

For Discussion – NYSRC ULFS Requirement

The NYSRC Reliability Rules and Compliance Manual (“RR&CM”) carries a provision under section D.2 *Underfrequency Load Shedding* requirement R1 *Load Shedding Allocation* that is not clear (vague) and may not be aligned with NPCC Directory 12 and NERC PRC-006-NPCC. The provision is the 3rd paragraph of R1 *Load Shedding Allocation*:

“If frequency is still declining below 58.5 Hz, all transmission systems shall take such steps as are necessary, including separating units to preserve generation, [to] minimize damage and service interruption.”

The philosophy of NPCC Directory 12 is to “[...] ensure that declining frequency is arrested and recovered [...] to prevent system collapse due to load-generation imbalance” and similarly the philosophy of NERC PRC-006-NPCC is to “[...] preserve the security and integrity of the bulk power system during declining system frequency events [...]”. This is done through requirements that: (1) establish appropriate stages of load shedding and (2) require generators not to be tripped for under-frequency conditions (if tripped [special case], require additional load shedding amounts). In an essence, the goal of NPCC Directory 12 and NERC PRC-006-NPCC is to stabilize and recover the system during an under-frequency event (by tripping load and keeping generators on-line).

The 3rd paragraph of R1 *Load Shedding Allocation* (under NYSRC RR&CM D.2) stipulates – and the language appears to be in a form of a general operating guideline (where demonstration of compliance may be a challenge) – that if the frequency is still declining below 58.5 Hz the Transmission Owners (and the NYISO) shall take other steps to preserve the system, meaning that the operators are at a point of no return and they shall prepare the system for a safe shot down; one example is provided: to island generation resources (please note that tripping generators would aggravate the already declining frequency leading to a collapse). No other examples are provided.

The following are discussion questions:

- 1) Does NYSRC D.2 requirement R1 align with the philosophy of NPCC Directory 12 and NERC PRC-006-NPCC?
- 2) Does the 3rd paragraph of RR&CM D.2 requirement R1 violate the requirements established in NPCC Directory 12 and NERC PRC-006-NPCC that require: “[...] generators shall not be tripped for under-frequency conditions in the area above the curve in Figure 1 [...]” (NPCC Directory 12 R5.4 / NERC PRC-006-NPCC R13)?

Also, NPCC Directory 2 Requirement 6.1 states *“If the frequency decays below the curve shown in Directory#12 Figure 1, steps may be taken to protect generating equipment, including separation from the system with or without load. In such cases isolation onto a generator's own auxiliaries is preferred to facilitate rapid resynchronization as soon as system conditions permit [...].”*

- 3) Is 58.5 Hz a valid threshold? As NPCC Directory 12 Figure 1 and NERC PC-006-NPCC-1 Figure 1 allow a floor frequency of 57 Hz for setting under-frequency trip protection for generators. In addition, NPCC Directory 2 Requirement 6.1 (see Q2) refers to Figure 1 as the trigger point for generation isolation.
- 4) Also, is 58.5 Hz a valid threshold? As NPCC Directory 12 allows a floor frequency of 58.0 Hz and TOs have additional load shedding stages beyond those of NPCC (down to 58.0 Hz). See D12 R5.1.1.
- 5) Also, is 58.5 Hz a valid threshold? As NPCC Directory 12 has an anti-stall stage (an addition that was implemented post 2003 Blackout) that would trip additional 2-3 percent of load in 10 seconds if the frequency decline is arrested and a boost is required (back to 60 Hz).
- 6) What operator actions can be attempted during a rapid under-frequency event that triggers an automatic under-frequency schemes which last milliseconds (the whole event may last few seconds)? Is the 3rd paragraph provision (of D.2 R1) even implementable under a rapid under-frequency event?
- 7) Is section D.2 *Underfrequency Load Shedding* of the NYSRC RR&CM mixing two issues: rapid under-frequency events and events that may require manual load shedding?
- 8) Should D.2 *Underfrequency Load Shedding* (with its 3 generic requirements) be removed from NYSRC RR&CM as NPCC addresses this issues through Directory 12 and NERC addresses this issues through PRC-006-NPCC?

The following is a comparison of the relevant Underfrequency Load Shedding Requirements from NYSRC RR&CM, NPCC Directory 12 and NERC PRC-006-NPCC-1.

1. NYSRC RR&CM

NYSRC RR&CM D.2 *Underfrequency Load Shedding* / R1 *Load Shedding Allocation* requirement is as follows (this requirement was established prior to NYSRC RR&CM):

“R1.

In the event that the frequency decline is so rapid as to prevent operator action, automatic facilities shall achieve load shedding without regard for transmission loadings. Load shedding allocation procedures shall be developed which meet the requirements of the NPCC Underfrequency Load Shedding Guides.

The NYCA must be capable of shedding at least 50 percent of its load in ten (10) minutes or less. Insofar as practical, the first half of the load shed manually should not include that load which is part of any automatic load shedding plan.

If frequency is still declining below 58.5 Hz, all transmission systems shall take such steps as are necessary, including separating units to preserve generation, minimize damage and service interruption.”

2. NPCC Directory 12 (last updated 7/9/2013)

The general Criteria for Under Frequency Load Shedding Program, as specified in NPCC Directory 12, is as follows:

"R5.1

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.

[...]

5.2.1 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:

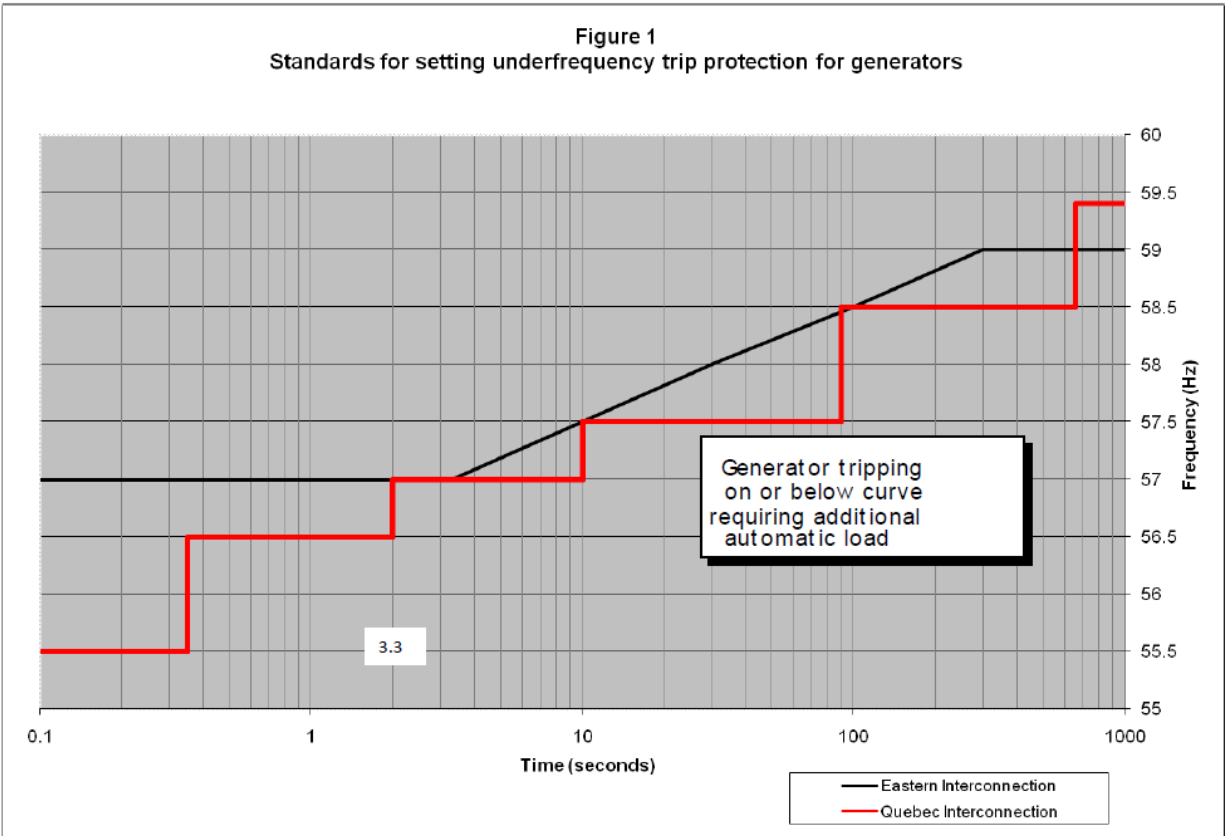
(1) Total operating time is the load-weighted average for all **load** within a Balancing Authority area, with maximum deviation for any load limited to ±50 ms.

5.4 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.



3. NERC PRC-006-NPCC-1 Automatic Under Frequency Load Shedding (Effective: 7/1/2015)

The general Criteria for Under Frequency Load Shedding Program, as specified in PRC-006-NPCC-1 follow NPCC Directory 12, and is as follows:

“R4

Each Distribution Provider and Transmission Owner in the Eastern Interconnection portion of NPCC shall implement an automatic UFLS program reflecting normal operating conditions excluding outages for its Facilities based on frequency thresholds, total nominal operating time and amounts specified in Attachment C, Tables 1 through 3, or shall collectively implement by mutual agreement with one or more Distribution Providers and Transmission Owners within the same island identified in Requirement R1 and acting as a single entity, provide an aggregated automatic UFLS program that sheds their coincident peak aggregated net Load, based on frequency thresholds, total nominal operating time and amounts specified in Attachment C, Tables 1 through 3.”

PRC-006-NPCC-1 Attachment C

| UFLS Table 1: Eastern Interconnection | | | |
|---|---|--|--|
| Distribution Providers and Transmission Owners with 100 MW or more of peak net Load shall implement a UFLS program with the following attributes: | | | |
| Frequency Threshold (Hz) | Total Nominal Operating Time (s) [†] | Load Shed at Stage as % of TO or DP Load | Cumulative Load Shed as % of TO or DP Load |
| 59.5 | 0.30 | 6.5 – 7.5 | 6.5 – 7.5 |
| 59.3 | 0.30 | 6.5 – 7.5 | 13.5 – 14.5 |
| 59.1 | 0.30 | 6.5 – 7.5 | 20.5 – 21.5 |
| 58.9 | 0.30 | 6.5 – 7.5 | 27.5 – 28.5 |
| 59.5 | 10.0 | 2 – 3 | 29.5 31.5 |

“R13

Each Generator Owner shall set each generator underfrequency trip relay, if so equipped, below the appropriate generator underfrequency trip protection settings threshold curve in Figure 1, except as otherwise exempted in Requirements R16 and R19.”

