

Underfrequency Load Shedding Standard Drafting Team

August 15, 2007 — 1–5 p.m. Central Time
August 16, 2007 — 8 a.m.–5 p.m. Central Time
August 17, 2007 — 8 a.m.–noon Central Time

ERCOT Offices
7620 Metro Center Drive
Austin, Texas 78744
☎ (512) 225-7000

Meeting Notes

1) Administrative

a) Roll Call

Jonathan Glidewell welcomed the members and guests of the Standards Drafting Team for Project 2007-01 Underfrequency Load Shedding.

Drafting team members in attendance:

- Dana Cabbell — Southern California Edison Co. (Chair)
- Paul Attaway — Georgia Transmission Corporation
- Brian Bartos — Banders Electric Cooperative
- Larry E. Brusseau — Midwest Reliability Organization
- Jonathan Glidewell — Southern Company Transmission Company
- Robert W. Millard — ReliabilityFirst Corporation
- Steven Myers — Electric Reliability Council of Texas, Inc.
- Mak Nagle — Southwest Power Pool
- Robert J. O'Keefe — American Electric Power
- Arthur Vierling — National Grid
- Robert Williams — Florida Municipal Power Agency (via telephone)
- Richard Young — American Transmission Company, LLC
- David Taylor — North American Electric Reliability Corporation

Drafting team members not in attendance:

- Geral Keenan — Bonneville Power Administration
- Donal Kidney — Northeast Power Coordinating Council, Inc.
- Mohsen Zamzam — Consolidated Edison Co. of New York

Guests in attendance:

- Barry Francis — Basin Electric (via telephone)
- Roy McCoy — Electric Reliability Council of Texas, Inc.
- John Schmall — Electric Reliability Council of Texas, Inc.

- Phil Tatro — National Grid
- Farzaneh Tafreshi — Texas Regional Entity (Texas RE or TRE)
- Van Weldon — Electric Reliability Council of Texas, Inc.
- Guy Zito — Northeast Power Coordinating Council, Inc.
- Laura Zotter — Electric Reliability Council of Texas, Inc.

Each standard drafting team member was asked to verify the information on the UFLS SDT roster and notify David Taylor via e-mail of any corrections that should be made.

b) NERC Antitrust Compliance Guidelines

The NERC Antitrust Compliance Guidelines were reviewed. Anyone with questions was asked to contact David Taylor.

It is NERC’s policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition. It is the responsibility of every NERC participant and employee who may in any way affect NERC’s compliance with the antitrust laws to carry out this commitment.

2) Action Items

Dana Cabbell will review the actions generated during the June 20–22 meeting of the standard drafting team for Project 2007-01:

Action Items	Status:	Assigned To:
Each person that presented the regional UFLS program at the June 20–22 meeting of the SDT needs to find a person to present the technical UFLS report at the August 15–17 SDT meeting in Austin and provide an electronic copy of the technical report to the team (the technical reports are not to be posted on the NERC website and not be distributed outside the UFLSDT distribution list)	Remains Open — Completed The presentations on the regional technical reports were scheduled for and provided as part of this meeting. See agenda item 4 below.	Steve Myers, Bob Williams, Larry Brusseau, Mohsen Zamzam, Bob Millard, Jonathan Glidewell, Mak Nagle, and Dana Cabbell
Dave Taylor to provide an overview of the NERC data rule at the next standard drafting team meeting.	New — Remains Open Dave was not able to prepare a presentation on the data rule and will attempt to have the presentation ready for the next face-to-face meeting.	David Taylor
Pamela Dautel is to report back to the group what percentage of load might not be obligated to provide UFLS	New — Completed (Note: See Attachments 2a and 2b as posted on the NERC website)	Pamela Dautel

Action Items	Status:	Assigned To:
capability due to registration cutoff levels.	http://www.nerc.com/~filez/standards/Underfrequency_Load_Shedding-RF.html) for this meeting).	
Richard Young to draft requirements to include in the draft standard related to over-voltage (off-nominal voltage) protection.	New — Completed Rich e-mailed the group with his suggestion (See Attachment 7d — Draft PRC-0xx-1_reg-rev 02 Off-nominal Voltage Requirements as posted on the NERC website http://www.nerc.com/~filez/standards/Underfrequency_Load_Shedding-RF.html) for this meeting). His proposal will be discussed during agenda item 6 below.	Richard Young

3) Project Schedule

David Taylor reviewed the schedule for Project 2007-01 with the team.

4) UFLS Programs — Technical Reports

Presentations highlighting the technical basis for each of the regional UFLS programs were provided by representatives of each of the NERC regions:

- a) ERCOT — John Schmall
- b) FRCC — Bob Williams was not able to travel to the meeting. The FRCC presentation will be provided at a later date.
- c) MRO — Barry Francis
- d) NPCC — Phil Tatro
- e) RFC — Rob O'Keefe and Rich Young
- f) SERC — Jonathan Glidewell
- g) SPP — Mak Nagle
- h) WECC — Dana Cabbell

The presentations have been posted on the NERC website http://www.nerc.com/~filez/standards/Underfrequency_Load_Shedding-RF.html) as additional material for this meeting.

5) Generator Underfrequency Trip Settings

Robert O'Keefe reviewed a graph identifying the regional generator underfrequency trip points. The group discussed which NERC project this issue should be addressed under (Project 2007-09 Generator Verification or Project 2007-01 UFLS). Dave Taylor suggested the issue should be addressed by the Generation Verification project and specifically draft standard PRC-024 Generator Performance during Frequency and Voltage Excursions.

Rob suggested the UFLS SDT draft a recommendation to the SDT for Generator Verification highlighting the coordination required between the UFLS programs and generator tripping during system frequency excursions.

Rob also suggested having each region create a scatter graph showing all the unit trip points for each unit in the region. The group felt this was a good suggestion but would require a huge amount of work. As an alternative Dana volunteered to investigate the relative data the WECC Control Work Group has collected to date. Dana will report back to the SDT during the upcoming conference call.

Action Item: Dana to contact the WECC Control Work Group to inquire as to what data they have collected relative to generator trip settings during frequency excursions and report back to the UFLS SDT.

Action Item: The UFLS SDT to develop a recommendation on generator trip settings during frequency excursions and forward the recommendation to the standard drafting team for the Project 2007-09 Generator Verification.

6) Standards Revisions

Dana Cabbell led the group in discussing possible revisions to the standards that are within the scope of the SAR for Project 2007-01:

- a) Draft Pro Forma Regional Standard
- b) PRC-007 — Assuring Consistency with Regional UFLS Programs
- c) PRC-009 — UFLS Performance Following an Underfrequency Event
- d) Strawman for PRC-0xx-1 — Automatic Underfrequency Load Shedding

Attachment 1 summarizes the discussion of the group relative to principles of UFLS, items/issues the group needs to reach consensus on relative to UFLS, and objectives the group feels a UFLS standard should achieve.

Attachment 1 also provides a tally of a straw vote the SDT took relative how to proceed with the development of the continent-wide and regional standards associated with the project. In summary, the SDT agreed to develop a set of UFLS performance characteristics which should be included in each regional standard. As for a continent-wide standard, the SDT agreed that if a requirement could be determined to apply to every region, the requirement would become part of the continent-wide standard. If no continent-wide requirements could be identified, the continent-wide standard would contain the list of performance characteristics to be identified in the regional standards. These would not necessarily be requirements; they would instead just be a list or “pro forma” regional standard.

Attachment 2 contains suggested changes to the draft continent-wide standard the group discussed.

Attachment 3 contains a number of issues the SDT discussed should be considered when developing a “pro forma” regional standard.

7) Action Items

Dana Cabbell reviewed the action items generated during the meeting and confirmed assignments.

Action Items	Status:	Assigned To:
Dave Taylor to provide and	Remains Open	David Taylor

Action Items	Status:	Assigned To:
overview of the NERC data rule at the next standard drafting team meeting.		
Dana to contact the WECC Control Work Group to inquire as to what data they have collected relative to generator trip settings during frequency excursions and report back to the UFLS SDT.	New	Dana Cabbell
The UFLS SDT to develop a recommendation on generator trip settings during frequency excursions and forward the recommendation to the standard drafting team for the Project 2007-09 Generator Verification.	New	UFLS SDT

8) Next Steps

The group will discuss and identify the next steps and establish future meeting dates and locations.

Next meetings:

- September 14 — Conference Call — 2–5 p.m. Eastern Time
- October 3–5 — Tampa
 - October 3— 1–5 p.m. Eastern Time
 - October 4 — 8 a.m.–5 p.m. Eastern Time
 - October 5 — 8 a.m.–noon Eastern Time
- October 19 — Conference Call — 2–5 p.m. Eastern Time

7) Adjourn

Principles of Under Frequency Load Shed

1. Prevent excessive load shedding which may result in over-frequency conditions or unnecessary loss of service continuity and revenue
2. Avoid insufficient load shedding which in turn may lead to system blackout
3. Provide sufficient load shedding to maintain the frequency in the acceptable operating range.

Items of concern for UFLS scheme

1. Acceptable operating range and basis (end users, generators, other system needs, other industry established standards...)
2. What load? (% , steps, blocks, MW, MVAR, real-time vs forecast, firm vs interruptible, peak vs average over an hr,
3. On x% of load shed, x% of what? (what is the basis of x%, threshold, Evidence of situational readiness, retroactive, what is excessive,
4. System losses?
5. What time of day? (24/7, other,
6. Voltage? (over voltage, under voltage, equipment drop outs, what is acceptable, not to maintain voltage in a specified range but needs to address voltage impact during a frequency event,
7. Is scheme to create Islands or deal with Islands that are created from events.
8. Prohibit unintended loss of load?
9. Generator limits? (Generator deficiency, protection scheme,
10. Interaction with other relay schemes, protection schemes, ...
11. Inter-regional coordination? Consistency between regions,
12. Area issues unique to frequency/islanding.
13. Overshoot,
14. Manual load shedding,
15. Restoration, manual vs automatic,
16. Rate of decline,
17. Operating times of breakers, relays, sensors,

Objectives of UFLS

1. Review and convert under frequency relay database into a format suitable for use for time-domain simulations.
2. Conduct simulations on the power system to determine if the UFLS scheme is compliant with the NERC/Region requirements in maintaining system security under severe imbalance between load and generation scenarios.
3. Recommend modifications to the UFLS scheme if deemed necessary.
4. Provide documentation detailing the results of the study.

1	2	3	4
<u>Continent wide w/interconnect</u>	<u>Regional Proforma</u>	<u>Continental</u>	<u>Continental Standard</u>

<u>reqs</u>			<u>(default)</u>
Eastern FRCC ERCOT WECC	WECC FRCC SERC NPCC ERCOT	SPP MRO RFC	<u>Regional Proformas</u>
	Jonathan Rich Dave Brian Mak Bob Paul Dana Art Phil Steve Laura		Rob Vann

A. Introduction

1. **Title:** Automatic Underfrequency Load Shedding
2. **Number:** PRC-0xx-1
3. **Purpose:** Provide requirements for implementing automatic Underfrequency Load Shedding (UFLS) programs to arrest declining Bulk Electric System frequency.
4. **Applicability:**
 - Reliability Coordinator (RC)
 - Transmission Operator (TOP)
 - Transmission Owner (TO)
 - Distribution Provider (DP)
 - Generator Owner (GO)
5. **Effective Date:** TBD

B. Requirements

- R1.** TOs and DPs with end use load connected to their facilities shall each implement an UFLS Program or shall participate with one or more geographically contiguous TOs or DPs to collectively implement a single UFLS Program. UFLS Programs shall be implemented per the applicable Regional Standard where the TO or DP geographically resides.
- R2.** TOs and DPs or, by specific alternative agreement, LSEs with automatic load restoration programs, if permitted within the region, shall make available the following data to the regional UFLS database on request. The data shall be supplied in a format and level of detail as determined by the UFLS database:
- Frequency at which load is restored (Hz)
 - Amount of load restored at each stage (MW or percent)
 - Amount of BES capacitors restored at each stage (Mvar or percent)
 - Total time delay to restore load (cycles or seconds)

[I think we should propose a requirement on permissible generator UF tripping to forward to Project 2007-9. Granted, we would not be able to control what happens to it after that, but at least that team would know what we forward them is a point of reference for the UFLS standard (R1.3).]

- R3.** GOs shall set underfrequency tripping protection on each generator in conformance with Figure X. [Figure X to be devised.]
- RX.1 GOs with generator underfrequency tripping protection set at any underfrequency level with a delay time less than specified in Figure X may comply by arranging for a block of load equal to or greater than the generator MW dispatch to be tripped at the same time as the generator is tripped when due to an underfrequency condition.

- RX.2 GOs shall provide generator underfrequency trip characteristics consisting of frequency trip settings (Hz) and time delays (cycles or seconds) for each unit to the Regional UFLS database within X days of request.
- R4.** The Reliability Coordinator and Planning Coordinator shall each provide documentation of the analysis of the UFLS program to its Regional Entity and NERC as scheduled after a system event. *[Violation Risk Factor: Lower] Alternatively, the RC and PC may submit documentation of a jointly prepared analysis.*

Generator issues affecting system frequency (refer to Project 2007-9):

- 1) Auto generator reconnect (wind farms, distributed generation) HSM: We probably should draft a requirement that no auto reconnect is allowed following an underfrequency event when the post-event frequency is lower than X Hz. This frequency may differ between Interconnections.
- 2) Generator load controllers superceding governor operation—HSM: shouldn't this be covered in a different standard?
- 3) Governor modeling verification for doing UFLS studies—HSM: shouldn't this be covered in a different standard?

Emergency Operations issue (refer to Project 2007-8):

- 1) Manual load shedding—HSM: We probably should draft a requirement addressing the need to perform additional manual load shedding following an underfrequency event when the post-event frequency is lower than X Hz. This frequency may differ between Interconnections.

Miscellaneous issues to defer to Regions (?)—HSM: Does this mean these should be covered in the pro-forma for the Regional Standards?

- 1) Permissibility of auto load restoration and any associated restrictions
- 2) Need for transmission shunt caps tripping on underfrequency (UF) in addition to OV
- 3) Any requirements associated with UFLS geographic distribution
- 4) Any restrictions on overlapping UFLS / undervoltage load shedding (UVLS) load
- 5) Any requirements beyond R1 for probable islands

C. Measures

- M1.** Each Transmission Owner’s, Transmission Operator’s, Load-Serving Entity’s and Distribution Provider’s documentation of the UFLS program performance following an underfrequency event includes all elements identified in Reliability Standard PRC-009-0_R1.
- M2.** Each Transmission Owner, Transmission Operator, Load-Serving Entity and Distribution Provider that owns or operate a UFLS program, shall have evidence it provided documentation of the analysis of the UFLS program performance following an underfrequency event as specified in Reliability Standard PRC-009-0_R1.

What about the RC and PC per Requirement 6?

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Monitoring Responsibility

Compliance Monitor: Regional Entity

1.2. Compliance Monitoring Period and Reset Time Frame

On request 90 calendar days after the system event.

1.3. Data Retention

None specified.

1.4. Additional Compliance Information

None.

2. Levels of Non-Compliance

2.1. Level 1: Analysis of UFLS program performance following an actual underfrequency event below the UFLS set point(s) was incomplete in one or more elements in Reliability Standard PRC-009-0_R1.

2.2. Level 2: Not applicable.

2.3. Level 3: Not applicable.

2.4. Level 4: Analysis of UFLS program performance following an actual underfrequency event below the UFLS set point(s) was not provided.

E. Regional Differences

None identified.

F. Associated Documents

Version History

Version	Date	Action	Change Tracking
0	April 1, 2005	Effective Date	New
0	April 4, 2007	Regulatory Approval — Effective Date	New

Proforma considerations.

- R5.** Each UFLS Program shall conform to the following:
- R5.1.** Each Program shall cover a minimum of 25 percent of hourly Demand connected year round, or higher .
 - R5.2.** UF load shedding blocks (steps) shall be size limited to prevent UFLS caused frequency overshoots exceeding 60.5 Hz. The TO, DP, or LSE shall demonstrate conformance to this requirement by actual event analysis or by simulation.
 - R5.3.** UF load shedding blocks shall also include the shedding of a sufficient amount of BES capacitors to assist in load reduction and prevent voltage excursions above 110% of nominal voltage for more than 10 seconds during UFLS. [Conformance to this requirement can be verified by simulation.]
 - R5.4.** UF trip points and time delays shall be selected to allow for completion of UFLS operations and of underfrequency generator tripping, as specified in PRC-XXX, while assuming a constant system frequency.
 - R5.5.** UF trip points and time delays shall be selected such that, for load-generation imbalances less than or equal to the load of any UFLS block, activation of the next lower frequency block is prevented.
 - R5.6.** UFLS relay under-voltage inhibits shall be set no higher than 80 percent voltage.
- R6.** TOs and DPs, or by specific alternative agreement, LSEs shall provide the following data to the Regional UFLS database on request. The data shall be supplied in a format and level of detail as determined by the Regional UFLS database.
- R6.1.** UFLS relay UF trip points (Hz)
 - R6.2.** Amount of load shed at each trip point (MW or percent)
 - R6.3.** Amount of BES capacitors shed at each trip point (Mvar or percent)
 - R6.4.** Total relay operating and delay times (cycles or seconds)
 - R6.5.** Circuit breaker operating times (cycles or seconds)
 - R6.6.** Relay under-voltage inhibit settings (% voltage)
 - R6.7.** TOs and DPs with automatic underfrequency tie tripping, automatic underfrequency islanding, other automatic underfrequency programs, or other programs that are part of, or impact, the UFLS Program, shall document such programs and provide detailed modeling information to allow dynamic simulations. This documentation shall be made available to the TP and PC within X days of request.