:
 - M7.1:** For the Transmission Owner, Distribution Provider, or Load Serving Entity having installed UFLS equipment, the data described in R7.1;

M7.2: For the Generator Owner, the data described in R7.2.

M8: The Transmission Planner shall maintain documentation of the following:

M8.1: A list of neighboring entities that were provided a description and study results for the UFLS scheme as specified in R8.1.

M8.2: The timeframe in which information was provided for R8.1.

M8.3: A list of neighboring entities from which UFLS information was requested and a list of the information received from those entities as specified in R8.3.

D. Compliance

1. Compliance Monitoring Process

1.1 Compliance Monitoring Responsibility

Compliance Monitor: SERC Reliability Corporation

1.2 Compliance Monitoring Period and Reset

On request (within 30 calendar days)

1.3 Data Retention

Seven years

1.4 Additional Compliance Information

None

2. Violation Severity Levels

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|------|---|---|---|--|
| R1 | N/A | <p>The Transmission Planner did not have documentation that identified a single island that includes all of the SERC Region.</p> <p>OR</p> <p>The Transmission Planner did not have documentation that identified a single island for its SERC Sub-region.</p> | N/A | <p>The Transmission Planner did not have documentation that identified a single island that includes all of the SERC Region.</p> <p>AND</p> <p>The Transmission Planner did not have documentation that identified a single island for its SERC Sub-region.</p> |
| R2 | The Transmission Planner did not meet one of the UFLS system design requirements identified in R2.2 through R2.6. | The Transmission Planner did not meet two of the UFLS system design requirements identified in R2.2 through R2.6. | The Transmission Planner did not meet three of the UFLS system design requirements identified in R2.2 through R2.6. | The Transmission Planner did not meet R2.1 OR four or more of the UFLS system design requirements identified in R2.2 through R2.6. |
| R3.1 | The design of the UFLS scheme failed to satisfy one of the performance requirements identified in R3.1.1 through R3.1.4 for underfrequency conditions resulting from an imbalance between load and generation of 25% for any design basis | The design of the UFLS scheme failed to satisfy two of the performance requirements for underfrequency conditions resulting from an imbalance between load and generation of 25% for any design basis island. | The design of the UFLS scheme failed to satisfy three of the performance requirements for underfrequency conditions resulting from an imbalance between load and generation of 25% for any design basis island. | The design of the UFLS scheme failed to satisfy four of the performance requirements for underfrequency conditions resulting from an imbalance between load and generation of 25% for any design basis island. |

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|------|---|---|---|--|
| | island. | | | |
| R3.2 | N/A | The Transmission Planner did not perform a dynamic simulation of one of the identified islands that demonstrates that the performance requirements listed in R3.1 were met. | N/A | The Transmission Planner did not perform a dynamic simulation of any of the identified islands that demonstrates that the performance requirements listed in R3.1 were met. |
| R4 | <p>The Transmission Planner did not perform the dynamic simulation that demonstrates that the performance requirements of R3.1 are met at least once every five years.</p> <p>OR</p> <p>The Transmission Planner provided its study results 31 to 45 calendar days after the request was made.</p> <p>OR</p> <p>The Transmission Planner did not perform the dynamic simulation within one year that demonstrates</p> | <p>The Transmission Planner provided its study results 46 to 60 calendar days after the request was made.</p> | <p>The Transmission Planner provided its study results 61 to 75 calendar days after the request was made.</p> | <p>The Transmission Planner provided its study results 76 or more calendar days after the request was made.</p> <p>OR</p> <p>The Transmission Planner did not perform the dynamic simulation that demonstrates that the performance requirements of R3.1 are met at least once within six years.</p> <p>OR</p> <p>The Transmission Planner did not perform the dynamic simulation within 18 months that demonstrates</p> |

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|------|---|--|--|---|
| | that the performance requirements of R3.1 are met when the conditions in R4.1 occurred. | | | that the performance requirements of R3.1 are met when the conditions in R4.1 occurred. |
| R5.1 | The Transmission Owner did not have documentation showing how the installed scheme implements the requirements of the TP's UFLS design including how the DP/LSE support its implementation (when DP/LSE participate in the UFLS scheme) | The Transmission Owner's documentation of the implemented UFLS scheme indicated one load shedding step outside the range specified in R5.1.1. | The Transmission Owner's documentation of the implemented UFLS scheme indicated two load shedding steps outside the range specified in R5.1.1. | The Transmission Owner's documentation of the implemented UFLS scheme indicated three or more load shedding steps outside the range specified in R5.1.1. OR The Transmission Owner's documentation of the implemented UFLS scheme indicated a total load in the UFLS scheme outside the range specified in R5.1.2. |
| R5.2 | N/A | The Distribution Providers and Load Serving Entities that participate in the UFLS scheme had one load shedding step outside the range specified in R5.2. | The Distribution Providers and Load Serving Entities that participate in the UFLS scheme had two load shedding steps outside the range specified in R5.2 | The Distribution Providers and Load Serving Entities that participate in the UFLS scheme had three or more load shedding steps outside the range specified in R5.2. OR |

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|-----|--|---|--|---|
| | | | | The Distribution Providers and Load Serving Entities that participate in the UFLS scheme had a total load in the scheme outside the range specified in R5.2 |
| R6 | <p>The Generator Owner arranged for load shedding, but did not meet one of the requirements identified in R6.1 through R6.3.</p> <p>OR</p> <p>The Generator Owner did not have documentation showing that the generating unit will not be tripped, automatically or manually, for underfrequency excursions less severe than those described in Requirements R3.1.1 and R3.1.2.</p> | The Generator Owner arranged for load shedding, but did not meet two of the requirements identified in R6.1 through R6.3. | The Generator Owner arranged for load shedding, but did not meet any of the three requirements identified in R6.1 through R6.3 | The Generator Owner did not arrange for load shedding as required per R6. |
| R7 | The Transmission Owner, Generator Owner, or entity that participates in a UFLS scheme provided the | The Transmission Owner, Generator Owner, or entity that participates in a UFLS scheme provided the | The Transmission Owner, Generator Owner, or entity that participates in a UFLS scheme provided the | The Transmission Owner, Generator Owner, or entity that participates in a UFLS scheme did not provide or |

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|------------------|--|---|--|---|
| | <p>data requested in R7 to SERC 31 to 45 days after the request was made</p> | <p>data requested in R7 to SERC 46 to 60 days after the request was made</p> <p>OR</p> <p>The Transmission Owner or entity that participates in a UFLS scheme did not provide to SERC one piece of information listed in the subrequirements of R7.1</p> <p>OR</p> <p>The Generator Owner did not provide one of the pieces of information to SERC listed in subrequirements R7.2</p> | <p>data requested in R7 to SERC 61 to 75 days after the request was made</p> <p>OR</p> <p>The Transmission Owner or entity that participates in a UFLS scheme did not provide to SERC two pieces of information listed in the subrequirements of R7.1</p> <p>OR</p> <p>The Generator Owner did not provide two of the pieces of information to SERC listed in subrequirements R7.2</p> | <p>provided the data requested in R7 to SERC more than 75 days after the request was made</p> <p>OR</p> <p>The Transmission Owner or entity that participates in a UFLS scheme did not provide to SERC any pieces of information listed in the subrequirements of R7.1</p> <p>OR</p> <p>The Generator Owner did not provide three or more pieces of information to SERC listed in subrequirements R7.2.</p> |
| <p>R8</p> | <p>The Transmission Planner provided required data within 31 to 45 days after the request was made,</p> <p>OR</p> <p>The Transmission Planner did not request all neighboring entities to provide a description of the UFLS schemes and</p> | <p>The Transmission Planner provided required data within 46 to 60 days after the request was made</p> | <p>The Transmission Planner provided required data within 61 to 75 days after the request was made</p> | <p>The Transmission Planner did not provide the required data within 75 days after the request was made,</p> <p>OR</p> <p>Transmission Planner did not request any neighboring entities to provide a description of the UFLS schemes and the results of the studies</p> |

| R # | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|-----|----------------------------|--------------|----------|------------|
| | the results of the studies | | | |

E. Intraregional Variances
None

F. Associated Documents

Version History

| Version | Date | Action | Change Tracking |
|---------|------------------------|---|---|
| Draft-1 | 09/19/08 thru 10/20/08 | Posted for 1 st Comment Period | Initial version |
| Draft-2 | 11/21/08 thru 12/22/08 | Posted for 2 nd Comment Period | Revised to address comments received on Draft-1 and to include measures and compliance sections |
| Draft-3 | 02/09/09 | Posted for information | Revised to address comments received on Draft-2 |