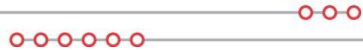




SPP UFLS Plan

July 16, 2013

SPP Planning Coordinator



Revision History

| Date or Version Number | Author | Change Description | Comments |
|------------------------|--------------------------|--------------------|---|
| 7/2/2013 | SPCWG | Rev. 0 | Initial draft |
| 7/16/2013 | SPP Planning Coordinator | Rev. 1 | MOPC approved SPCWG's Recommendation to endorse the UFLS Plan from the Consent Agenda |
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Introduction

The Southwest Power Pool (SPP) Automatic Underfrequency Load Shedding Plan (UFLS Plan) is designed to develop, coordinate and document requirements for automatic underfrequency load shedding (UFLS) programs to arrest declining frequency and assist recovery of frequency following underfrequency events. The SPP UFLS Plan data will be collected annually and the SPP UFLS Plan study will be performed at least every 5 years.

SPP's UFLS Plan applies to the Planning Coordinator (SPP), Generator Owners, and UFLS entities. UFLS entities will mean all entities that are responsible for the ownership, operation, or control of UFLS equipment as required by the UFLS program established by the Planning Coordinators. Such entities may include one or more of the following: Transmission Owners and Distribution Providers. This UFLS Plan requires annual updates to the UFLS data by UFLS entities.

SPP UFLS Plan

Section 1 - Study Island Identification (PRC-006-1.R1)

PRC-006-1-R1 requires that criteria be specified for selection of a study island. SPP will examine historical events as well as conduct future studies to determine the adequacy of its UFLS system. When SPP, as the Planning Coordinator, has evidence to warrant investigation of including more than one UFLS island, it will coordinate the analysis with the System Protection and Control Working Group (SPCWG), UFLS Entities, MRO, and other affected Planning Coordinators to develop a subsequent UFLS Plan to meet NERC PRC-006-1.

Section 2 - Island Selection (PRC-006-1.R2)

SPP as the Planning Coordinator has from previous studies identified one island consisting of the SPP RTO footprint to serve as a basis for designing its UFLS program. The SPP island was selected by considering the following:

- Those islands selected by applying the criteria in Section 1, and
- Any portions of the BES designed to detach from the Interconnection (planned islands) as a result of the operation of a relay scheme or Special Protection System, and
- A single island that includes all portions of the BES in either the Regional Entity area or the Interconnection in which the Planning Coordinator's area resides. If a Planning Coordinator's area resides in multiple Regional Entity areas, each of those Regional Entity areas will be identified as an island. Planning Coordinators may adjust island boundaries to differ from Regional Entity area boundaries by mutual consent where necessary for the sole purpose of producing contiguous regional islands more suitable for simulation.

Section 3 – Performance Characteristics (PRC-006-1.R3)

As a part of the SPP UFLS evaluation, V/Hz for all SPP UFLS Entities generators at generator terminal bus and/or generator step-up (GSU) transformer high-side bus will be studied. This study is performed to assess generators and transformers magnetic flux during 30% generation loss scenario. The actual magnitude of magnetic flux in the generator stator or transformer core is difficult to measure, however it can be quantified in terms of per unit V/Hz, since the operating magnetic flux in electric machines is proportional to the ratio of the operating voltage to the electrical frequency. Therefore, V/Hz provides a measure of generator stator and transformer core magnetic flux. Excessive magnetic flux in the transformer or generator results in thermal damages to the generator and GSU transformer. These damages are typically cumulative. These damages include, but are not limited to, generator stator and GSU transformer core damage, and degradation of insulation material. Excessive magnetic flux may even cause unwanted operation of protection system. The objective of the study is to identify generator terminal or GSU transformer high-side buses for which V/Hz exceeds stipulated values of 1.18 PU for longer than two seconds cumulatively, or 1.1 PU for longer than 45 seconds cumulatively for the simulated event of 30% generation loss scenario.

Therefore, Volts per Hz (V/Hz) will not exceed 1.18 per unit for longer than two seconds cumulatively per simulated event, and will not exceed 1.10 per unit for longer than 45 seconds cumulatively per simulated event at each generator bus and generator step-up transformer high-side bus associated with each of the following:

- Individual generating units greater than 20 MVA (gross nameplate rating) directly connected to the BES
- Generating plants/facilities greater than 75 MVA (gross aggregate nameplate rating) directly connected to the BES
- Facilities consisting of one or more units connected to the BES at a common bus with total generation above 75 MVA gross nameplate rating.

Section 4 - Island Coordination (PRC-006-1.R5)

SPP is the only Planning Coordinator in the SPP UFLS Island. When multiple Planning Coordinators are included in the SPP UFLS Island then SPP as the Planning Coordinator will coordinate its UFLS program design with adjacent Planning Coordinators whose areas or portions of whose areas are also part of the same identified island through one of the following:

- Develop a common UFLS program design and schedule for implementation among the Planning Coordinators whose areas or portions of whose areas are part of the same identified island, or
- Conduct a joint UFLS design assessment at least every five years among the Planning Coordinators whose areas or portions of whose areas are part of the same identified island, or
- Conduct an independent UFLS design assessment per the SPP UFLS Plan, and if the assessment fails to meet SPP UFLS Plan, identify modifications to the UFLS program(s) to meet the SPP UFLS Plan and report these modifications as recommendations to the other Planning Coordinators whose areas or portions of whose areas are also part of the same identified island and the ERO.

Section 5 - UFLS Program > 100MW

Each UFLS entity that has a total forecasted peak Load greater than or equal to 100 MW will develop and implement an automatic UFLS program that meets the following requirements:

- A minimum of 10% will be shed at each UFLS step in accordance with the table below.

| (1) UFLS Step | (2) Frequency (hertz) | (3) Minimum accumulated load relief as percentage of forecasted peak Load (%) | (4) Maximum accumulated load relief as percentage of forecasted peak Load (%) |
|------------------|-----------------------------|---|---|
| 1 | 59.3 | 10 | 25 |
| 2 | 59.0 | 20 | 35 |
| 3 | 58.7 | 30 | 45 |

- The intentional relay time delay for UFLS will be less than or equal to 30 cycles.
- Undervoltage inhibit setting will be less than or equal to 85 percent of nominal voltage.

UFLS entities may implement an aggregated UFLS program with other UFLS entities. The 100 MW limit refers to the aggregated plan, if one exists.

Section 6 - UFLS Program < 100MW

Each UFLS entity that has a total forecasted peak Load less than 100 MW will develop and implement an automatic UFLS program that meets the following sections:

- A minimum of one UFLS step with the frequency set point as assigned by the Planning Coordinator.
- The minimum accumulated Load relief will be at least 30% of the forecasted peak Load.
- The intentional relay time delay for UFLS will be less than or equal to 30 cycles.
- Undervoltage inhibit setting will be less than or equal to 85 percent of nominal voltage.

UFLS entities may implement an aggregated UFLS program with other UFLS entities. The 100 MW limit refers to the aggregated plan, if one exists.

Section 7 - Islanding Schemes

Each UFLS entity electing to use underfrequency islanding schemes will design those islanding schemes to operate after all 3 steps of UFLS have been exhausted and the frequency continues to fall to 58.5 Hz or below. For islanding schemes designed to operate at or between 58.5 Hz and 58.0 Hz, the minimum time delay will be 2 seconds. For islanding schemes designed to operate below 58.0 Hz, no time delay is required.

Section 8 – Post-Event Technical Assessment

The Planning Coordinator will perform and document a UFLS technical assessment within one year after the occurrence of any of the following situations:

- Performance characteristic changes to PRC-006 or the SPP UFLS Plan.
- Changes to the boundaries of a specified island are identified.

Section 9 – UFLS Entity Data Submittal

Each UFLS entity will maintain and submit the following UFLS data based on the forecasted peak Load to the Planning Coordinator within (30) calendar days upon request from the Planning Coordinator:

- Location of installed UFLS equipment
- Trip frequency(s) for each location
- Total relay operating time of each location (time required for the relay to reliably sense the frequency + intentional delay time (if any))
- Breaker operating time (nameplate) of each location
- Percentage and/or MW of bus load to be shed at the location
- Total amount of load shed by each trip frequency and the total forecasted peak Load
- Tie tripping schemes and the frequency and time delay at which they operate
- Islanding schemes and the frequency and time delay at which they operate.

Section 10 – Generator Owner Data Submittal

Each Generator Owner will maintain and submit the following data to the Planning Coordinator within (30) calendar days upon request from the Planning Coordinator:

- Location of underfrequency and overfrequency equipment
- Trip frequency(s) for each location
- Total relay operating time of each location (time required for the relay to reliably sense the frequency + intentional delay time (if any))
- Breaker operating time (nameplate) of each location
- MW of generation shed at each location.

Section 11 – Generator Owner Trip Verification

Each Generator Owner will verify that their generating unit(s) will not trip above the Generator underfrequency curve and will not trip below the Generator overfrequency curve in NERC PRC-006-1 Attachment 1 as a result of the unit(s) frequency protective relay settings.

For generating units with operating characteristics that limit the unit's ability to perform in accordance with this requirement, the Generator Owner will provide to the Planning Coordinator technical evidence demonstrating that the unit cannot operate within the specified frequency range without causing equipment damage or violating manufacturer's published equipment ratings.

Section 12 – Supplemental Load Shedding

The Planning Coordinator will determine if the Generator Owner has provided technical evidence demonstrating that the unit cannot operate within the specified frequency range without causing equipment damage or violating manufacturer’s published equipment ratings.

The Planning Coordinator will determine if the UFLS program performance is degraded due to the removal of any generation identified in accordance with Section 11 and verified in accordance with Section 11.

If the Planning Coordinator determines the UFLS program is degraded in accordance with Section 11 and that supplementary load shedding is, therefore, required, the Planning Coordinator will notify the Generator Owner or UFLS entity(s) in accordance with the following:

- Where the Generator Owner is a UFLS Entity and has the required amount of supplementary Load available, the Planning Coordinator will notify the Generator Owner of Load the entity is required to shed (in addition to that required in accordance with Section 5 and Section 6)
- Where the Generator Owner is not a UFLS Entity, or does not have the required supplementary Load available for shedding, the Planning Coordinator will notify any other UFLS Entity(s) within the Planning Coordinator Area of Load the entity(s) is required to shed (in addition to that required in accordance with Section 5 and Section 6).

Section 13 – Implementation of Supplemental Load Shedding

The Generator Owner or other UFLS entity(s) will implement supplementary shedding of Load required by the Planning Coordinator in accordance with Section 12.

Section 14 - Data Coordination with other Planning Coordinators (PRC-006-1.R7)

SPP as the UFLS Planning Coordinator will provide its UFLS database containing data necessary to model its UFLS program to other Planning Coordinators within its Interconnection within 30 calendar days of a request for data.

Section 15 – Post Event UFLS Plan Design Assessment (PRC-006-1.R11-12)

SPP as the UFLS Planning Coordinator, in whose area a BES islanding event results in system frequency excursions below the initializing set points of the UFLS program, will conduct and document an assessment of the event within one year of event actuation to evaluate: the performance of the UFLS equipment, and the effectiveness of the UFLS program. When the SPP islanding event assessment UFLS program deficiencies are identified, SPP as the Planning Coordinator will conduct and document a UFLS design assessment within two years of event actuation to consider the identified deficiencies.

Section 16 – Post Event Island Assessment Coordination (PRC-006-1.R13)

SPP as the Planning Coordinator, in whose area a BES islanding event occurred that also included the area(s) or portions of area(s) of other Planning Coordinator(s) in the same islanding event and that resulted in system frequency excursions below the initializing set points of the UFLS program, will coordinate its event assessment with all other Planning Coordinators whose areas or portions of whose areas were also included in the same islanding event through one of the following:

- Conduct a joint event assessment among the Planning Coordinators whose areas or portions of whose areas were included in the same islanding event, or
- Conduct an independent event assessment that reaches conclusions and recommendations consistent with those of the event assessments of the other Planning Coordinators whose areas or portions of whose areas were included in the same islanding event, or
- Conduct an independent event assessment and where the assessment fails to reach conclusions and recommendations consistent with those of the event assessments of the other Planning Coordinators whose areas or portions of whose areas were included in the same islanding event, identify differences in the assessments that likely resulted in the differences in the conclusions and recommendations and report these differences to the other Planning Coordinators whose areas or portions of whose areas were included in the same islanding event and the ERO.