



Comment Form for 1st Draft of Under Frequency Load Shedding Regional Reliability Standard Characteristics — Project 2007-01

Please **DO NOT** use this form to submit comments on the proposed 1st draft of the Under Frequency Load Shedding Regional Reliability Standard Characteristics developed by the standard drafting team for Project 2007-01 – Underfrequency Load Shedding. Comments must be submitted by **August 15, 2008**. If you have questions please contact Stephanie Monzon at stephanie.monzon@nerc.net or by telephone at 610-608-8084.

Please submit your comments by using the [Electronic Comment Form](#) posted on the Project 2007-01 Underfrequency Load Shedding Drafting Team Web site.

Background Information

The major objectives of Project 2007-01 Underfrequency Load Shedding are to:

- 1) Ensure UFLS standards are developed that are complete and the requirements are set at an appropriate level to ensure reliability (not least common denominator).
- 2) Ensure that the standards are enforceable with clearly defined requirements and unambiguous language.
- 3) Address the issues raised by FERC Order 693 and other applicable orders.
- 4) Address the issues raised in the original Standards Authorization Request (SAR) for this project.
- 5) Address coordination between underfrequency load shedding and generator trip settings during frequency excursions.

The standard drafting team (SDT) for Project 2007-01 Underfrequency Load Shedding (UFLS) based its work on the existing NERC standards:

- PRC-006-0 — Development and Documentation of Regional UFLS Programs,
- PRC-007-0 — Assuring Consistency with Regional UFLS Program Requirements, and
- PRC-009-0 — UFLS Performance Following an Underfrequency Event.

Project 2007-01 Under Frequency Load Shedding is one of four projects¹ identified in the Reliability Standards Development Plan 2008-2010 as requiring a set of Regional Standards to support a continent-wide standard.

In accordance with the associated SAR, a standard drafting team was appointed to draft the continent-wide UFLS standard with consideration of developing supporting regional standards. The team is recommending that, instead of developing a continent-wide standard, NERC issue a set of UFLS performance characteristics required in regional reliability standards for implementing automatic UFLS programs to arrest declining Bulk Electric System frequency.

NERC will include the approved UFLS Regional Reliability Standard Characteristics in a directive that it provides to each regional entity requiring the regional entity to develop a regional UFLS reliability standard. NERC is authorized to direct a regional entity to develop a

¹ The other three projects were, Project 2007-05 Balancing Authority Controls; Project 2007-11 Disturbance Monitoring; and Project 2008-04 Protection Systems

regional standard pursuant to section 312.2 of the Rules of Procedure of the North American Electric Reliability Corporation which states:

Regional Reliability Standards That are Directed by a NERC Reliability Standard — Although it is the intent of NERC to promote uniform reliability standards across North America, in some cases it may not be feasible to achieve a reliability objective with a reliability standard that is uniformly applicable across North America. In such cases, NERC may direct regional entities to develop regional reliability standards necessary to implement a NERC reliability standard. Such regional reliability standards that are developed pursuant to a direction by NERC shall be made part of the NERC reliability standards.

The standard drafting team's proposed approach of establishing common system performance characteristics rather than prescribing a uniform design specification for all UFLS programs within a continent-wide standard recognizes that the objective of the UFLS programs is to arrest and recover frequency in islanded portions of an interconnection. In addition, UFLS programs with differing design specifications can be successfully coordinated if they are designed to achieve the same system performance characteristics, even across interconnected regions.

The drafting team reviewed the existing UFLS programs from each Region and it became clear that various combinations of load steps and frequency set points exist and can achieve the objective of arresting and recovering frequency. Also, it became clear that there is not one way to design a UFLS program. Additional reasons the drafting team is recommending the development of a UFLS Regional Standard as opposed to a continent-wide standard:

- The Region's UFLS programs are repeatedly evaluated for their effectiveness;
- Applicability and responsibility for a UFLS program varies among the Regions;
- A UFLS infrastructure is already in place within each Region and to convert to one UFLS program would take time/effort and expense; and
- The expertise resides in each region to develop a UFLS Regional Standard.

Part of the intent of directing the regions to develop UFLS Regional Standards is because each regional entity has specific expertise relative to defining credible islands within or between its region and neighboring regions. The regional entities also have specific expertise for assessing islands within their regions based on electrically interconnected areas. Analysis of islands occurring between regions is intended to require coordination of programs by the Regions across which an island may form.

Characteristics of UFLS Regional Reliability Standards

The SDT developed the set of characteristics which each of the regional entities will be directed to include in its UFLS regional reliability standard. The SDT developed these characteristics for directing the regional entities in developing requirements that can be defined based on system performance, without prescribing specifics of how these system performance requirements should be met. This approach for identifying regional reliability standard characteristics for implementation of a regional standard by a regional entity is being used for the very first time by a NERC drafting team.

The technical basis for each of the parameters is summarized as:

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

The technical basis for this design parameter is coordination with generating unit protections and the generator underfrequency tripping requirements proposed by the

Generator Verification Standard Drafting Team. The tripping threshold proposed for NERC Reliability Standard PRC-024 is 57.8 Hz with no intentional time delay. Arresting declining frequency within an island at or above 58.0 Hz provides proper coordination to prevent tripping of generation prior to allowing the UFLS program to arrest frequency decline.

- 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.

The technical basis for this design parameter is coordination with generating unit protection and the generator underfrequency tripping requirements proposed by the Generator Verification Standard Drafting Team. Recovering frequency within an island in accordance with these parameters avoids operating conditions for which the generating units are subject to turbine damage and provides proper coordination to prevent tripping of generation prior to allowing the UFLS program to recover frequency.

- 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.

The technical basis for this design parameter is coordination with generating unit protection and the generator overfrequency tripping requirements proposed by the Generator Verification Standard Drafting Team. Controlling frequency overshoot during frequency recovery within an island in accordance with these parameters avoids operating conditions for which the generating units are subject to turbine damage and provides proper coordination to prevent tripping of generation, which could lead to additional UFLS operations and possible frequency collapse.

- 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 6 seconds cumulatively, and will not exceed 1.10 for longer than 1 minute cumulatively.

The technical basis for the V/Hz design parameter was developed through a review of relevant industry standards that include voltage and frequency limits for major electrical equipment. Low levels of overexcitation cause excessive core and non-magnetic structure heating, which can lead to loss of life and degradation of insulation. High levels of overexcitation can cause insulation failure within seconds.

IEEE Standard C37.102 recommends generator V/Hz protection set to trip in 45 to 60 seconds at V/Hz greater than 1.10 per unit (pu), and in 2 to 6 seconds at V/Hz greater than 1.18 pu, and that the manufacturer's limitations should be respected. IEEE Standard C37.106 includes typical generator overexcitation limitation curves from various manufacturers which show time limits of roughly 60-100 seconds at 1.10 pu V/Hz, and 6 seconds or less at 1.20-1.30 pu V/Hz. IEEE Draft Standard PC37.91 includes typical curves from three manufacturers which show transformer limits of roughly 100 minutes at 1.10 pu, 1 minute at 1.20 pu, and 6 seconds at 1.30 pu.

The performance requirements were selected to prevent equipment damage and to coordinate with generating unit protection. Protection coordination is critical to island survival since tripping of generation during underfrequency conditions may lead to cascading tripping and frequency collapse.

Coordination with Generation Underfrequency Tripping and Existing Settings

The SDT recognized the importance of coordination with generator underfrequency tripping. Accordingly, the drafting team choose the specific technical design parameter values in order to coordinate with a generator under (and over) frequency tripping characteristic that has been proposed for continent-wide use by the NERC standard drafting team addressing PRC-024 – Generator Verifications, and which that team has accepted for inclusion in its draft standard.

In addition to coordination with generator under and over frequency tripping, the drafting team also considered the existing regional UFLS set points and time delays in aggregate. The drafting team did not wish to force adjustments to UFLS relay settings and time delays simply to give the appearance of uniformity. There exists a degree of latitude over which the technical design parameters may vary and yet remain in coordination with the proposed generator tripping characteristics. Most existing regional UFLS programs should find conformance to the technical design parameters requires minimal or no adjustment of relay settings and time delays.

The above two factors, coordination with generator under and over frequency tripping as first priority, and then minimization of adjustments to existing relay settings, constituted the basis for choosing the technical design parameter values related to frequency.

Compliance with the regional standards will fulfill the intent of PRC-007-0 — Assuring Consistency with Regional UFLS Program Requirements, in that the performance characteristics will be detailed in the Regional Standards, along with associated compliance elements.

As for the event reporting required by PRC-009-0 — UFLS Performance Following an Underfrequency Event, the standard drafting team is recommending that this should be covered under the NERC Rules of Procedure and be included as a delegated responsibility for the Regional Entities as many other reporting tasks.

The following questions will assist the SDT in finalizing the development of the Under Frequency Load Shedding Regional Reliability Standard Characteristics. For questions where you agree with the SDT, please state that you agree and if available, please provide supporting documentation. If you disagree with the SDT, please explain why you disagree and provide data to support your position. To improve the Under Frequency Load Shedding Regional Reliability Standard Characteristics, the SDT would appreciate responses to as many of these questions as you can answer.

You do not have to answer all questions. Enter All Comments in Simple Text Format.

Insert a "check" mark in the appropriate boxes by double-clicking the gray areas.

Characteristics of UFLS Regional Reliability Standards

1. The SDT determined that there is no need to have a continent-wide standard, and proposes that all UFLS requirements be contained within the regional UFLS standards developed in accordance with the Characteristics of UFLS Regional Reliability Standards.

The SDT developed a set of characteristics which each of the regional entities will be directed to include in its UFLS regional reliability standard. The SDT developed these characteristics in an attempt to direct the regional entities to develop requirements

based on system performance, without prescribing specifics of how to meet the specified performance.

Do you agree with the drafting team?

Yes

No

Yes and No

Comments: The Texas Regional Entity Regional Underfrequency Standard Drafting Team (TRE UFLS SDT) agrees with the direction that the NERC team is proposing.

Performance outcomes should be the focus of the regional standards development to allow for the proper integration of practices that have long been based on regional differences and practices. Those practices, where they obviously lend themselves to achieving the expected reliability outcomes, should be respected and incorporated in the development of these new regional standards.

2. As proposed, each regional UFLS standard must require that, for underfrequency conditions resulting from an imbalance between load and generation of at least 25 percent within an interconnection, region, or identified island(s) within or between regions, the UFLS must arrest frequency decline at no less than 58.0 Hz.

Do you agree with this design parameter? If you disagree, please identify whether you believe this design parameter should be deleted or revised.

Yes

No – Delete the design parameter

No – Revise the design parameter as noted in the comments

Comments: In general, the TRE UFLS SDT believes a UFLS program development for recovery from a frequency excursion in an event that utilizes a 25% contribution within a system allowed to go no further than 58.0 Hz is reasonable. Further we believe this set of parameters makes sense from the standpoint of the protection of certain equipment from sustained low frequency operation. The parameters are also viewed as essential to the protection of components of low pressure condensing turbines, which are very sensitive to low frequency operation and can quickly develop sub standard frequency resonance conditions which can lead to catastrophic failures.

The TRE UFLS SDT however does question the nature of the wording of the performance criteria "...an imbalance between load and generation of at least 25 percent within an interconnection, region, or identified island(s)" Is the above stated incorrectly? Can the BES remain at a frequency greater than 58.0 Hz with a 25% Imbalance between load and generation? Can generation maintain 125% loading without tripping and frequency collapse? Is the statement intended to imply that 25% of the load should be controlled by UFLS relays? Should the 25% be stated?

3. As proposed, each regional UFLS standard must require that, for underfrequency conditions resulting from an imbalance between load and generation of at least 25 percent within an interconnection, region, or identified island(s) within or between regions, the UFLS must act such that frequency does not remain below 58.5 Hz for

greater than 10 seconds, cumulatively, and frequency does not remain below 59.5 Hz for greater than 30 seconds, cumulatively.

Do you agree with this design parameter? If you disagree, please identify whether you believe this design parameter should be deleted or revised.

- Yes
- No – Delete the design parameter
- No – Revise the design parameter as noted in the comments

Comments: The TRE UFLS SDT recommends the NERC performance criteria be revised from 59.5 Hz to 59.3 Hz. 59.5 Hz is a frequency level that should be supported by high set relays, (59.7 Hz), and when high sets are activated, the next level of intervention should be 59.3 Hz for no more than 30 seconds.

4. As proposed, each regional UFLS standard must require that, for underfrequency conditions resulting from an imbalance between load and generation of at least 25 percent within an interconnection, region, or identified island(s) within or between regions, the UFLS must act such that the frequency overshoot resulting from operation of UFLS relays will not exceed 61.0 Hz for any duration and will not exceed 60.5 Hz for greater than 30 seconds, cumulatively.

Do you agree with this design parameter? If you disagree, please identify whether you believe this design parameter should be deleted or revised.

- Yes
- No – Delete the design parameter
- No – Revise the design parameter as noted in the comments

Comments: The TRE UFLS SDT believes that the NERC standard should not define the frequency overshoot limit; instead, the NERC standard should state this as a requirement for the region to establish as part of the UFLS standard. For example, the NERC standard might state as follows: "The Regional Standard shall define the frequency overshoot it determines appropriate in arresting the imbalance between load and generation."

5. As proposed, each regional UFLS standard must require that, for underfrequency conditions resulting from an imbalance between load and generation of at least 25 percent within an interconnection, region, or identified island(s) within or between regions, the UFLS must act such that the Bulk Electric System voltage during and following UFLS operations is controlled such that the per unit Volts per Hz (V/Hz) does not exceed 1.18 for longer than 6 seconds cumulatively, and does not exceed 1.10 for longer than 1 minute cumulatively.

Do you agree with this design parameter? If you disagree, please identify whether you believe this design parameter should be deleted or revised.

- Yes
- No – Delete the design parameter
- No – Revise the design parameter as noted in the comments

Comments: The TRE UFLS SDT feels that, due to the interplay between load and generation components during a firm load shedding event, it would seem impractical to decompose their individual contributions to the volts/Hz ratio; therefore, compliance enforcement would likely prove to be impossible.

The TRE UFLS SDT feels that NERC standard should not specify the relay coordination requirements with generation protection relays. Instead, the NERC standard should state as a requirement for each region to establish as part of the UFLS standard a planning study to determine adequacy and consistency with other standards. For example, the NERC standard might state as follows: "The Regional Standard shall address the requirement for the UFLS to coordinate with existing regional generation relaying requirements." As written, it may conflict with ERCOT's Operating Guide 3.1.4.6 where v/Hz is specified.

6. If there are any other characteristics in the UFLS Regional Reliability Standard Characteristics document that you disagree with, please identify them here, and either identify that they should be deleted, or recommend an alternative.

Agree with all proposed characteristics

Disagree with one or more of the characteristics as noted in the comments

Comments: The TRE UFLS SDT believes that the requirement that frequency shall not remain below 59.5 Hz for greater than 30 seconds would require a change in the existing ERCOT UFLS program Step 1 (59.3 Hz). The half-way-point between 60 Hz (Normal) and 58.5 Hz (10 second Minimum) is 59.25 Hz.

Frequency overshoot can be planned for by providing numerous steps of UFLS to avoid the overshoot. This should be fine for a gradual decay of frequency. However during a large drop in frequency, all steps will operate simultaneously causing a possible overshoot. What can be done to reduce frequency at this point?

BES voltage during and following UFLS operations shall be controlled not to exceed 1.18 for longer than 6 seconds cumulatively, and 1.10 for longer than 1 minute cumulatively. Who should be responsible for non-compliance? Can this standard be enforced?

7. The SDT proposes that the regional standards include the database requirements contained in existing Reliability Standard PRC-007. Do you agree that database requirements should be addressed within the Regional Standards?

Yes

No

Yes and No

Comments: The TRE UFLS SDT believes each regional UFLS program should include the requirement for archiving the region's UFLS data and that database should be available to entities within the region and should be part of the region's requirements constituting auditable compliance with the standard. The TRE UFLS SDT feels these databases are required to efficiently conduct the studies.

The regional standard should also clearly define the entity responsible / accountable for complying with the standard (equipment ownership, equipment maintenance, database maintenance, reporting, etc.) perhaps the RC or the PA. Regardless of who is designated, that functional entity should be responsible for developing a database format / template to ensure UFLS data consistency and completeness as well as study efficiency.

8. Are you aware of any conflicts between the proposed regional standards and any regulatory function, rule, order, tariff, rate schedule, legislative requirement, or agreement?

- Yes
 No
 Yes and No

Comments: The TRE UFLS SDT believes there may potentially be a conflict. The ERCOT Power Region has customer choice of Retail Energy Provider (REP)/LSE. Although the standard appears to be written as permissible in not enforcing UFLS requirements on LSE (“...and Load-Serving Entity that owns or operates a UFLS program (as required by its Regional Reliability Organization...)”), it might be construed that LSEs in ERCOT may be subject to the requirements under the Standard as written.

The TRE UFLS SDT also comments that the proposed standard does not address allocation to self serve or large industrials. The TRE UFLS SDT believes that self serve entities with load and generation connected to the grid should be addressed.

9. Do you have any other questions or concerns with the proposed Under Frequency Load Shedding Regional Reliability Standard Characteristics that have not been addressed? If yes, please explain.

- Yes
 No
 Yes and No

Comments: The TRE UFLS SDT believes the NERC standard should recognize the coordination requirements within and between the region's automatic UFLS and other frequency-related load shed programs. The continent-wide performance criteria should require the regional standard clearly state the entity (i.e., RE, TP, TO, DSP, LSE, etc) that is responsible for the various requirements specified in the standard.

The TRE UFLS SDT also questions if the NERC performance criteria should set the values for frequency decline (etc) in the NERC characteristics? Could these be a required characteristic but set by the Region with proof of methodology? Also, what supporting documentation for restricting frequency overshoot to 61Hz? Request NERC Generation Verification SDT for reasoning/explanation.

The TRE UFLS SDT also expresses its concern regarding compliance issues. For example, how will compliance be addressed for an entity which meets the region's UFLS program's design standards, yet the program does not yield the results expected under actual conditions? How will compliance be determined?