

1 INTRODUCTION

This report presents a summary of historical 2010 annual reliability performance metrics for load-generation resource adequacy for the three NERC interconnections known as Eastern, Western, and ERCOT. The metrics presented measure primary and secondary load-generation control performance.

The report is organized into seven sections as summarized below:

- Section 2 presents summary data and performance metrics for load-generation balance for the year 2009 and 2010.
- Section 3 presents the Epsilon report for the year 2009 and 2010 and the Frequency Bias report for the year 2005, 2006, 2007, 2008, 2009 and 2010. Both metrics are indicators of secondary control performance.
- Section 4 presents CPS1 and CPS2 metrics extrapolated to the interconnection level for the year 2005, 2006, 2007, 2008, 2009 and 2010. These are indicators of load-generation control performance.
- Section 5 presents Frequency Response metric for the year 2005, 2006, 2007, 2008, 2009 and 2010. This is an indicator of primary control performance.
- Section 6 presents for the year 2005, 2006, 2007, 2008, 2009 and 2010 the frequency median and variability for each 5-minute period for the morning peak and late evening hours. This performance indicator captures the impact of schedule ramps. One-second frequency data is used for this section of the report.
- Section 7 presents number of frequency events with a 1-minute frequency delta high/low events and events that go beyond the FTL high and low limits for the year 2005, 2006, 2007, 2008, 2009 and 2010.

Historical archived data from NERC data bases is used to present the data, metrics, tables, and charts. The report can be used as a starting point for analyzing:

- Comparative reliability performance among the three NERC interconnections
- Identification of key trends in reliability performance
- Analysis of reliability performance relative to industry established thresholds and standards, where applicable
- Comparison of traditional industry reliability performance metrics, and equivalent performance metrics based on statistical process control (SPC) analysis
- Adequacy of current load-generation reliability performance standards or need for new standards
- Areas requiring corrective performance for reliability improvements, for example, load-generation resources adequacy issue for hours 6-7, 22 to 24.

2 SUMMARY SECTION

2.1 Epsilon Performance Metric Using Statistical Process Control (SPC) Criteria

The hours during which the Epsilon variability and mean exceeds the SPC criteria are presented below. Both metrics are indicators of secondary load-generation control performance.

Hours During which Interconnections Epsilon Variability Exceeds Statistical Process Control (SPC) Criteria			
Interconnection	The Year 2010 Hours	The Year 2009 Hours	Hours The Year 2010 vs The Year 2009
Eastern	7, 8, 18, 19, 20, 23, 24	7, 18, 23, 24	Higher
Western	2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 22, 23, 24	None	Higher
ERCOT	1, 5, 14, 16, 17	5, 7	Higher

Hours During which Interconnections Epsilon Mean Exceeds Statistical Process Control (SPC) Criteria			
Interconnection	The Year 2010 Hours	The Year 2009 Hours	Hours The Year 2010 vs The Year 2009
Eastern	7, 23, 24	24	Higher
Western	None	None	Same
ERCOT	None	None	Same

2.2 Frequency Bias for Events Exceeding FTL During the On-Peak and Off-Peak Periods

The Committed Frequency Bias for the year 2010 for each of the 3 interconnections is: Eastern 6242 MW/0.1Hz; Western 1999 MW/0.1Hz; and ERCOT 667 MW/0.1Hz. The actual Frequency Bias for events exceeding the FTL during the on-peak and off-peak periods are presented below.

Yearly Frequency Bias [Mw/0.1Hz] for Events Exceeding FTL During On-Peak (NA = Not Available)			
Interconnection	2010	2009	2008
Eastern	6695	6348	6945
Western	1803	1661	1699
ERCOT	645	598	532

Yearly Frequency Bias [Mw/0.1Hz] for Events Exceeding FTL During Off-Peak (NA = Not Available)			
Interconnection	2010	2009	2008
Eastern	4834	6205	6612
Western	2689	429	NA
ERCOT	682	673	630

2.3 CPS1 and CPS2 Load-Generation Control Performance Metrics Extrapolated to the Interconnection Level

Currently, the CPS1 and CPS2 apply to the balancing authority level. For this report, these metrics were extrapolated to the interconnection level. The thresholds and the actual performance are presented below.

Yearly CPS1 and CPS2 Performance				
Intercon.	CPS1 Threshold 100%		CPS2 Threshold 90%	
	2010	2009	2010	2009
Eastern	137	145	72	75
Western	171	187	75	93
ERCOT	151	141	91	71

2.4 Frequency Response for Events with 1-Minute Frequency Delta Below and Above Threshold

The frequency response expected values are Eastern 2497 MW/0.1Hz; Western 800 MW/0.1Hz; and ERCOT 600 MW/0.1Hz. The actual values are presented below:

Yearly Frequency Response for Events with 1-Minute Delta f > 35mHz for Eastern and Western and 1-Minute Delta f > 70mHz for ERCOT			
Interconnection	2010	2009	2008
Eastern	2331	2582	2526
Western	1086	1278	1309
ERCOT	NA	NA	NA

Yearly Frequency Response for Events with 1-Minute Delta f < -35mHz for Eastern and Western and 1-Minute Delta f < -70mHz for ERCOT			
Interconnection	2010	2009	2008
Eastern	2399	2707	2547
Western	1087	1222	1208
ERCOT	NA	NA	NA

2.5 Lowest/Highest Frequency During Morning Peak and Late Evening Hours for the YEAR 2008, 2009 and 2010

The following two tables present each interconnection’s lowest or highest frequencies and the time they occurred during the morning peak and late evening hours for the year 2008, 2009 and 2010:

Yearly Morning Peak Hours Highest/Lowest 5-Minute Average Frequency (Hz)			
Interconnection	2010	2009	2008
Eastern	59.932 (7:05AM)	59.940 (7:05AM)	59.923 (6:05AM)
Western	59.919 (8:10AM)	60.056 (6:00AM)	59.917 (8:20AM)
ERCOT	59.852 (6:15AM)	60.141 (8:05AM)	60.126 (5:50AM)

Yearly Late Evening Hours Highest/Lowest 5-Minute Average Frequency (Hz)			
Interconnection	2010	2009	2008
Eastern	60.055 (10:55PM)	59.936 (11:05PM)	59.935 (10:15PM)
Western	60.067 (10:00PM)	59.953 (10:10PM)	60.064 (9:25PM)
ERCOT	59.800 (10:05PM)	60.127 (9:30PM)	60.124 (10:05PM)

2.6 Number of Events with 1-Minute Frequency Delta Below and Above Threshold

The number of 1-minute delta frequency low/high events during the year 2008, 2009 and 2010 are presented below:

Events with 1-Minute Delta f < -35mHz for Eastern and Western and Delta f < -70mHz for ERCOT			
Interconnection	2010	2009	2008
Eastern	443	262	252
Western	153	74	159
ERCOT	102	64	194

Events with 1-Minute Delta f > 35mHz for Eastern and Western and Delta f > 70mHz for ERCOT			
Interconnection	2010	2009	2008
Eastern	343	222	199
Western	106	40	116
ERCOT	75	68	224

2.7 Number of Events When Frequency Exceeds FTL Low/High Event

The number of events when frequency exceeds FTL low/high limits during the year 2008, 2009 and 2010:

Events When Frequency Below FTL Low			
Interconnection	2010	2009	2008
Eastern	770	583	961
Western	73	23	43
ERCOT	145	58	1256

Events When Frequency Above FTL High			
Interconnection	2010	2009	2008
Eastern	390	326	510
Western	28	6	0
ERCOT	256	250	1542

3 EPSILON AND FREQUENCY BIAS TRENDS - INDICATORS OF SECONDARY CONTROL PERFORMANCE

This section shows for each interconnection the Epsilon median and variability during the on-peak and off-peak periods the year 2005, 2006, 2007, 2008, 2009 and 2010, and the Epsilon mean and variability for each hour-type for the year 2009 and 2010. Frequency Bias is presented for the year 2009 and 2010. Both Epsilon and Frequency Bias are performance indicators for secondary load-generation control. Statistical Process Control (SPC) criteria are used to indicate if the yearly Epsilon metric for each interconnection is within acceptable statistical margins. Yearly Frequency Bias is calculated and shown for each interconnection as the slope [MW/0.1 Hz] of scatter Frequency-NetACE diagrams.

3.1 Eastern Yearly Epsilon Performance Metric

Figure 1 shows Epsilon median and variability during the on-peak and off-peak periods for the year 2005, 2006, 2007, 2008, 2009 and 2010.

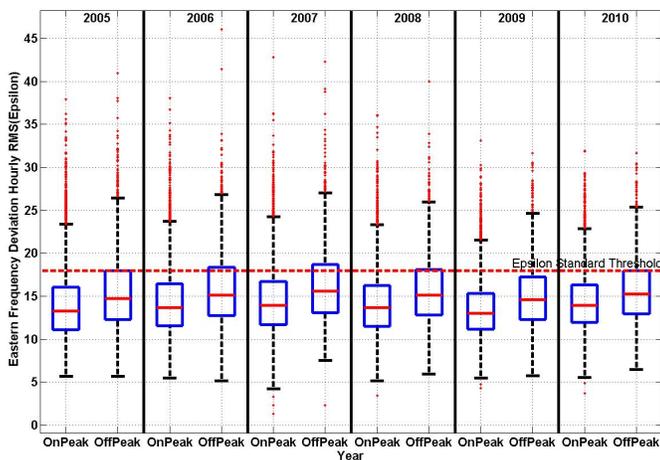


Figure 1: Eastern Epsilon Performance Metric

During the year 2005, 2006, 2007, 2008, 2009 and 2010, the Epsilon median for the off-peak hours operated closer to the threshold

than during the on-peak hours.

3.2 Western Yearly Epsilon Performance Metric

Figure 2 shows Epsilon median and variability during the on-peak and off-peak periods for the year 2005, 2006, 2007, 2008, 2009 and 2010.

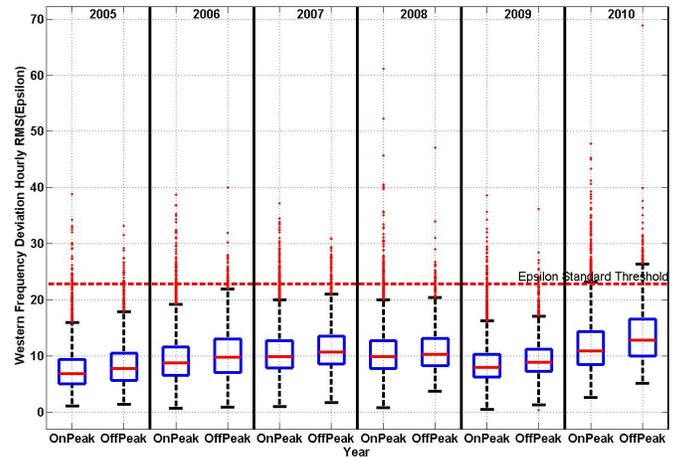


Figure 2: Western Epsilon Performance Metric

During the year 2005, 2006, 2007, 2008, 2009 and 2010, the Epsilon median for the off-peak and on-peak hours operated well below the threshold.

3.3 ERCOT Yearly Epsilon Performance Metric

Figure 3 shows Epsilon median and variability during the on-peak and off-peak periods for the year 2005, 2006, 2007, 2008, 2009 and 2010,

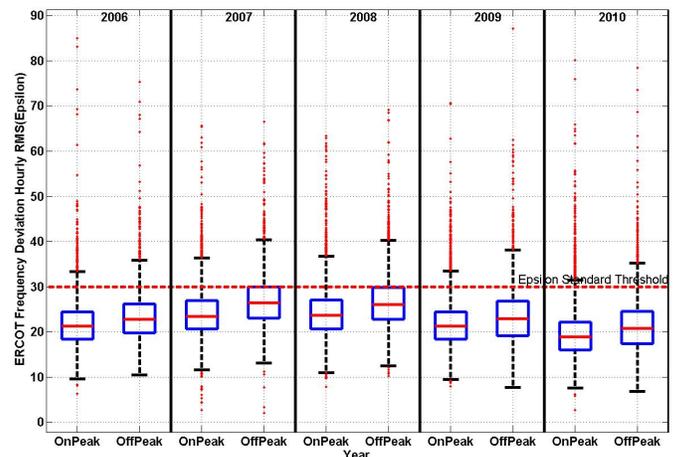


Figure 3: ERCOT Epsilon Performance Metric

During the year 2005, 2006, 2007, 2008, 2009 and 2010, the Epsilon median for the off-peak hours operated closer to the threshold than during the on-peak hours.

The following three sections present the Xbar-SD Statistical Process Control (SPC) charts for the year 2009 and 2010 for the Epsilon metric to indicate if its hourly magnitude and variability for each interconnection is within acceptable statistical margins.

3.4 Eastern Hourly Epsilon Magnitude and Variability Performance Trend Using Statistical Process Control (SPC) Criteria

Figure 4 shows for the year 2009 and 2010 the two SPC charts with the first showing hourly Epsilon magnitude, and the second showing hourly Epsilon variability.

Magnitude: For the year 2010, hours 7, 23, and 24 are above the high limit. For the year 2009, hour 24 is above the high limit.

Variability: For the year 2010, hours 7, 8, 18, 19, 20, 23, and 24 are above the high limit. For the year 2009, hours 7, 18, 23, and 24 are above the high limit.

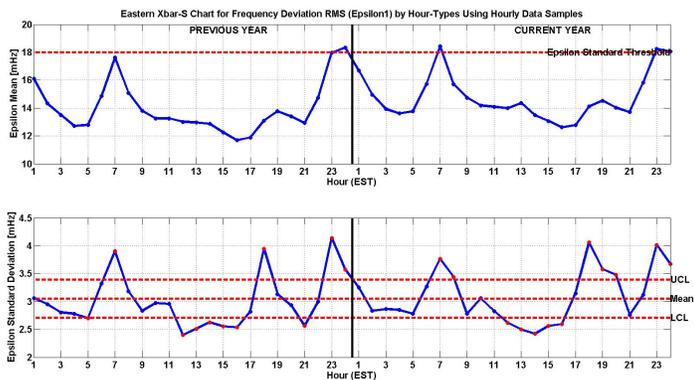


Figure 4: Eastern Epsilon Performance Using SPC Criteria

3.5 Western Hourly Epsilon Magnitude and Variability Performance Trend Using Statistical Process Control (SPC) Criteria

Figure 5 shows for the year 2009 and 2010 the two SPC charts with the first showing hourly Epsilon magnitude, and the second showing hourly Epsilon variability.

Magnitude: For the year 2010, no hours are above the high limit. For the year 2009, no hours are above the high limit.

Variability: For the year 2010, hours 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 22, 23, and 24 are above the high limit. For the year 2009, no hours are above the high limit.

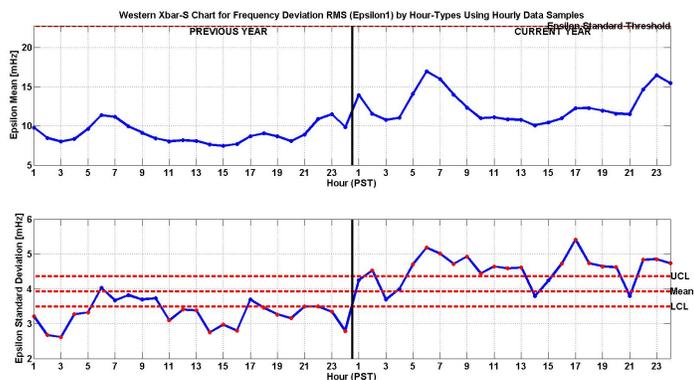


Figure 5: Western Epsilon Performance Using SPC Criteria

3.6 ERCOT Hourly Epsilon Magnitude and Variability Performance Trend Using Statistical Process Control (SPC) Criteria

Figure 6 shows for the year 2009 and 2010 the two SPC charts with the first showing hourly Epsilon magnitude, and the second showing hourly Epsilon variability.

Magnitude: For the year 2010, none hour is above the high limit. For the year 2009, none hour is above the high limit.

Variability: For the year 2010, hours 1, 5, 14, 16, and 17 are above the high limit. For the year 2009, hours 5 and 7 are above the high limit.

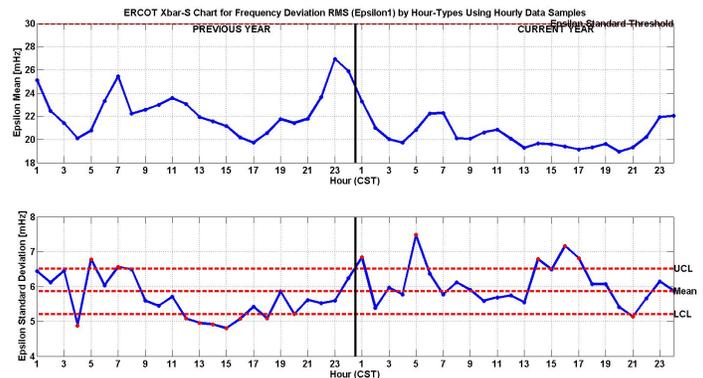


Figure 6: ERCOT Epsilon Performance Using SPC Criteria

3.7 Interconnections Yearly Frequency Bias Trend for Events Exceeding FTL Low Limit During the On-Peak and Off-Peak Periods

Figure 7 presents the yearly Frequency Bias chart for events exceeding the FTL low limit during the on-peak period for the year 2005, 2006, 2007, 2008, 2009 and 2010. The Frequency Bias reference values are: Eastern 6242 MW/0.1Hz; ERCOT 667 MW/0.1 Hz; and Western Data 1999 MW/0.1Hz. The years below reference value were:

- Eastern: 2005,2006;
- ERCOT:2006,2007,2008,2009,2010;
- Western:2008,2009,2010.

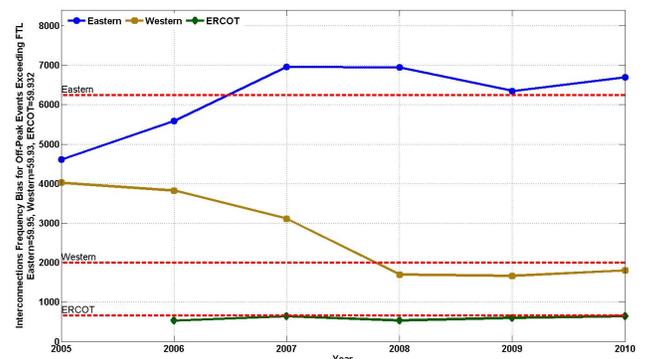


Figure 7: Interconnections Frequency Bias for Events Exceeding FTL Low Limit East=59.95, West=59.93, ERCOT=59.932 During On-Peak

Figure 8 presents the yearly Frequency Bias chart for events exceeding the FTL low limit during the off-peak period for the year 2005, 2006, 2007, 2008, 2009 and 2010. The Frequency Bias reference values are: Eastern 6242 MW/0.1Hz; ERCOT 667 MW/0.1 Hz; and Western Data 1999 MW/0.1Hz.

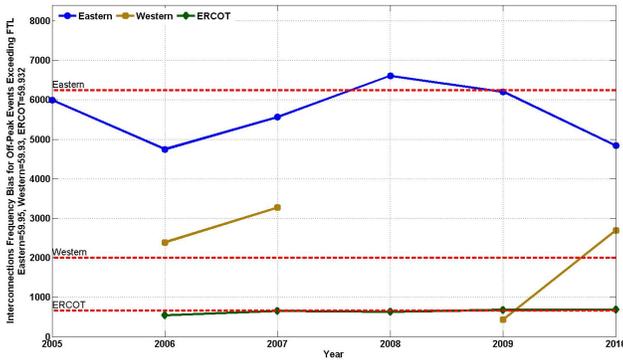


Figure 8: Interconnections Frequency Bias for Events Exceeding FTL Low Limit East=59.95, West=59.93, ERCOT=59.932 During Off-Peak

The years below reference value were:

- Eastern: 2005, 2006, 2007, 2009, 2010;
- ERCOT: 2006, 2007, 2008;
- Western: 2009.

4 INTERCONNECTIONS YEARLY CPS1 AND CPS2 METRICS TREND WHICH ARE INDICATORS OF LOAD-GENERATION CONTROL PERFORMANCE

Currently, the NERC CPS1 and CPS2 load-generation performance metrics apply to the balancing authority level. These metrics were extrapolated to the interconnection level.

4.1 Interconnections CPS1 Yearly Trend

Figure 9 shows the CPS1 extrapolated to the interconnection level for the year 2005, 2006, 2007, 2008, 2009 and 2010.

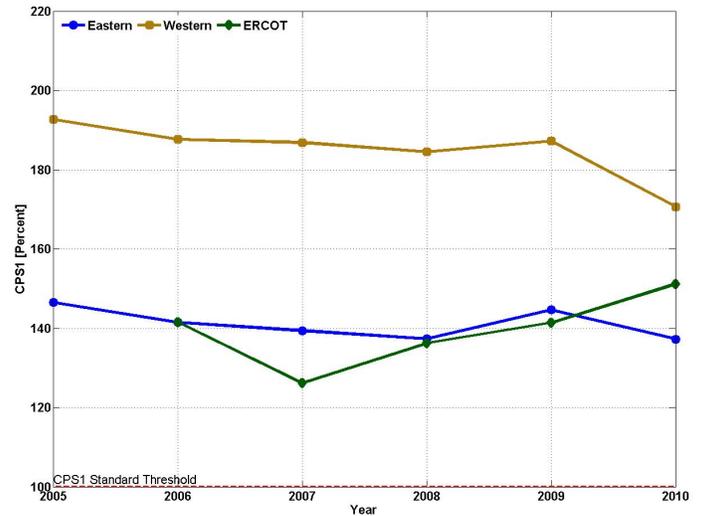


Figure 9: Interconnections CPS1 Yearly Trend

- Eastern: none below threshold.
- Western: none below threshold.
- ERCOT: none below threshold.

4.2 Interconnections CPS2 Yearly Trend

Figure 10 shows the CPS2 extrapolated to the interconnection level for the year 2005, 2006, 2007, 2008, 2009 and 2010. The performance of interconnections was as follows:

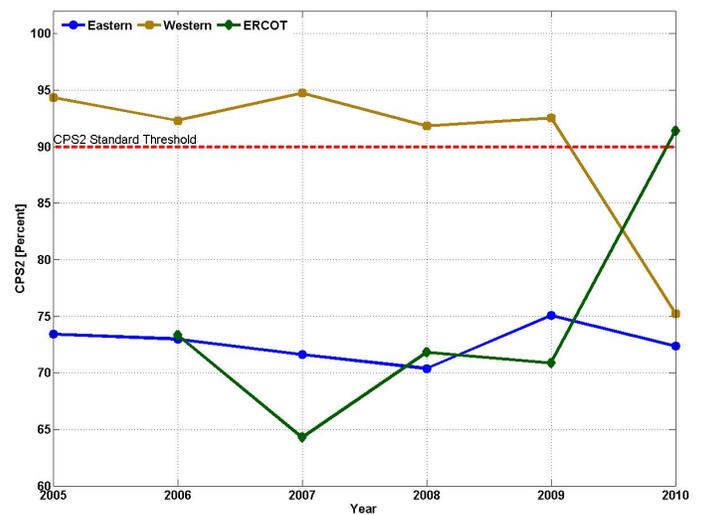


Figure 10: Interconnections CPS2 Yearly Trend

- Eastern: all years below threshold.
- Western: Year 2010 below threshold.
- ERCOT: Years 2005, 2006, 2007, 2008, 2009 below threshold.

5 INTERCONNECTIONS YEARLY FREQUENCY RESPONSE METRIC TREND – INDICATOR OF PRIMARY CONTROL PERFORMANCE

Figure 11 shows interconnections Frequency Response for those events in which 1-minute frequency differential is below -35 mHz for Eastern and Western and -70 mHz for ERCOT.

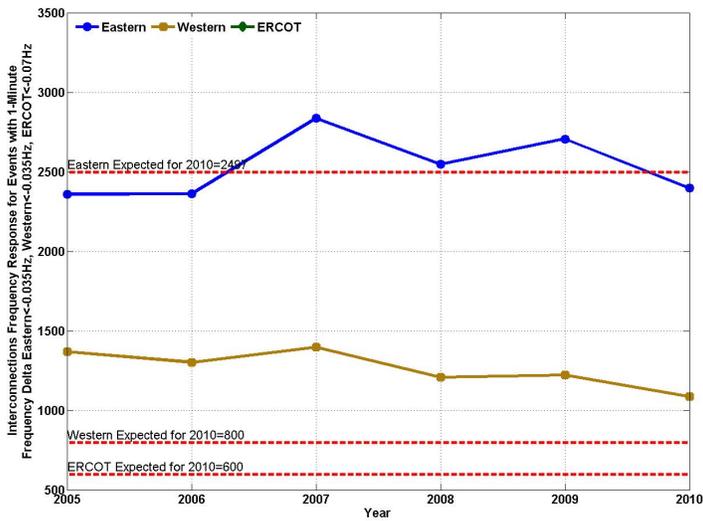


Figure 11: Frequency Response for Low Events

The expected response values are: Eastern: 2497 MW/0.1 Hz; Western 800 MW/0.1 Hz; and ERCOT 600 MW/0.1 Hz. The performance of the interconnections is summarized below:

Eastern: 2005,2006,2010 below expected value.
Western: none below expected value.
ERCOT: NA.

Figure 12 shows interconnections Frequency Response for those events in which 1-minute frequency differential is above +35 mHz for Eastern and Western and +70 mHz for ERCOT. The expected response values are: Eastern: 2497 MW/0.1 Hz; Western 800 MW/0.1 Hz; and ERCOT 600 MW/0.1 Hz. The performance of the interconnections is summarized below:

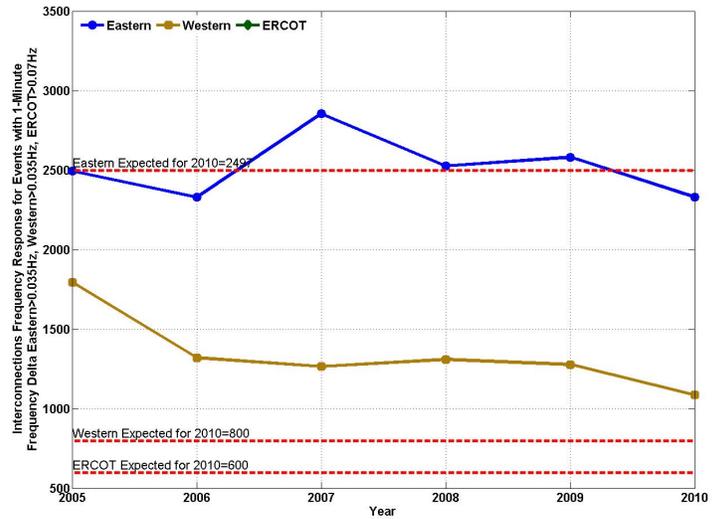


Figure 12: Frequency Response for High Events

Eastern: 2005, 2006, 2010 below expected value.
Western: none below expected value.
ERCOT: NA.

6 INTERCONNECTIONS FREQUENCY PERFORMANCE DURING MORNING PEAK HOURS(5 TO 9) AND LATE EVENING HOURS (22 TO 24) FOR THE YEAR 2005, 2006, 2007, 2008, 2009 AND 2010

The objective of this section is to present interconnections frequency or load-generation control performance during schedule ramp periods.

To identify frequency performance during schedule ramps, statistical box plots are presented using 1-second frequency data to show the frequency median and variability for each 5-minute period for the morning peak and late evening hours. This performance indicator capture the impact on frequency of schedule ramps.

6.1 Eastern Frequency Performance During Morning Peak and Late Evening Hours

Figure 13 shows one boxplot for each 5-minute period during the morning hours for the year 2005, 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2005, 2006, 2007, 2008, 2009 and 2010 is summarized below:

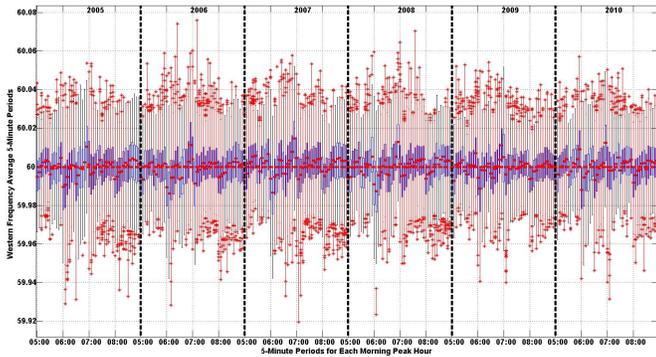


Figure 13: Frequency During Five Minute Periods for Morning Peak Hours

Year 2010 – 59.932 Hz, occurred at 7:05 time.
 Year 2009 – 59.940 Hz, occurred at 7:05 time.
 Year 2008 – 59.923 Hz, occurred at 6:05 time.
 Year 2007 – 59.920 Hz, occurred at 7:05 time.
 Year 2006 – 60.076 Hz, occurred at 7:10 time.
 Year 2005 – 59.929 Hz, occurred at 6:05 time.

Figure 14 shows one boxplot for each 5-minute period during the late evening hours for the year 2005, 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2005, 2006, 2007, 2008, 2009 and 2010 is summarized below:

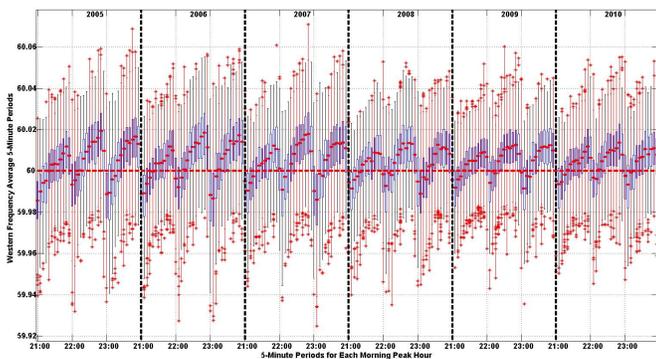


Figure 14: Frequency During Five Minute Periods for Late Evening Hours

Year 2010 – 60.055 Hz, occurred at 22:55 time.
 Year 2009 – 59.936 Hz, occurred at 23:05 time.
 Year 2008 – 59.935 Hz, occurred at 22:15 time.
 Year 2007 – 59.925 Hz, occurred at 23:05 time.
 Year 2006 – 59.927 Hz, occurred at 22:05 time.
 Year 2005 – 60.069 Hz, occurred at 22:45 time.

6.2 Western Frequency Performance During Morning Peak and Late Evening Hours

Figure 15 shows one boxplot for each 5-minute period during the morning hours for the year and for the year 2005, 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2005, 2006, 2007, 2008, 2009 and 2010 is summarized below:

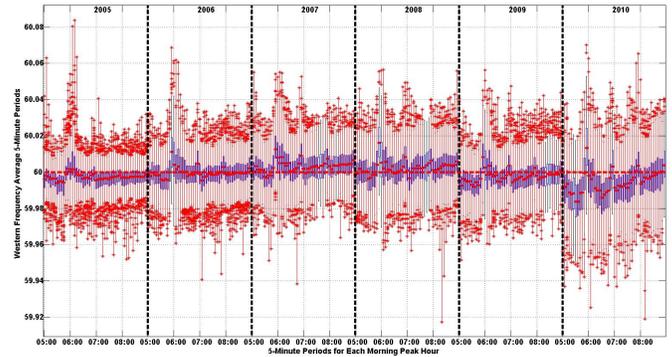


Figure 15: Frequency During Five Minute Periods for Morning Peak Hours

Year 2010 – 59.919 Hz, occurred at 8:10 time.
 Year 2009 – 60.056 Hz, occurred at 6:00 time.
 Year 2008 – 59.917 Hz, occurred at 8:20 time.
 Year 2007 – 59.938 Hz, occurred at 6:45 time.
 Year 2006 – 60.069 Hz, occurred at 5:55 time.
 Year 2005 – 60.084 Hz, occurred at 6:10 time.

Figure 16 shows one boxplot for each 5-minute period during the late evening hours for the year 2005, 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2005, 2006, 2007, 2008, 2009 and 2010 is summarized below:

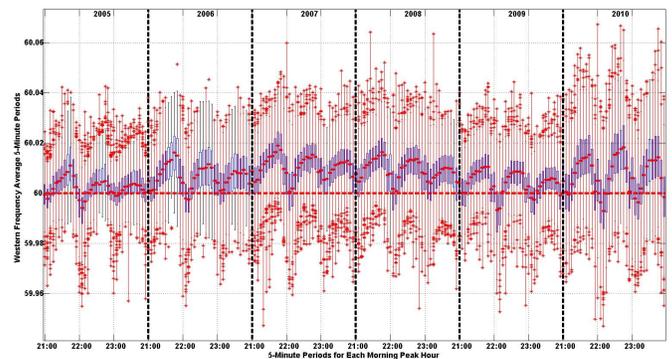


Figure 16: Frequency During Five Minute Periods for Late Evening Hours

Year 2010 – 60.067 Hz, occurred at 22:00 time.
 Year 2009 – 59.953 Hz, occurred at 22:10 time.
 Year 2008 – 60.064 Hz, occurred at 21:25 time.
 Year 2007 – 60.060 Hz, occurred at 22:00 time.
 Year 2006 – 60.051 Hz, occurred at 21:50 time.
 Year 2005 – 59.955 Hz, occurred at 22:05 time.

6.3 ERCOT Frequency Performance During Morning Peak and Late Evening Hours

Figure 17 shows one boxplot for each 5-minute period during the morning hours for the year 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2006, 2007, 2008, 2009 and 2010 is summarized below:

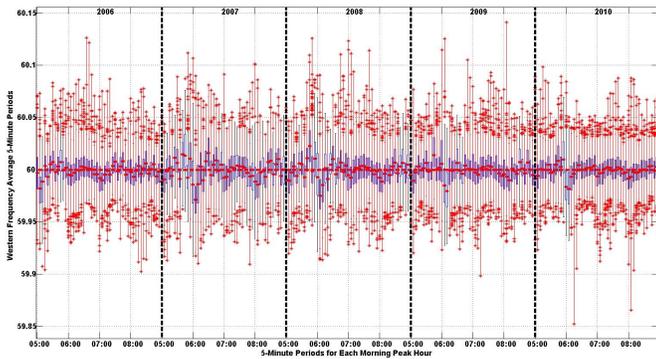


Figure 17: Frequency During Five Minute Periods for Morning Peak Hours

Year 2010 – 59.852 Hz, occurred at 06:15 time.
 Year 2009 – 60.141 Hz, occurred at 08:05 time.
 Year 2008 – 60.126 Hz, occurred at 05:50 time.
 Year 2007 – 60.112 Hz, occurred at 05:50 time.
 Year 2006 – 60.126 Hz, occurred at 06:35 time.

Figure 18 shows one boxplot for each 5-minute period during the late evening hours for the year 2006, 2007, 2008, 2009 and 2010. The minimum or maximum frequency for the year 2006, 2007, 2008, 2009 and 2010 is summarized below:

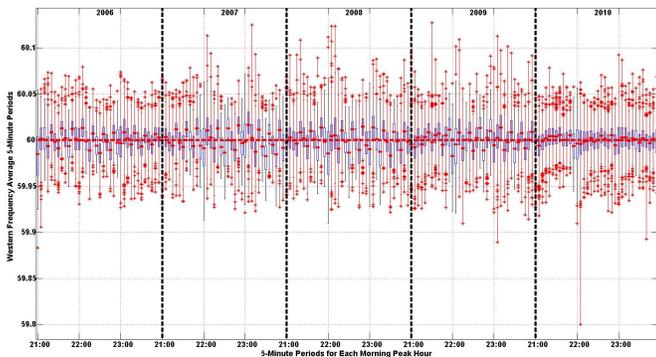


Figure 18: Frequency During Five Minute Periods for Late Evening Hours

Year 2010 – 59.800 Hz, occurred at 22:05 time.
 Year 2009 – 60.127 Hz, occurred at 21:30 time.
 Year 2008 – 60.124 Hz, occurred at 22:05 time.
 Year 2007 – 60.125 Hz, occurred at 23:10 time.
 Year 2006 – 59.883 Hz, occurred at 21:00 time.

7 INTERCONNECTIONS NUMBER OF 1-MINUTE FREQUENCY DELTA HIGH/LOW EVENTS AND EVENTS WHEN FREQUENCY WAS BEYOND THE FTL HIGH/LOW LIMITS

7.1 Number of 1-Minute Delta Frequency Low/High Events

Figure 19 presents the number of events with 1-minute frequency delta below -35 mHz for Eastern and Western, and below -70 mHz for ERCOT. The highest number of events for each of the intercon-

nections over the year 2005, 2006, 2007, 2008, 2009 and 2010 is as summarized below:

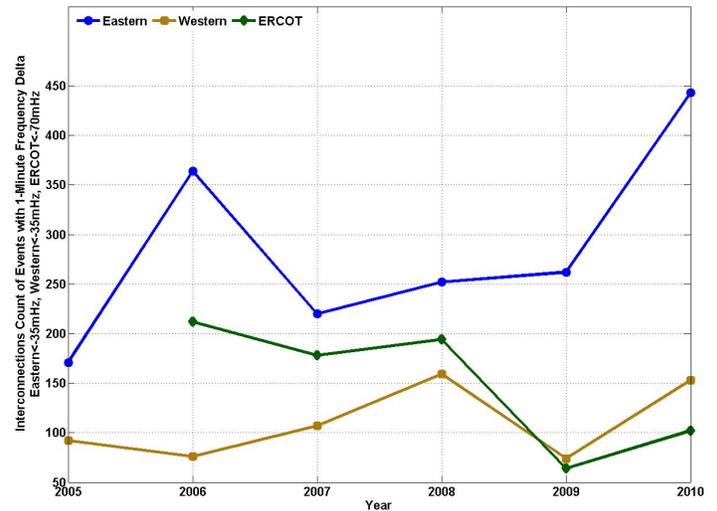


Figure 19: Number of 1-Minute Frequency Delta Low Events

Eastern – 443 events occurred in year 2010.
 Western – 159 events occurred in year 2008.
 ERCOT – 212 events occurred in year 2006.

Figure 20 presents number of events with 1-minute frequency delta above +35 mHz for Eastern and Western, and above +70 mHz for ERCOT. The highest number of events for each of the interconnections over the year 2005, 2006, 2007, 2008, 2009 and 2010 is as follows:

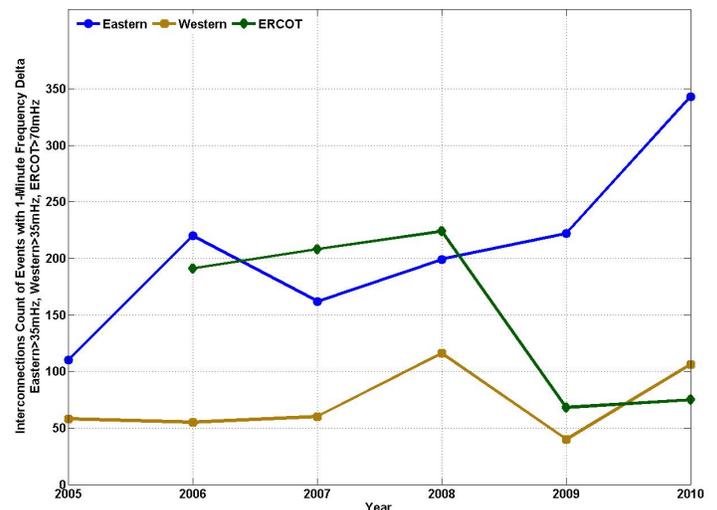


Figure 20: Number of 1-Minute Frequency Delta High Events

Eastern – 343 events occurred in year 2010.
 Western – 116 events occurred in year 2008.
 ERCOT – 224 events occurred in year 2008.

7.2 Number of Events with Frequency Exceeding FTL limits

Figure 21 presents the number of events with frequency exceeding the FTL low limit. The highest number of events crossing FTL low

limit for each of the interconnections over the year 2005, 2006, 2007, 2008, 2009 and 2010 is as follows:

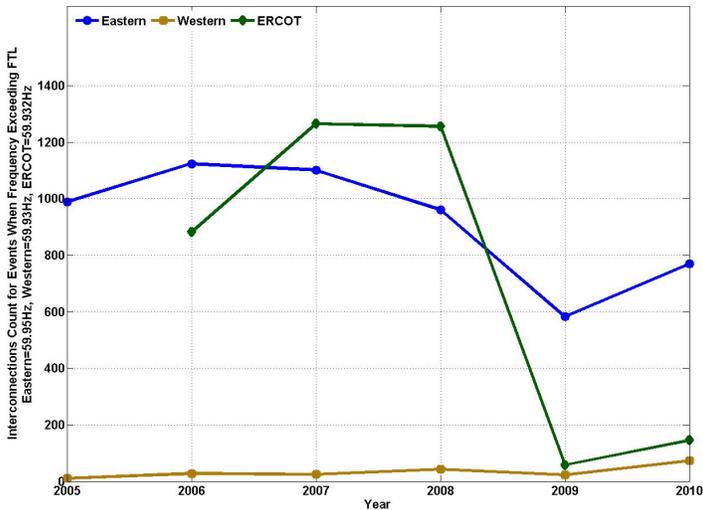


Figure 21: Number of Events With Frequency Exceeding FTL Low Limit

Eastern – 1124 events occurred in year 2006.
 Western – 73 events occurred in year 2010.
 ERCOT – 1265 events occurred in year 2007.

Figure 22 presents number of events with frequency exceeding FTL High limit. The highest number of events crossing FTL high limit for each of the interconnections over the year 2005, 2006, 2007, 2008, 2009 and 2010 is as follows:

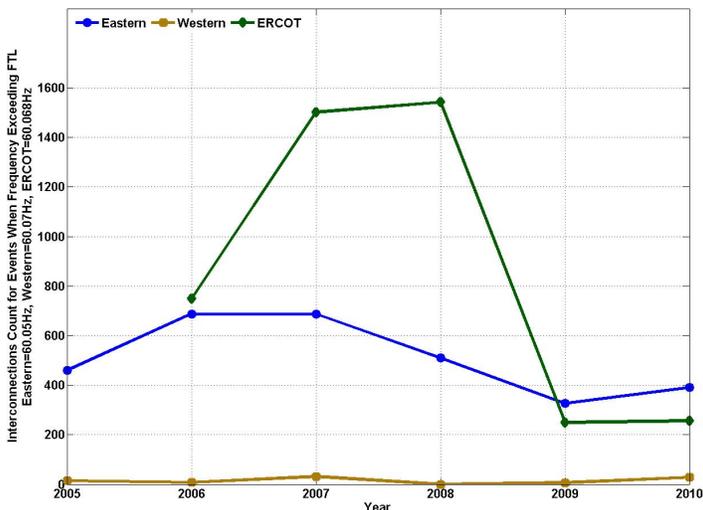


Figure 22: Number of Events with Frequency Exceeding FTL High Limit

Eastern – 688 events occurred in year 2006 and 2007.
 Western – 31 events occurred in year 2007.
 ERCOT – 1542 events occurred in year 2008.