LUMA

Energy Dispatch, Scheduling & Merit Order

ENERGY DISPATCH, SCHEDULING & MERIT ORDER

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1.0 Executive Summary

This Energy Dispatch, Scheduling and Merit Order procedure focuses on the real-time operations of the Bulk Power System. This procedure describes how the Transmission Operations Center operators plan, dispatch, control generation resources, monitor the transmission of energy flow and respond to fluctuations throughout the shift. It also describes best practices for preparing and the scheduling of resources for each shift as well as guidance for utilizing and maintaining a merit order dispatch sequence. Preparing for each shift includes developing G-1 level contingency plans for the potential loss of any one interconnected generating plant and N-1 contingency plan for the loss of any transmission element.

2.0 Objective/Scope/Roles

2.1 Objective

The objective of this procedure is to provide direction to the Senior Shift Engineer, Shift Engineer, Senior Transmission Operator, and Transmission Operator to ensure reliable and safe supply of generation to meet system load requirements via Merit Order Dispatch while properly maintaining voltage and frequency.

2.2 Scope

This procedure provides System Operations with the detailed steps required for balancing the Bulk Power System. This includes establishing and maintaining Situational Awareness of the Bulk Power System at all times.

2.3 Roles and Responsibilities

This procedure describes the actions and decisions of the following roles:

2.3.1 Manager Control Center Operations (MCCO)

Responsible for oversight of the Transmission Operations Center (TOC) operations.

2.3.2 Senior Shift Engineer (SSE)

- Is responsible for the overall operation of the system and works directly with the SE, STO, and TO to manage the overall technical operation of all interconnected facilities in real-time.
- The operation of both the Monacillo and the Ponce TOCs.
- Provides direction and supervision to the SE, STO, and the TO.

2.3.3 Shift Engineer (SE)

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

2.3.4 Senior Transmission Operator (STO) and Transmission Operator (TO)

- The STO is responsible for the routing and balance of real and reactive power through the 230/115kV and the TO is responsible for the 38kV transmission lines and working with the SE to jointly manage energy needs.
- The STO and TO are responsible for coordinating with the SE regarding frequency regulation, transmission flows, outage status, recall times, as directed by the SSE.

3.0 Procedure

This procedure consists of three primary sets of steps. These steps outline the requirements of the SSE, SE, STO and TO to safely operate the BPS and the documentation and reporting requirements

- Preparation for each shift (Including the construction of a Shift Plan)
- Execution of the Shift Plan
- Ensure proper record-keeping and turnover to the next shift

NOTE: 3-Part Communication and the Phonetic Alphabet **shall** be used in all communications with all personnel.

3.1 Preparing for Each Shift

- The SSE, SE, STO, and TOs are each responsible to establish their Situational Awareness at the beginning of each shift.
- Conduct a thorough shift turnover from the previous SSE, SE, STO & TOs and learning the current state of all major elements of the system.
- Review the appropriate information and perform the necessary analysis (See Appendix D– Shift Turnover Checklist).
- The SSE, SE, STO, and TOs establish a Shift Plan for the current shift including any reasonable contingencies to that plan based on the current state, assets at their disposal and their experience.
- The SSE, SE, STO, and TOs are responsible to maintain Situational Awareness throughout the shift and work to proactively prepare for system problems and how to quickly mitigate contingency situations

- Any Shift Plan that does not conform to System Operations procedures, proper system configuration and adequate system reserves must seek approval from the SSE and record any exceptions in the SSE Log.

3.1.1 SE Pre-Shift Information Checklist

The SE **shall** review the following information before each shift:

- Daily Load Forecast Worksheet produced by the Lead Engineer Energy Planning (LEEP).
- Weather forecasting information – NOAA SJU https://www.weather.gov/sju/
- Latest Production Cost Data produced by System Operations displayed on SCADA system.
- Latest Economic Dispatch/Merit Order sequence.
- Historical System Generation Data (HSGDSDAT).
- Planned outage schedule (current shift and for next 7 days).
- Reserve requirement versus availability of reserves
- Shift logs from the same shift on the previous day.

Using this information, the SE **shall** complete the SE Shift Preparation Checklist in Appendix B.

3.1.2 STO and TO Pre-Shift Information Checklist

Each STO and TO will review the following information before each shift:

- List of all transmission assets that are offline due to maintenance, schedule or unscheduled and their Recall Times for this shift.
- List of transmission assets without a planned Recall Time.
- Planned outage schedule (next 7 days).

- Reference recommended weather service for the hourly ambient temperature information for the next 8 hours. Should also monitor for inclement weather, winds, and possible storm activity on a regular basis.
- Using this information, each STO and TO will complete the TO Shift Preparation Checklist in Appendix C.

3.1.3 Preparing the Shift Plan

The Shift Plan consists of the following:

- Dispatch Schedule.
- Transmission Status report.
- Contingency Plan for a G-1 event during the shift.

3.1.4 Stand up Meeting

The SSE **shall** call a standup meeting at the beginning of each shift. Standup meeting **shall** include the following:

- Shift Turnover report.
- Confirmation of the Load Forecast.
- Dispatch Schedule as prepared by the SE.
- Confirm that the Transmission Status report given by the TO supports the Dispatch Schedule.
- Report on G-1 contingency plan with input from SE and TO.

THE MEETING SHALL ALSO COVER ANY PROCEDURAL UPDATES OR COMMUNICATIONS FROM MANAGEMENT.

3.1.5 SE shall Validate Current Load Forecast

- SE shall obtain the Daily Load Forecast Worksheet produced by the Lead Engineer Energy Planner (LEEP).
- SE shall consult the historical system generation data (HSGDSDAT) for comparable days, considering the day of week, season, and weather. Review the previous day, week and year.
- SE shall reference recommended weather service for the hourly ambient temperature information for the next 8 hours, recording the time of sunrise and sunset in the Daily Load Forecast worksheet.
- SE shall monitor for inclement weather, wind and possible storm activity.
- SE shall verify the operating costs in the latest merit order sequence. If the operating cost for any unit exceeds the operating cost for the units subsequent in the merit order, notify the SSE and recommend the merit order be adjusted until no unit's operating cost exceeds that of a subsequent unit.
- SE shall refer to the Load Forecasting Procedure to determine if the provided Daily Load Forecast Worksheet requires any manual adjustment. If an adjustment is warranted, then elevate the concern to the SSE with a recommended capacity adjustment.
- SE shall implement any SSE recommended adjustments to the Daily Load Forecast and the merit order. Adjustments to the Daily Load Forecast can be made in the Manual Bias field of the Daily Load Forecast worksheet.
- SE shall document any changes to the Daily Load Forecast and Merit Order by recording the actions taken in the SE Operator's Daily Log and will submit to the SSE for approval.

3.1.6 SE shall Verify Generation Capacity and Availability

- At the beginning of every shift, the SE shall establish Situational Awareness regarding the current state and output of each generating unit as per the Energy Management System EMS, populating this information into the Daily System Condition Report, see Appendix I.
- At the beginning of every shift, the SE shall contact each of the plants to update the Generator Capability Checklist (see Appendix D Generator Capability Checklist of Interconnected Facilities Capability Procedure).
- SE shall calculate Spinning, Control, Fast Start and Contingent Reserves and update the Energy Management System (EMS), in accordance with the Policy on Reserves Procedure. and update the Daily Load Forecast Worksheet (see Appendix E for an example).
- SE shall verify the availability data provided by the plants against the EMS. Then update the EMS with the verified data, if necessary.

3.1.7 STO and TO shall Verify Transmission Status

- At the beginning of every shift, STO and TO shall establish Situational Awareness regarding the current state and output of each transmission asset per EMS.
- The STO and TO shall review all logged exceptions from the previous day that may impact the current shift. At the beginning of each shift, the STO and TO shall contact the responsible transmission maintenance teams to ensure that maintenance tasks for the shift are expected to be completed as scheduled, identifying Recall times where possible. See Appendix C– TO Shift Preparation Checklist.
- The STO and TO shall analyze which transmission resources could be recalled from maintenance during the current shift if required and the Recall Time.

3.1.7 SE shall Construct the Dispatch Schedule

- The SE **shall** print the updated Daily Load Forecast worksheet and review load forecast for the next 2 days.
- The SE, in consultation with the SSE **shall** identify which units are currently dispatched and which unit **shall** be dispatched during the shift, noting the unit, capacity and the approximate time of dispatch on the printed Daily Load Forecast considering transmission limitations and the following guidelines:
  - Schedule units from the North Power Plants for a total capacity equal to 30% of the Load Forecast for each hour (NORTH LOAD). The North power plants include San Juan SP, Palo Seco SP, Palo Seco GP, Cambalache GP, and Vega Baja GP. Units in the North shall be scheduled per the merit order.
- SE **shall** schedule renewable capacity following the example load curve in Appendix I, Solar Capability, of Interconnected Facilities Capability Procedure.
  - The curve shall begin at sunrise and end at sunset and have a capacity equal to the total of the renewables maximum capacity in the EMS.
  - Schedule AES and Ecoelectrica with the total optimal capability for cogeneration in the EMS.
  - Set the Spinning Reserve and Control Reserve per Policy on Reserves Procedure.
  - Schedule the remaining available units in merit order and dispatch to satisfy the Daily Load Forecast with consideration for the following constraints:
    - If the schedule cannot satisfy the Policy on Reserves, the SSE must seek approval from the MCCO and record any exceptions in the SSE Log.

3.2 Executing the Shift Plan

Executing the Shift Plan is based on the Amended Daily Load Forecast worksheet that was constructed at the beginning of the shift.

SE **shall** contact each of the plants regarding scheduled dispatch for the current shift, communicating the units to be dispatched and their anticipated timing.

3.2.1 Dispatching and Monitoring System Operations

- SE shall dispatch a combination of base load units, intermediary units and peaking units as available, to satisfy load forecast requirements.
- SE shall Designate or confirm Spinning Reserves as available per the Policy on Reserves Procedure Update the EMS accordingly.
- SE shall Dispatch the units per the Amended Daily Load Forecast when called for during the shift. Update the EMS Accordingly.
- While maintaining Situational Awareness, the SSE, SE, STO & TO **shall** monitor the system to maintain the following:
  - SE - Control Reserves within current shift limits [Hourly].
  - SE - Spinning Reserves within current shift limits [Hourly].
  - SE - Recalculate Contingent Reserves [Hourly].30
  - SE – **shall** Endeavor to maintain 30% of Generation from Northern Units.
  - SE - Contingency plan for the sunset of renewables [within 90 min of sunset].
  - SE - Re-validate contingency plans for G-1 event hourly when flows and loads are increasing [Hourly].

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- SSE, SE, STO, and TO – In the event of a G-1 event, execute the G-1 Contingency Plan in the current Shift Plan and rebalance Reserves following the Policy on Reserves.
- STO and TO - System frequency within the range of 59.8 Hz to 60.2 Hz per Balancing Frequency and Voltage Procedure. For Alarm condition handling recommendations see Balancing Frequency and Voltage Procedure.
- STO and TO - Alarm conditions for Transmission lines flows (Basic Signaling window). In an Alarm1 (80%), Alarm 2 (90%), or Alarm 3 (100%) condition refer to the Contingency and System Operating Limits procedure for recommended response and actions For Alarm1/Alarm2 conditions, dispatch additional generation, or utilize parallel lines, capacitor banks, tap changers, line optimization through load balancing and switching. For Alarm3 conditions, if load shedding is required, reference the Load Shedding and Critical Loads procedures.
- SE & SSE – Alarm conditions from generation plants (Basic Signaling Window). Review and acknowledge generation alarm (Alarm Summary Page - Generation). Contact appropriate personnel at the affected plant to confirm the alarm condition and review the resolution plan. If the plant requests to shut the unit down or reduce generation capacity, notify the SSE, negotiate an appropriate schedule for shutdown, or power reduction, and arrange for the dispatch of additional generation, as necessary. SSE to notify SO Management.

- The Monitoring System Operations workflow charts in Appendix G and H provide guidance on which procedure to follow when systems operate outside of nominal limits.
- Any events in which the system operates outside of System Operations procedures limits, the SSE shall seek approval from MCCO and be recorded in the SSE logbook.
- If there are situations when resources cannot meet system load and load shedding is being considered, refer to the Load Shedding procedure.

3.3 Shift Turnover

3.3.1 Shift Turnover Report

Shift Turnover Report from the exiting SE, STO, and TO (see Appendix D) **shall** cover the following points:

- Review any unit trips, and the previous shift's logs.
- Review the generation outage coordination.
- Review transmission line and significant equipment outages.
- Review the reserves as of the end of the previous shift.
- Review the Amended Daily Load Forecast Worksheet.
- Review and update the Automatic Generator Control (AGC) limits and Merit Order Dispatch sequence, if either has changed.

3.3.2 Complete Shift Requirements

The following tasks **shall** be completed before the end of the shift:

- Verbal shift report to SE, STO, and TO coming on shift (See Appendix B and C and D).
- Complete and submit to SSE all required shift reports.
- Preserve the original Amended Load Forecast Worksheet and any documents from Turnover Report and file accordingly.
- Ensure all significant events are logged appropriately.
- Procedure Deviation Forms are filed appropriately, Appendix J.

3.3.3 System Operations Procedure Exceptions & Reserve Exceptions

MCCO shall prepare a monthly control room logbook exception report by the fifth day of the following month that includes the following daily System Operations Procedure exception statistics:

- Monthly statistics on the total number of System Operations Procedure exceptions of each type of reserve, total duration of all summed exceptions in each type, and the total number of days out of the month that each System Operations Procedure was in an exception condition, including N-1 and G-1 situations.
- Summary statement characterizing each System Operations Procedure exception type and the impact the exceptions had on the ability to operate the BPS without impairing system safety, stability and reliability.
- Submit Monthly Reports to the Director System Operations.

Appendix A: Glossary

Term	Definition
Spinning Reserve	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.
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.
Economic Dispatch/Merit Order Dispatch	The merit order is a way of ranking available resources of energy in ascending order of price. Dispatching generation in this way, known as economic dispatch and is designed to minimize the cost of electricity. SOP: The short-term determination of the optimal output of generation facilities, to meet system load, at the lowest possible cost, subject to transmission and operational constraints.
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.
Energy Management System (EMS)	An energy management system is usually a collection of computer-aided tools used by operators of electric facilities to monitor, control, and optimize the performance of the generation and/or transmission system.
SCADA	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.
System Operations	Department in LUMA that operates the Bulk Power System
Recall Times	The amount of time required to restore a Transmission Line or Interconnected Facility to service that may either be currently out of service or that is scheduled to be taken out of service during the current shift.
Phonetic Alphabet	A communications technique used to help ensure that letters of the alphabet are accurately communicated. This is used in virtually all military communications. Examples: a=alpha, b=bravo, c= Charlie, d=delta, e=echo, f=foxtrot, f=Golf, etc.)
Three-Part Communication	The sender states the message, the receiver acknowledges the sender and repeats the message in a paraphrased form, and the sender acknowledges the receiver's reply.
Daily Load Forecast	Forecasts load by selecting similar historical days' data and then obtaining a weighted average from them.

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Term	Definition
Situational Awareness	Is the understanding of what is happening, why it is happening and what might happen next. It involves utilizing a questioning attitude to challenge assumptions and proactively operate the system to minimize or mitigate system events.
N-1 Contingency	Single Outage Contingency (N-1). The N-1 criterion is a minimum system security measure that the System Operator models the transmission network to address redundancy avoiding potential power interruptions. If a component (any transmission element) should fail or be shut down the network security must still be guaranteed.
G-1 Contingency	G-1 contingency is the loss or failure of individual equipment such as a generator or transformer. It simulates and quantifies the results of problems that could occur in the power system in the immediate future.

Appendix B: SE Shift Preparation Checklist

Start-of-Shift Checklist	
Gather Information	
☐	Get Daily Load Forecast Worksheet
☐	Review Weather Data
☐	Review Production Costs Data on SCADA
☐	Obtain Most Recent Merit Order Sequence
☐	Retrieve Historical Load Data
☐	Planned Generation Outage Information
Define Dispatch Plan for Shift	
☐	Verify Unit Production Cost Data
☐	Verify Load Forecast Inputs
☐	Verify Generation Capacity and Availability
☐	Construct and Communicate Dispatch Schedule for Current Shift

Completed by: _____

Date: _____

Shift: _____

Appendix C: TO Shift Preparation Checklist

TO Shift Preparation Checklist	
Review and update the following:	
☐	Latest list of all transmission assets that are currently offline due to maintenance
☐	List of all maintenance outages to begin during the shift and their Recall times
☐	Contact each maintenance team to confirm the maintenance schedule and Recall time
☐	Update maintenance schedules as necessary
☐	Determine which lines could be recalled if required and necessary Recall times

Completed by: _____

Date: _____

Shift: _____

Appendix D: Shift Turnover Checklist

Shift Turnover Checklist	
Verify and discuss the status of the following:	
☐	Review any unit trips SO Policy exceptions, and previous shift logs (SE & TO)
☐	Review the generation outage coordination (SE)
☐	Review transmission line and significant equipment outages (TO)
☐	Review the reserves as of the end of the previous shift (SE)
☐	Review the Amended Daily Load Forecast Worksheet and the G-1 contingency plan for the previous shift (SE)
☐	Review and update the AGC limits and other Merit Order Dispatch sequence data, if either has changed (SE)

Completed by: _____

Date: _____

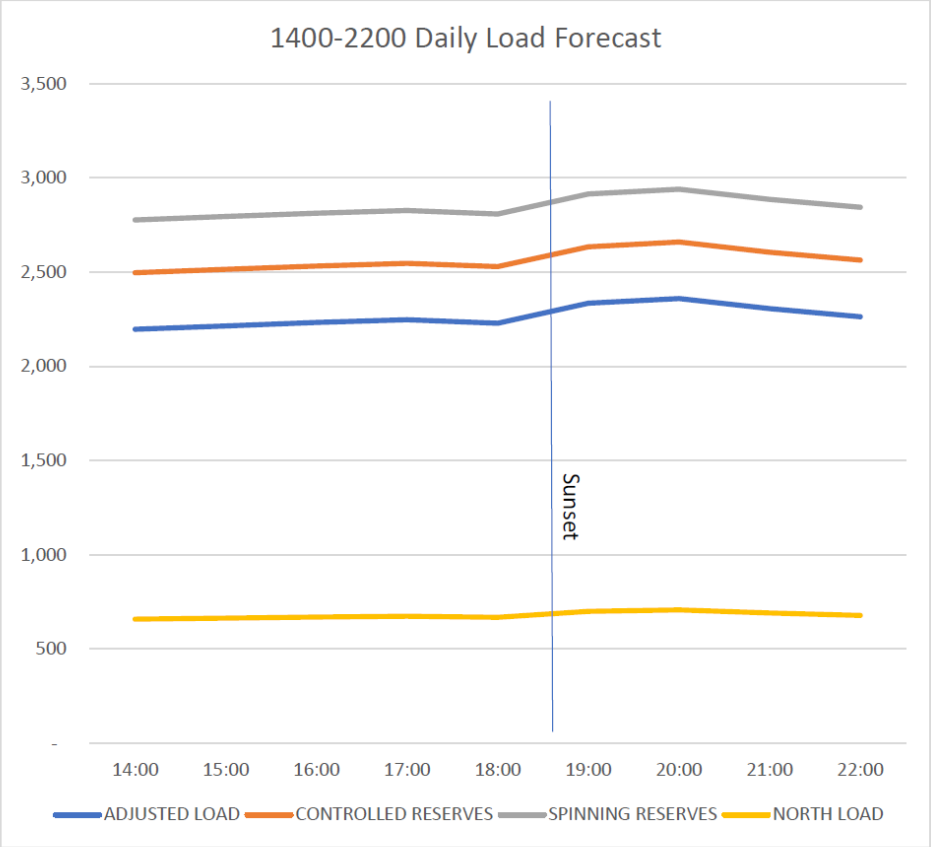
Shift:

Appendix E: Daily Load Forecast Worksheet

Daily Load Forecast Worksheet

DATE	TIME	PLANNED LOAD	ADJUSTED LOAD	CONTROLLED RESERVES	SPINNING RESERVES	NORTH LOAD
3/4/2021	14:00	2,097	2,197	2,497	2,777	659.10
3/4/2021	15:00	2,115	2,215	2,515	2,795	664.50
3/4/2021	16:00	2,133	2,233	2,533	2,813	669.90
3/4/2021	17:00	2,147	2,247	2,547	2,827	674.10
3/4/2021	18:00	2,129	2,229	2,529	2,809	668.70
3/4/2021	19:00	2,235	2,335	2,635	2,915	700.50
3/4/2021	20:00	2,260	2,360	2,660	2,940	708.00
3/4/2021	21:00	2,206	2,306	2,606	2,886	691.80
3/4/2021	22:00	2,164	2,264	2,564	2,844	679.20

Sun Rise 6:38 Sun Set 18:31



Appendix F: 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 & Merit Order	X	X	X	X	X	X	X	X		X	X	X		X
Transmission Operations														
Plant Level Communications														
Balancing Frequency and Voltage														
Demand-Side Resources (NWA)														
System Operator Training														
Scheduling Planned T&G Outages														
Forced Outage														
Outage Execution and Closeout														
Emergency Response Execution														
Emergency Response Drills														

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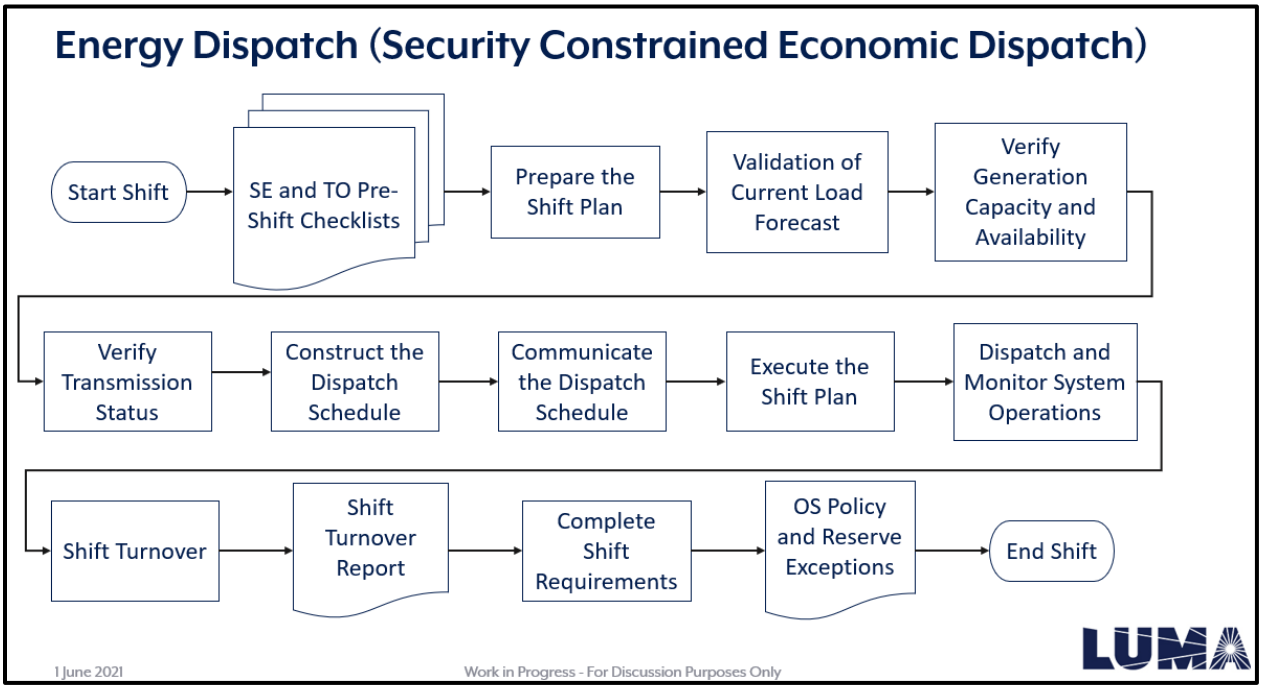
Procedure Reference Matrix, Part 2 of 2	Reducing Risk Exposure to Contingencies	Critical Loads	Load Shedding	Contingency & System Operating Limits Response	Energy Dispatch, Shedding & Merit Order	Transmission Operations	Plant Level Communications	Balancing Frequency & Voltage	Demand Side Resources (NWA)	System Operator Training	Scheduling Planned T&G Outages	Forced Outage	Outage execution & Closeout	Emergency Response Execution	Emergency Response Drills
Load Forecasting															
New Facility Interconnections															
Resource Adequacy Assessments															
Retirements															
Legacy T&G Demarcation															
Generator capability															
Black Start															
Telemetry															
Data/Cybersecurity															
Root Cause & Lessons Learned															
Public Reporting															
Performance Reporting															
Stakeholder Management															
Policy on Reserves															
Reducing Risk Exposure to Contingencies															
Critical Loads															
Load Shedding															
Contingency & System Operating Limits															
Energy Dispatch, Scheduling & Merit Order	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Transmission Operations															
Plant Level Communications															
Balancing Frequency and Voltage															
Demand-Side Resources (NWA)															
System Operator Training															
Scheduling Planned T&G Outages															
Forced Outage															
Outage Execution and Closeout															
Emergency Response Execution															
Emergency Response Drills															

Appendix G: TO Monitoring System Operations Workflow



Appendix H: Transmission Operations Center (TOC) Room Layout

Appendix I: Daily Generation Status Report

LUMA						
Informe Diario Condiciones Del Sistema						
Fecha: Day of Week, Month Day, Year						
Turno	Turno 10-6		Turno 6-2		Turno 2-10	
	Min	Max	Min	Max	Min	Max
Turno Ing.	Hinojosa		Davey		Monasterio	
Generator Name 1						
Turno Ing.	Walker		Hinojosa		Campone	
Generator Name 2						
Turno Ing.						
Generator Name 3						
Turno Ing.						
Generator Name 4						
Turno Ing.						
Generator Name 5						
Turno Ing.						
Generator Name 6						
Turno Ing.						
Generator Name 7						
Turno Ing.						
Generator Name 8						
Turno Ing.						
Generator Name 9						
Turno Ing.						
Generator Name 10						
Turno Ing.						
Generator Name 11						

Appendix J: Procedure Deviation Form

APPENDIX J EXAMPLE: Procedure Deviation Form
Date:
SSE:
Reason for Deviation:

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