LUMA

Balancing Frequency & Voltage

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Procedure Title: **Balancing Frequency & Voltage**

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1.0 Executive Summary

The Balancing Frequency and Voltage procedure provides direction to the Transmission Operations Center personnel to utilize generation and transmission elements to control the Bulk Power System's frequency and voltage.

- The lack of ability or capability to balance frequency or voltage or both can lead to negative events such as: equipment damage, load shedding, brownouts and blackouts.

2.0 Objective/Scope/Roles

2.1 Objective

To provide the actionable steps for Transmission Operations Center personnel to anticipate and mitigate system imbalances as well as responding to real-time imbalances related to frequency and voltage.

2.2 Scope

This procedure illustrates that balancing frequency and voltage is a critical component of properly operating the Bulk Power System. In addition, it provides direction to the Transmission Operations Center personnel to manage the Bulk Power System frequency and voltage in a continuous manner. This procedure focuses on the high-voltage operating system, with the equipment, limits and corrective action steps described all residing within the same high-voltage operating system.

2.3 Roles and Responsibilities

The Senior Shift Engineer (SSE) is the main decision maker during this process. He is supported by the Shift Engineer (SE), Senior Transmission Operators (STO) and Transmission Operators (TO). They communicate verbally in the Transmission Operations Center (TOC). The SSE may consult with the Manager Control Center Operations (MCCO) as necessary.

The process is performed daily and begins when the SSE enters for their shift. The SSE monitors the balancing process continually.

2.3.1 Senior Shift Engineer (SSE)

The SSE is responsible for:

- The overall operation of the system; works directly with the SE, STO and TO to manage the overall technical operation of all interconnected facilities in a real-time setting.
- The operation of both the primary and back up control centers.
- Supervision of the SE, STO and TO during the shift.

2.3.2 Shift Engineer (SE)

The SE is responsible for:

- Dispatch of real and reactive power, as well as ancillary services, for all interconnected facilities.
- Communication with primary contacts for all power plants and TO's.

2.3.3 Senior Transmission Operator (STO)

The STO is responsible for:

- The routing and balance of real and reactive power through the 230/115 kV transmission lines and working with the SE to jointly manage energy needs.
- Coordinating with the SE regarding frequency regulation, transmission flows and the current state of outages and Recall times for assets and interacts with SSE.

2.3.4 Transmission Operator (TO)

The TO is responsible for:

- The routing and balance of real and reactive power through the 38 kV transmission lines and working with the SE to jointly manage energy needs
- Coordinating with the SE regarding frequency regulation, transmission flows and the current state of outages and Recall times for assets and interacts with SSE.

3.0 Procedure

The SE, STO and TO **shall** communicate verbally and will take immediate action upon receiving SCADA alarms for frequency and voltage variations as follows:

3.1 Low-Voltage Alarm (-5% nominal voltage)

The following responses **shall** be used as needed to resolve the condition:

- The SE, STO and TO **shall** locate the condition of the low voltage.
- The SE, STO and TO **shall** identify resources available to be enlisted to correct the low-voltage situation.
- The STO or TO **shall** switch capacitor banks in-service via SCADA from the TOC as a first action.
- The STO or TO **shall** switch reactors out-of-service via SCADA from the TOC (if capability exists).
- The STO or TO **shall** raise high-voltage transformer taps via SCADA from the TOC as a second action.
- The SE **shall** use the generators to generate more reactive power via SCADA from the TOC as a third action.

3.2 High-Voltage Alarm (+5% nominal voltage)

The following responses **shall** be used as needed to resolve the condition:

- The SE and STO or TO **shall** locate the condition of the high voltage.
- The SE and TO **shall** identify resources available to be enlisted to correct the high-voltage situation.

- The SE **shall** use the generators to generate less reactive power via SCADA from the TOC as a first action.
- The STO or TO **shall** lower high-voltage transformer taps via SCADA from the TOC as a second action.
- The STO or TO **shall** switch capacitor banks in-service via SCADA from the TOC as a third action.
- The STO or TO **shall** switch reactors out-of-service via SCADA from the TOC (if capability exists).

3.3 Low-Frequency Alarm (Frequency at 59.8 Hz)

The following responses **shall** be used as needed to resolve the condition:

- The SE and STO or TO **shall** locate the condition of the low frequency, which for this alarm will always be island wide.
- The SE and STO or TO **shall** identify all generation resources available to be enlisted to correct the low frequency situation.
- The SE **shall** increase generation capacity using adequate reserves via SCADA from the TOC as the main action.
- The SE, STO and TO **shall** consider manual load shedding as a possibility if they deem additional generation **shall** not be available in time to halt the decrease in frequency prior to the 59.2 Hz auto under-frequency relay load shedding.

3.4 High-Frequency Alarm (Frequency at 60.2 Hz)

The following responses **shall** be used as needed to resolve the condition:

- The SE and STO or TO **shall** locate the condition of the high frequency, which for this alarm will always be island-wide
- The SE and STO or TO **shall** identify all generation resources available to be enlisted to correct the high-frequency situation
- The SE **shall** reduce generation (ramp down) via SCADA from the TOC as the main action

Appendix A: Glossary

Term	Definition
Transmission Operations Center (TOC)	The main control room for the LUMA transmission system and interconnected facilities. The TOC has certified Independent System Operators who are responsible for operation and communication with all Interconnected Facilities and the operation of 230 KV, 115 KV and 38 KV. systems
Bulk Power System (BPS)	Refers to all transmission and distribution system and related facilities, equipment and other assets related to the transmission and distribution system. The collection of interconnected transmission, generation, and control systems necessary to operate an integrated transmission system while maintaining reliability.
Capacitor	A device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator.
Controlled Reserves	The online generation capacity that is devoted to providing the fast up and down balancing service controlled by the Automatic Generator Control (AGC). In this capacity, this generation is capable to increase output in response to a decline in frequency and decrease output in response to an increase in system frequency.
Automatic Generator Control (AGC)	A computerized system that helps calculate the required parameters or changes to optimize the operation of generation units. The automatic generation control software uses real-time data such as frequency, actual generation, tie-line load flows, and the plant unit controller status to provide automatic electrical generation changes.
SCADA System	An acronym for the Supervisory Control and Data Acquisition computer system. It is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation or transmission system.
Spinning Reserves	Spinning reserve is defined as unloaded generation that is rotating in synchronism with a utility-grid, i.e., the spinning generator is rotating at a speed that will produce power at precisely the same frequency as the frequency of the grid power. A generation load that is online, begins responding immediately, and is fully responsive within 10 minutes.

Appendix B: Procedure Cross-Reference Matrix

Procedure Reference Matrix, Part 1 of 2	Short Term Load Forecasting	New Facility Interconnection	Resource Adequacy Planning	Interconnected Facility Retirements	Legacy T&G Demarcation	Interconnected Facilities Capabilities	Black Start	Telemetry	Cybersecurity	Root Cause Analysis & Corrective Actions	Public Reporting	Performance Reporting	Stakeholder Management	Policy on Reserves
Short Term Load Forecasting														
New Facility Interconnection														
Resource Adequacy Planning														
Interconnected Facility Retirements														
Legacy T&G Demarcation														
Interconnected Facilities Capabilities														
Black Start														
Telemetry														
Cybersecurity														
Root Cause Analysis and Corrective Actions														
Public Reporting														
Performance Reporting														
Stakeholder Management														
Policy On Reserves														
Reducing Risk Exposure to Contingencies														
Critical Loads														
Load Shedding														
Contingency and System Operating Limits Response														
Energy Dispatch, Scheduling and Merit Order														
Transmission Operations														
Plant Level Communications														
Balancing Frequency & Voltage														
Demand-Side Resources (Non-Wire Alternatives)														
System Operator Training														
Scheduling Planned T&G Outages														
Forced Outage														
Outage Execution & Closeout														
Emergency Response Execution														
Emergency Drills														

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Procedure Reference Matrix, Part 2 of 2	Reducing Risk Exposure to Contingencies	Critical Loads	Load Shedding	Contingency & System Operating Limits Response	Energy Dispatch, Shedding & Merit Order	Transmission Operations	Plant Level Communications	Balancing Frequency & Voltage	Demand Side Resources (NWA)	System Operator Training	Scheduling Planned T&G Outages	Forced Outage	Outage Execution & Closeout	Emergency Response Execution	Emergency Response Drills
Short Term Load Forecasting															
New Facility Interconnection															
Resource Adequacy Planning															
Interconnected Facility Retirements															
Legacy T&G Demarcation															
Interconnected Facilities Capabilities															
Black Start															
Telemetry															
Cybersecurity															
Root Cause Analysis and Corrective Actions															
Public Reporting															
Performance Reporting															
Stakeholder Management															
Policy On Reserves															
Reducing Risk Exposure to Contingencies															
Critical Loads															
Load Shedding															
Contingency and System Operating Limits Response															
Energy Dispatch, Scheduling and Merit Order															
Transmission Operations															
Plant Level Communications															
Balancing Frequency & Voltage								X							
Demand-Side Resources (Non-Wire Alternatives)															
System Operator Training															
Scheduling Planned T&G Outages															
Forced Outage															
Outage Execution & Closeout															
Emergency Response Execution															
Emergency Drills															

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