Synchronized Reserve Deployment

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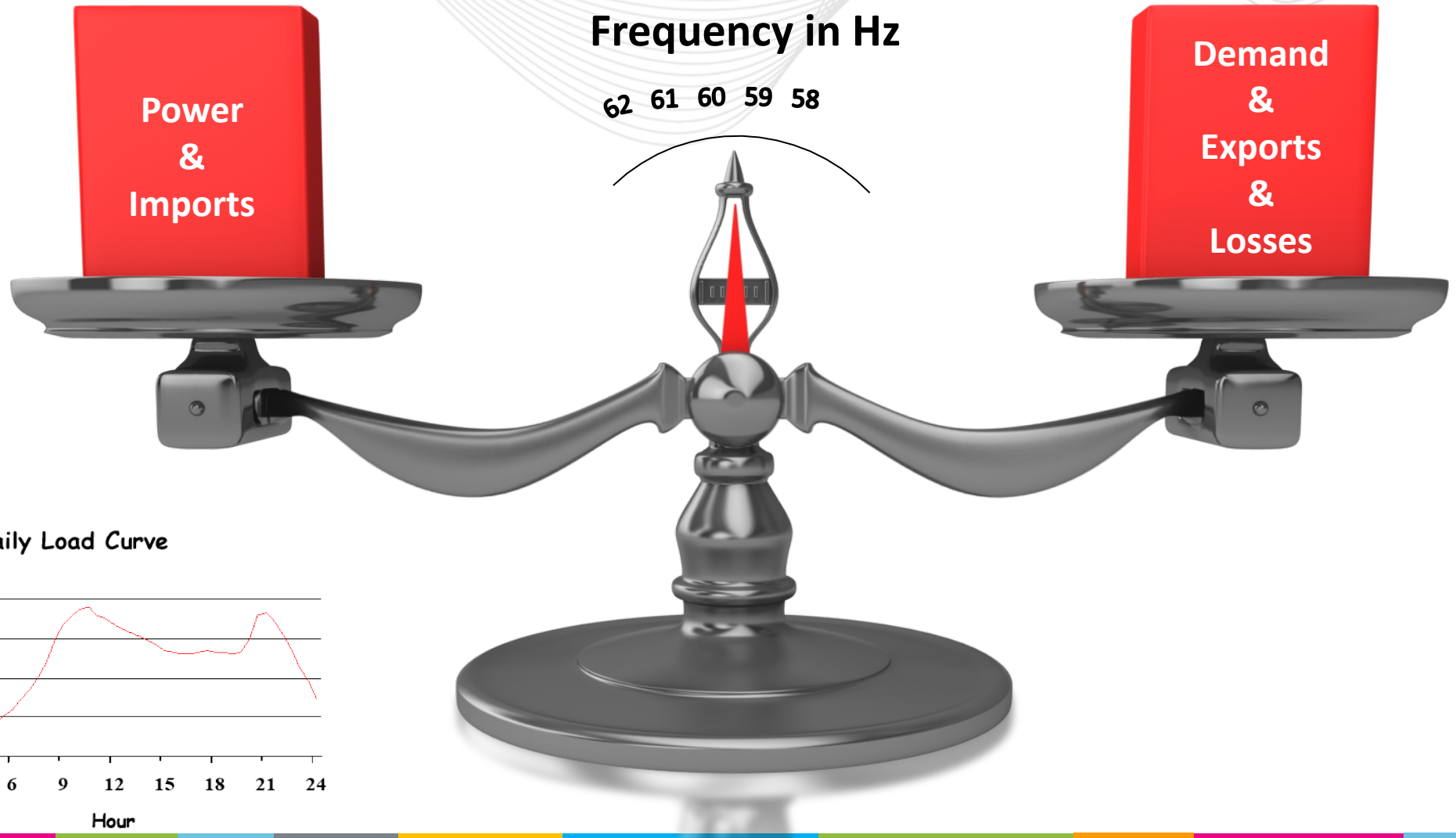
October 26, 2023

Achieving Energy Balance



ACE Equation

$$\mathbf{ACE} = (NI_A - NI_S) - 10B\,(F_A - F_S) - I_{ME}$$

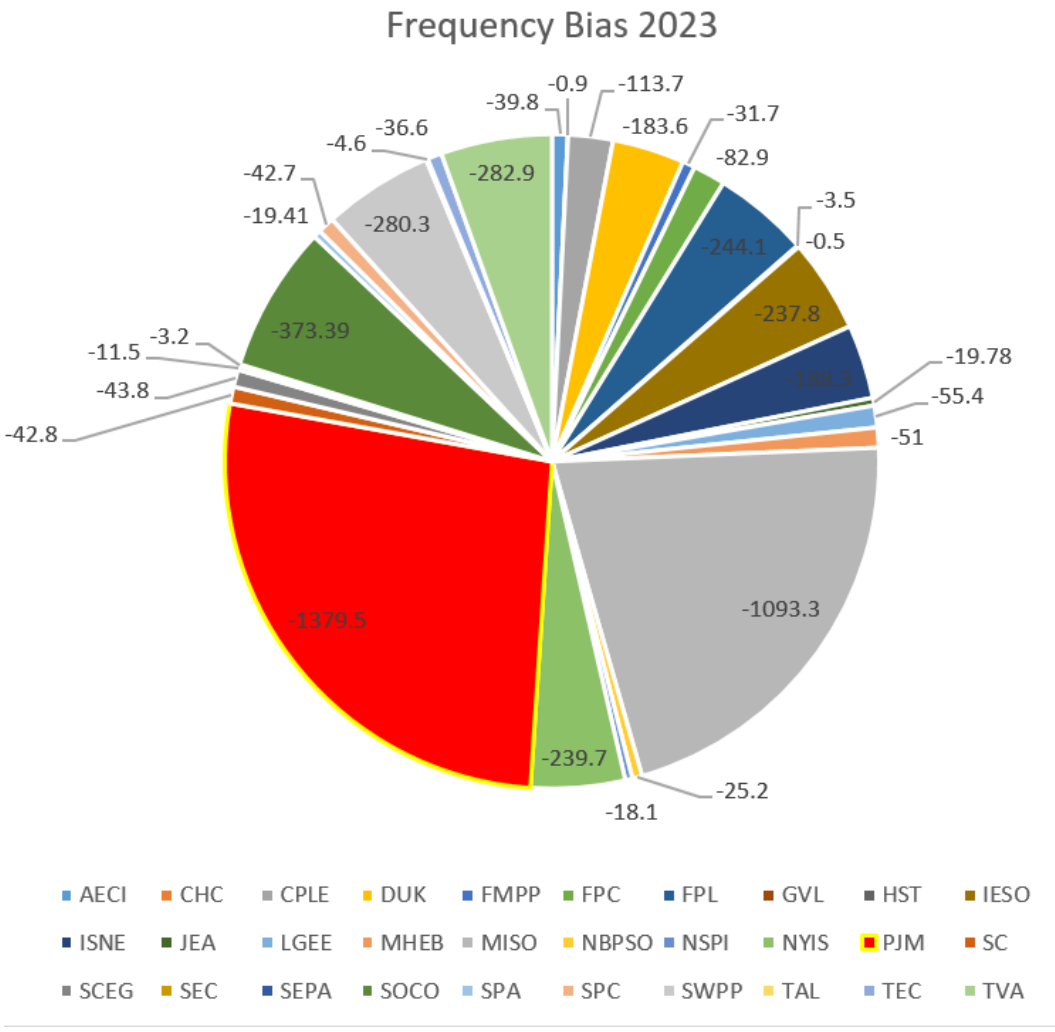
Where:

NI_A	is the algebraic sum of actual flows on all tie lines (i.e., Actual Net Interchange)
NI_S	is the algebraic sum of scheduled flows on all tie line (i.e., Scheduled Net Interchange)
B	is the Frequency Bias Setting (MW/0.1 H_Z) for the Balancing Authority. The constant factor of 10 converts the frequency setting to MW/ H_Z
F_A	is the actual frequency
F_S	is the scheduled frequency
I_{ME}	is the meter error correction factor

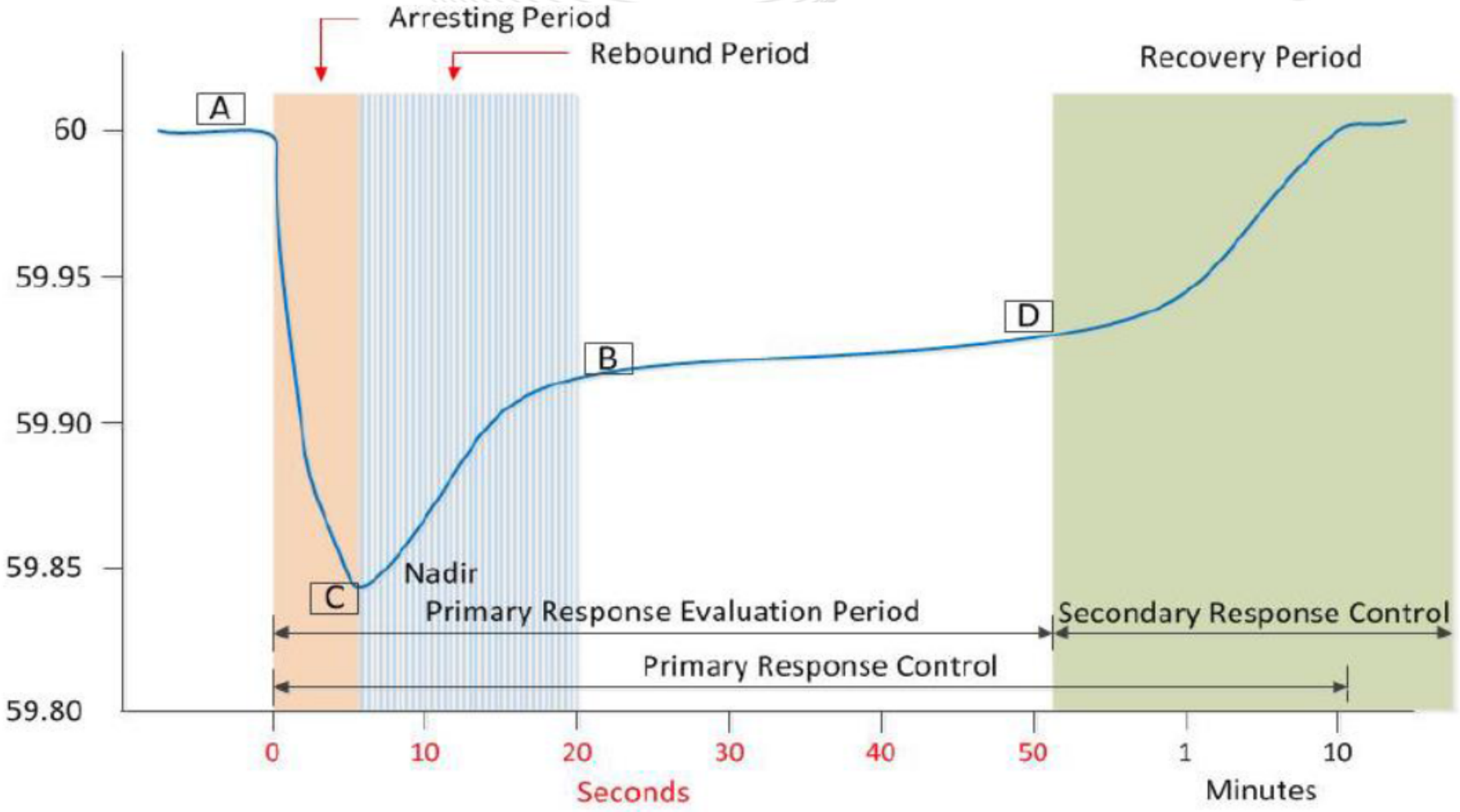
2023 Frequency Bias Settings

[1]

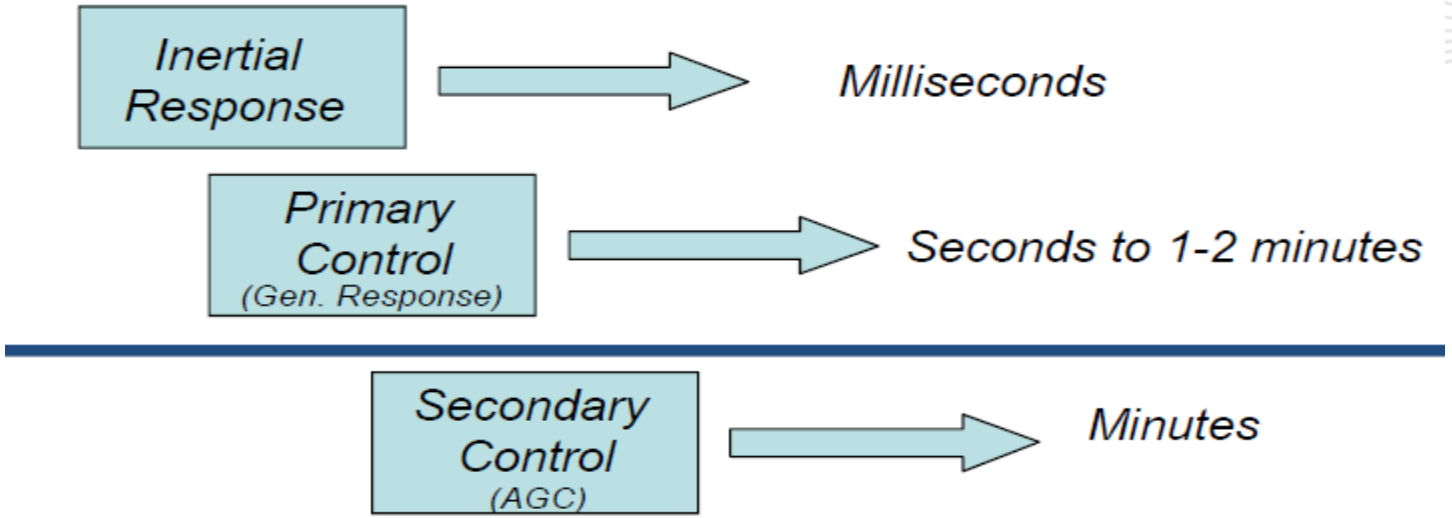
BA	%	Frequency Bias 2023
PJM	27%	-1379.5



Classic Frequency Excursion Recovery



Types of Control



Control	Service	Timeframe
Inertial Control	Inertia	0-10 Seconds
Primary Control	Primary Frequency Response	10-60 Seconds
Secondary Control	Regulation / Reserves	1-10 Minutes
Tertiary Control	System Re-dispatch (SCED)	10-30 Minutes

Synchronized Reserve Event Timing

Unit Trip or Low ACE

PJM Dispatcher starts event in EMS (ICCP/DNP3 point) and sends ALL-CALL message

Resources manually load reserves until event ends (ICCP/DNP3 point and/or ALL-CALL)

ICCP/DNP3 point – 10 seconds
ALL-CALL – 10 seconds – 2 minutes

NERC Standards

- NERC Reliability Standards aim to regulate and ensure the quality of North American bulk power system
- They set the **minimum** requirements regarding the reliability, efficiency, safety and risk management of operations that provide bulk power
  - PJM operates more conservative than NERC standards
- Reliability standards are enforceable in all interconnected jurisdictions in North America
  - Section 215 of the Federal Power Act
  - Required in 2005 post 2003 blackout
- "BAL" Standards: Resource and Demand Balancing [2]
  - Reliability guidelines provided [3]
- PJM is the Balancing Authority (and RC, TOP, PC, TSP)

PJM Dispatcher Actions

- Implement Synchronized Reserves and/or Quick Start Reserves
  - Typically 100% but a smaller percentage could be requested
    - Can be for entire RTO or limited to a specific subzone
  - This action will send an initiating signal to Resource Owners capable of receiving the signal using ICCP or DNP3 protocols
  - PJM dispatcher will follow up with a PJM ALL-CALL Message
  - Quick Start (Non-Synchronized) Reserves can be called for energy
  - A Reportable Balancing Contingency Event (DCS) is the lesser of 900 MW or 80% of Most Severe Single Contingency
  - PJM will request NPCC shared reserves, as required
  - As soon as possible, PJM Dispatcher approves new SCED case which includes lost resource
    - Economically increases generation and restores reserves

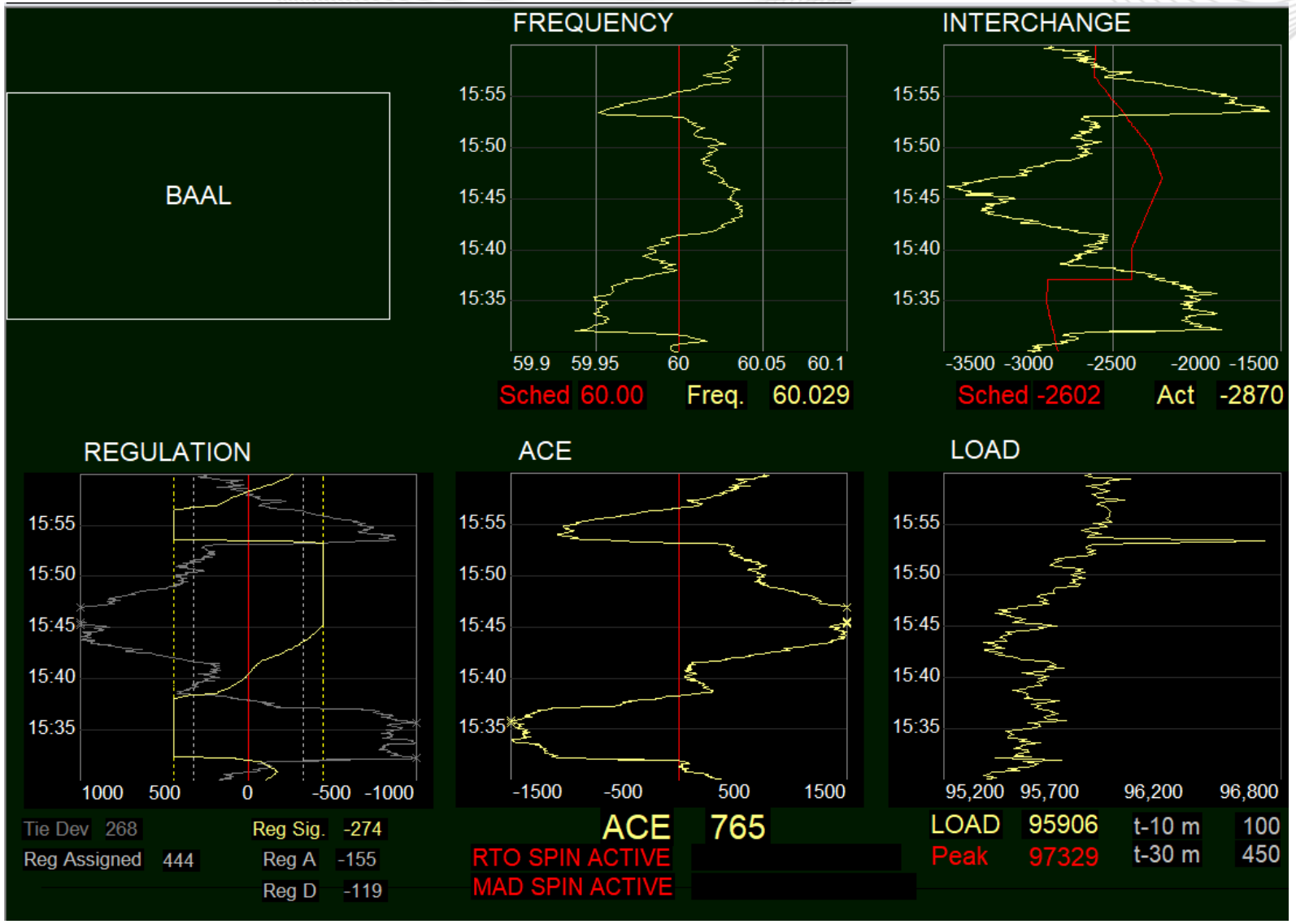
PJM Manual M-12 – Balancing Operations
Section 4.1.2 Loading Reserves

PJM Member Actions

- Resource owners with Real time Synchronized Reserve assignments:
  - Without regard to price and as quickly as possible, load the requested amount and type of reserves
    - Immediately after receiving either the PJM ICCP signal, DNP3 signal, or PJM ALL-CALL Message
    - Continue to load any available reserves until directed by the PJM dispatcher to discontinue
    - Resources should not follow economic basepoints during a Synchronized Reserve event as these basepoints do not reflect the loading of reserves
    - Resources providing Regulation service should only provide Synchronized Reserves to the extent that they can quickly resume accurate Regulation control following the event

PJM Manual M-12 – Balancing Operations
Section 4.1.2 Loading Reserves

5/16/2022 Example



References

- [1] 2023 Frequency Bias Annual Calculations
  - https://www.nerc.com/comm/OC/RS%20Landing%20Page%20DL/Frequency%20Response%20Standard%20Resources/OY_2023_Frequency_Bias_Annual_Calculations.pdf
- [2] NERC Reliability Standards
  - https://www.nerc.com/pa/Stand/Pages/ReliabilityStandards.aspx
- [3] Reliability Guideline Operating Reserve Management
  - https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Reliability_Guideline_Operating_Reserve_Management-v4-clean.pdf

Acronyms

Acronym	Term & Definition
ACE	**Area Control Error** A measure of the imbalance between sources of power and uses of power within the PJM RTO. The ACE calculation uses the difference between scheduled and actual net interchange plus the PJM RTO frequency bias contribution.
DCS	**Disturbance Control Standard** The NERC DCS measures the ability of a control area to return Area Control Error either to zero or to its initial value following the loss of a large generating unit.
NPCC	**Northeast Power Coordinating Council** The Regional Entity comprised of ISO-NE, NY-ISO, IESO, and New Brunswick.
ICCP	**Inter-Control Center Protocol** An industry standard protocol used to communicate real-time data between control centers. PJM uses this to send and receive operations analog data measurements and digital measurements.
DNP3	**Distributed Network Protocol 3** A set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water companies. Usage in other industries is not common.

PJM Glossary

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Synchronized Reserve Deployment

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PROTECT THE POWER GRID

THINK BEFORE YOU CLICK!

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Report suspicious email activity to PJM.

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