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NPCC
Regional Reliability Reference Directory # 12
Under frequency Load Shedding Program Requirements

Task Force on System Studies Revision Review Record:
June 26th, 2009
March 3rd, 2010
July 9th, 2013

Adopted by the Members of the Northeast Power Coordinating Council, Inc. June 26th, 2009 based on recommendation by the Reliability Coordinating Committee, in accordance with Section VIII of the NPCC Amended and Restated Bylaws dated July 24, 2007 as amended to date.

Revision History

Version	Date	Action	Change Tracking (New, Errata or Revisions)
0	6/26/09	Effective Date	New
1	3/03/10	Sections 5.2.2 and 5.2.3 revised to consider small entity participation.	Revision
2	1/06/2011	Section 1.4 revised to reflect RCC approved Quebec implementation.	Errata.
3	7/09/2013	Section 5.2.1 and Section 5.2.2 Tolerances Revised. Section 5.5.2 Frequency of UFLS Studies revised.	Revision.

Table of Content

1.0 Introduction

1.1 Title Under frequency Load Shedding Program Requirements

1.2 Directory Number 12

1.3 Objective

This Directory presents the basic criteria for the design and implementation of under frequency **load shedding** programs to ensure that declining frequency is arrested and recovered in accordance with established NPCC performance requirements to prevent system collapse due to load-generation imbalance.

1.4 Effective Date **June 26th, 2009**

The effective date of this Directory also is the initial date of a six-year implementation plan for under frequency **load shedding** program in the portion of NPCC in the Eastern Interconnection and a three -year implementation plan in the Québec Interconnection.

1.5 Background

This Directory was developed from the automatic Under frequency **Load Shedding** requirements in NPCC Directory #2, Emergency Operations, and the recommendations and implementation plans provided in the study reports: 2006 Assessment of Under frequency Load Shedding Adequacy Part III – Assessment of Program Modifications and 2008 Assessment of Under frequency Load Shedding Adequacy – Québec Area, approved by the Reliability Coordinating Committee on November 19, 2008.

1.6 Applicability

1.6.1 Functional Entities

Balancing Authorities
Transmission Operators
Generator Owners

2.0 Terms Defined in this Directory

The definitions of terms found in this Directory appearing in bold typeface can be found in the Appendix A.

3.0 NERC ERO Reliability Standard Requirements

The NERC ERO Reliability Standards containing Requirements that are associated with this Directory include, but may not be limited to:

3.1 EOP-003: Load Shedding Plans
3.2 PRC-006: Automatic Under frequency Load Shedding
3.3 PRC-007: Assuring Consistency with Regional UFLS Program Requirements

4.0 NPCC Regional Reliability Standard Requirements

PRC-006- NPCC-1 Automatic Under frequency Load Shedding.

5.0 NPCC Full Member, More Stringent Criteria

These Criteria are in addition to, or more stringent or more specific than the NERC or any Regional Reliability standard requirements.

5.1 Under frequency Load Shedding Program – General Criteria

The intent of the NPCC automatic Under frequency **Load Shedding** program is to ensure that declining frequency is arrested and recovered in accordance with established NPCC performance requirements stipulated in this document, as follows:

5.1.1 Frequency decline is arrested at no less than 58.0 Hz for the portions of NPCC in the Eastern Interconnection and 56.0 Hz for the portion of NPCC in the Québec Interconnection.

5.1.2 Frequency does not remain below 58.5 Hz for greater than 10 seconds, and does not remain below 59.5 Hz for greater than 30 seconds, for a generation deficiency of up to 25% of the **load**.

5.2 Under frequency Load Shedding Program – Eastern Interconnection specific Requirements

Each Balancing Authority in the NPCC portion of the Eastern Interconnection shall develop an automatic Under frequency **Load Shedding** Program that meets the following requirements, unless an alternative plan is submitted by the Balancing Authority for review by the NPCC Task Forces on Coordination of Operation and System Studies and approved by the NPCC Reliability Coordinating Committee:

5.2.1 The program shall consist of five stages of **load shedding** to be provided by entities with 100 MW or more of end-use load connected to its facilities with the following attributes:

	Threshold Setting	Block Size	Cumulative Load Shed as % of TO or DP Load	Total Operating Time (1)
Stage 1	59.5 Hz	6.5-7.5 percent	6.5-7.5	300 ms
Stage 2	59.3 Hz	6.5-7.5 percent	13.5-14.5	300 ms
Stage 3	59.1 Hz	6.5-7.5 percent	20.5-21.5	300 ms
Stage 4	58.9 Hz	6.5- 7.5 percent	27.5-28.5	300 ms
Stage 5 (anti-stall)	59.5 Hz	2-3 percent	29.5-31.5	10 s

Notes:

(1) Total operating time is the load-weighted average for all **load** within a Balancing Authority area, with maximum deviation for any load limited to ±50 ms.

5.2.2 The program shall consist of two stages of **load shedding** to be provided by entities with 50 MW or more and less than 100 MW of end-use load connected to its facilities with the following attributes:

	Threshold Setting	Block Size	Cumulative Load Shed as % of TO or DP Load	Total Operating Time (1)
Stage 1	59.5 Hz	14-25 percent	14-25	300 ms
Stage 2	59.1 Hz	14-25 percent	28-50	300 ms

Notes:

(1) Total operating time is the load-weighted average for all **load** within a Balancing Authority area, with maximum deviation for any load limited to ±50 ms.

5.2.3 The program shall consist of one stage of **load shedding** to be provided by entities with 25 MW or more and less than

50 MW of end-use load connected to its facilities with the following attributes:

	Threshold Setting	Block Size	Cumulative Load Shed as % of TO or DP Load	Total Operating Time (1)
Stage 1	59.5 Hz	28-50 percent	28-50	300 ms

Notes:

(1) Total operating time is the load-weighted average for all **load** within a Balancing Authority area, with maximum deviation for any load limited to ±50 ms.

5.2.4 Entities with less than 25 MW of end-use load connected to its facilities are exempt from providing UFLS.

5.2.5 Entities with less than 100 MW of end-use load connected to its facilities may collectively implement by mutual agreement with one or more entities within the same island[1]identified an aggregated automatic UFLS program that sheds load based on the frequency thresholds in section 5.2.1 as an alternative to implementing the applicable program in section 5.2.2 or 5.2.3.

5.2.6 Under frequency threshold **relays** shall be set to a nominal total operating time of 300 ms, from the time when frequency passes through the set point to the time of circuit breaker contact opening (including any communications time delay), with a minimum relay operating time to be no less than 100 ms when the rate of frequency decay is 0.2 Hz per second.

5.3 Under frequency Load Shedding Program – Québec Interconnection Specific Requirements

The Balancing Authority in the Québec Interconnection shall develop an automatic Under frequency **Load Shedding** Program that meets the following requirements, unless an alternative plan is submitted by the Balancing Authority for review by the NPCC Task Forces on Coordination of Operation and System Studies and approved by the NPCC Reliability Coordinating Committee:

[1] BA shall identify the appropriate island for entities participating in the program.

5.3.1 The program shall consist of five threshold stages and four rate-of-change (slope) stages of **load shedding** as depicted in Table 2.

Table 2 – UFLS Parameters for the Québec Interconnection Portion of NPCC

	Rate	Frequency	MW at System Peak	Mvar at System Peak	Total Operating Time
Threshold Stage 1	——	58.5 Hz	1000 MW (1)	1000 Mvar	300 ms
Threshold Stage 2	——	58.0 Hz	800 MW (1)	800 Mvar	300 ms
Threshold Stage 3	——	57.5 Hz	800 MW	800 Mvar	300 ms
Threshold Stage 4	——	57.0 Hz	800 MW	800 Mvar	300 ms
Threshold Stage 5 (anti-stall)	——	59.0 Hz	500 MW	500 Mvar	20 s
Slope Stage 1	-0.3 Hz/s	58.5 Hz	400 MW	400 Mvar	300 ms
Slope Stage 2	-0.4 Hz/s	59.8 Hz	800 MW (1)	800 Mvar	300 ms
Slope Stage 3	-0.6 Hz/s	59.8 Hz	800 MW (1)	800 Mvar	300 ms
Slope Stage 4	-0.9 Hz/s	59.8 Hz	800 MW	800 Mvar	300 ms

Notes:

(1) These stages shed fixed load independent of system load level.

(2) The amount of load shedding in this table includes load shedding to compensate for generators that trip above the curve in Figure 1.

5.4 Generator Under frequency Protection Requirements

Generators shall not be tripped for under-frequency conditions in the area above the curve in Figure 1, except as provided for in Sections 5.4.1 and 5.4.2.

5.4.1 It is recognized that, in special cases, requirements may dictate generator trip in the region above the curve. In those cases, the Generator Owner shall so notify its Balancing Authority and shall ensure through alternate arrangements, that automatic **load shedding** additional to the amount set out in Section 5.2 and in Section 5.3, equivalent (+/- 5%) to the amount of **generation** to be

tripped, is provided. Such cases shall be reviewed by the Task Force on Coordination of Operation

5.4.2 Generator Owners shall not increase the under frequency trip settings or make other modifications to the existing exempt generators (that trip above the curve in Figure 1) that may cause these generators to, directly or indirectly, trip at a higher frequency.

5.5 UFLS Program Assessment Requirements

5.5.1 Studies shall be performed by the associated Transmission Operator to ensure satisfactory voltage and loading conditions after automatic **load shedding**.

5.5.2 The Task Force on System Studies shall conduct a study to coordinate the Automatic Under frequency **Load Shedding** Program among the NPCC Balancing Authorities, in accordance with the timeline indicated within NERC standard PRC-006-1.

6.0 Measures and Assessments

Measures and corresponding Levels of Non Compliance for these requirements are contained within the compliance templates associated with this Directory.

7.0 Compliance Monitoring

Adherence to these Criteria shall be reported by the responsible entity in a manner and form designated by the Compliance Committee.

Prepared by: Task Force on System Studies

Review and Approval: Revision to any portion of this Directory will be posted by the lead Task Force in the NPCC Open Process for a 45 day review and comment period. Upon satisfactorily addressing all the comments in this forum, the Directory document will be sent to the remaining Task Forces for their recommendation to seek RCC approval.

Upon approval of the RCC, this Directory will be sent to the Full Member Representatives for their final approval if sections pertaining to the Requirements and Criteria portion have been

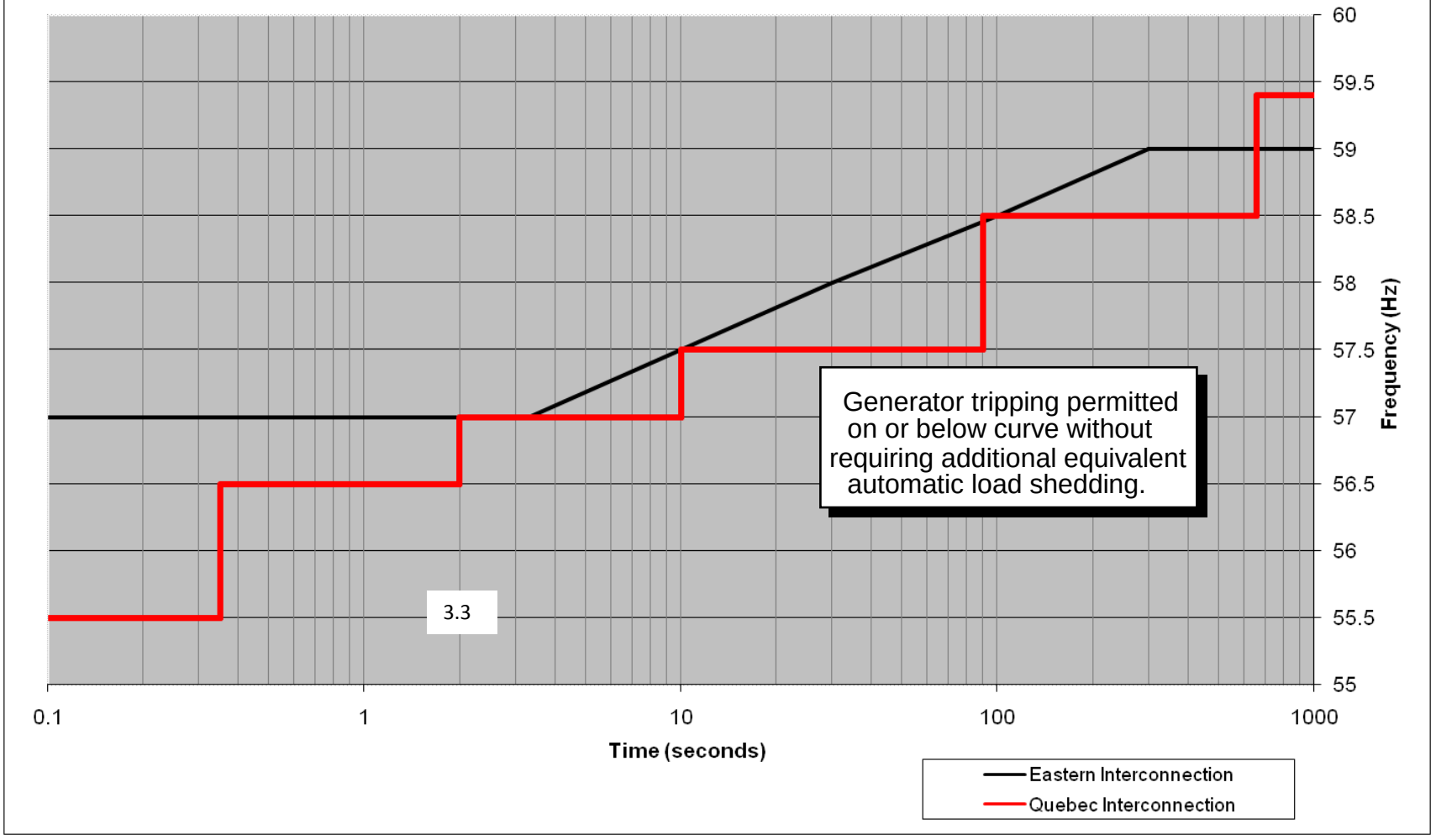
revised. All voting and approvals will be conducted according to the most current "NPCC Bylaws" in effect at the time the ballots are cast.

Revisions pertaining to the Appendices or any other portion of the document such as Links, glossary of terms, etc., will only require RCC Members' approval. Errata may be corrected by the Lead Task Force at any time and provide the appropriate notifications to the NPCC Inc. membership.

This Directory will be updated at least once every three years and as often as necessary to keep it current and consistent with NERC, Regional Reliability Standards and other NPCC documents.

References: NPCC Directory #2 – Emergency Operations.

Figure 1
Standards for setting underfrequency trip protection for generators



Appendix A
Definition of Terms[2]

Bulk power system — The interconnected electrical systems within northeastern North America comprised of system **elements** on which **faults** or **disturbances** can have a **significant adverse impact** outside of the **local area**.

Island — A portion of a **power** system or several power systems that is electrically separated from the interconnection due to the disconnection of transmission system **elements**.

Load — The electric **power** used by devices connected to an electrical generating system. (IEEE Power Engineering). Also see **Demand**.

NPCC Specific Definitions:

Firm Load — Loads that are not **Interruptible Loads**.

Interruptible Load — Loads that are interruptible under the terms specified in a contract.

Load Shedding — The process of deliberately removing (either manually or automatically) preselected customers' **load** from a power system in response to an abnormal condition to maintain the integrity of the system and minimize overall customer outages.

Relay — An electrical device designed to respond to input conditions in a prescribed manner and after specified conditions are met to cause contact operation or similar abrupt change in associated electric control circuits. (Also: see **protective relay**).

[2] These terms will be moved and grouped under a separate Directory when all other Directories are developed.