Frequency Response Standard Technical Issues

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November 15, 2006

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Overview

- Frequency Response Measurement
- Central vs. Local Measurement
- Sampling Procedures & Bias
- Local Measurement Limitation
- PGFR Measurement Change
  - From Tie Line Error and Frequency
  - To ACE, Bias and Frequency
- Significance of Measured PGFR

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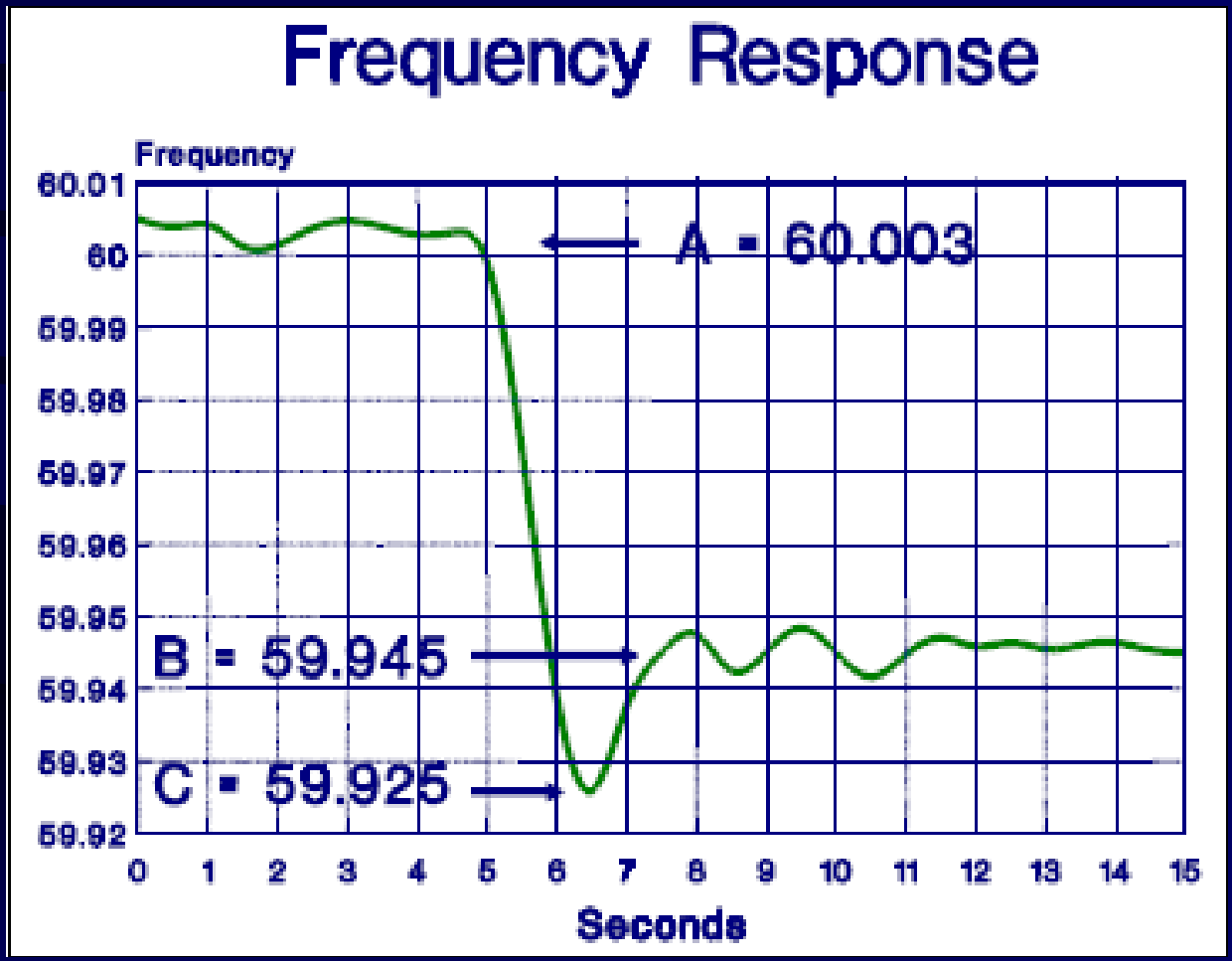
Frequency Response Plot



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Frequency Response

- Initial Frequency – Point A
- Settling Frequency – Point B
- Minimum Frequency – Point C
- Oscillations – from C to B

Measurement of PGFR

- Values of Interest
  - Minimum Frequency
  - Settling Frequency
- Minimum - High Resolution Data
- Settling Frequency – Step Function
- Use Two Step Measurement ?
  - High Resolution Minimum Frequency
  - Step Function Settling Frequency
  - Consistent Minimum to Settling Ratio ?

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Central vs. Local Measure

- Central measurement can provide answers to reliability requirements.
- If reliability is affected significantly, then local measurement is required to assign responsibility for meeting minimum reliability needs.

Sampling Procedures

- **Frequency Threshold**
  - May tend to select lower response events
- **Minute to Minute Unit Step Function**
  - Inconsistent selection method
- **3-Minute Unit Step Function**
  - Provides more consistent selection
  - Provides multiple data values
  - Enables internal consistency checking

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Frequency Threshold

- Assume 1,000 Mw Event:

	PGFR / 0.1 HZ	Frequency Change
A	1,000 MW	100 mHz
B	2,000 MW	50 mHz
C	3,000 MW	33 mHz

- 40 mHz Sampling Limit will select A and B from above but exclude C.

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Minute to Minute

- Assume 1,000 MW Event with a 2,000 MW / 0.1 Hz Response:

Min	Event at			
Avg	0 Sec	15 Sec	30 Sec	45 Sec
1	60.000	60.000	60.000	60.000
2	59.950	59.963	59.975	59.988
3	59.950	59.950	59.950	59.950

- Use Minute 1 to Minute 3 average.

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Minute 1 - Minute 3 Sample

- Minute 1 to Minute 3 sampling provides 1 or 2 samples per event.
- Each event weighted equally.
- Multiple sample events enable the investigation of other data inconsistencies.
- This is still Frequency Threshold Sampling. Can we overcome the sampling bias in other ways?

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Measurement Limitation

- Balancing Authority Metering

$$\sum E_T = 0$$

- Therefore:

$$\sum E_{T,1} = 0 \cdot \& \cdot \sum E_{T,2} = 0$$

- And:

$$\sum \left(\Delta E_T / \Delta F \right) = 0 \cdot \& \cdot \sum FR = 0$$

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Local Measure Required

- These equations indicate that the information required determine the contribution to unreliability is contained in the local measurements.
- Therefore, local measurement is required to assign responsibility for provision of Frequency Response.
- The information is contained in combined **Disturbance Imbalance Errors** and the resulting **Frequency Response** to them.

PGFR Measurement Change

- Change PGFR Measurement
  - From Tie Line and Frequency
  - To ACE, Bias and Frequency
- This change is dependent on the consistency of Variable Frequency Bias use.

Significance of PGFR

- **Frequency Error Drivers**
  - Normal Control Errors
  - Disturbance Errors
  - Disturbance Recovery Errors
  - Scheduled Time Error Corrections
- **Sensitivity Variables**
  - Epsilon 1
  - Generation and Transmission Inventory
  - DCS Limits: Size and Recovery Limits
  - Time Error Correction Procedures

Questions

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