Automatic Underfrequency Load Shedding Program Standard PRC-006-MRO-01

Frequently Asked Questions - Practical Compliance and Implementation

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1. Introduction

The following is a draft collection of questions, and answers as developed, that the MRO UFLS SDT believes could be helpful to those implementing MRO Standard PRC-006-MRO-01 Automatic Underfrequency Load Shedding Requirements.

2. Executive Summary

This FAQ document provides definitions for a variety of terms that do not have formal definitions.

This document highlights that UFLS programs are to provide a line of defense against the collapse of credible BES islands for a wide range of underfrequency events, but should not be expected to be effective for all possible events. It also notes that although the tripping of 30% load is appropriate for most credible islands, the characteristics of some credible islands warrant the use of higher load shedding percentages.

This document discusses topics that may be used and useful toward fulfilling the requirements in PRC-006-MRO-01.

- The consideration of tripping of non-BES (e.g. distribution system) elements in the UFLS Program for the desired BES performance.
- The usage of MRO 2007 UFLS Report and the “equivalent inertia” analytical method.
- Suggestions of acceptable forms of compliance evidence
- Suggestions of appropriate reactive power device data
- Suggestions for the handling of intentional time delay
- Comments on reporting of load for the UFLS program data base
- Maximum frequency overshoot limits
- Exemption in R11.1

This document provides opinion on the types of relays that would be acceptable and the use of automatic load restoration, and the consideration of tripping reactive power devices.

3. Additional Topics for Consideration in FAQ

None

4. Terms Used in PRC-006-MRO-01

Credible Island (R1, R2, R2.1, R2.2, R2.3, R3.1, & R13) – A portion of the transmission network that is capable of sustaining a balance of its own generation, load, and loss characteristics if synchronization with the grid is lost

Load and Resource Balancing Method (R3.1) – A Load and Resource Balancing Method is any . . . [Be sure to provide sufficient reactive device detail to allow proper modeling of the device in a dynamics simulation.]

Load Characteristics (R4) – The load attributes that the Distribution Provider (DP) considers when developing or revising its portion of the UFLS plan. All Load Serving Entities within the DP's Footprint shall provide input, which should include (but not limited to), the following data points:

- Critical loads to be avoided in plan development
- Installed under frequency capability in addition to that owned by the distribution provider, frequency setpoints of under frequency relays in service
- Possible loads to be added to the under frequency plan
- Seasonal peak loads (Winter and Summer)
- Distributed ("behind the meter") generation locations

Reactive Power Device (R3.1, R6, R7, R9, & R13) – Applicable reactive power devices may include capacitor banks, static var compensators, inductor banks, for example, devices that are tripped by frequency or voltage relays. These devices are typically rated 100 kV or higher. Reactive power devices that are rated less than 100 kV should be considered if they have a significant effect on the BES. [Be sure to provide sufficient reactive device detail to allow proper modeling of the device in a dynamics simulation.]

System Protection Scheme (R9) – Applicable schemes may include: non-Fault clearing schemes, tie-tripping schemes, islanding schemes, or additional Load shedding schemes. [Be sure to provide sufficient protection scheme detail to allow proper modeling of the scheme in a dynamics simulation.]

5. Frequently Asked Questions

5.1 We have an Underfrequency Load Shedding system in place that prevents one of our distribution substations from supplying load in the case of an Underfrequency excursion. If the load is not part of the BES, does this load fall within this standard?

If an underfrequency excursion is on the BES or impacts the BES, then this frequency excursion needs to be mitigated by shedding load. The participation of this load is determined by the UFLS program and not dependent on whether it meets a particular voltage rating.

5.2 Is the UFLS Program expected to prevent the collapse of any islanded portion of the BES for all underfrequency events?

No. The UFLS program is to provide a line of defense against the collapse of any islanded portion of the BES for a wide range of possible system conditions. However, it is not practical or reasonable to expect a UFLS Program to be effective for every possible system condition and underfrequency event.

5.3 Can the UFLS Program be designed to trip more than 30% of the island load?

Yes. Some credible islands of the BES have facility characteristics and system conditions that would be protected better by a UFLS Program that trips more than 30% of the load. The guiding objective is to provide a line of defense against collapse of the island for the best range of possible system conditions.

5.4 Can the "equivalent inertia" analysis method be used to assess the expected performance of a UFLS Program?

Yes. The "equivalent inertia" method is an effective approach for assessing the expected performance of a UFLS Program for a wide range of facility characteristics and system operating conditions. However other methods, such as dynamic simulation must be used to evaluate the possible system bus voltage levels.

5.5 Can the MRO 2007 UFLS Report be used to fulfill any of the PRC-006-MRO-01 requirements?

Yes. The MRO report may be used to fulfill portions of the performance methodology requirement, the assessment requirement, and other requirements generally until it becomes more than 5 years old (2013). The report identifies recognized credible islands, suggests design and performance methodology, and assesses the expected performance of the proposed UFLS program.

5.6 What forms of compliance evidence are acceptable?

Acceptable forms of evidence include but are not limited to:

- Process document or plan
- Data (such as relay settings sheets, photos, SCADA).
- Database screen shots that demonstrate compliance information.
- Diagrams, engineering prints, schematics, maintenance and testing records, etc.
- Logs (operator, substation, and other type of log).

- U.S. mail, memos, or email proving the required information was exchanged, coordinated, submitted or received.
- Database lists.

Evidence of the distribution of information to applicable entities:

- U.S. mail letters
- Business memos
- Email proving

These forms of communication should demonstrate that the required information was exchanged, coordinated, submitted or received.

5.7 What data should be provided on applicable reactive power devices (R9)?

Reactive power device data should include:

- Point of interconnection on the transmission system where the reactive power device effect can be modeled
- A block quantity and size for each reactive power device
- Set points for any frequency or voltage tripping function associated with the reactive power device
- Time delay duration for each frequency or voltage tripping function
- Voltage range of reactive power devices and their voltage step sizes

5.8 How should intentional time delay be handled?

Generally, an intentional relay time delay should be not more than ten cycles, with certain documented exceptions. The documentation shall consist of reports of mis-operations or distributed generation issues or analysis of large motor Loads:

- For installations where large motor Loads may be isolated, undercurrent supervision shall be used to avoid false operation during Fault isolation. If this is not available, planned total time delay may be increased to no greater than 29 cycles.
- For installations where distributed generation may be isolated, undercurrent supervision shall be used to avoid false operation during Fault isolation. If this is not available, planned total time delay may be increased to no greater than 29 cycles.

5.9 What types of relays may be used in a UFLS Program?

The type of relays that may be used in a UFLS program should be adequately described in each Planning Coordinators design methodology. The MRO UFLS Report and Recommendations suggest using high speed digital or computer based relays because they are faster and more effective in responding to underfrequency events than electromechanical relays. However, to prevent false trips, the electronic relay operating time delay should be set to at least 6 cycles.

5.10 What kind of load levels should be reported for the UFLS program database?

The kind of load levels to be reported for the UFLS Program database should be adequately described in each Planning Coordinator's design

methodology. Each design methodology is expected to indicate that the load for each reported UFLS step at each BES interconnection location is the forecasted peak load for the next projected peak season and is to be derived from the latest actual data from previous peak seasons. The load data should not be a simplistic assigned percentage of total station load at the associated BES interconnection location.

5.11 Should the automatic load restoration be considered along with a UFLS Program?

No. The automatic restoration of load may aggravate island frequency oscillations. Load should be restored carefully through manual means after the island frequency has recovered to 60 Hz to maintain acceptable frequency levels.

5.12 Should the automatic tripping of reactive power devices be considered along with a UFLS Program?

Yes. Overvoltage conditions may occur when significant amounts of load are automatically tripped in an area where reactive power devices, particularly capacitor banks are in service to provide adequate pre-event voltage. The proper tripping of bulk power capacitor banks and/or distribution substation capacitor banks can prevent severe overvoltage conditions. However, capacitor bank trip settings should be chosen carefully because the bank cannot be restored for at least 5 minutes after it is tripped. Keep in mind that in some cases, the tripping of lower voltage capacitor banks can be more effective than tripping higher voltage capacitor banks.

5.13 What would warrant a higher overshoot frequency limit?

An answer to this question about frequency overshoot (per R3.1) is covered in the UFLS Report and Recommendations document Section 7: The Proposed MRO UFLS Program, which indicated the following acceptable range:

> "The maximum frequency and final frequency are sufficient and meet the desired targets (maximum frequency remains less than approximately 61.2-61.4 Hz and final frequencies remain in the range of 59.5 Hz to 60.5 Hz)."

5.14 Is the generator MW dispatching a fixed or variable value (R11.1)?

For intermediate and peaking type units the output or dispatch is not a fixed value, but can change rapidly and widely from nearly zero to full MW output. This situation can present a challenge to those generator owners who want to arrange of the exemption described in R11.1 because the offsetting load may have to change rapidly and widely.

5.15 Would a SPS be required to fulfill R11.1?

If the amount of load shedding is dependent on the generator output levels of the generator, then it is likely that the additional load tripping system would be a Special Protection System.