BAL-003 Frequency Response Modeling in System Studies

WECC Modeling and Validation Subcommittee

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History

- In early 2000s, WECC Modeling and Validation Working Group determined by conducting event model validation studies that simulated frequency response was very optimistic
- The group found that many thermal power plants provided greater frequency response in simulations compared to reality
- WECC MVWG implemented Thermal Governor Modeling Recommendation by classifying generators as (i) frequency responsive, (ii) base-loaded and (iii) under load control, which resulted in significant improvement in modeling frequency response, https://ieeexplore.ieee.org/document/1267435

History

- Adherence to WECC recommendation has been inconsistent
- Many inverter-based resources are modeled as frequency responsive
- BPA and COI owners use historic events to benchmark simulated governor power pick-up on COI for large generation losses in the South against a historic baseline
- Currently, we assume COI pick-up between 38% and 40% of amount of generation lost in the South
- WECC cases often come with COI pick-up in 25% range
- Baseload flags are adjusted until the target pick-up is reached

Moving forward >>>>

Objective

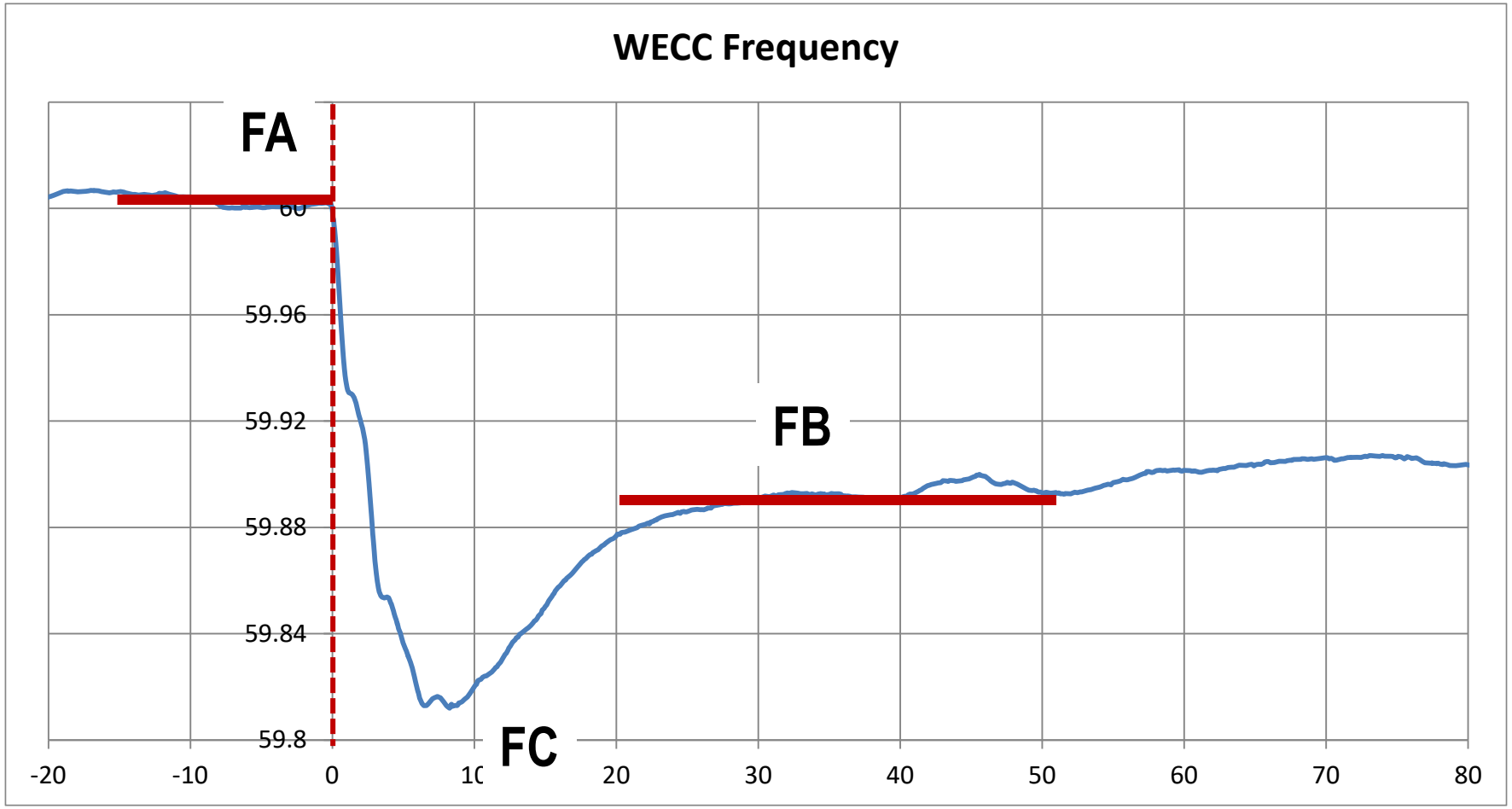
- Ensure dynamic simulations reasonably represent Frequency Response Obligations put on Balancing Authorities under NERC BAL-003 Frequency Response Standard
  - Develop processes and tools for calculating Frequency Response Measure (FRM), defined in NERC BAL-003, based on dynamic simulations
  - Compare simulated FRM with Frequency Response Obligation (FRO) for Balancing Authorities in Western Interconnection
  - Identify outliers in frequency response modeling

Background – NERC BAL-003

NERC BAL-003 Reliability Standard

- NERC BAL-003 Reliability Standard is to ensure the interconnection frequency does not get to coordinated UFLS threshold (59.5 Hz) for Resource Loss Protection Criteria (RLPC) event
- NERC assessed RLPC at 3,069 MW for Western Interconnection
- NERC BAL-003 uses settling frequency (Point B) to calculate FRM, the ratio between settling frequency (Point B) and nadir (Point C) is factored in the calculation – see next slide
- The maximum acceptable settling frequency deviation is 0.28 Hz for Western interconnection
- Western Interconnection FRO is -1,096 MW per 0.1 Hz (=3,069/0.28/10)
- 2019 FRAA Report Final (nerc.com)

NERC-BAL-003-1 Reliability Standard



FA = pre-disturbance frequency (average from -16 to 0 sec)

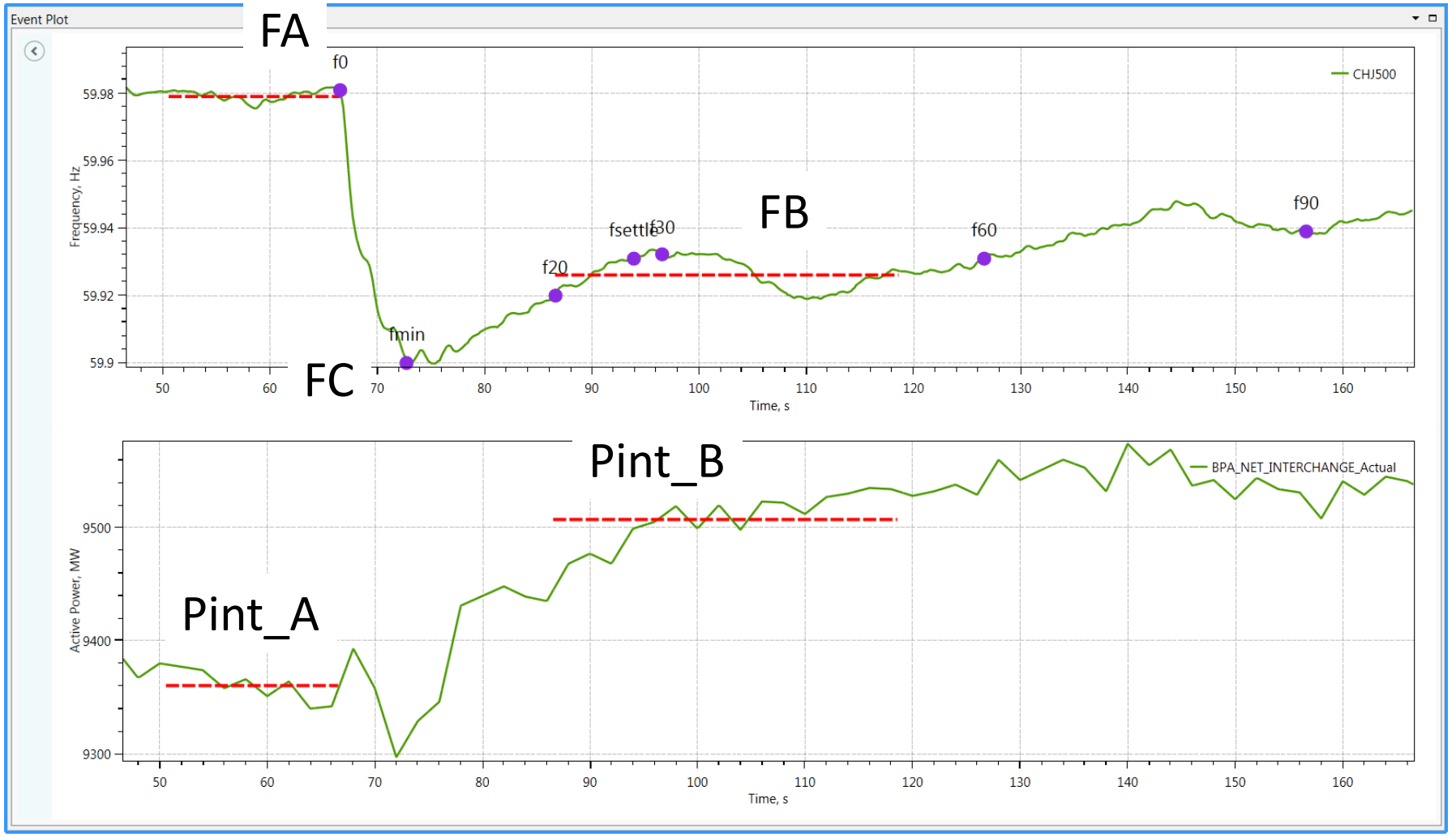
FB = settling frequency (average from 20 to 52 sec)

FC = minimum (nadir) frequency

NERC BAL-003 Reliability Standard

- Western Interconnection FRO is prorated among Balancing Authorities based on its annual energy
- https://www.nerc.com/comm/OC/RS%20Landing%20Page%20DL/Frequency%20Response%20Standard%20Resources/BA_FRO_Allocations_for_OY2023-document.pdf
- Each BA is expected to carry sufficient Frequency Responsive Reserves to meet its FRO
  - hydro-based BAs usually have excessive reserves due to frequency response capabilities and operations of hydro-turbines
  - thermal based BAs are more likely to be close to their FRO
- BA FRM is measured as change in BA interchange flows over change in BA frequency – see next slide

BA Frequency Response Calculation



FRM = (Pint_B – Pint_A + BA Gen Loss) / (FA – FB)

Frequency Response Simulation

Tools Needed

- Make sure that powerflow base cases have correct and up-to-date BA data in generator model records
  - WECC to request data review
- Make sure baseload flags are up-to-date reflecting expected plant operation
- Have models that track total generation output in each BA
- Have tools that extract total generation output for each BA, as well as BA frequency
- Have Python, or MATLAB, or Excel app that calculates simulated BA FRM and graphically compares it with BA FRO

Thank you