EIPC
Eastern Interconnection Planning Collaborative

Frequency Response Task Force

ISO New England Planning Advisory Committee Update

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March 21, 2019

EIPC Purpose

- Develop an open and transparent process through an interactive planning dialogue with industry stakeholders
- Foster additional consistency and coordination in the Eastern Interconnection
- Provide an interface with other interconnections
- Provide policy makers and regulators with current and technically sound transmission planning information

Frequency Response Task Force

- Created July 2017 by EIPC Technical Committee in response to request from North American Electric Reliability Corporation (NERC) Essential Reliability Services Working Group (ERSWG)
  - ➢ Change in generation resource mix / reduced inertia due to non-synchronous generation
  - ➢ Concern with potential exposure to Under-frequency Load Shedding (UFLS) events
  - ➢ Need for improved frequency responsive simulation models
  - ➢ Establish trending of interconnection frequency response over time

Objectives

- Determine Measures 1, 2, and 4 from the ERSWG Measures Framework Report for the Eastern Interconnection (EI)
  - ➢ Measurement 1 – Synchronous Inertial Response (SIR) of EI
  - ➢ Measurement 2 – Initial Frequency Deviation Following Largest Contingency
  - ➢ Measurement 4 – Frequency Response at Interconnection Level
- Additional EIPC EI Measure
  - ➢ Calculate MW margin (<= 10,000 MW) before reaching 59.5 Hz nadir

Objectives – Measurement 1

- Measurement 1 – Synchronous Inertial Response (SIR) of EI
  - Measure of kinetic energy at the interconnection level. It provides both a historical and future (5-years-out) view.

vs.

Objectives – Measurement 2

- Measurement 2 – Initial Frequency Deviation Following Largest Contingency
  - At minimum SIR conditions from Measure 1, determine the frequency deviation within the first 0.5 seconds following the largest contingency (as defined by the Resource Contingency Criteria [RCC] in BAL-003-1 for each interconnection).

Objectives – Measurement 2, cont.

- Calculated ERCOT System Frequency Response after largest generation trip (2010-2017)
- Shows inertial response of system with increased wind penetration

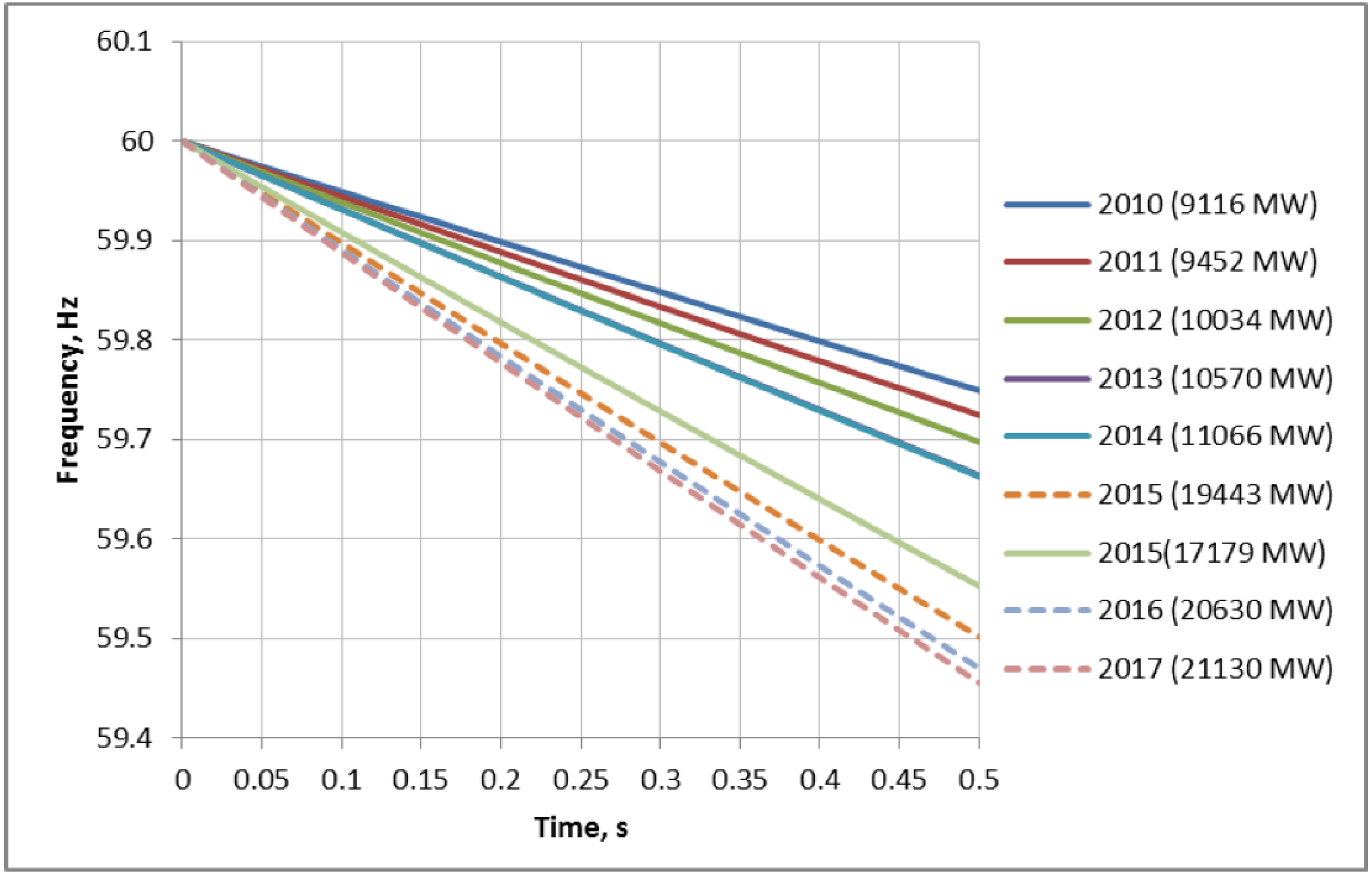

Figure 2 from NERC Essential Reliability Services Task Force: Measures Framework Report, November 2015

Objectives – Measurement 4

- Measurement 4 – Frequency Response at Interconnection Level
  - ➢ Measure 4 is a comprehensive set of frequency response measures at all relevant time-frames (A, B, C, C', etc…)
- Frequency response example for large disturbance in EI
- Demonstrates governor withdrawal in red shaded region

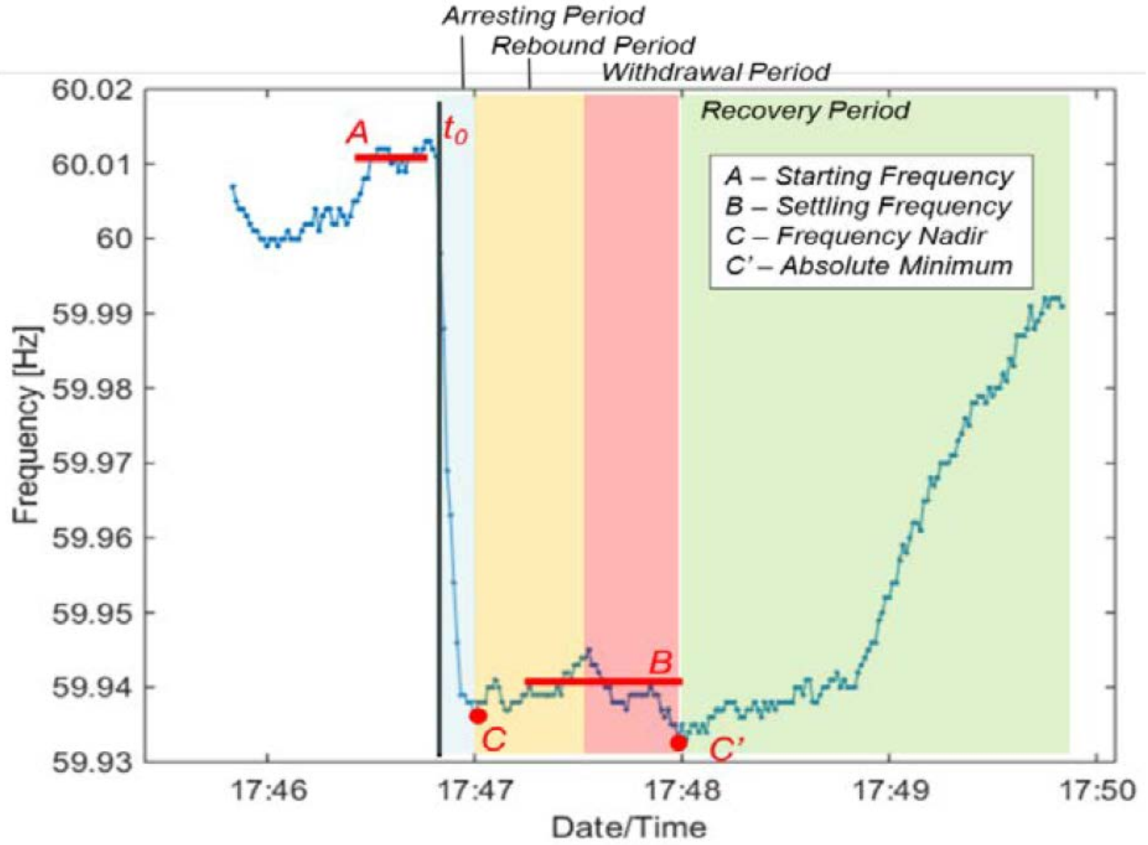

Figure 4 from NERC Essential Reliability Services Task Force: Measures Framework Report, November 2015

Results – Measurement 4 – MSSC 2,513 MW

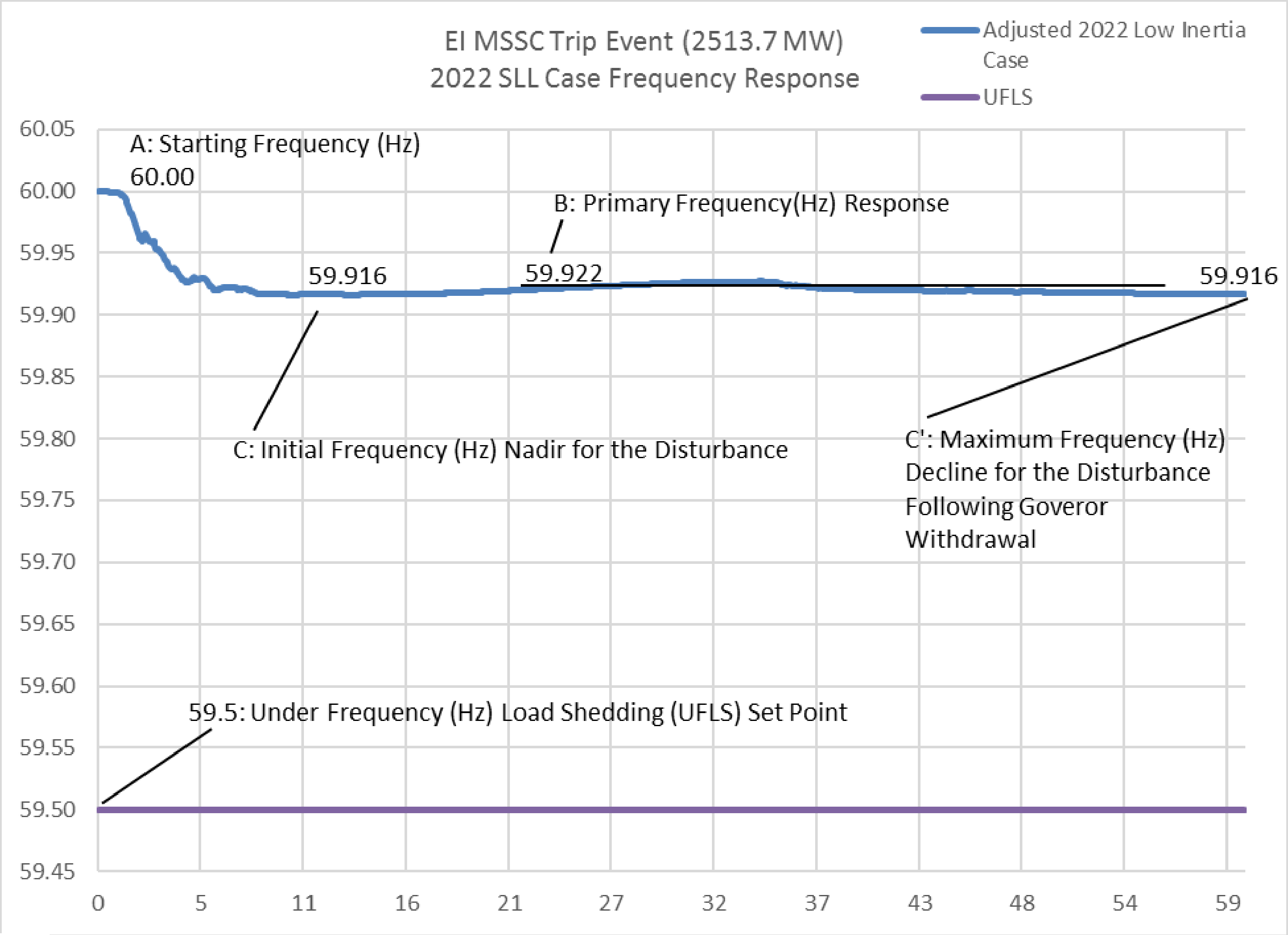

Figure 6-17 from EIPC FRTF 2018 Final Report

Results – Measurement 4 – 3,100 MW Event

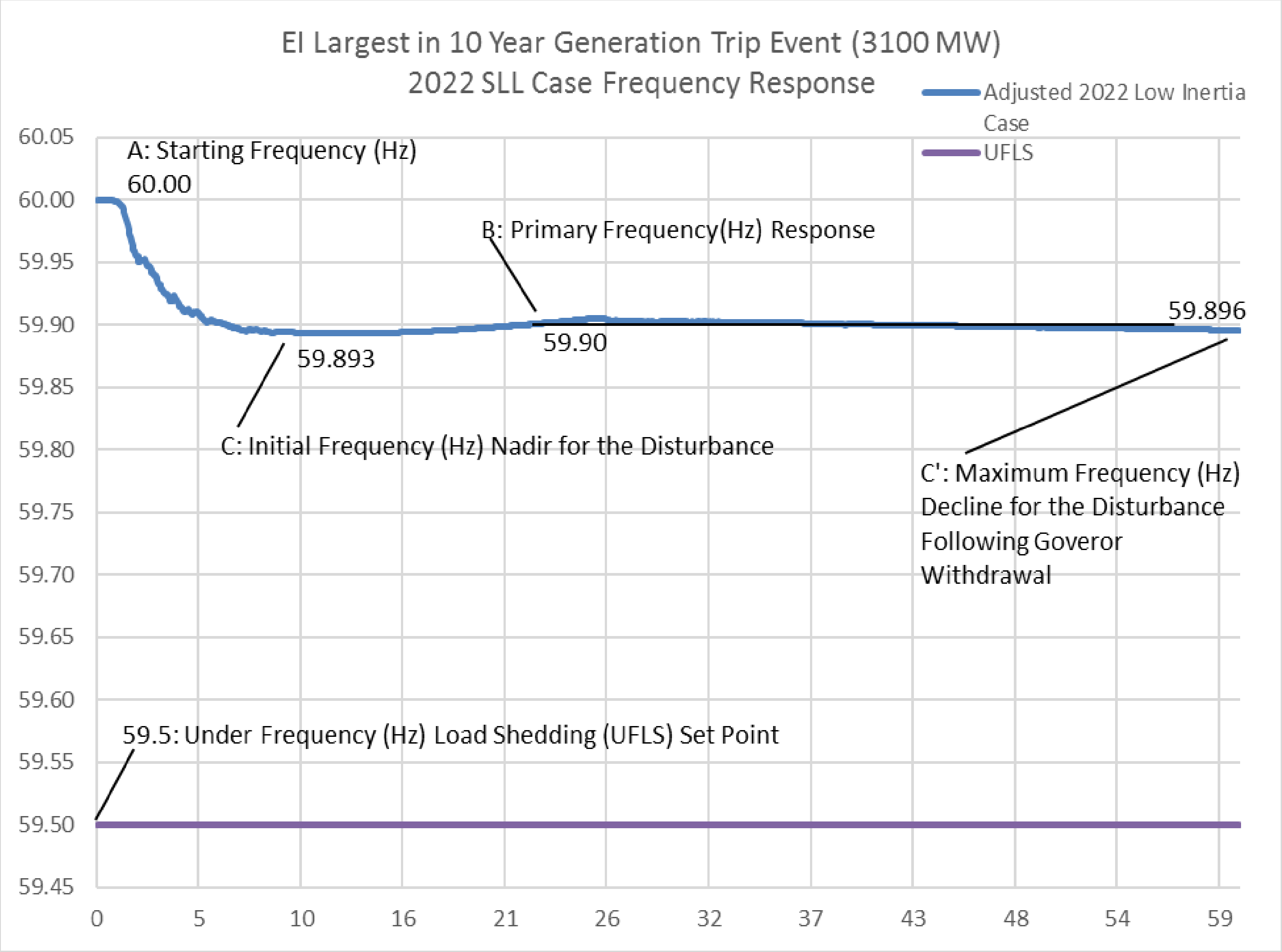

Figure 6-16 from EIPC FRTF 2018 Final Report

Results – Measurement 4 – 4,500 MW Event

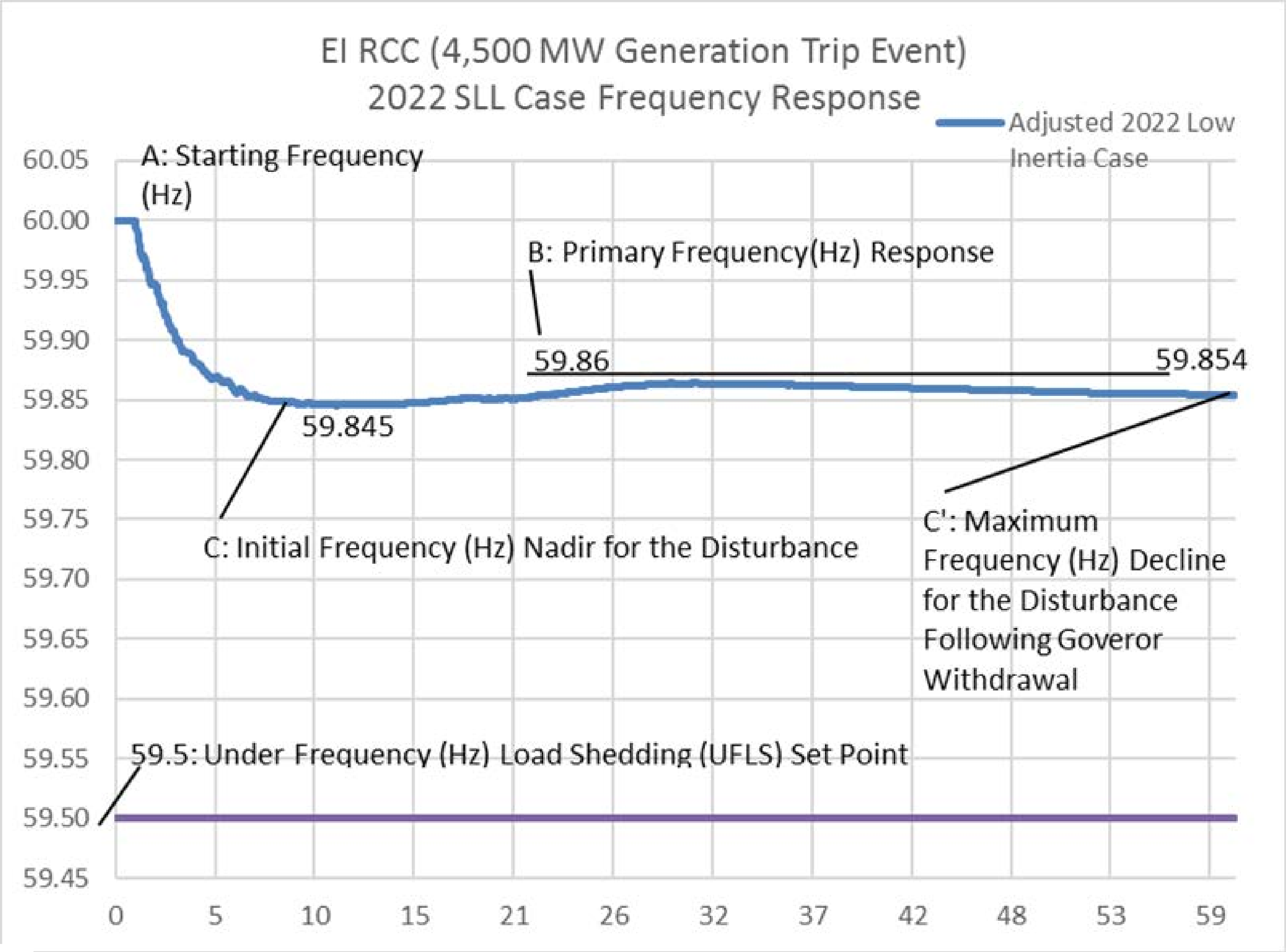

Figure 6-15 from EIPC FRTF 2018 Final Report

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Results – Measurement 4 – 10,000 MW

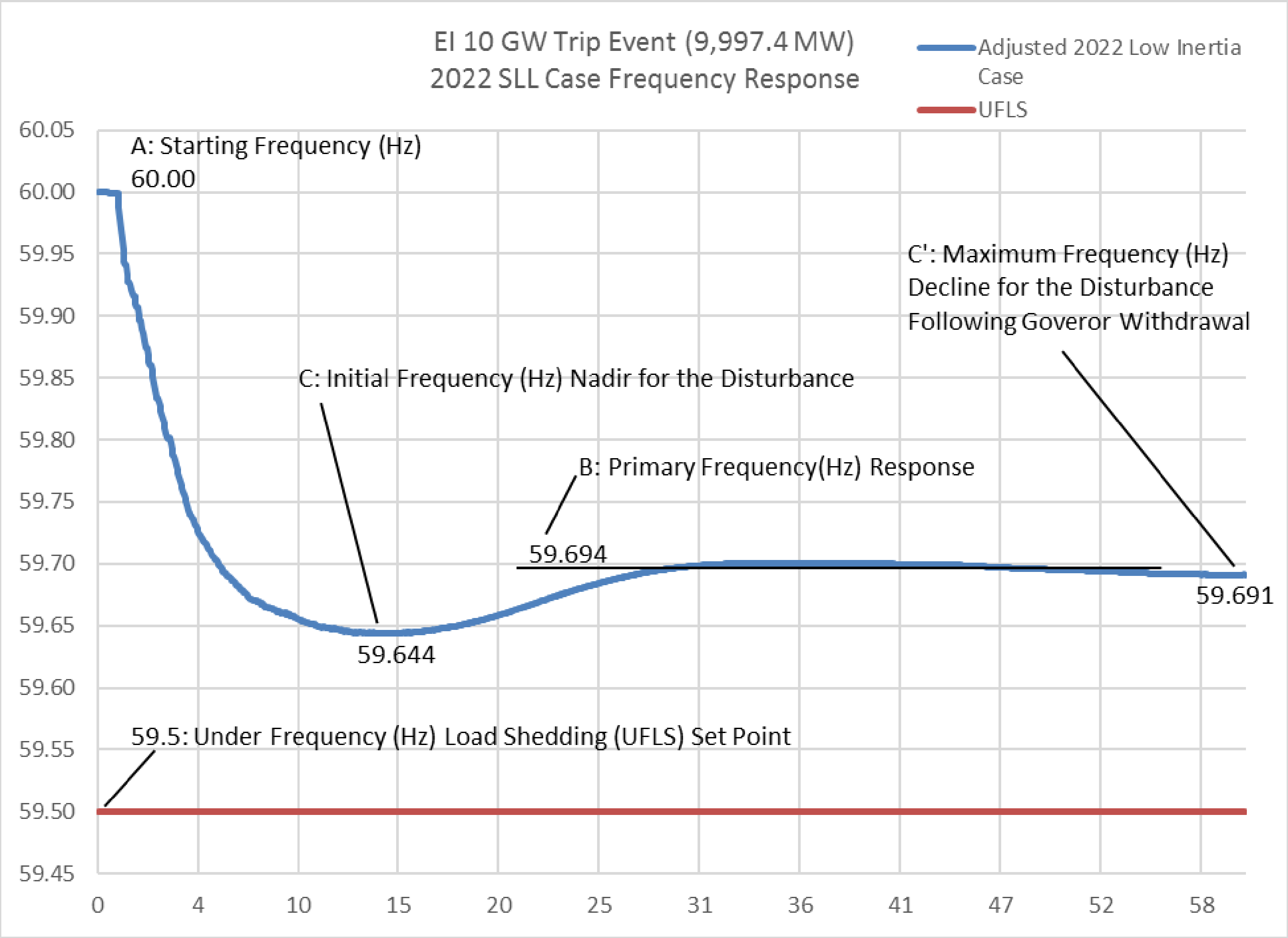


Figure 6-18 from EIPC FRTF 2018 Final Report

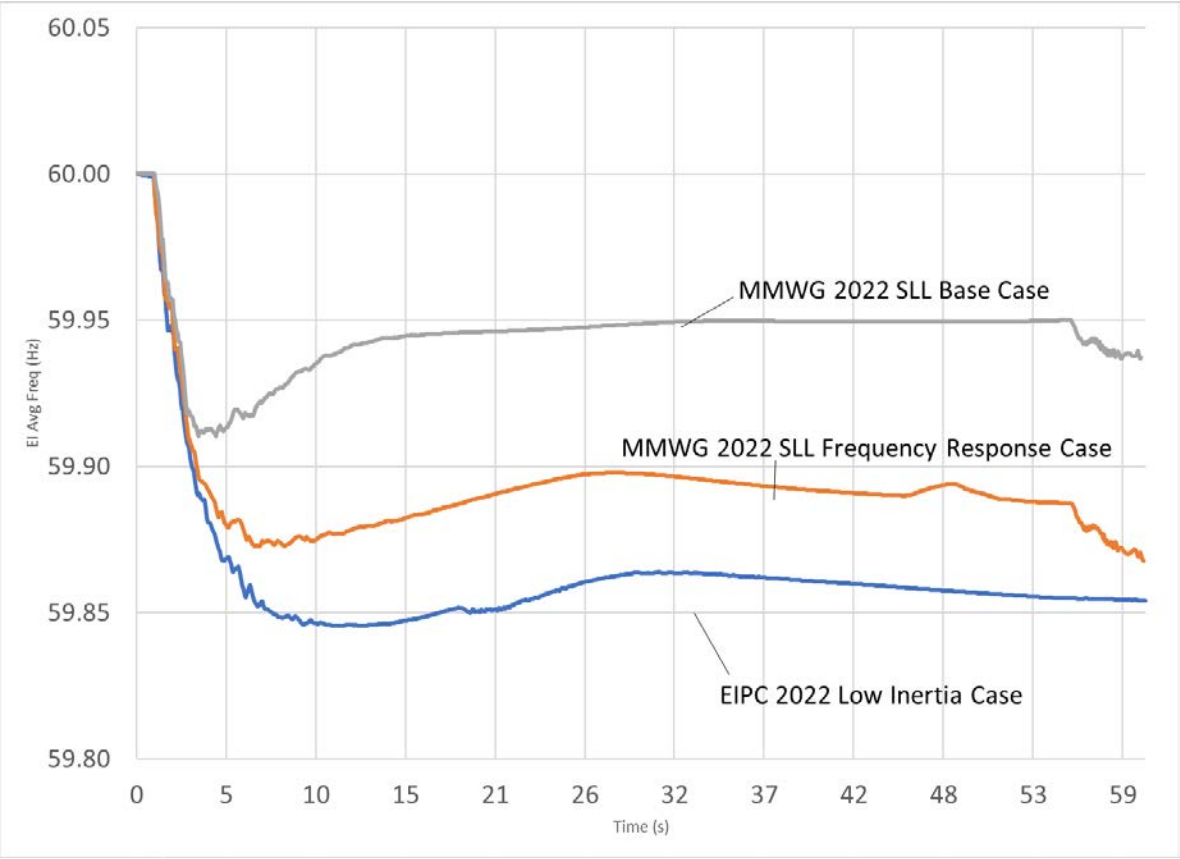
FRTF 2018 Report Recommendations

- Work with NERC to remove the 4,500 MW event from testing for the EI
- The FRTF developed 4 recommendations for modeling as a result of the 2018 analysis
  - #1 – Generator Gross Maximum Power Ratings
  - #2 – Generator Governor Modeling
  - #3 – Frequency Responsive Dynamics Files
  - #4 – Need for New Low Inertia / Minimum Load Library Case
- Recommendation 4 is discussed in more detail on the following slides, recommendations 1-3 are described more in detail as an appendix of this presentation and in the report
- The report will be posted publically on EIPC website late March / early April

Recommendation #4 – Need for a Minimum Load / Low Inertia Library Case

- Recommendation: The Multi-regional Modeling Working Group (MMWG) should consider the benefits of creating a new, or at a minimum replace an existing case(s) of the current library set that reflects a historically low inertia / minimum load time period for long-term power flow and transient stability models.
- Currently the best option available for a frequency response study is the 5 year out Spring Light Load (SLL) case which does not currently match recorded historical min inertia recorded for the EI.
- Note: EIPC is working with EI Data Sharing Network (EIDSN) to review and update if necessary the models they are using to calculate EI inertia

Recommendation #4 – Need for a Minimum Load / Low Inertia Library Case, cont.



- There is a significant difference in response from SLL library case to modified EIPC low inertia case
- The modeled load and inertia in the SLL case is much higher than historical low inertia

Data Source	Time of Year	Inertia (GVA-s)	Load (GW)
MMWG 17Series_22SLL	4/15 early morn	1,671	297
2017 EI Historical	5/7/17 2:43AM	1,038	215
Difference		-37.9%	-27.6%

FRTF 2019-2020 Scope of Work

- Build min load / low inertia case starting with 2018 Series 2023SLL MMWG library case in 2019 Q3-Q4
  - Update to expected low inertia conditions based on lowest recorded inertia observed in 2018
    - Work with EIDSN to coordinate future calculation of EI inertia and load
  - Update to reflect planned synchronous resource retirements and non-synchronous resource additions (wind, solar, HVDC, etc.) expected in 2023
  - Case will then be used in early 2020 to submit data to NERC for 2020 LTRA in July
- Work with MMWG to improve future library cases w.r.t. frequency
  - Use 2018 recommendations as points of emphasis in future frequency responsive case builds
  - 2019 Main Goal: Add minimum load / low inertia case to 2020 case library

Questions?

Appendix:
2018 FRTF Recommendations

Recommendation #1 – Gross PMax

- Recommendation: The MMWG should emphasize to generator data submitters the importance of using Gross MW capability for PMAX and inclusion of generator auxiliary load in the case models.
  - For frequency studies, generator Gross MW output is necessary
  - Gross PMax will correctly represent the range of the turbine-governor capability needed for dynamics models of governors
  - Netting out of station service load can also have an effect on the frequency response of the system

Recommendation #2 – Governor Modeling

- Recommendation: The MMWG should emphasize to generator data submitters the importance of appropriate selection and coordination of the frequency and turbine-governor related model parameters such as Governor Droop, Governor Dead Band, and Maximum Turbine Power.
- With the upcoming PSS/E version change to 34, governor models can fully implement dead bands. As part of the MOD-027 process, it should be stressed to generator owners to provide accurate governor models with dead bands

Recommendation #3 – Frequency Responsive Dynamics Files

- Recommendation: The MMWG should consider the benefits of including Load-Frequency Response Characteristic Models as part of the annual MMWG Dynamics Update process.
  - Load frequency response is a significant contributor to slowing the decay of frequency, particularly in the initial seconds after the loss
  - The tracking of the expected decay of load frequency response due to more electronic loads will help the interconnection detect an issue prior to it becoming a problem on the system

Recommendation #4 – Need for a Low Inertia / Minimum Load Library Case

- Recommendation: The MMWG should consider the benefits of creating a new, or replacing an existing case(s) of the current library set that reflects a historically low inertia / minimum load time period for long-term power flow and transient stability models.
- Currently the best option available for a frequency response study is the 5 year out SLL case
  - YYYY+5SLL Case: 1,671 GVA-s of inertia, 297 GW of load
  - EI 2017 Low Inertia Event: 1,038 GVA-s of inertia, 215 GW of load
  - EI 2017 Lowest Recorded Load: 167 GW
  - The historical low inertia case has ~38% less inertia and ~28% less load

Recommendation #4 – Need for a Low Inertia / Minimum Load Library Case, cont.

- The large differences in inertia and load make it difficult to represent an interconnection wide low inertia event using existing library
- Benefits of a low inertia / minimum load case
  - ➢ Ability to study high voltage events during low loads
  - ➢ Ability to accurately capture frequency response of the system
  - ➢ Ability to study weak grid situations for high renewable penetrations