



FY13 DOE/CERTS Transmission Reliability R&D Internal Program Review

Reliability Standards Analysis and Assessment

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June 27-28, 2013

Washington, DC



CERTS
CONSORTIUM FOR ELECTRIC RELIABILITY TECHNOLOGY SOLUTIONS

NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION



Electric Power Group

Research Projects

Reliability Standards Analysis and Assessments

- **Frequency Response Event Collection and Analysis**
- **NERC Interconnections 2012 Annual Grid Reliability Performance Analysis and Report**



Reliability Standards Analysis and Assessment

- **Objective:**

Collect grid data and conduct grid reliability performance analysis to support the NERC committees/groups (Resources Subcommittee and RS-Frequency Working Group) in the following ways:

- **Perform grid reliability metrics analysis using data collected in CERTS applications as requested by the RS**
- **Analyze collected data to assess reliability performance at different levels – Interconnection, Reliability Coordinator, Balancing Authority**
- **Perform analysis, testing, and monitoring of current and proposed reliability standards**



Reliability Standards Analysis and Assessment

Major technical accomplishments that will be completed this year:

- **Frequency Response Event Collection and Analysis**
 - Use the delta frequency and Point C methodologies to detect, capture, and analyze significant frequency events and related key parameters in support of NERC Frequency Response Standards development
- **NERC Interconnections 2012 Annual Grid Reliability Performance Analysis and Report**
 - Analyzed 2012 Load-Generation control performance metrics for the Eastern, WECC, and ERCOT interconnections, and prepared report for the Resources Subcommittee



Frequency Response

Event Collection and Analysis

Background

- Frequency Response is a measure of an Interconnection's ability to stabilize frequency immediately following the sudden loss of generation or load
- The RS initiated the Standards Authorization Request (SAR) for BAL-003 for measurement and analysis of Frequency Response adequacy
- CERTS-EPG researched and defined a frequency event identification methodology and criteria for capturing significant frequency events for all NERC interconnections
- EPG uses 1-second phasor data to identify, capture, analyze, and report all significant frequency events for all NERC interconnections
- Analysis results of captured events and corresponding plots and key parameters are submitted to the RS Frequency Working Group
- RS selects candidate events for BAs to use to measure yearly Frequency Response performance and develop Frequency Response Obligation (FRO)



Frequency Response

Event Collection and Analysis

Method of Analysis:

- **Delta Frequency Event Detection Methodology (Primary)** - change in frequency exceeds the predetermined threshold (see following slide) during a 15-second rolling time window
- **Point C methodology (Secondary)** – frequency events with the following criteria for the Eastern and ERCOT interconnections:
 - Eastern: Point C at/below 59.96 and delta frequency of at least 30 mHz within 15-second time window
 - ERCOT: Point C at/below 59.90 and at/above 60.10 Hz
- The following key parameters for all detected events are identified and analyzed:
 - Value A Average frequency values between T(-16) and T(-1)
 - Value B Average frequency values between T(20) and T(52)
 - Point C Min/Max Frequency within 12 seconds after T(0) (Must be above UFLS setting)
 - T(0) (beginning of event) - The point with the minimum frequency change of 5 mHz within 1-second
- Frequency Response for each event is calculated as follows:

$$\text{Frequency Response} = \text{MWLoss}/10 * \text{DeltaFreq}$$

$$\text{Where: DeltaFreq} = \text{Value A} - \text{Value B}$$

$$\text{MWLoss (Est.)} = \text{Max}(\text{DeltaACE}(\text{BA})) - \text{Const} * 10 * \text{FreqBias} * \text{DeltaFreq}$$

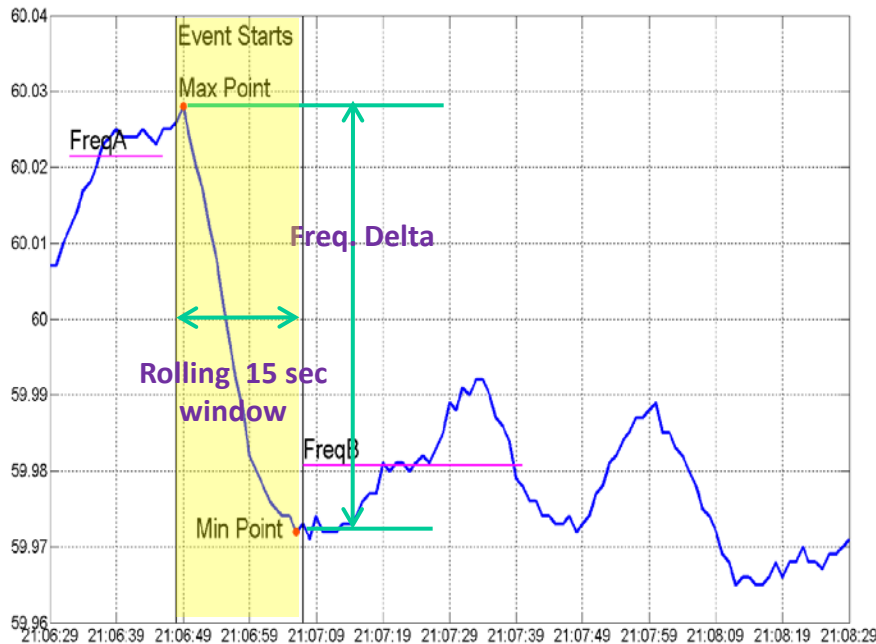
$$\text{The Constants are: EI \& WECC} = 0.6; \text{ERCOT} = 0.3; \text{HQ} = 0.1$$



Frequency Event Detection Methodology

Delta Frequency Detection Methodology

A frequency event occurs if during a 15-second rolling time window the change frequency exceeds the frequency threshold shown in the table below for each interconnection. The thresholds in the table are approved and revised by the Resources Subcommittee



Delta Methodology		
Interconnections	Freq. Delta for Candidate Event (mHz)	Time Window (second)
Eastern	36	15
Western	70	15
ERCOT	90	15
Quebec	300	15

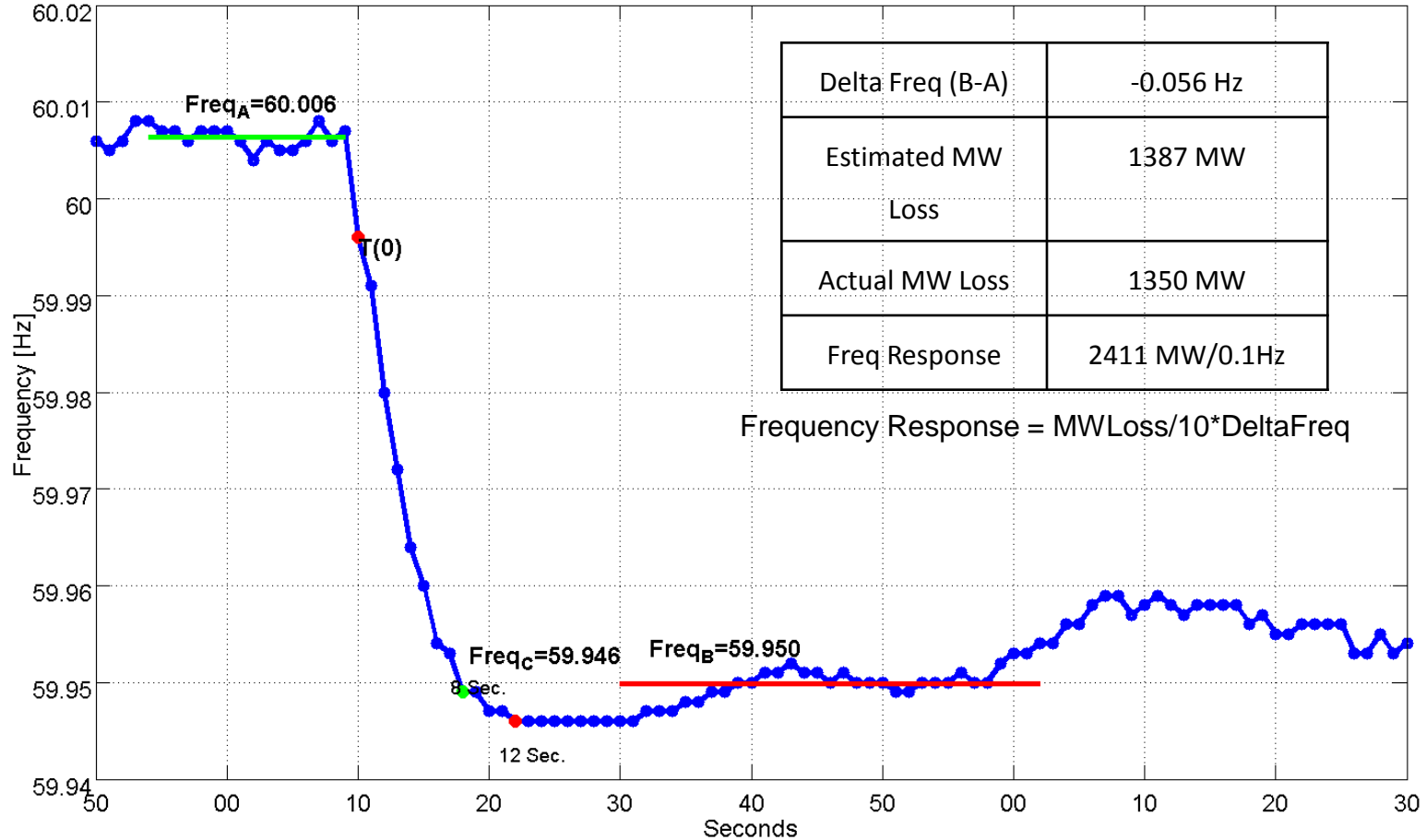
Point C Methodology For Eastern and ERCOT - events with the following criteria:

- Eastern: Point C at/below 59.96 Hz And delta frequency of at least 30 mHz within 15 second time window
- ERCOT: Point C at/below 59.90 Hz and at/above 60.10 Hz



Sample Event Plot and Frequency Response Calculation

2013/02/23 9:04:10 PM Sat Eastern Time



Frequency Response Event Collection and Analysis

Results and Conclusion:

- A monthly report summarizing the frequency events collected with the corresponding plots is prepared, analyzed, and submitted to the NERC RS-FWG
- Monthly summary reports are posted at the NERC RS website under “Candidate Frequency Events”
- RS reviews and selects candidate events for BAs to use to measure yearly Frequency Response performance and develop Frequency Response Obligation (FRO)
- The process and methodologies have been accepted and approved by the NERC RS as being effective in identifying candidate events for the implementation of Reliability Standard BAL-003

Next Steps:

- EPG will continue to work closely with CERTS and the NERC RS-FWG to detect, capture, and analyze all significant frequency events for all interconnections
- The current methodologies and thresholds will continue to be monitored and refined/modified as necessary

EPG wants to acknowledge the collaborative effort of Mr. Carlos Martinez at Advanced Systems Researchers in the preparation and production of the monthly summary reports



NERC Interconnections 2012 Annual Reliability Performance Analysis

Background

- EPG uses the NERC ACE and Frequency data to generate and distribute an Interconnections Daily Automated Reliability Report (ARR) to the FERC/NERC authorized users
- EPG prepares an annual grid reliability metrics and grid performance summary report for each interconnection that is submitted to the NERC Resources Subcommittee



NERC Interconnections 2012 Annual Reliability Performance Analysis

Method of Analysis:

- The following reliability metrics were analyzed for the year 2012 and compared to the previous years to determine the trends and level of performance at the interconnection level.
 - Control Performance Metrics (Load-Generation Resource Adequacy)
 - Primary Control Performance - CPS1 and CPS2
 - CPS1 threshold: >100% compliance
 - CPS2 threshold: >90% compliance
 - Secondary Control Performance - Epsilon
 - Thresholds: Eastern: 18 mHz; Western: 23 mHz; ERCOT: 30 mHz
 - Frequency Performance During Morning/Evening Peaks – Impact on frequency during schedule ramp periods.
 - Frequency Events
 - Number of events with 1-minute frequency delta exceeding the following thresholds:
 - Eastern and Western Interconnections: 35 mHz
 - ERCOT Interconnection: 70 mHz
 - FTL (Frequency Trigger Alarms)
 - Number of Events when Frequency > FTL Low/High Limits:
 - FTL High Limit: Eastern – 60.05 Hz; Western – 60.07 Hz; ERCOT – 60.068 Hz
 - FTL Low Limit: Eastern – 59.95 Hz; Western – 59.93 Hz; ERCOT – 59.932 Hz



NERC Interconnections 2012 Annual Reliability Performance Analysis

Results Presented in Annual Report:

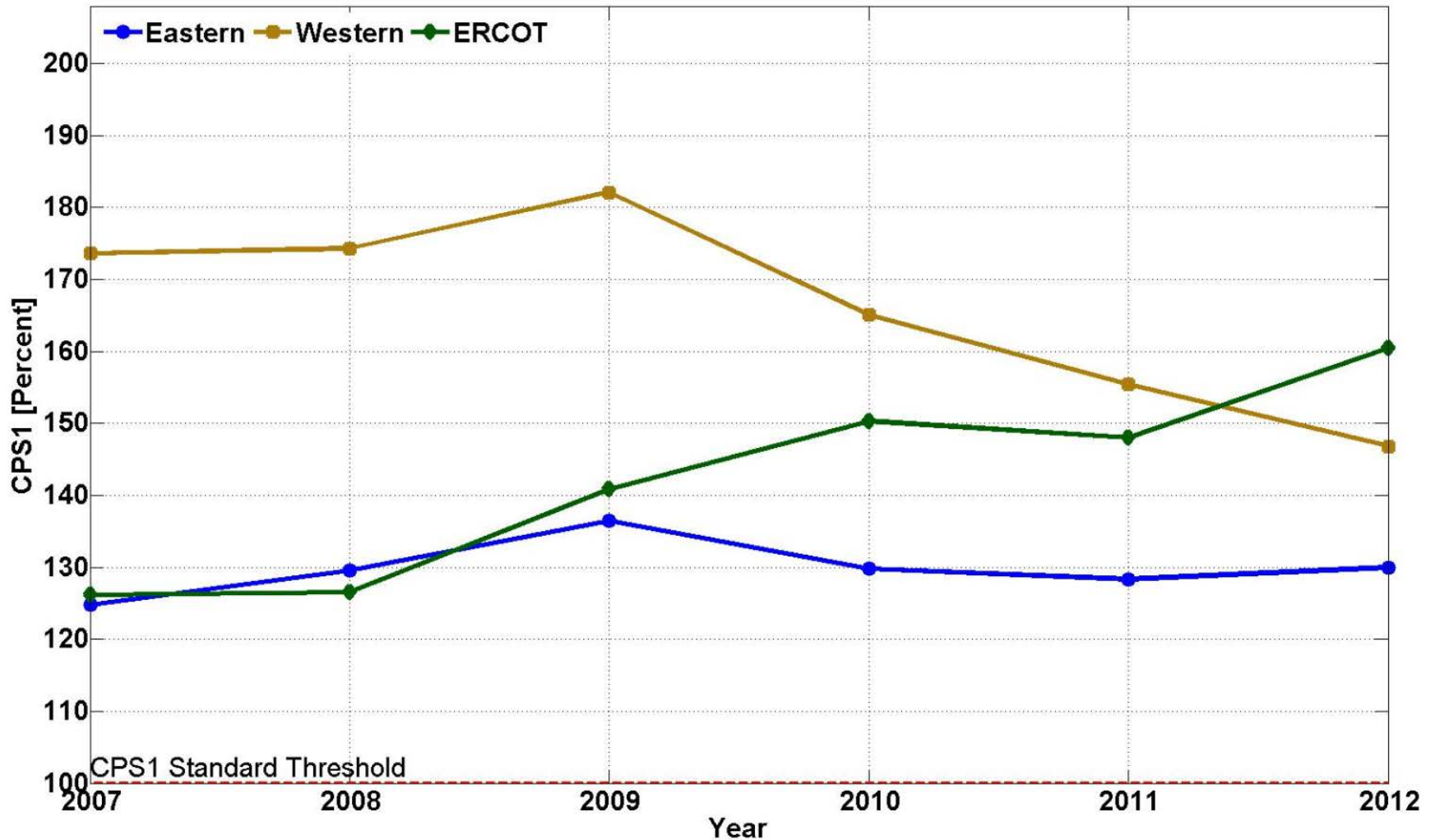
- **Control Performance Metrics:**
 - **Interconnections Primary Control Performance - CPS1 and CPS2 Trend:**
 - All three Interconnections operated above CPS1 threshold
 - Eastern and Western operated below CPS2 threshold; ERCOT operated above CPS2 threshold (ERCOT is exempted from CPS2)
 - Graph for 6-years attached
 - **Interconnection Secondary Control Performance - Epsilon:**
 - All 3 interconnections operated within their thresholds but Western showed an upward trend
- **Frequency Performance During Morning/Evening Peaks – Impact on frequency during schedule ramps**
 - Western – The variability of frequency for each 5 –minute period increased
 - Eastern – No noticeable changes
 - ERCOT – The variability of frequency for each 5-minute period decreased
- **Frequency Events (see following slide)**
 - Number of events exceeding the thresholds increased by 25% between 2012 & 2011 for WI and EI
 - Number of events exceeding the thresholds decreased by over 40% between 2012 & 2011 for ERCOT
- **FTL (Frequency Trigger Alarms)**
 - **Number of Events when Frequency > FTL Low/High Limits:**
 - The number of events decreased for all three interconnections when compared to 2011

Next Steps:

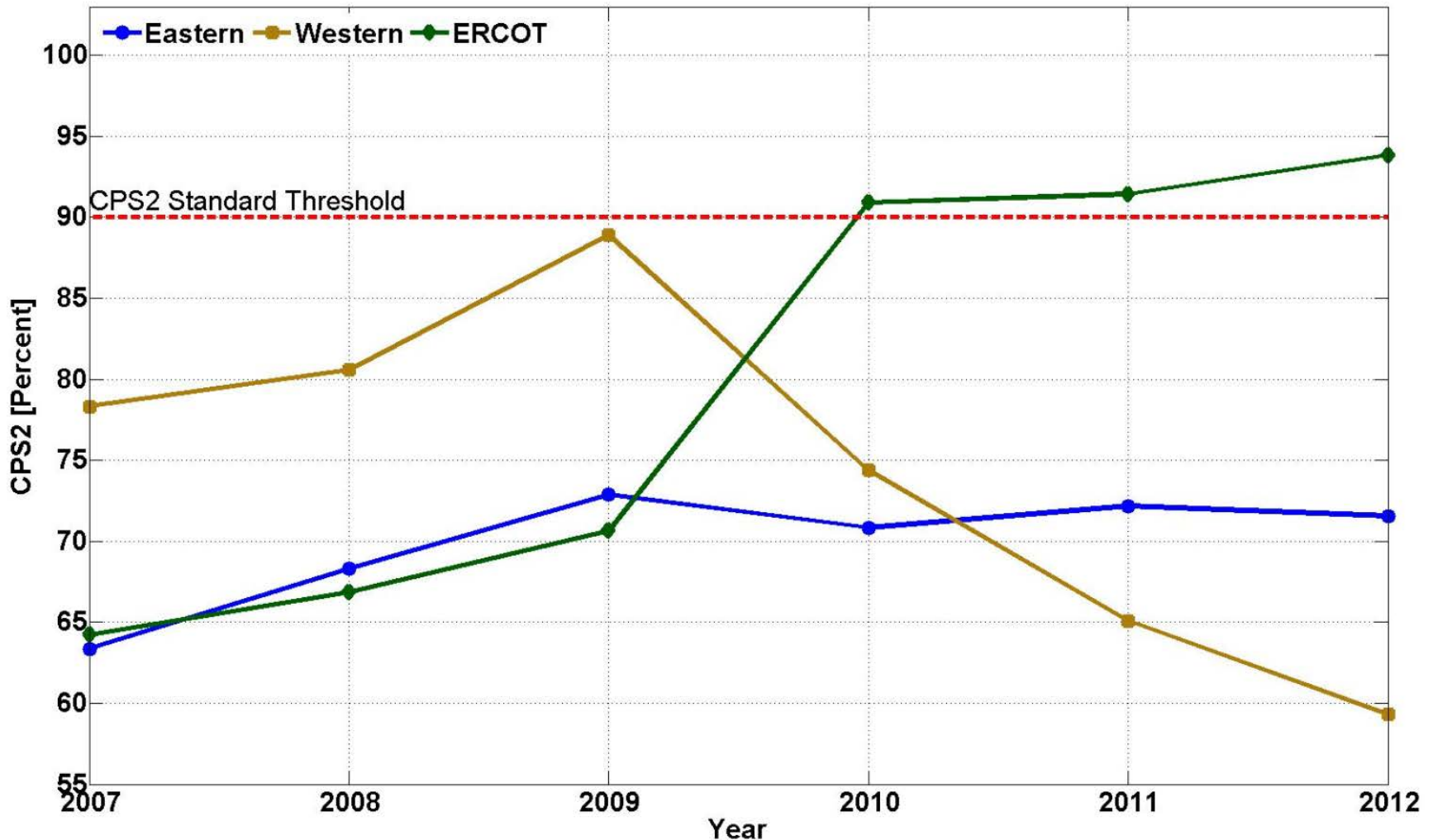
- **Submit Report with summary analysis to NERC RS**
- **Continue to monitor and performance interconnection reliability performance and present results to NERC RS**



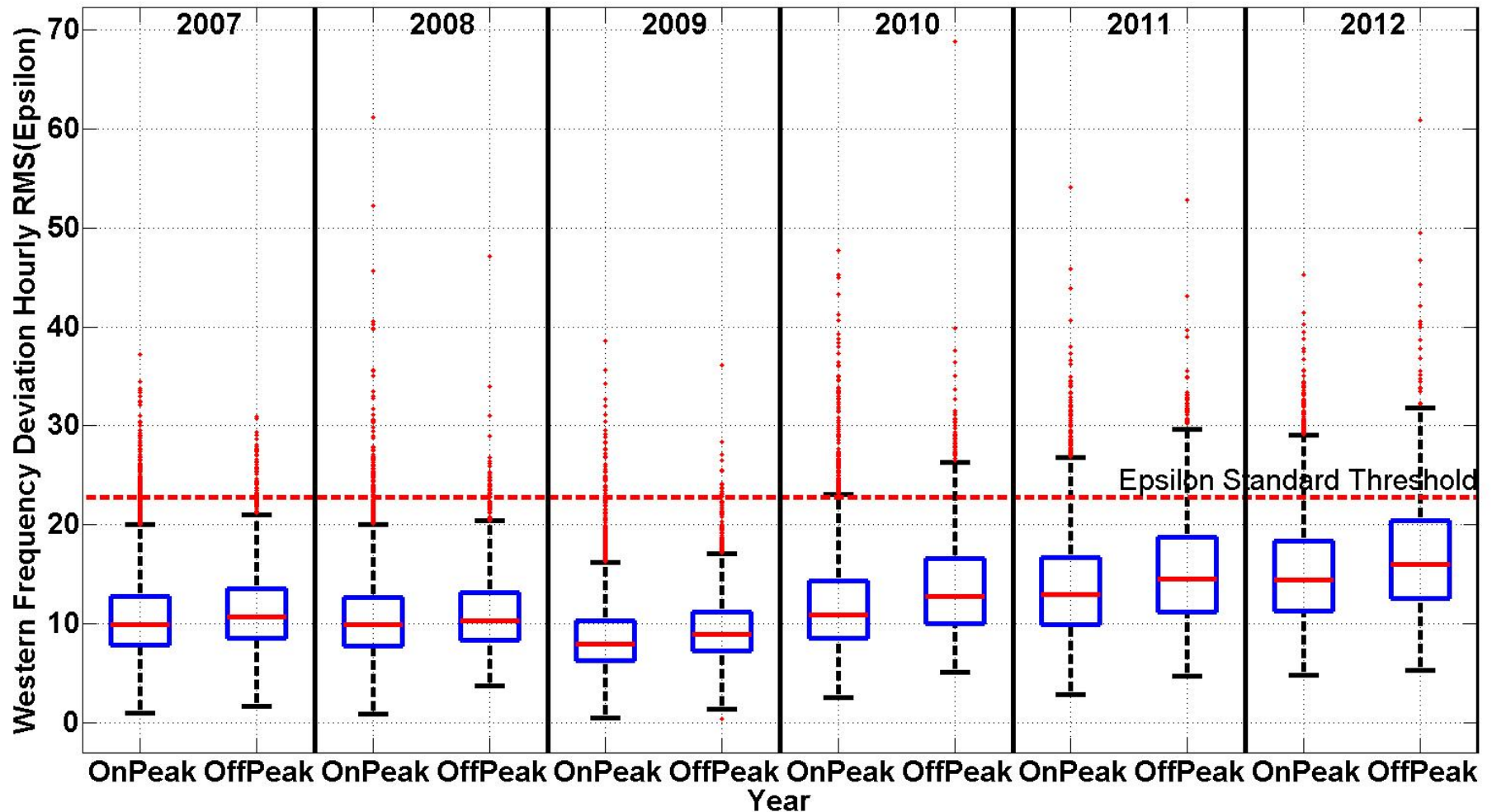
Interconnections CPS1 6-Year Trend



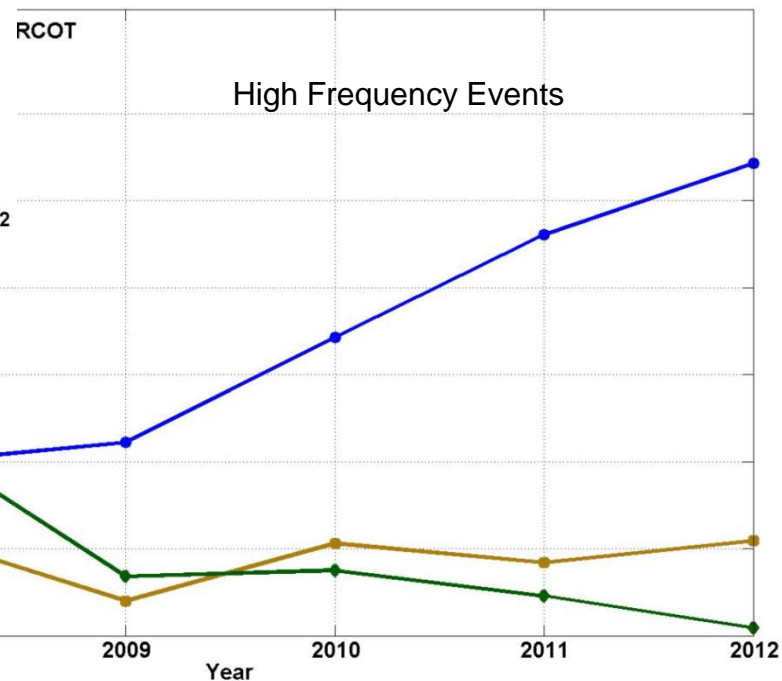
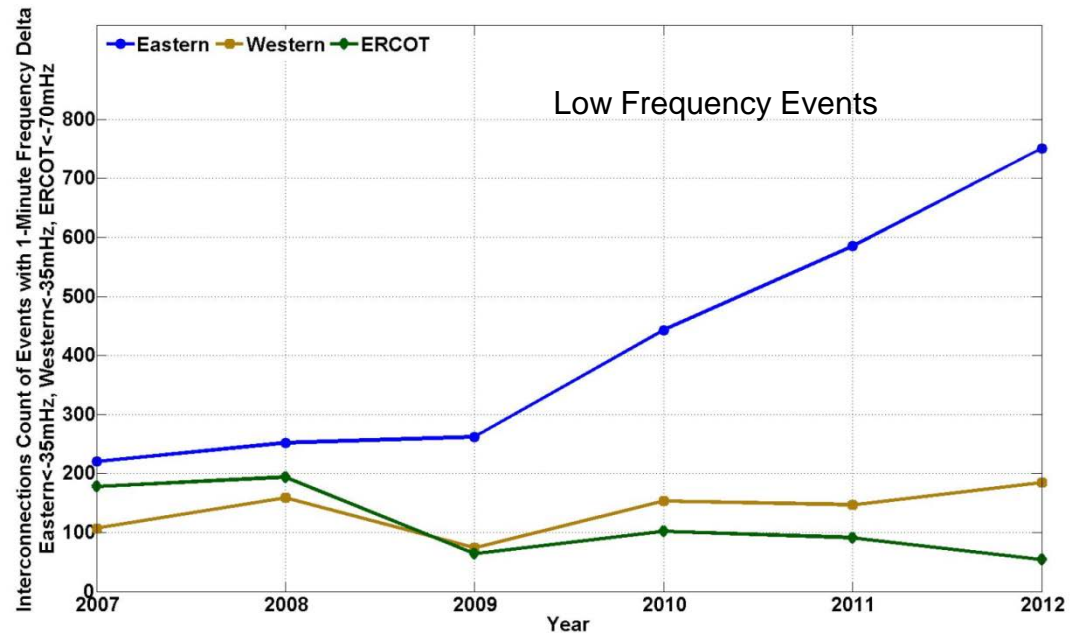
Interconnections CPS2 6-Year Trend



Interconnections Epsilon 6-Year Trend



Frequency Events Exceeding the Thresholds



Summary

Accomplishments and Next Steps:

- **Frequency Response Event Collection and Analysis**
 - EPG has effectively detected, captured, and analyzed all candidate frequency events for the NERC RS in support of the implementation of Reliability Standard BAL-003
- **NERC Interconnections 2012 Annual Reliability Performance Analysis and Report**
 - **The 2012 Annual Grid Reliability Performance Report** for the Eastern, WECC, and ERCOT interconnections has been completed and submitted to the NERC Resources Subcommittee

Risks and Challenges:

- The ability to get quality data reliably
- Continue to refine analysis approaches based on industry guidance in providing analytic and research support for further development of grid reliability standards

Next Steps:

- DOE's continuing support of this activity is critical to continue to research and analyze reliability performance and proposed standards in light of changing resource mix, smart grid technologies, and integration of intermittent renewables



Q & A

