

NERC

***Frequency Monitoring and Analysis (FMA)
Application – Release 1.0 For Field Trial***

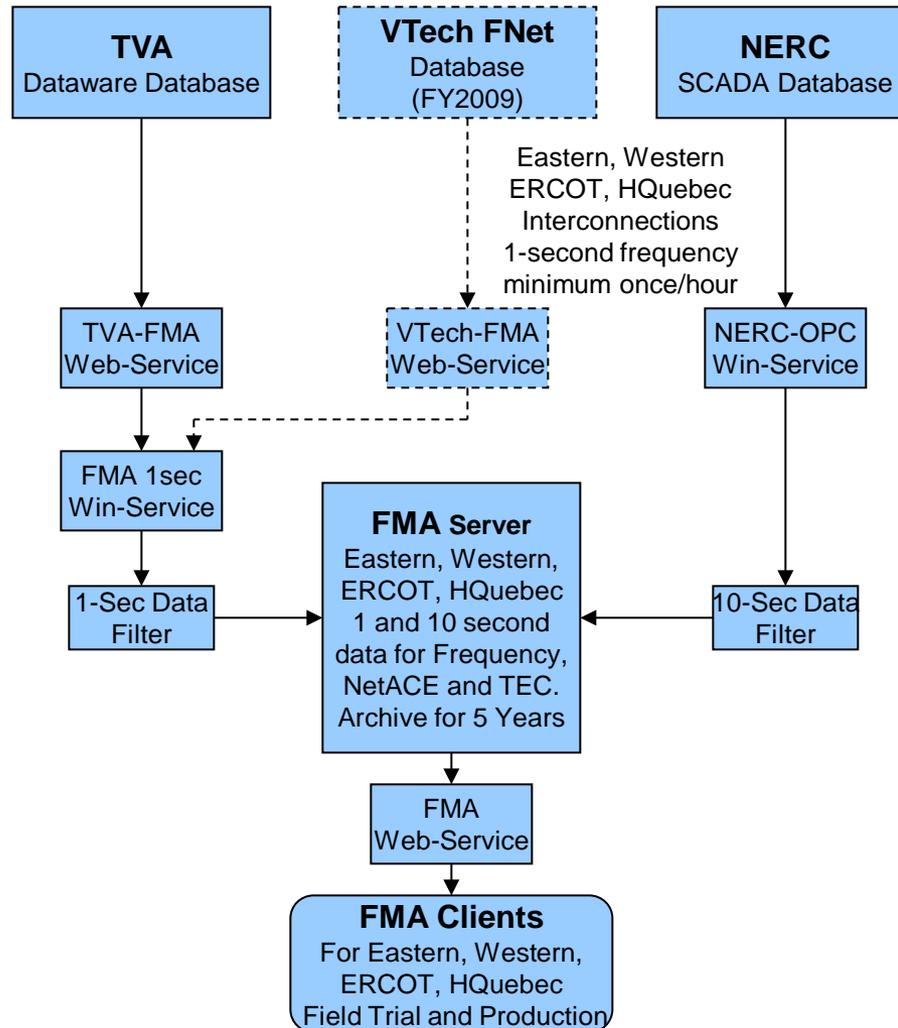
***Data Communications, Functionality, and
Navigation Overview
Data Availability and Case Studies***

Date: November 07, 2008

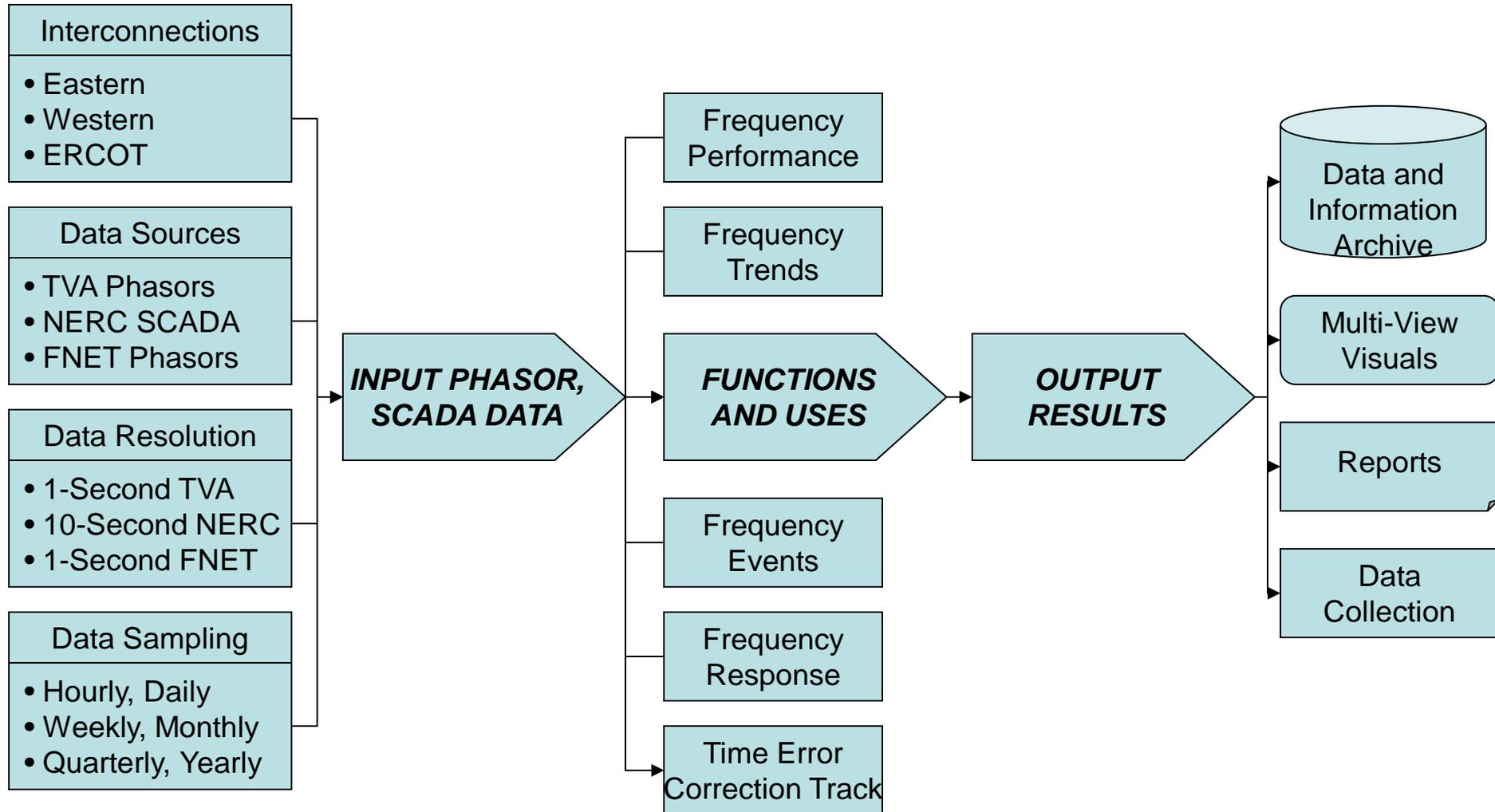
NERC FMA Data Communications, Functionality and Navigation Overview

**Review the Data Availability Section to Identify if for the Period
you Need to Analyze the Data is Archived and
What its Availability Percent is
(The NERC 10-Second Data Has About 98-99 Percent Availability)**

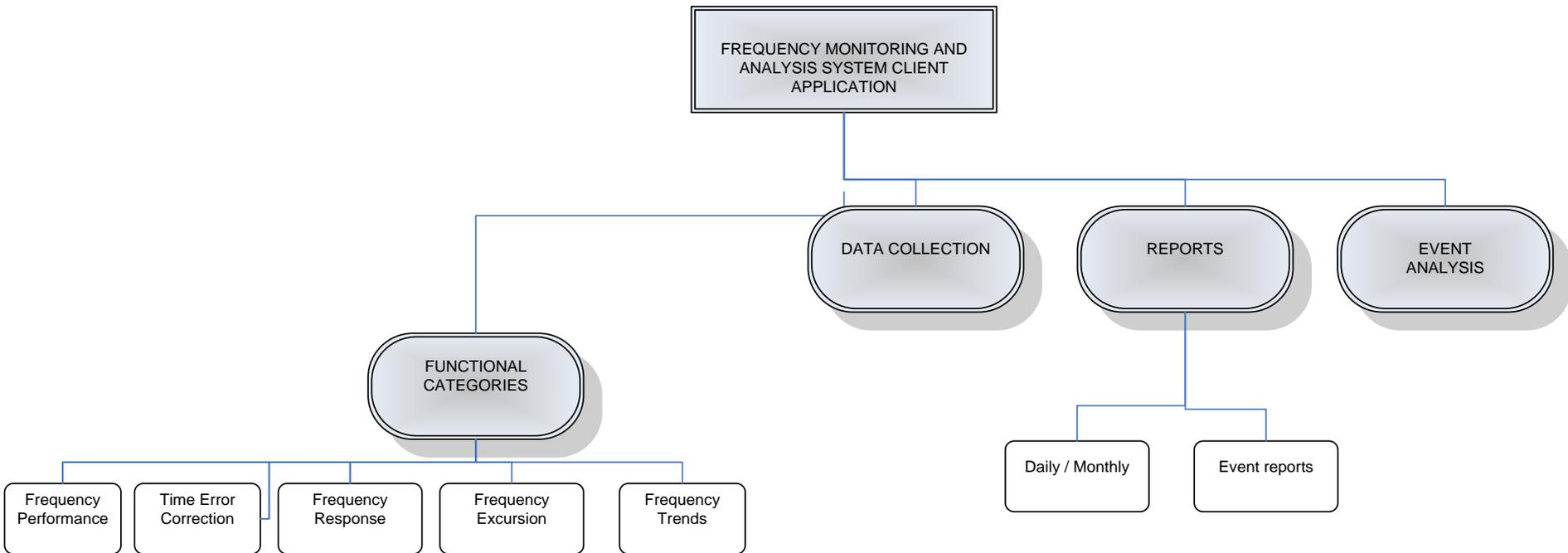
NERC Frequency Monitoring and Analysis (FMA) Data Communications Architecture



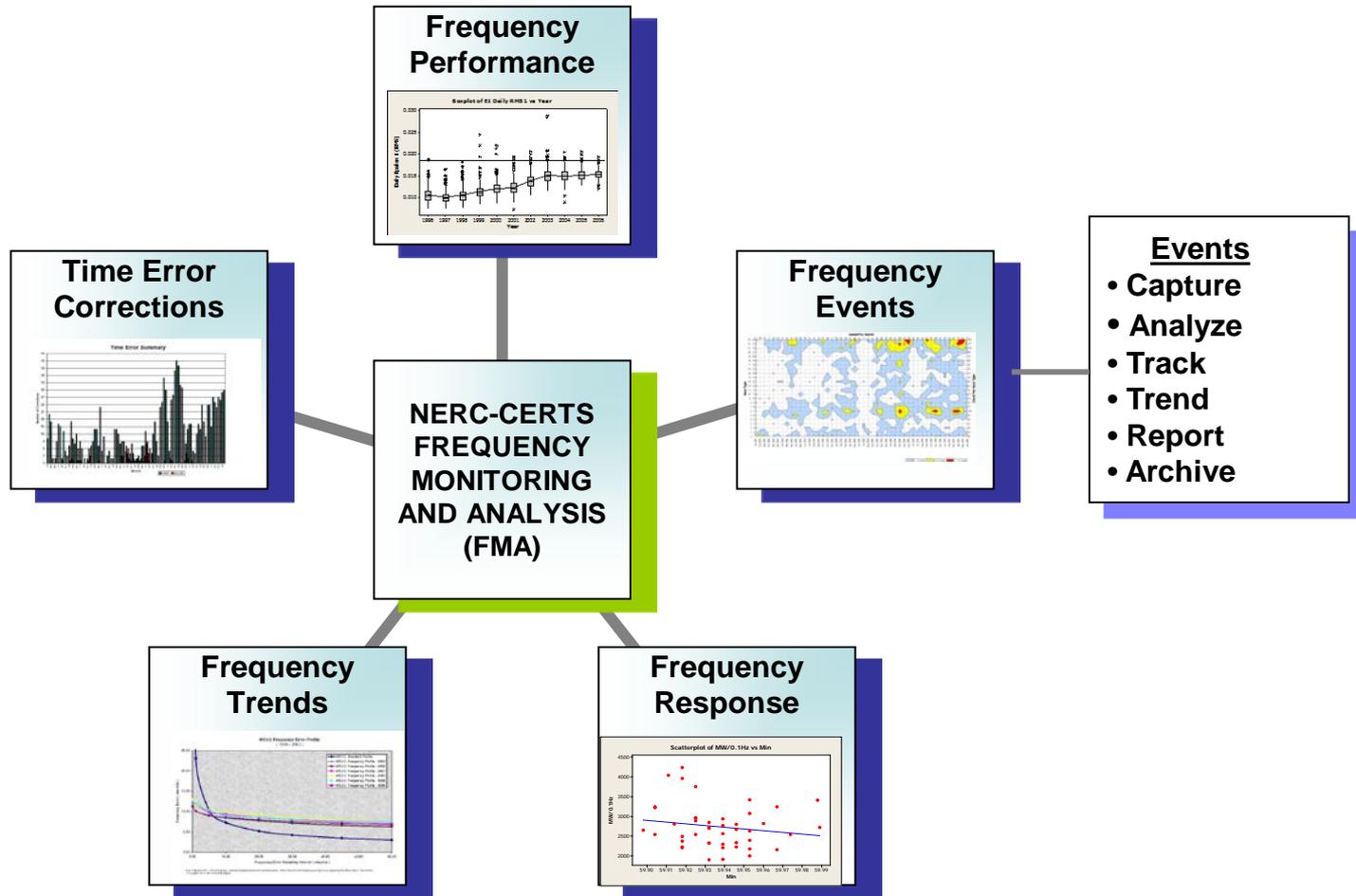
NERC FREQUENCY MONITORING AND ANALYSIS (FMA) FOR INTERCONNECTIONS – FUNCTIONAL OVERVIEW



FMA Navigation

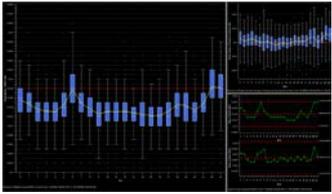
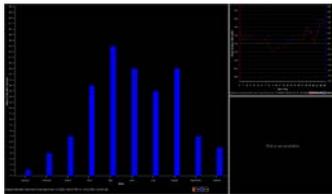
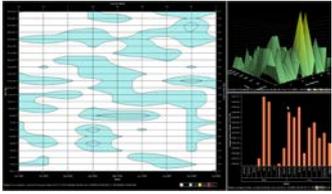
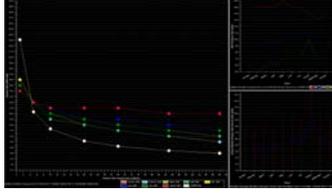
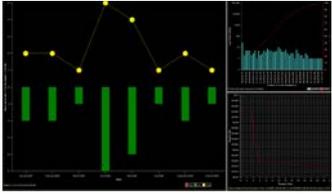
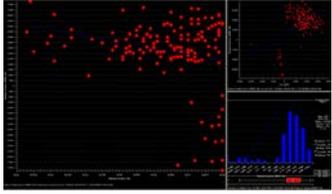
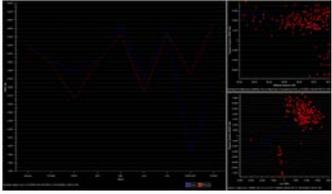


Frequency Analysis and Monitoring (FMA) Functions and Visualization Modules



***NERC FMA
Frequency Data Calculation
and Data Filtering***

Frequency Calculated Values Used by FMA Displays and Reports

Function	Display Sample	Calculated Values	Function	Display Sample	Calculated Values
Frequency Performance		Panel 1: Interconnection Average Frequency	Time Error Collection Analysis		Panel 1: Schedule Frequency
		Panel 2: Interconnection Average Frequency			Panel 2: Schedule Frequency
		Panel 3: Interconnection Average Frequency			NA
Frequency Events Duration, Distribution		Panel 1: Frequency Events with Valid Status	Frequency Trend		Panel 1: Interconnection Average Frequency
		Panel 2: Frequency Events with Valid Status			Panel 2: Interconnection Average Frequency
		Panel 3: Frequency Events with Valid Status			Panel 3: Interconnection Average Frequency
Frequency Events Counts, Typical		Panel 1: Frequency Events with Valid Status	Reports		Periodic Reports: Interconnection Average Frequency
		Panel 2: Frequency Events with Valid Status			Events Reports: Frequency Events with Valid Status
		Panel 3: Frequency Events with Valid Status			Retrieve Reports: Interconnection Average Frequency
Frequency Response Response vs: MinFreq and Loss		Panel 1: Frequency Events with Valid Status	Data Collection		Frequency from Individual Frequency Source
		Panel 2: Frequency Events with Valid Status			
		Panel 3: Frequency Events with Valid Status			
Frequency Response Response vs: Date		Panel 1: Frequency Events with Valid Status	FR Event Editor		Frequency Event Detected from Primary Data Source is Initially Marked as Valid and Shown in Black Text in Event List. Frequency Event Detected from non-Primary Data Source is Initially Marked as Invalid and Shown in Red Text in Event List.
		Panel 2: Frequency Events with Valid Status			
		Panel 3: Frequency Events with Valid Status			

FMA Frequency Data Calculations

FMA queries the available values from the 3 data sources per interconnection, does the average calculation and archives the result in FMA frequency data table.

The following two tables show the components for the average calculations for the 1-second frequency and 10-second frequency data.

1-second data source	<i>Eastern</i>	<i>Western</i>	<i>ERCOT</i>	<i>Quebec</i>
Provider	TVA	FNET	FNET	
Primary data source	Volunteer (VOLU-FQ) of TVA	LA-Pasadena, CA	Houston	
Secondary data source	Callaway (CALY-FQ) of Ameren	EPRI-Palo Alto, CA	UTSA - San Antonio, TX	
Tertiary Data source	Jacksons Ferry (JFRY-FQ) of AEP	NewWSU-Pullman, WA		

10-second data source	<i>Eastern</i>	<i>Western</i>	<i>ERCOT</i>	<i>Quebec</i>
Provider	NERC	NERC	NERC	NERC
Primary data source	TVA	BCTC	ERCO	HQT
Secondary data source	PJM	PNM		
Tertiary Data source	ISNE	PACE		

FMA Data Filtering

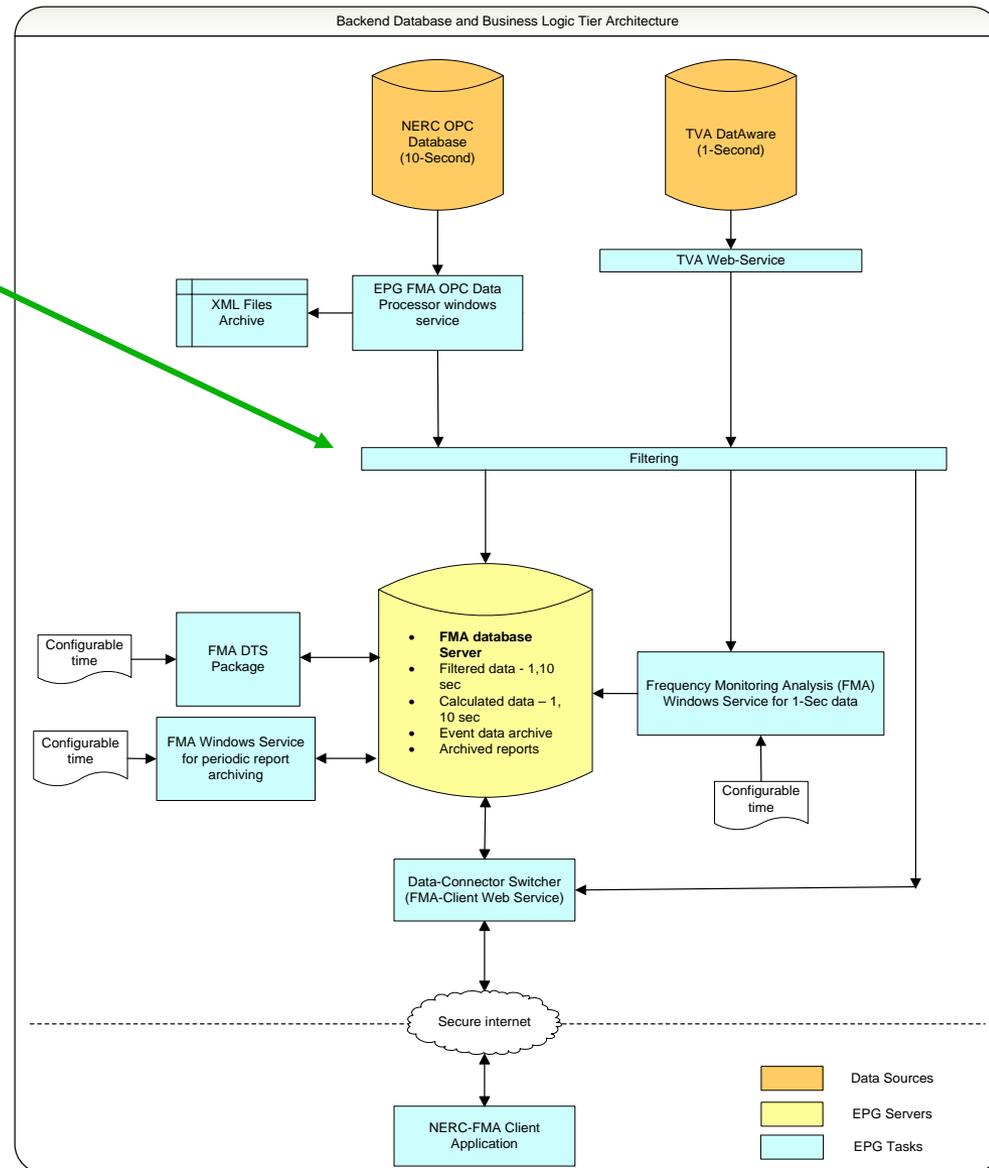
FMA data filtering (see diagram) only checks for abnormal frequency extremes. Frequencies exceeding a high of 62 Hz or low of 58 Hz will be filtered and will not be stored in FMA database

FMA does not do any replacement for the data not transmitted from sources

Following are the data-quality codes shown in the data collection displays.

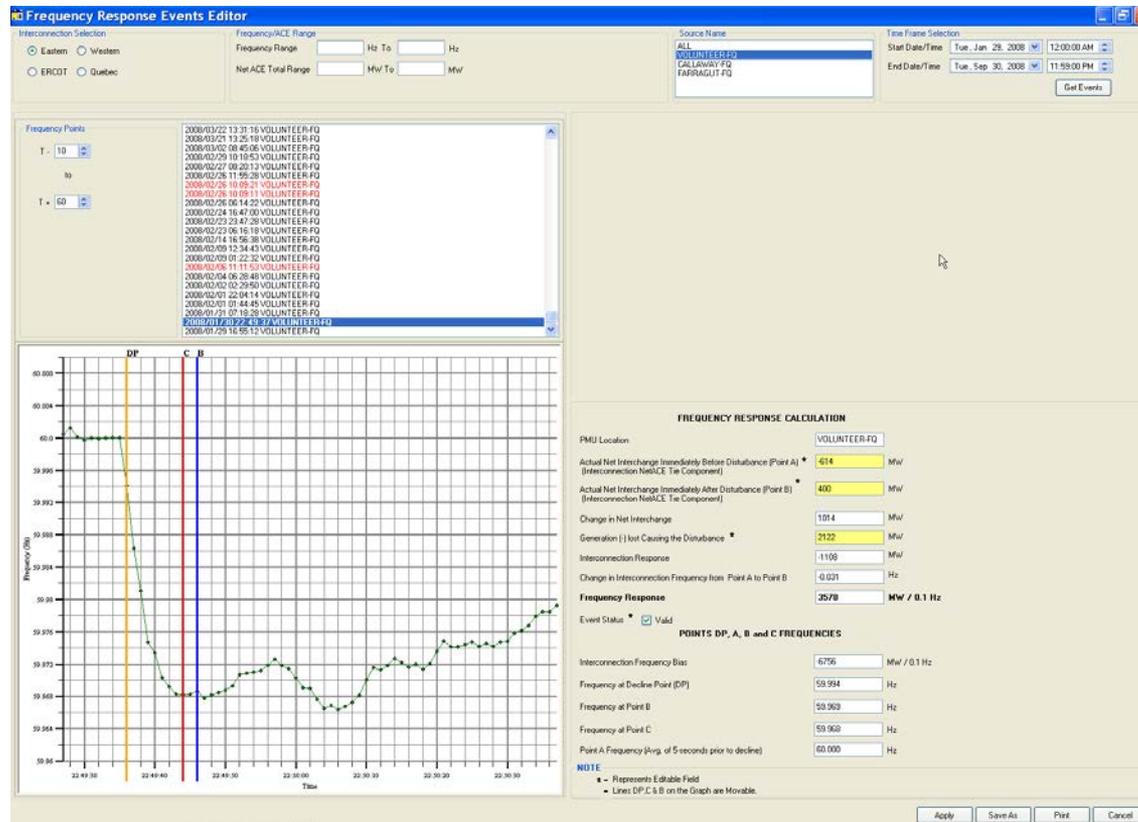
TVA Phasor Data Quality Code	
Good Data	29
Bad Data – Detected by TVA	14
Bad Data – Detected by CERTS-EPG	5

NERC SCADA Quality Code	
Good Data	192



***NERC FMA
Event Frequency Response
Archive, Editor and Reports***

Events Frequency Response Editor Capability



Frequency Response Calculation Method	Frequency Data Source	Frequency at Point A	Frequency at Point C	Frequency at Point B	MW Loss Source	Frequency Response Calculation
FMA Method (Uses NERC Guide in Training Document)	TVA 1-second phasor data	Average of the 5 Frequencies before the decline point *	Lowest frequency for the next 10 seconds after the decline point	Highest frequency for the next 5 seconds after Point C	Calculated value using NERC 10-second NetACE Bias data **	FMA automatically calculates Frequency Response using the NERC-Guide method (Training Document -2/20/2003)

Decline Point Definition Used by FMA: The Decline Point is Defined at the Time When the Standard Deviation of 8 Consecutive Frequencies is Greater than Predefined Threshold.

**** Loss MW Calculation in FMA =** Interconnection NetACE Bias at Point A – Interconnection NETACE Bias at Point B.

Yellow Text Box, Valid Check Box, Line DP, C and B – Are Editable. User can See the Changes of calculated Frequency Response by Moving or Change These Information. Only Authorized User Have the Ability to Save the Changes into the Database by Clicking Apply button. Once These Changes are Saved, They are Available to All the Users.

Valid status - Frequency Response Event Detected from Primary Data Source is Initially Marked as Valid. The Event Detected from non-Primary Data Source is Initially Marked as Invalid. The Event with Calculated Frequency Response is not in [0,8000] MW/0.1Hz is Initially Marked as Invalid. Invalid Events are Shown in Red in Event List. Valid Events are Shown in Black in Event List.

Frequency/ACE Range – Can Help to Further Narrow Down the Event Shown in Event List. If User doesn't Want to Narrow Down, He does not Need to Enter Anything. ACE Range is Used to Define the Range of NetACE at Point C. Frequency Range is used to Define the Frequency Range at Point C.

Events Reports Capability

Report Part 1:
Report Header

NERC - FREQUENCY EVENTS REPORT - Created : 10/23/08
 Interconnection : Eastern
 Event Type : Low Frequency Events
 Time Period : 09/22/2008 07:00:00 - 10/22/2008 07:00:00 [PDT]
 Day Selection : All Week Days
 Hour Selection : All Hours
 Frequency Range : Not Applicable
 NET ACE Range : Not Applicable
 Frequency Points : 20,20

Report Part 3:
Event Detail

The screenshot shows the 'Event Reports' window with several sections:

- Interconnection Selection:** Radio buttons for Eastern (selected), Western, ERCOT, and Quebec.
- Event Type:** Radio buttons for High Frequency Events and Low Frequency Events (selected).
- Time Frame Selection:** Input fields for Start date/time and End date/time.
- User Data Selection:** A list of days (Sunday to Saturday) with Sunday selected.
- Hour Selection:** Radio buttons for Hours (selected), On-Peak, Off-Peak, and All Hours.
- Frequency/NET ACE Range Selection:** Input fields for Frequency Range (Hz To), NET ACE Range (MW To), and Frequency Points (T-20 to T+20).
- Select Variables:** A list of available variables including NetBias, ACE, and ACE Data Quality.

Select Interconnection

Select Date Range

Select Weekday Type

Select Range of Freq at Point C

Select Range of NetACE at Point C

Select Hour Type

Select Number Points or Each Event Example Shows to Collect 20 Data Points Before and 20 Data Points After for Each Event

Report Part 2:
Selected Valid Frequency Response Events List

Requested Events Consecutive Frequency (Hz), Net ACE Total, Ties and FBias (MW)

Event	Date	Time	Frequency	Frequency Data Quality	Scheduled Frequency	NetTotal ACE	NetTies ACE	NetFBias ACE	ACE Data Quality
28106	9/26/2008	02:04:19	59.997	0	60	8	212	-203	0
28106	9/26/2008	02:04:20	59.999	0	60	8	76	-68	0
28106	9/26/2008	02:04:21	59.997	0	60	8	212	-203	0
28106	9/26/2008	02:04:22	59.997	0	60	8	212	-203	0
28106	9/26/2008	02:04:23	59.996	0	60	8	280	-271	0
28106	9/26/2008	02:04:24	59.996	0	60	8	280	-271	0
28106	9/26/2008	02:04:25	59.994	0	60	8	415	-407	0
28106	9/26/2008	02:04:26	59.992	0	60	8	551	-542	0
28106	9/26/2008	02:04:27	59.991	0	60	8	619	-610	0
28106	9/26/2008	02:04:28	59.99	0	60	8	686	-678	0
28106	9/26/2008	02:04:29	59.99	0	60	-316	361	-678	0
28106	9/26/2008	02:04:30	59.988	0	60	-316	497	-813	0
28106	9/26/2008	02:04:31	59.988	0	60	-316	497	-813	0
28106	9/26/2008	02:04:32	59.988	0	60	-316	497	-813	0
28106	9/26/2008	02:04:33	59.986	0	60	-316	633	-949	0
28106	9/26/2008	02:04:34	59.985	0	60	-316	700	-1017	0
28106	9/26/2008	02:04:35	59.986	0	60	-316	633	-949	0
28106	9/26/2008	02:04:36	59.986	0	60	-316	633	-949	0
28106	9/26/2008	02:04:37	59.987	0	60	-316	565	-881	0
28106	9/26/2008	02:04:38	59.987	0	60	-316	565	-881	0
28106	9/26/2008	02:04:39	59.977	0	60	-718	706	-1424	0
28106	9/26/2008	02:04:40	59.979	0	60	-718	570	-1288	0
28106	9/26/2008	02:04:41	59.981	0	60	-718	841	-1559	0
28106	9/26/2008	02:04:42	59.977	0	60	-718	841	-1559	0
28106	9/26/2008	02:04:43	59.976	0	60	-718	909	-1627	0
28106	9/26/2008	02:04:44	59.977	0	60	-718	841	-1559	0
28106	9/26/2008	02:04:45	59.974	0	60	-718	1045	-1763	0
28106	9/26/2008	02:04:46	59.976	0	60	-718	909	-1627	0
28106	9/26/2008	02:04:47	59.974	0	60	-718	1045	-1763	0
28106	9/26/2008	02:04:48	59.973	0	60	-718	1112	-1830	0
28106	9/26/2008	02:04:49	59.973	0	60	-933	897	-1830	0
28106	9/26/2008	02:04:50	59.972	0	60	-933	965	-1898	0
28106	9/26/2008	02:04:51	59.971	0	60	-933	1033	-1966	0
28106	9/26/2008	02:04:52	59.973	0	60	-933	897	-1830	0
28106	9/26/2008	02:04:53	59.973	0	60	-933	897	-1830	0
28106	9/26/2008	02:04:54	59.971	0	60	-933	1033	-1966	0
28106	9/26/2008	02:04:55	59.974	0	60	-933	830	-1763	0
28106	9/26/2008	02:04:56	59.973	0	60	-933	897	-1830	0
28106	9/26/2008	02:04:57	59.974	0	60	-933	830	-1763	0
28106	9/26/2008	02:04:58	59.973	0	60	-933	897	-1830	0
28106	9/26/2008	02:04:59	59.974	0	60	-897	866	-1763	0
28110	9/26/2008	15:45:43	59.978	0	59.98	114	249	-136	0
28110	9/26/2008	15:45:44	59.978	0	59.98	114	249	-136	0

20 Points Before Event Time

Detail for 9/26/2008 02:04:39 Event

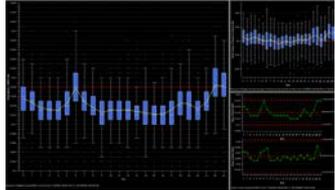
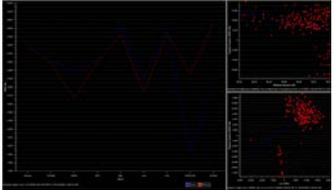
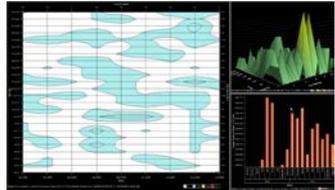
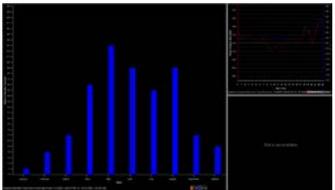
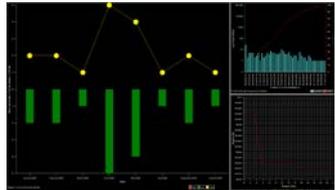
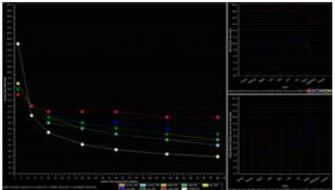
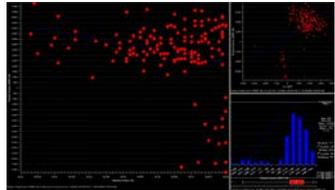
20 Points After Event Time

Requested Events Frequency (Hz) Points DP, A, B, C and Frequency Response (MW/0.1Hz)

Event	SourceName	Date	Time	Point-DP	Time-DP	Frequency of point-A which is 5-second average value	Point-B	Time-B	Point-C	Time-C	FResponse
28106	VOLUNTEER-FQ	9/26/2008	02:04:39	59.987	05:04:38	59.986	59.973	05:04:49	59.973	05:04:48	4743
28110	VOLUNTEER-FQ	9/26/2008	15:46:03	59.984	18:46:02	59.984	59.977	18:46:14	59.974	18:46:12	4471
28112	VOLUNTEER-FQ	9/26/2008	15:48:25	59.979	18:48:24	59.975	59.973	18:48:32	59.965	18:48:30	6786

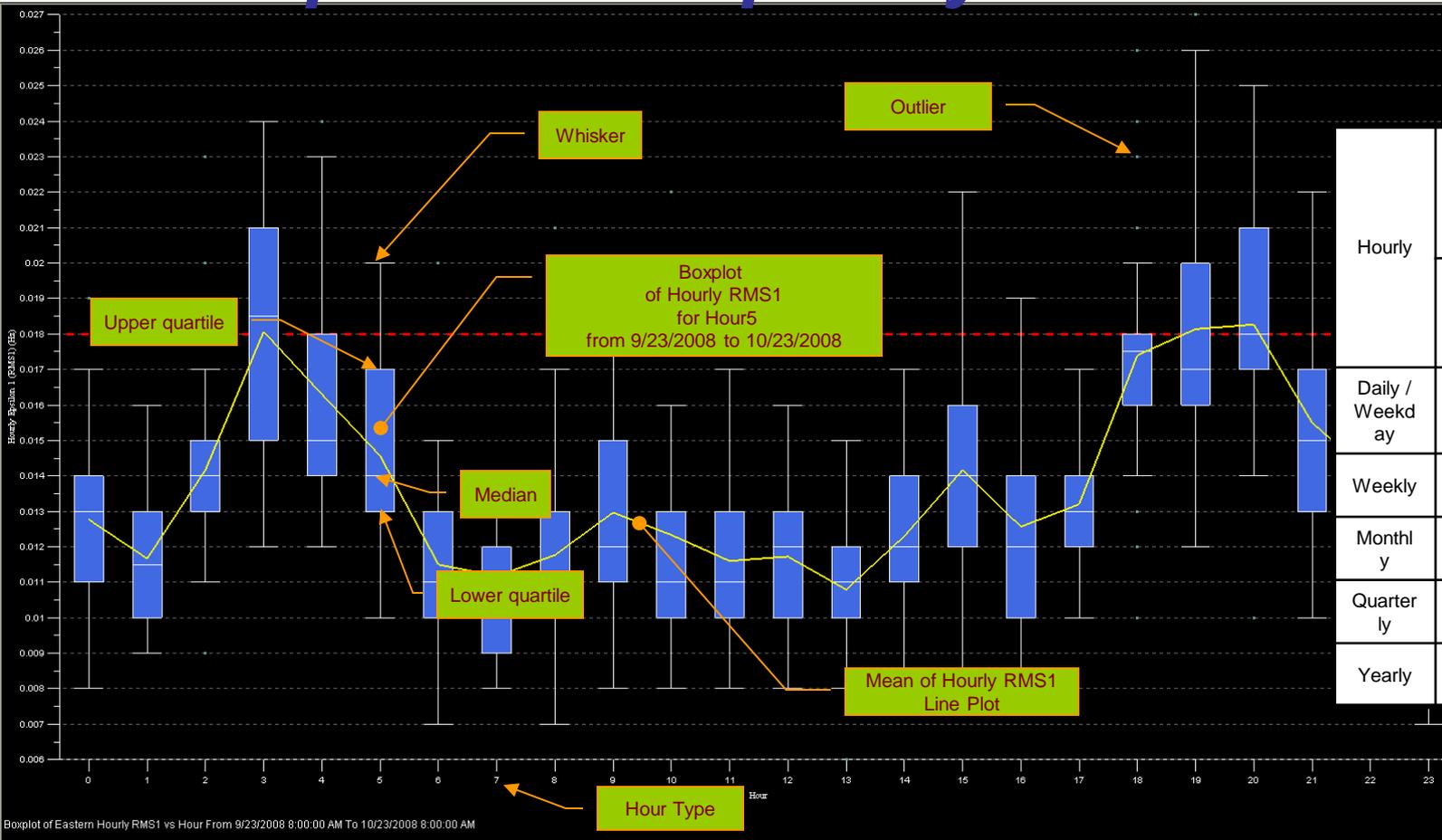
***NERC FMA
Displays Data Sets
Detail Description and Utilization***

FMA Display Sets Descriptions - Summary

Function Set	Display Sample	Graphic Description	Function Set	Display Sample	Graphic Description
Frequency Performance		Panel 1: Box plot for RMS1 of Frequency Deviation	Frequency Response Response vs. Date		Panel 1: Line chart for Frequency Response
		Panel 2: Box plot for Average Frequency Deviation			Panel 2: Scatter Plot of Frequency Response vs. Minimum Frequency
		Panel 3: Xbar-R Chart for RMS1 of Frequency Deviation			Panel 3: Scatter Plot of Frequency Response vs. Loss
Frequency Response Events Duration, Distribution		Panel 1: Contour Plot for Count of Frequency Response Events	Time Error Collection Analysis		Panel 1: Bar chart for Count of Time Error Correction
		Panel 2: 3D Probability of Frequency Response Event			Panel 2: Line chart for Frequency Error and Time Error
		Panel 3: Bar chart for Average Frequency Response Event Duration			NA
Frequency Response Events Counts, Typical		Panel 1: Bar chart for Count of Frequency Response Events vs. Date	Frequency Trend		Panel 1: Line chart for Frequency Error Profile
		Panel 2: Bar chart for Count of Frequency Response Events vs. Event Duration			Panel 2: line charts for frequency error RMS1 calculated using 1, 10 and 60 minutes sampling
		Panel 3: Line chart for Typical Frequency Response Event			Panel 3: Line chart for Average Frequency Error from Mean
Frequency Response Response vs. MinFreq and vs Loss		Panel 1: Scatter Plot of Frequency Response vs. Minimum Frequency			
		Panel 2: Scatter Plot of Frequency Response vs. Loss			
		Panel 3: Bar char for Frequency Response			

Frequency Performance Displays Set

Boxplot for Frequency Deviation RMS1



Hourly	Selected date/time range <=48 Hours	RMS1 for each 10-minute period of range selected
	Selected date/time range >48 Hours	RMS1 for each hour of range selected
Daily / Weekday	RMS1 for each hour of range selected	
Weekly	RMS1 for each hour of range selected	
Monthly	RMS1 for each day of range selected	
Quarterly	RMS1 for each day of range selected	
Yearly	RMS1 for each day of range selected	

Start Date/Time: 09/23/2008 08:00 AM

End Date/Time: 10/23/2008 08:00 AM

Eastern Interconnection Frequency Performance

Data Source: 1 Sec

Periodicity: Hourly

Time Zone: Pacific

Date_Time	Hour	Freq_Dev_RMS1
9/24/2008 12:00:00 AM	0	0.011
9/25/2008 12:00:00 AM	0	0.011
9/26/2008 12:00:00 AM	0	0.008
9/27/2008 12:00:00 AM	0	0.014
9/28/2008 12:00:00 AM	0	0.016

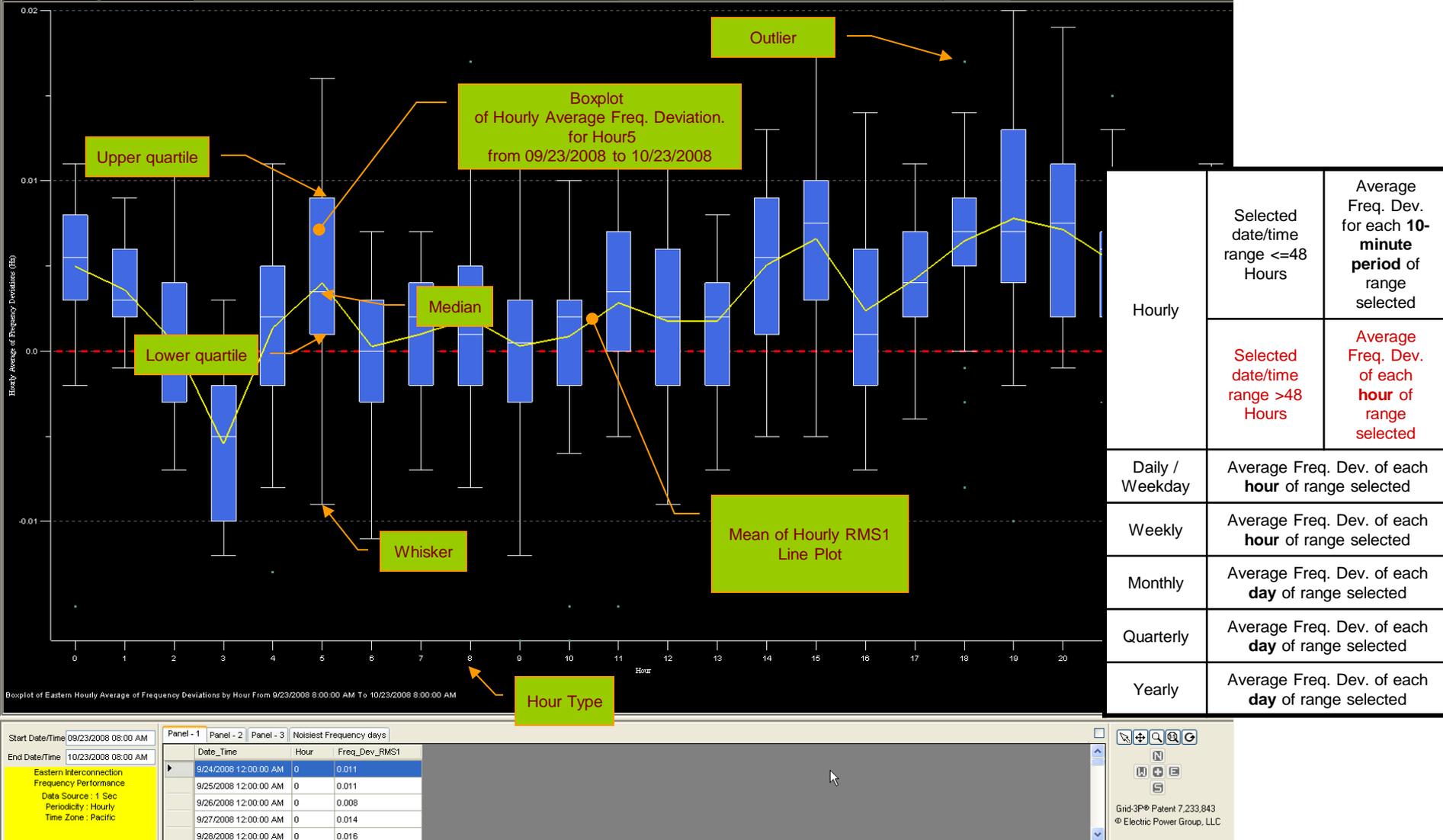
Grid-3P® Patent 7,233,843 © Electric Power Group, LLC

Boxplot Parameters – Boxplot produces a box and whisker plot using the sampling data for user selected timeframe. The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. Any data observation which lies more than 1.5 IQR (interquartile range) lower than the first quartile or 1.5 IQR higher than the third quartile is considered an outlier.

RMS1 - Root Mean Square of 1-Minute Average Frequency Deviation.
Frequency Deviation – The Deviation of Frequency from Scheduled Frequency.

Frequency Performance Displays Set

Boxplot for Frequency Average

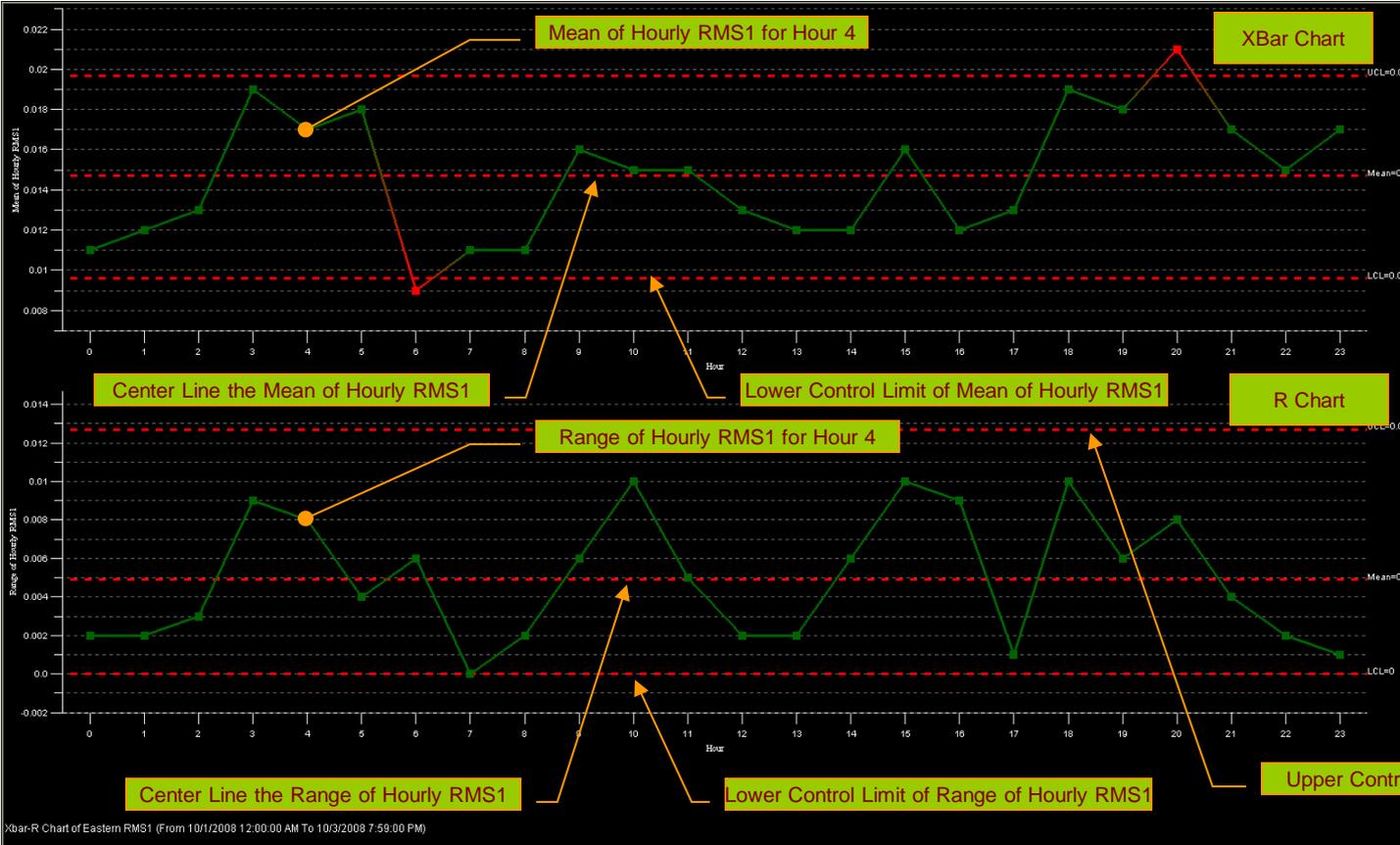


Boxplot Parameters – Boxplot produces a box and whisker plot using the sampling data for user selected timeframe. The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. Any data observation which lies more than 1.5 IQR (interquartile range) lower than the first quartile or 1.5 IQR higher than the third quartile is considered an outlier.

Frequency Deviation – The Deviation of Frequency from Scheduled Frequency.

Frequency Performance Displays Set

Frequency X-Bar R-Chart



Hourly	Selected date/time range <=48 Hours	RMS1 for each 10-minute period of range selected
	Selected date/time range >48 Hours	RMS1 for each hour of range selected
Daily / Weekday		RMS1 for each hour of range selected
Weekly		RMS1 for each hour of range selected
Monthly		RMS1 for each day of range selected
Quarterly		RMS1 for each day of range selected
Yearly		RMS1 for each day of range selected

Xbar-R Chart of Eastern RMS1 (From 10/1/2008 12:00:00 AM To 10/3/2008 7:59:00 PM)

Start Date/Time: 10/01/2008 12:00 AM
 End Date/Time: 10/03/2008 07:59 PM
 Eastern Interconnection
 Frequency Performance
 Data Source: 1 Sec
 Periodicity: Hourly
 Time Zone: Pacific

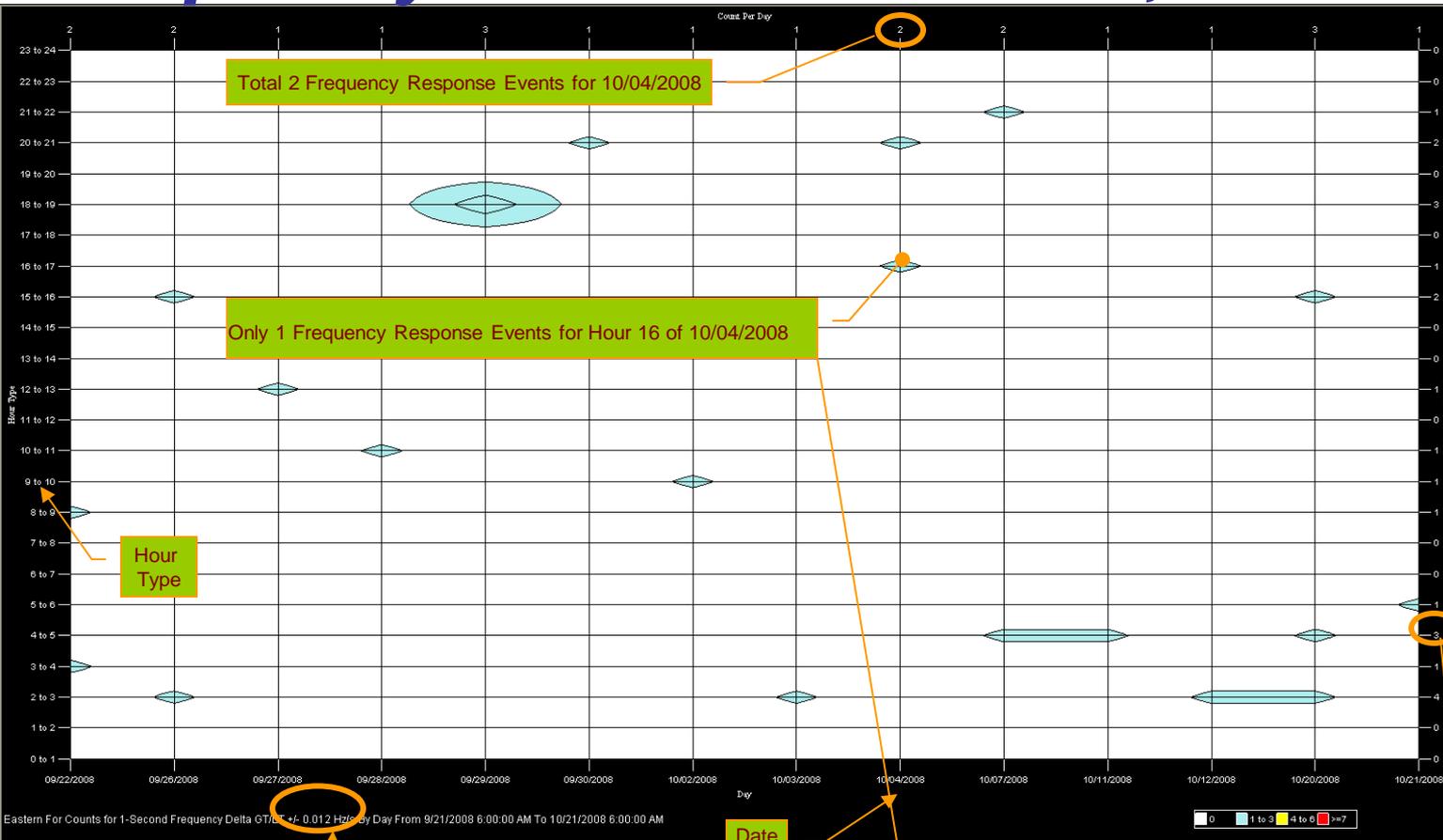
Hour	Mean	Range
0	0.0117	0.0096
1	0.012	0.009
2	0.013	0.008
3	0.019	0.009
4	0.017	0.008

Mean	LCL	UCL
0.0117	0.0095	0.0197
0.0049	0	0.0127

Grid-3P® Patent 7,233,843
 © Electric Power Group, LLC

Xbar-R Chart – Xbar Chart depicts the sample means and R Chart depicts the sample ranges. The charts plot the means of the subgroups, a center line at the average of the means, and upper and lower control limits (UCL, LCL) is calculated values based on the size of sample subgroup (see <http://www.qualitysptools.com/control.html> for detail). Out of control measurements are marked as violations and drawn in red. The X-Bar is indicative of the variation of the Mean, and the R-Chart indicative of the sensitivity of each sample.

Frequency Events – Duration, Distribution Set



Hourly	NA
Daily / Weekday	Counter Plot for Number of Frequency Response Events Per Day Per Hour Type
Weekly	Counter Plot for Number of Frequency Response Events Per Week Per Hour Type
Monthly	Counter Plot for Number of Frequency Response Events Per Month Per Hour Type
Quarterly	Counter Plot for Number of Frequency Response Events Per Quarter Per Hour Type
Yearly	Counter Plot for Number of Frequency Response Events Per Year Per Hour Type

Eastern For Counts for 1-Second Frequency Delta GT/ST +/- 0.012 Hz/Sec by Day From 9/21/2008 6:00:00 AM To 10/21/2008 6:00:00 AM

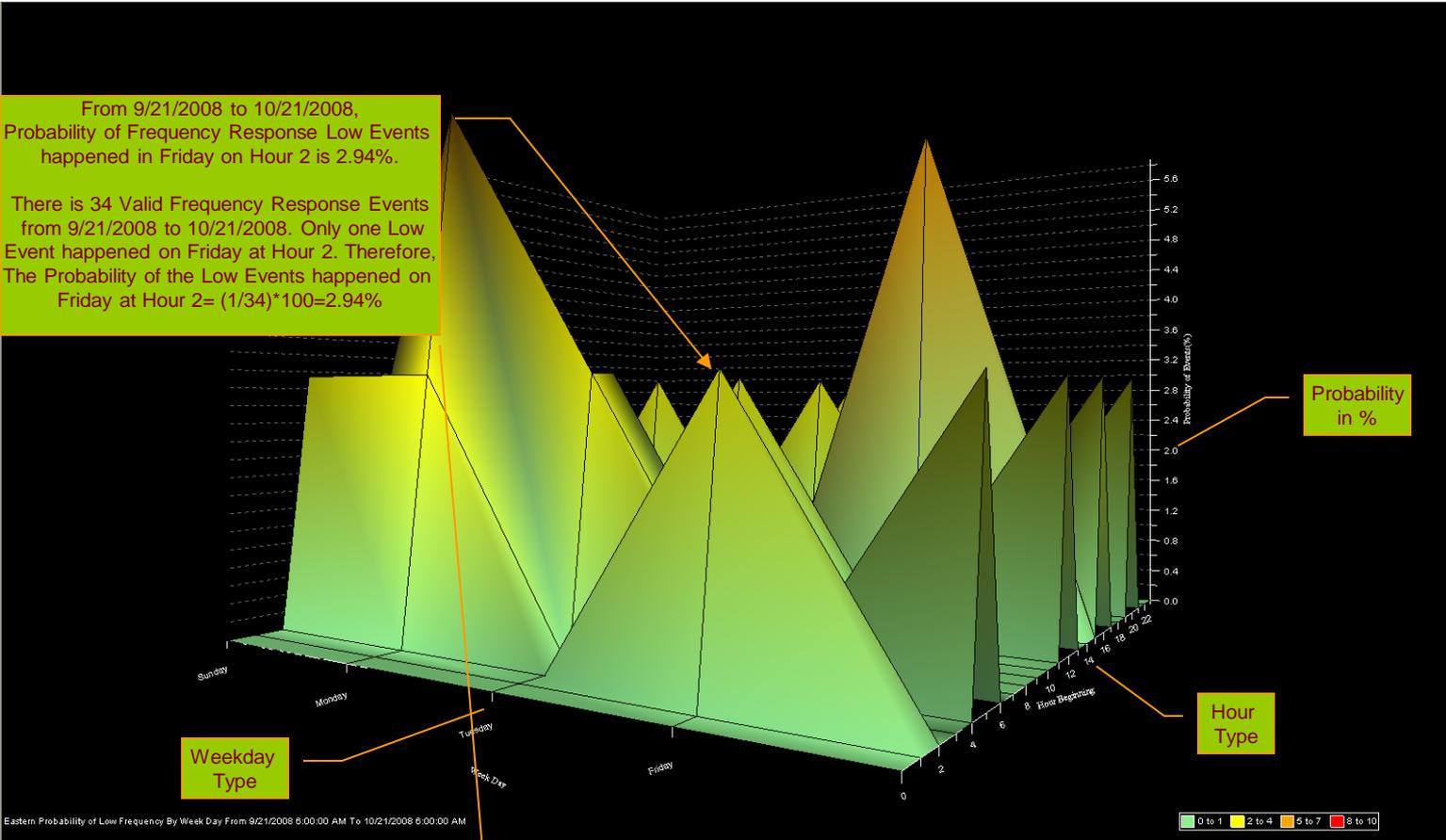
Hour	09/22/2008	09/23/2008	09/24/2008	09/25/2008	09/26/2008	09/27/2008	09/28/2008	09/29/2008	09/30/2008	10/01/2008	10/02/2008	10/03/2008	10/04/2008	10/07/2008	10/11/2008	10/12/2008	10/20/2008	10/21/2008
15	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
18	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0

Total 3 Frequency Response Events for Hour 4 from 9/21/2008 to 10/21/2008

Frequency Response Events Count – In FMA, we consider there is a frequency response event when the standard deviation of eight consecutive frequencies is greater than FMA preset threshold. FMA preset threshold can be found in Server Setting of Application Setting and it is configurable. The current setting is as following table. FMA only counts Frequency Response Events with valid status. Frequency Response Event detected from primary data source and the calculated frequency response in [0.8000] range is initially marked as valid. The valid status of Frequency Response Events is editable through FR Event Editor. Event counts can be further narrow down by redefined the threshold of two consecutive frequency data points. The default setting can be found in Client Setting of Application Setting. For example, for Eastern Interconnection, 1-second Data source, the default threshold is 0.012 Hz/Sec.

	Eastern	Western	Quebec	ERCOT
1-second Data Source Stdev of 8 samples	0.006	0.009	0.01	0.04
10-second Data Source frequency change rate df/dt	0.035 Hz/10sec	0.05 Hz/10sec	0.05 Hz/10sec	0.05 Hz/10sec

Frequency Events – Duration, Distribution Set



From 9/21/2008 to 10/21/2008, Probability of Frequency Response Low Events happened in Friday on Hour 2 is 2.94%.

There is 34 Valid Frequency Response Events from 9/21/2008 to 10/21/2008. Only one Low Event happened on Friday at Hour 2. Therefore, The Probability of the Low Events happened on Friday at Hour 2= $(1/34)*100=2.94\%$

Probability in %

Hour Type

Weekday Type

Hourly	NA
Daily / Weekday	3D Plot for Probability of Frequency Response Low Event Per Weekday Per Hour Type
Weekly	3D Plot for Probability of Frequency Response Low Event Per Week Per Hour Type
Monthly	3D Plot for Probability of Frequency Response Low Event Per Month Per Hour Type
Quarterly	3D Plot for Probability of Frequency Response Low Event Per Quarter Per Hour Type
Yearly	3D Plot for Probability of Frequency Response Low Event Per Year Per Hour Type

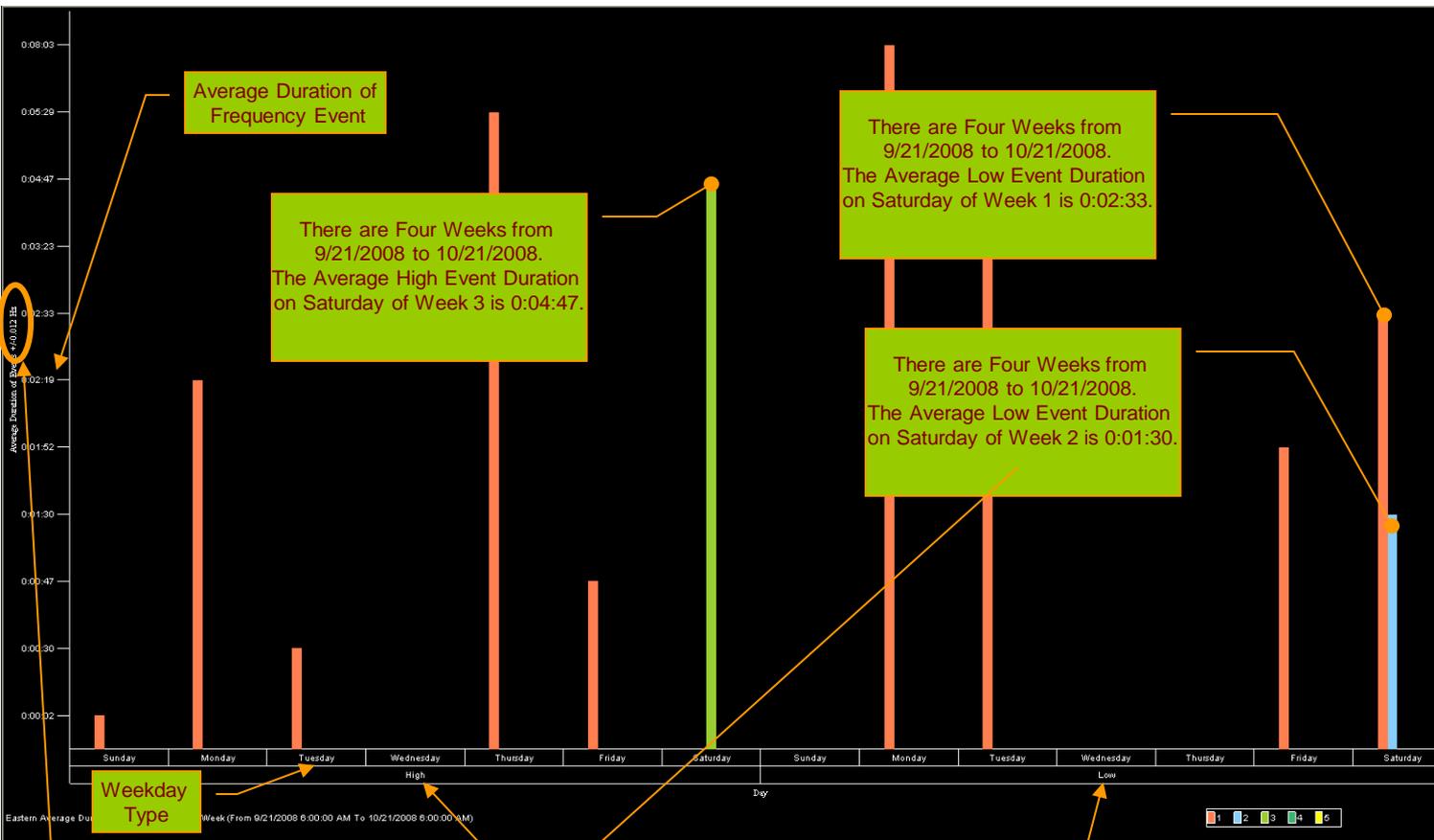
Start Date/Time: 09/21/2008 06:00 AM
End Date/Time: 10/21/2008 06:00 AM
Eastern Interconnection Frequency Events - Duration, Data Source: 1 Sec, Periodicity: Daily, Time Zone: Pacific

Hour	Sunday	Monday	Tuesday	Friday	Saturday
2	0	0	0	2.94	0
3	2.94	2.94	0	0	0
4	0	5.88	2.94	0	0
5	0	0	2.94	0	2.94
8	0	2.94	0	0	0

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Frequency Response Low Event - is referring the frequency having negative change.
Frequency Response High Event - is referring the frequency having positive change
 Only **valid** Frequency Response **Low Event** is considered in this Plot. The valid status of Frequency Response Events is editable through FR Event Editor

Frequency Events – Duration, Distribution Set



Hourly	NA
Daily / Weekday	Average Frequency Duration Group by Weekday and Event High/Low Type
Weekly	NA
Monthly	Average Frequency Duration Group by Month and Event High/Low Type
Quarterly	Average Frequency Duration Group by Quarter and Event High/Low Type
Yearly	Average Frequency Duration Group by Month and Event High/Low Type

Start Date/Time: 09/21/2008 06:00 AM
 End Date/Time: 10/21/2008 06:00 AM
 Eastern Interconnection Frequency Events - Duration, Data Source: 1 Sec, Periodicity: Daily, Time Zone: Pacific

Date_Time	Daily	High_Date_Time	Low_Date_Time
9/26/2008	Friday		00:01:52
9/27/2008	Saturday		00:02:33
10/4/2008	Saturday		00:01:30
10/11/2008	Saturday	00:04:47	
10/18/2008	Saturday		

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Frequency Responses Event Duration – Time to pre-disturbance frequency or Scheduled Frequency, whichever is sooner.

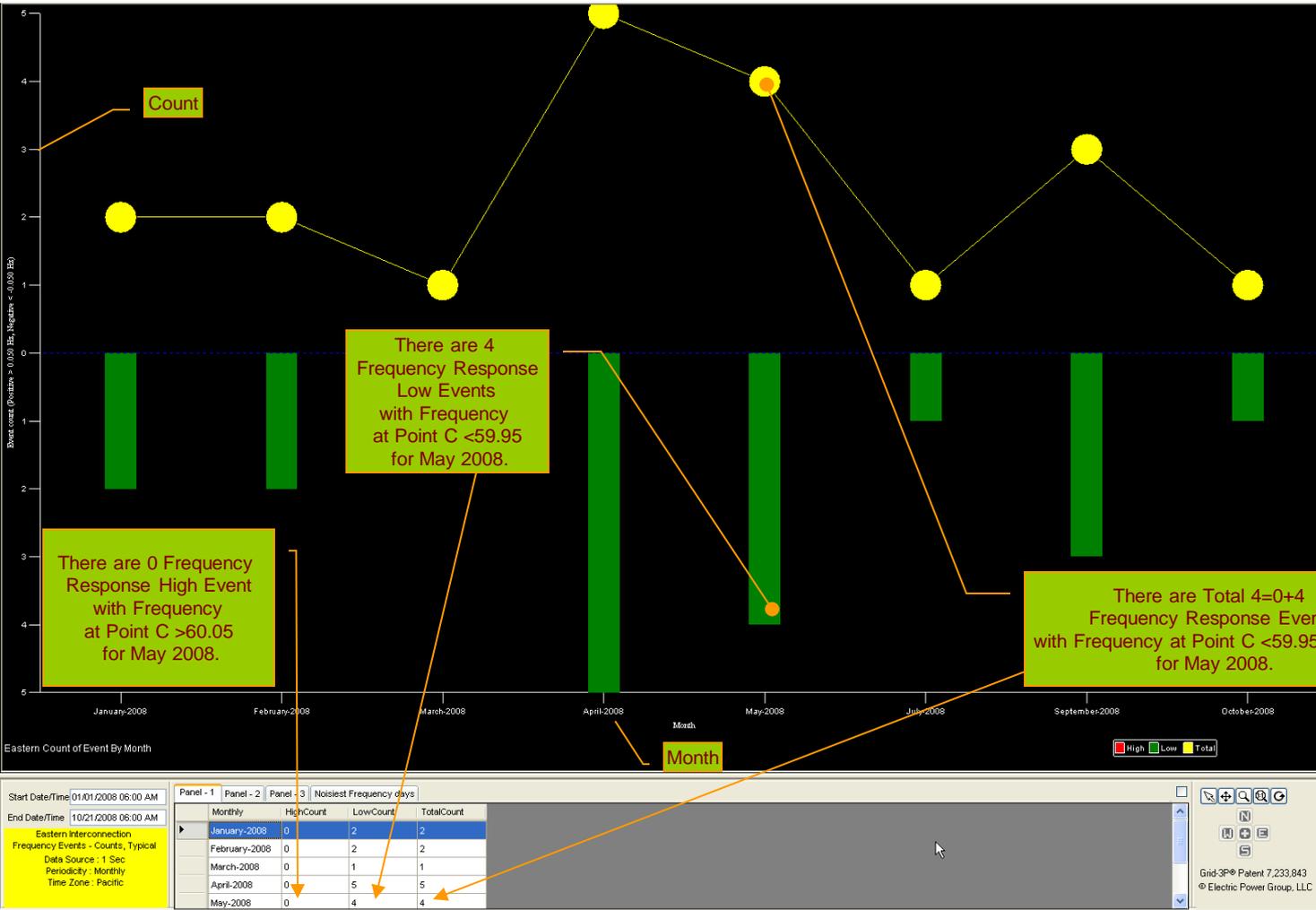
Frequency Response Events Count – In FMA, we consider there is a frequency response event when the standard deviation of eight consecutive frequencies is greater than FMA preset threshold. FMA preset threshold can be found in Server Setting of Application Setting and it is configurable. The current setting is as following table. FMA only counts Frequency Response Events with valid status. Frequency Response Event detected from primary data source and the calculated frequency response in [0,8000] range is Initially marked as valid. The valid status of Frequency Response Events is editable through FR Event Editor. Event counts can be further narrow down by redefined the threshold of two consecutive frequency data points. The default setting can be found in Client Setting of Application Setting. For example, for Eastern Interconnection, 1-second Data source, the default threshold is 0.012 Hz/Sec.

Frequency Response Low Event - is referring the frequency having negative change.

Frequency Response High Event - is referring the frequency having positive change

	Eastern	Western	Quebec	ERCOT
1-second Data Source Stdev of 8 samples	0.006	0.009	0.01	0.04
10-second Data Source frequency change rate df/dt	0.035 Hz/10sec	0.05 Hz/10sec	0.05 Hz/10sec	0.05 Hz/10sec

Frequency Events – Counts Set



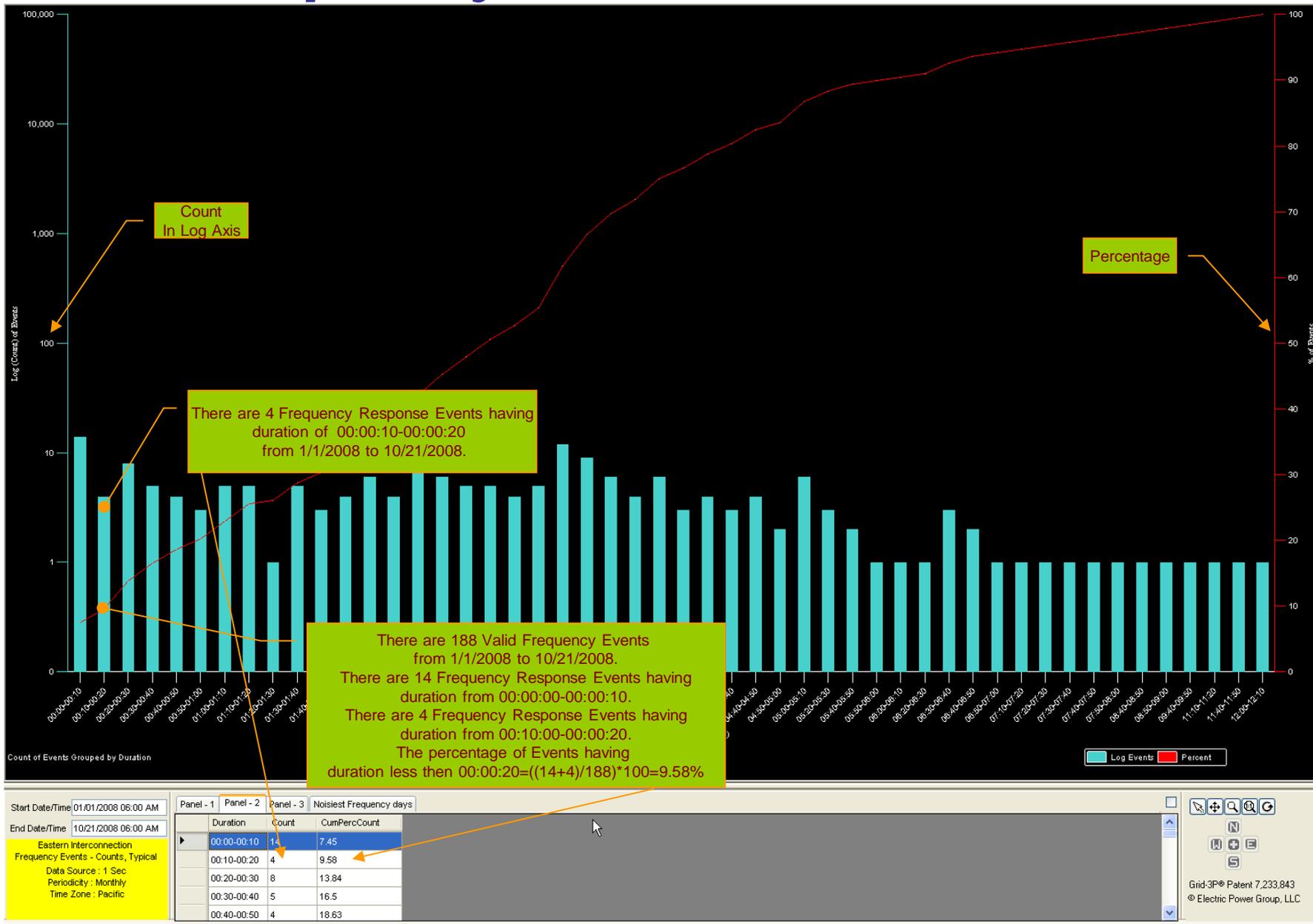
Hourly	NA
Daily / Weekday	Daily High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95
Weekly	Weekly High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95
Monthly	Monthly High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95
Quarterly	Quarterly High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95
Yearly	Yearly High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95

Frequency Response Low Event - is referring the frequency having negative change.

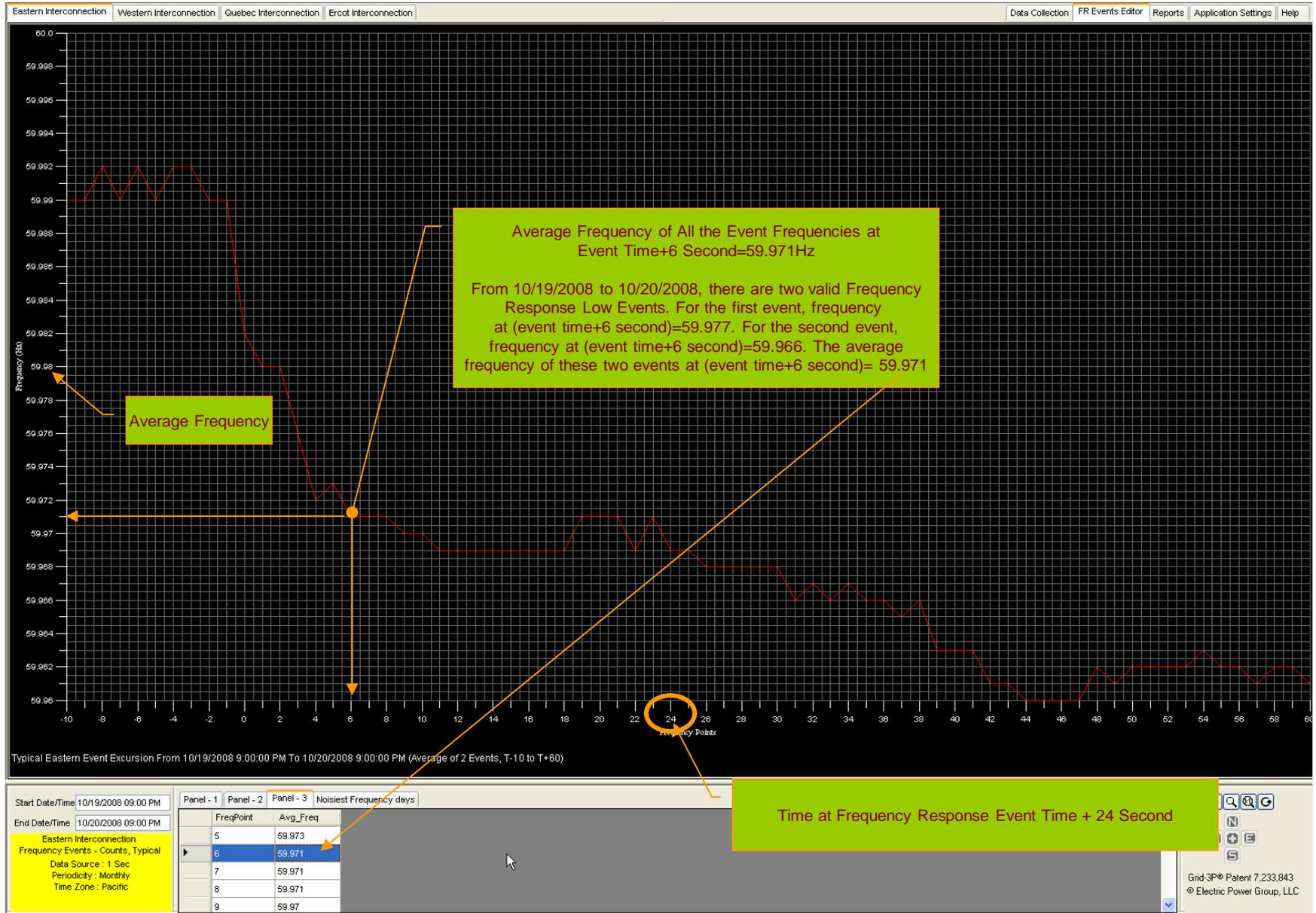
Frequency Response High Event - is referring the frequency having positive change.

Only **valid** Frequency Response Event with **Frequency at Point C <59.95 or >60.05** is considered in this Plot. The valid status of Frequency Response Events is editable through FR Event Editor

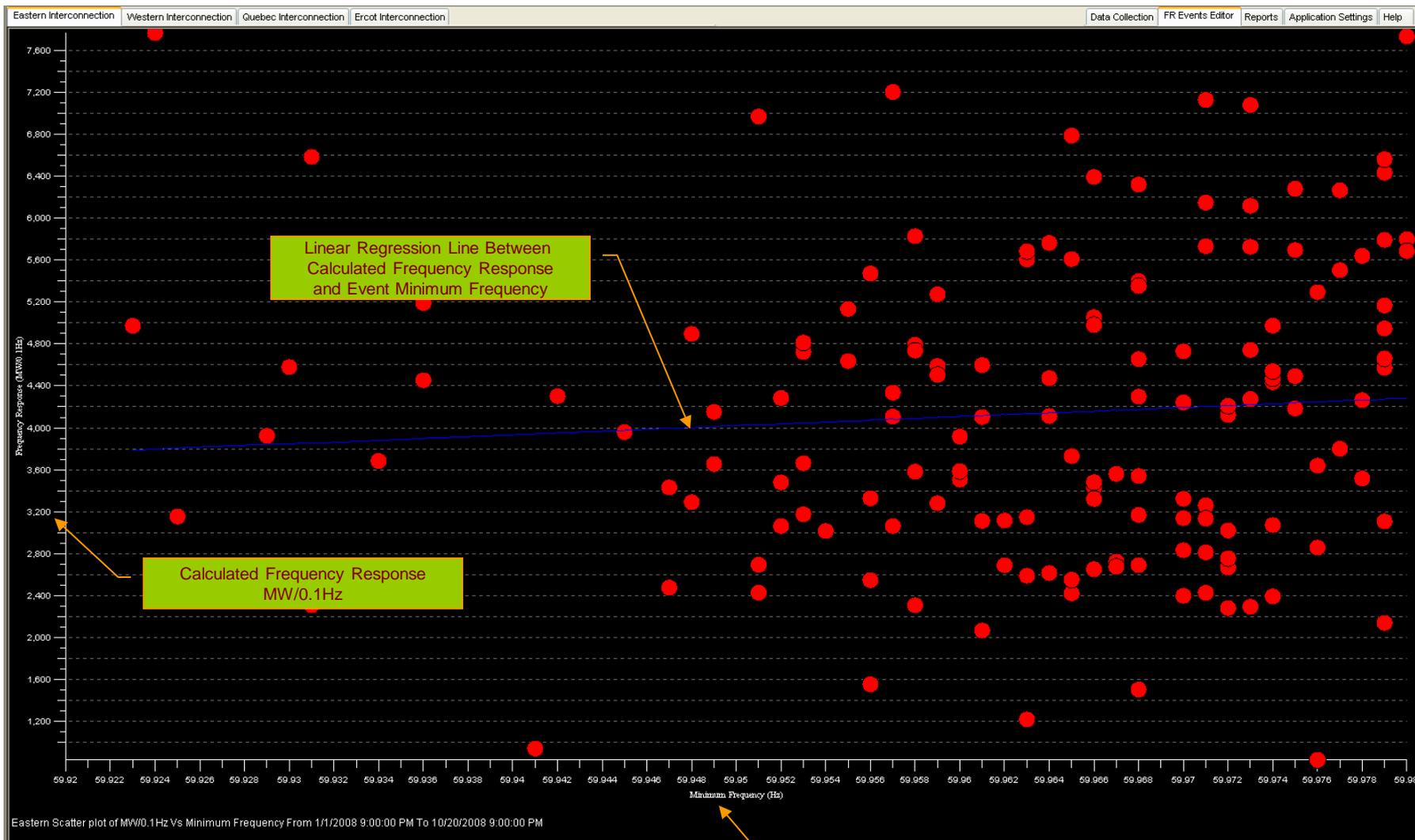
Frequency Events – Counts Set



Frequency Events – Counts Set



Events Freq. Response vs Minimum Freq.



Start Date/Time: 01/01/2008 09:00 PM | End Date/Time: 10/20/2008 09:00 PM

Eastern Interconnection
Frequency Response - Response vs
Data Source : 1 Sec
Periodicity : Monthly
Time Zone : Pacific

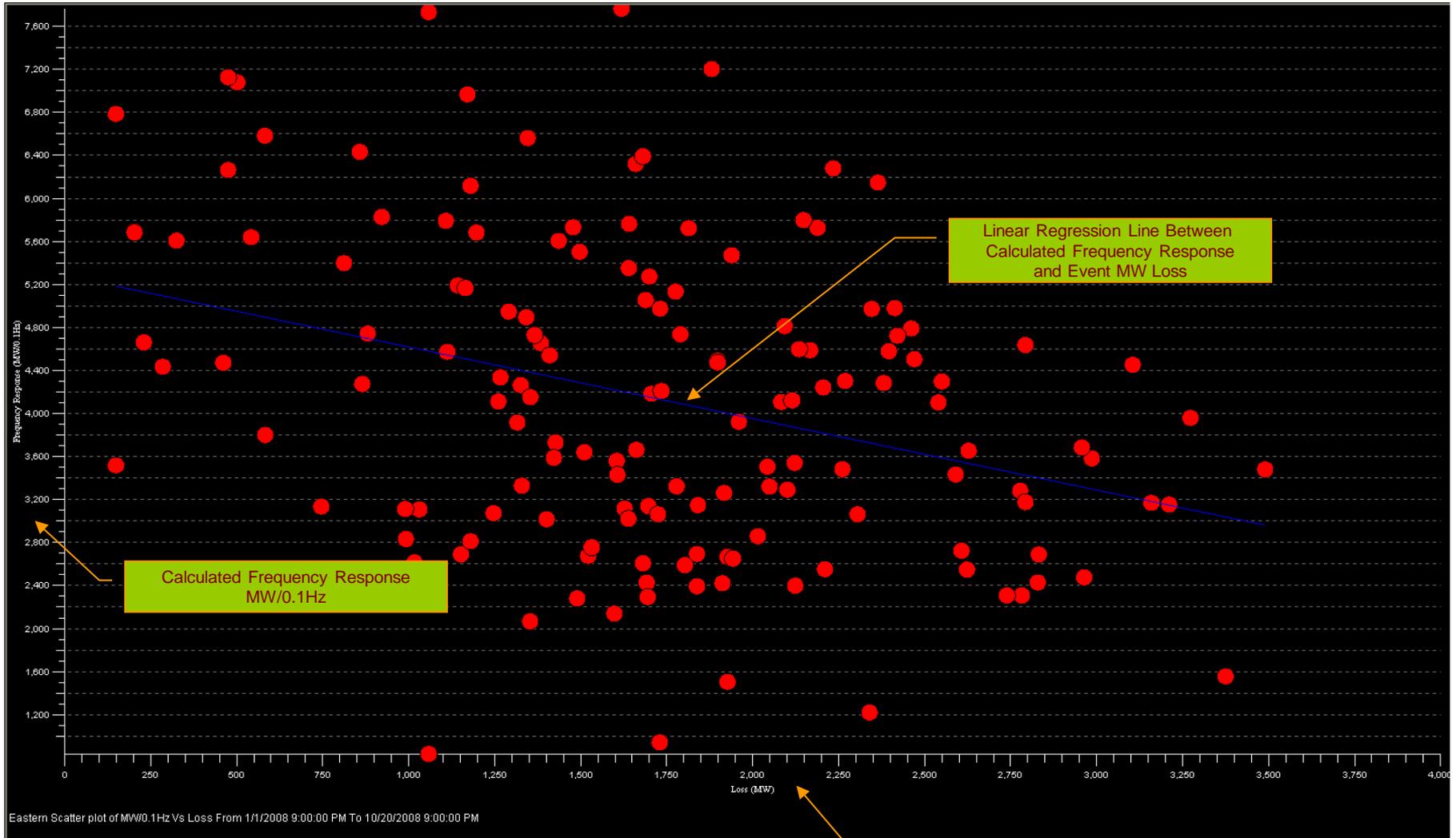
Panel - 1	Panel - 2	Panel - 3	Noisiest Frequency days
Frequency	Freq_Resp	BestFit	
59.936	5190	3897	
59.965	2422	4150	
59.968	4297	4175	
59.976	3639	4249	
59.972	2668	4213	

Event Minimum Frequency (Frequency at Point C)

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Only valid Frequency Response Event is considered in this plot. The valid status of Frequency Response Events is editable through FR Event Editor

Events Frequency Response vs Loss



Start Date/Time: 01/01/2008 09:00 PM
 End Date/Time: 10/20/2008 09:00 PM
 Eastern Interconnection
 Frequency Response - Response vs
 Data Source: 1 Sec
 Periodicity: Monthly
 Time Zone: Pacific

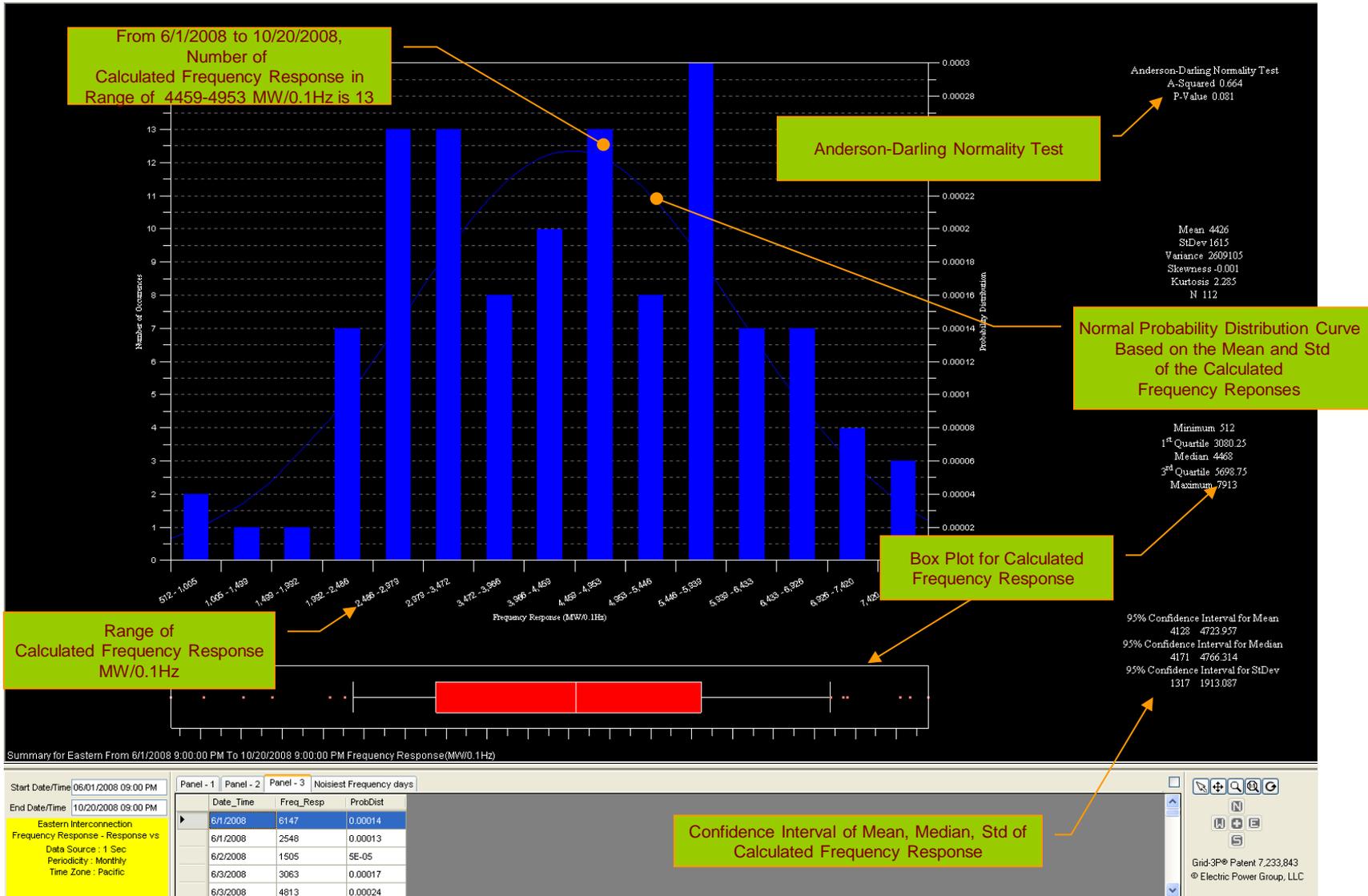
Panel - 1	Panel - 2	Panel - 3	Noisiest Frequency days
Frequency	Freq_Resp	BestFit	
59.936	5190	3897	
59.965	2422	4150	
59.968	4297	4175	
59.976	3639	4249	
59.972	2668	4213	

Event MW Loss

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Only valid Frequency Response Event is considered in this plot. The valid status of Frequency Response Events is editable through FR Event Editor

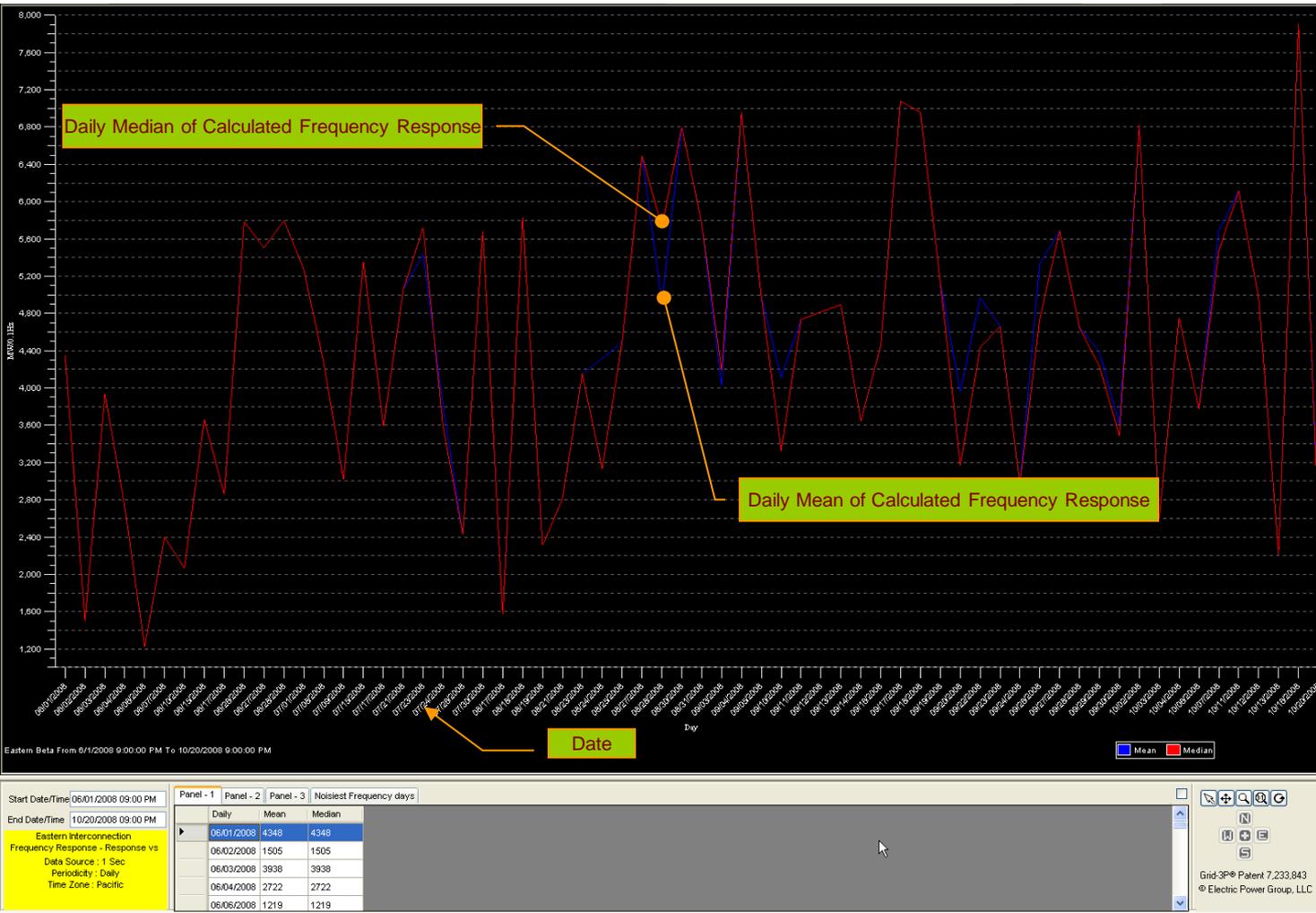
Events Frequency Response Statistics



Only valid Frequency Response Event is considered in this plot. The valid status of Frequency Response Events is editable through FR Event Editor.

Anderson-Darling Normality Test – A variation of the Kolmogorov-Smirnov (K-S) Test that uses a sample's "P-value" to measure whether it is "normal." P-value is the probability that the sample being tested was drawn from a population with a specific distribution; if the P-value is less than the generally-accepted standard of 0.05, the null hypothesis is likely to be false and differences between the samples are likely to exist.

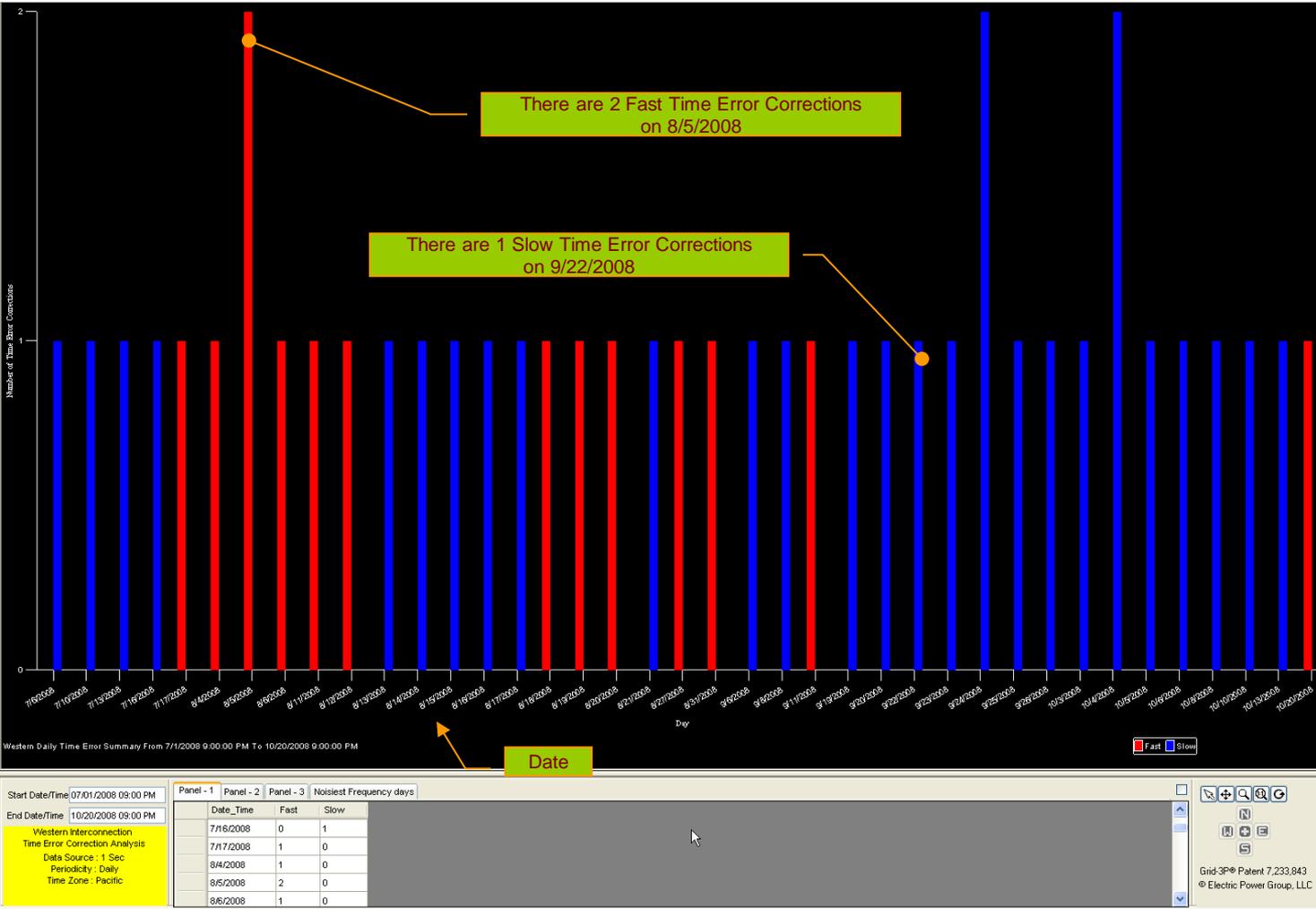
Events Frequency Response Mean/Median



Hourly	NA
Daily / Weekday	Daily Mean and Median of Calculated Frequency Response
Weekly	Weekly Mean and Median of Calculated Frequency Response
Monthly	Monthly Mean and Median of Calculated Frequency Response
Quarterly	Quarterly Mean and Median of Calculated Frequency Response
Yearly	Yearly Mean and Median of Calculated Frequency Response

Only valid Frequency Response Event is considered in this plot. The valid status of Frequency Response Events is editable through FR Event Editor.

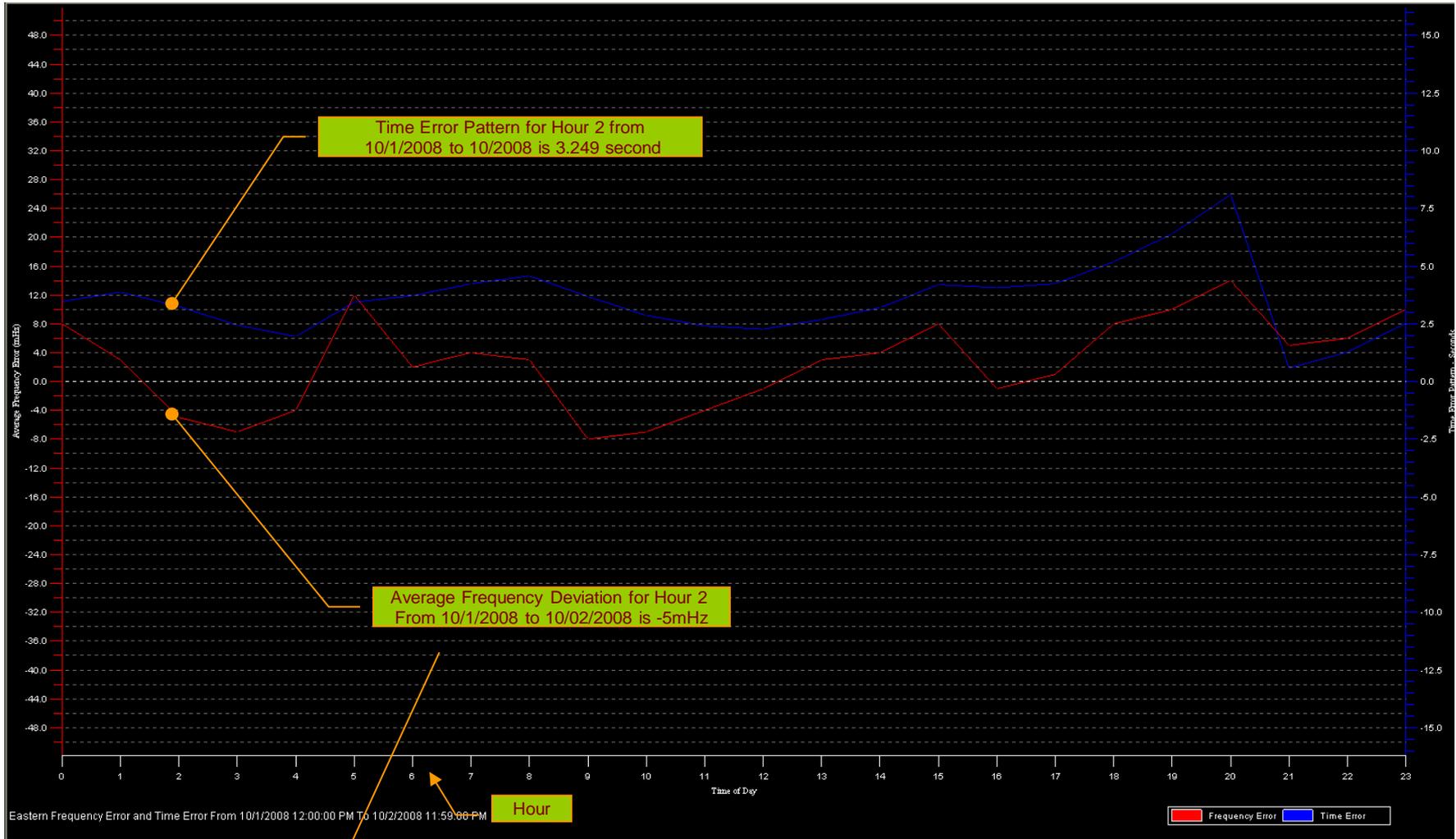
Time Error Corrections Summary



Hourly	NA
Daily / Weekday	Bar chart for Daily Count of Fast, Slow Time Error Correction
Weekly	Bar chart for Weekly Count of Fast, Slow Time Error Correction
Monthly	Bar chart for Monthly Count of Fast, Slow Time Error Correction
Quarterly	Bar chart for Quarterly Count of Fast, Slow Time Error Correction
Yearly	Bar chart for Yearly Count of Fast, Slow Time Error Correction

Fast Time Error Correction – When the scheduled frequency is 60Hz or more
Slow Time Error Correction – When the scheduled frequency is below 60 Hz.

Time Error Correction – Minutes Corrected



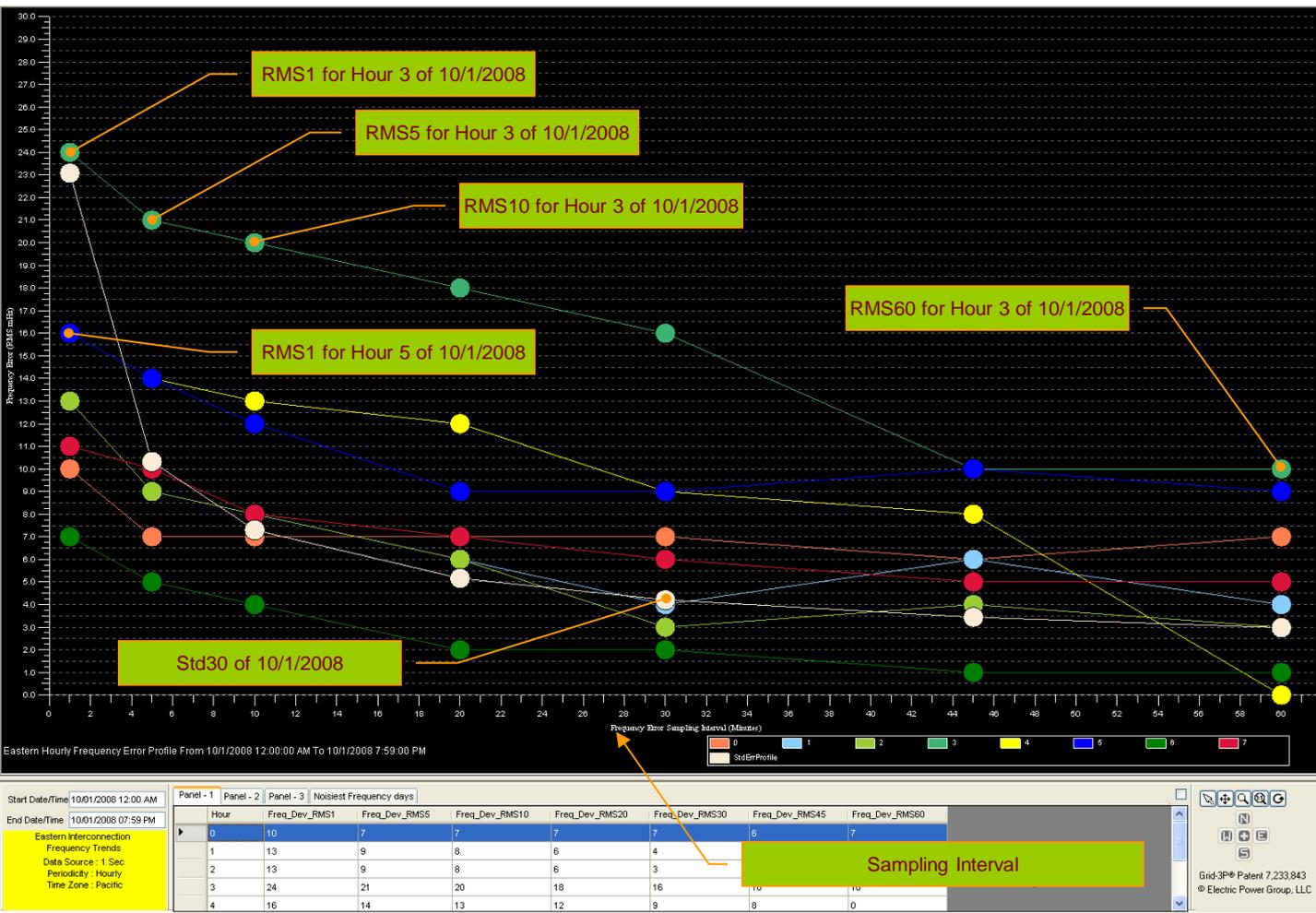
Start Date/Time: 10/01/2008 12:00 PM
 End Date/Time: 10/02/2008 11:59 PM
 Eastern Interconnection
 Time Error Correction Analysis
 Data Source: 1 Sec
 Periodicity: Daily
 Time Zone: Pacific

Hour	Frequency_Error	Time_Error
0	8	3.468
1	3	3.874
2	-5	3.249
3	-7	2.44
4	-4	1.948

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Time Error Pattern Calculation – $60 * \text{Avg}(\text{FreqDev}) * m / \text{Avg}(\text{SchedFreq})$. Avg(FreqDev)=hourly average frequency deviation, m=time duration in minutes, Avg(SchedFreq)=average scheduled frequency of system.

Frequency Error Patterns and Trends Set



Hourly	Top 8 Hourly RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Daily / Weekday	Top 8 Daily RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Weekly	NA
Monthly	Top 8 Monthly RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Quarterly	Top 8 Quarterly RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Yearly	Top 8 Yearly RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile

Sampling Interval

RMS1 - Root Mean Square of 1-Minute Average Frequency Deviation.

RMS5 - Root Mean Square of 5-Minute Average Frequency Deviation.

RMS10 - Root Mean Square of 10-Minute Average Frequency Deviation.

RMS20 - Root Mean Square of 20-Minute Average Frequency Deviation.

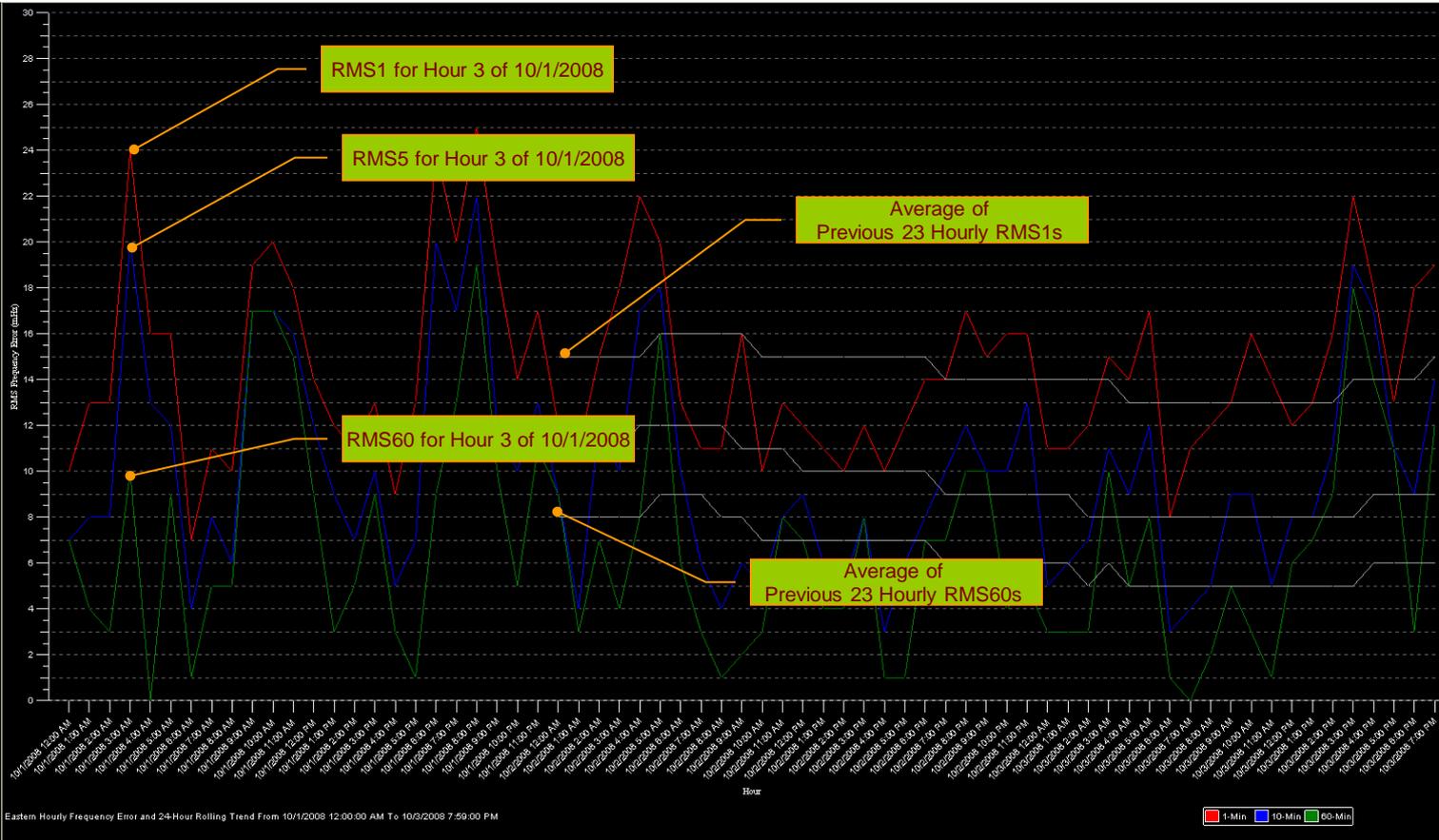
RMS30 - Root Mean Square of 30-Minute Average Frequency Deviation.

RMS45 - Root Mean Square of 45-Minute Average Frequency Deviation.

RMS60 - Root Mean Square of 60-Minute Average Frequency Deviation.

Standard Error Profile – Standard Error of 1-Minute Average Frequency Deviation, 5-Minute Average Frequency Deviation, 10-Minute Average Frequency Deviation, 20-Minute Average Frequency Deviation, 30-Minute Average Frequency Deviation, 45-Minute Average Frequency Deviation, 60-Minute Average Frequency Deviation

Frequency Error Patterns and Trends Set



Eastern Hourly Frequency Error and 24-Hour Rolling Trend From 10/1/2008 12:00:00 AM To 10/3/2008 7:59:00 PM

Hourly	Hourly RMS1 , RMS10, RMS60 and Average of Previous 23 Hourly RMS1, RMS10 and RMS 60
Daily / Weekday	Daily RMS1 , RMS10, RMS60 and Average of Previous 6 Daily RMS1, RMS10 and RMS 60
Weekly	Weekly RMS1 , RMS10, RMS60 and Average of Previous 11 Weekly RMS1, RMS10 and RMS 60
Monthly	Monthly RMS1 , RMS10, RMS60 and Average of Previous 11 Monthly RMS1, RMS10 and RMS 60
Quarterly	Quarterly RMS1 , RMS10, RMS60 and Average of Previous 3 Quarterly RMS1, RMS10 and RMS 60
Yearly	Yearly RMS1 , RMS10, RMS60 and Average of Previous 12 Yearly RMS1, RMS10 and RMS 60

Start Date/Time: 10/01/2008 12:00 AM
 End Date/Time: 10/03/2008 07:59 PM

Panel - 1 | Panel - 2 | Panel - 3 | Noisiest Frequency days

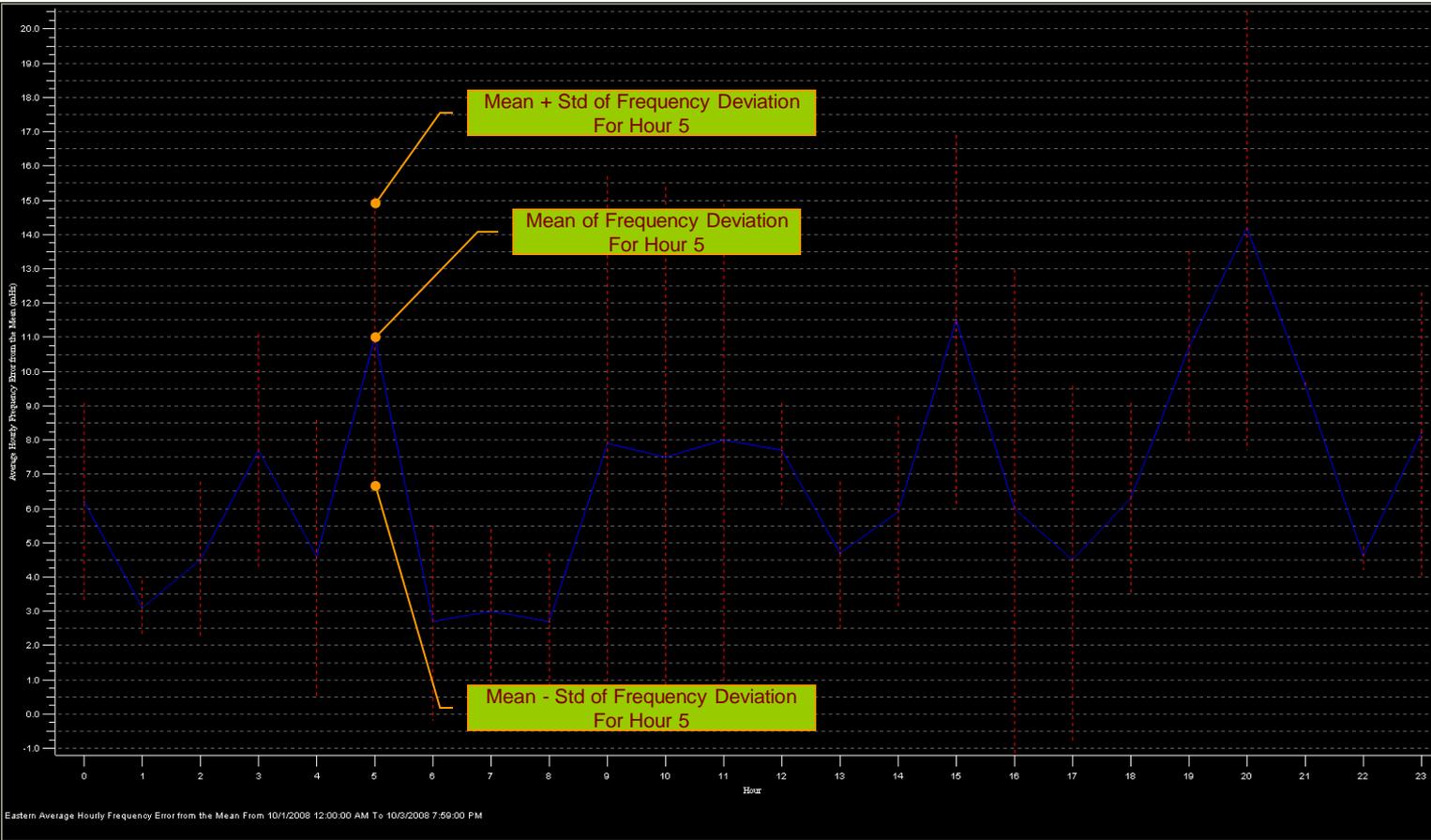
Date_Time	Freq_Dev_RMS1	Freq_Dev_RMS10	Freq_Dev_RMS60	RT_Freq_Dev_RMS1	RT_Freq_Dev_RMS10	RT_Freq_Dev_RMS60
10/1/2008 12:00:00 AM	10	7	7			
10/1/2008 1:00:00 AM	13	8	4			
10/1/2008 2:00:00 AM	13	8	3			
10/1/2008 3:00:00 AM	24	20	10			
10/1/2008 4:00:00 AM	16	13	0			

Eastern Interconnection
 Frequency Trends
 Data Source: 1 Sec
 Periodicity: Hourly
 Time Zone: Pacific

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 © Electric Power Group, LLC

RMS1 - Root Mean Square of 1-Minute Average Frequency Deviation.
RMS10 - Root Mean Square of 10-Minute Average Frequency Deviation.
RMS60 - Root Mean Square of 60-Minute Average Frequency Deviation.

Frequency Error Patterns and Trends Set



Hourly	Hourly Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Daily / Weekday	Weekday Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Weekly	Weekly Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Monthly	Monthly Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Quarterly	Quarterly Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Yearly	Yearly Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation

Start Date/Time: 10/01/2008 12:00 AM
 End Date/Time: 10/03/2008 07:59 PM

Panel - 1 | Panel - 2 | Panel - 3 | Noisiest Frequency days

Hour	Mean	Mean+StdDev	Mean-StdDev
0	6.2	9.2	3.3
1	3.1	4	2.3
2	4.5	6.9	2.2
3	7.7	11.2	4.2
4	4.6	8.7	0.5

Eastern Interconnection
 Frequency Trends
 Data Source : 1 Sec
 Periodicity : Hourly
 Time Zone : Pacific

Grid:3P® Patent 7,233,843
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***NERC FMA
Data Collection Capability***

Data Collection Capability

NERC - FMA Data Collection

Interconnection Selection: Eastern (Selected), Western, ERCOT, Quebec

Data Source Selection: 1-Second, 10-Seconds (Selected)

Select Device: TVA, RIM, ISNE

Time Frame Selection: Start Date/Time: Mon, Sep 22, 2008 7:00:00 AM; End Date/Time: Wed, Oct 22, 2008 7:00:00 AM

Plot Options: Chart Type: Line Chart; X-Axis: Date_Time; Y-Axis: Frequency, Scheduled_Frequency, NetACE

Data Collection Report - (Eastern, 10-Seconds, TVA, 9/22/2008 7:00:00 AM to 9/22/2008 7:10:00 AM)

Customize Columns: Available: [Empty]; Selected: Source_Name, Date_Time, Frequency, Scheduled_Frequency, NetACE, Quality

Source_Name	Date_Time	Frequency	Scheduled_Frequency	NetACE	Quality
TVA	9/22/2008 7:00:00 AM	60.008	60	437	192
TVA	9/22/2008 7:00:10 AM	60.008	60	583	192
TVA	9/22/2008 7:00:20 AM	60.013	60	702	192
TVA	9/22/2008 7:00:30 AM	60.011	60	658	192
TVA	9/22/2008 7:00:40 AM	60.013	60	662	192
TVA	9/22/2008 7:00:50 AM	60.011	60	468	192
TVA	9/22/2008 7:01:00 AM	60.01	60	497	192
TVA	9/22/2008 7:01:10 AM	60.005	60	452	192
TVA	9/22/2008 7:01:20 AM	60.011	60	506	192
TVA	9/22/2008 7:01:30 AM	60.004	60	437	192
TVA	9/22/2008 7:01:40 AM	60.008	60	542	192
TVA	9/22/2008 7:01:50 AM	60.006	60	430	192
TVA	9/22/2008 7:02:00 AM	59.998	60	66	192
TVA	9/22/2008 7:02:10 AM	59.995	60	-43	192
TVA	9/22/2008 7:02:20 AM	59.992	60	-183	192
TVA	9/22/2008 7:02:30 AM	59.993	60	-248	192
TVA	9/22/2008 7:02:40 AM	59.996	60	-119	192
TVA	9/22/2008 7:02:50 AM	59.995	60	-73	192
TVA	9/22/2008 7:03:00 AM	59.999	60	-149	192
TVA	9/22/2008 7:03:10 AM	59.998	60	-88	192
TVA	9/22/2008 7:03:20 AM	59.996	60	-171	192

From: 9/22/2008 7:00:00 AM To: 9/22/2008 7:10:00 AM

Page Slider: 1 / 4320 Pages

Save Data to .csv or .xls File

Print Data

NERC FMA Reports Overview

Periodic Reports Capability

The screenshot shows the 'Reports' application window with the following configuration options:

- Periodic Reports | Event Reports | Retrieve Reports**
- Interconnection Selection:** Eastern (selected), Western, ERCDT, Quebec. A callout box labeled 'Select Interconnection' points to the Eastern radio button.
- Report Type:** Daily (selected), Monthly, Yearly. A callout box labeled 'Select Report Type' points to the Daily radio button.
- Data Source Selection:** 1-Second (selected), 10-Seconds. A callout box labeled 'Select Data Source' points to the 1-Second radio button.
- Time Frame Selection:** Date: Mon, Sep 22, 2008. A 'Get Data' button is present.
- Select Variables:**
 - Available:** Minimum frequency recorded within the hour with site and time; Maximum frequency recorded within the hour with site and time.
 - Selected:** Hour; Mode of frequency deviation; Mean frequency deviation from schedule; Median frequency deviation from schedule; RMS 1 minute; RMS 10 minutes; RMS 60 minutes; Standard deviation of frequency deviation.
- Buttons:** OK, Export Data, Save Configuration, Load Configuration, Cancel.

Save Report to csv or xls File

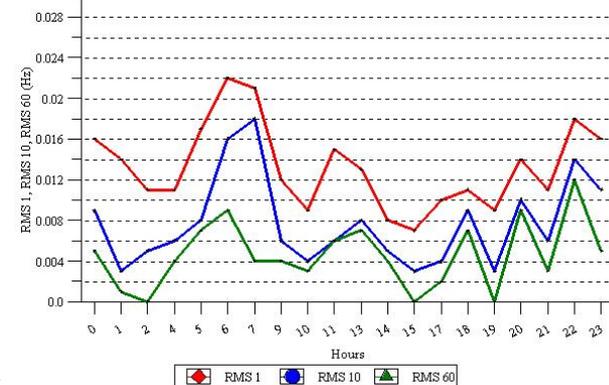
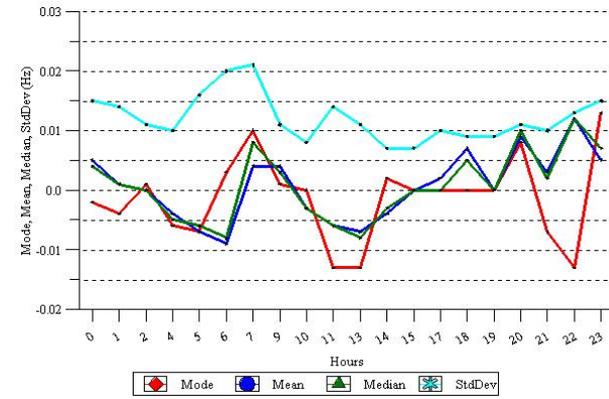
Show Report

NERC - DAILY FREQUENCY REPORT - Created : 10/22/2008

Interconnection : Eastern

Data Source : 1-s Data Source

Time Period : 09/22/2008 [PDT]



Hour	Mode of frequency deviation	Mean frequency deviation from schedule	Median frequency deviation from schedule	RMS 1 minute	RMS 10 minutes	RMS 60 minutes	Standard deviation of frequency deviation
0	-0.002	0.005	0.004	0.016	0.009	0.005	0.015
1	-0.004	0.001	0.001	0.014	0.003	0.001	0.014
2	0.001	0	0	0.011	0.005	0	0.011
4	-0.006	-0.004	-0.005	0.011	0.006	0.004	0.01
5	-0.007	-0.007	-0.006	0.017	0.008	0.007	0.016
6	0.003	-0.009	-0.008	0.022	0.016	0.009	0.02
7	0.01	0.004	0.008	0.021	0.018	0.004	0.021
9	0.001	0.004	0.003	0.012	0.006	0.004	0.011
10	0	-0.003	-0.003	0.009	0.004	0.003	0.008
11	-0.013	-0.006	-0.006	0.015	0.006	0.006	0.014
13	-0.013	-0.007	-0.008	0.013	0.008	0.007	0.011
14	0.002	-0.004	-0.003	0.008	0.005	0.004	0.007
15	0	0	0	0.007	0.003	0	0.007
17	0	0.002	0	0.01	0.004	0.002	0.01
18	0	0.007	0.005	0.011	0.009	0.007	0.009
19	0	0	0	0.009	0.003	0	0.009
20	0.008	0.009	0.01	0.014	0.01	0.009	0.011
21	-0.007	0.003	0.002	0.011	0.006	0.003	0.01
22	-0.013	0.012	0.012	0.018	0.014	0.012	0.013
23	0.013	0.005	0.007	0.016	0.011	0.005	0.015

RMS1 - Root Mean Square of 1-Minute Average Frequency Deviation.
RMS10 - Root Mean Square of 10-Minute Average Frequency Deviation.
RMS60 - Root Mean Square of 60-Minute Average Frequency Deviation.

Retrieve Reports Capability

Reports

Periodic Reports | Event Reports | **Retrieve Reports**

Interconnection Selection

Eastern Western
 ERCOT Quebec

Report Type

Daily Reports
 Monthly Reports

Get Reports

Reports Available

Select the report to be retrieved

Retrieve FMA Automatically Created Reports

OK Export Data Save

	A	B	C	D	E	F	G	H	I	J	K
1	Actual Frequency							Frequency Deviation			
	Hour	Mode	Minimum frequency recorded within the hour with Site & Time Stamp	Maximum frequency recorded within the hour with Site & Time Stamp	RMS 1 minute	RMS 10 minute	RMS 60 minute	Median frequency deviation from schedule	Mean frequency deviation from schedule	Std Deviation of frequency deviation	
2											
3	0100	0.009	59.949:TVA	60.067:ISNE	0.018	0.013	0.01	0.006	0.005	0.017	
4	0200	0.002	59.915:ISN	60.055:PJM	0.016	0.012	0.007	0.003	0.002	0.016	
5	0300	0.011	59.946:ISN	60.049:ISNE	0.015	0.011	0.009	0.004	0.004	0.014	
6	0400	0.001	59.943:PJM	60.054:TVA	0.014	0.01	0.009	0.004	0.005	0.013	
7	0500	0.005	59.952:ISN	60.047:ISNE	0.013	0.009	0.008	0.002	0.002	0.013	
8	0600	0.003	59.953:ISN	60.041:ISNE	0.013	0.008	0.006	0.001	0.001	0.013	
9	0700	0.007	59.93:ISNE	60.066:ISNE	0.02	0.017	0.011	0.008	0.008	0.019	
10	0800	0	59.94:TVA	60.053:ISNE	0.015	0.01	0.005	-0.001	0	0.015	
11	0900	-0.008	59.95:ISNE	60.042:PJM	0.015	0.01	0.008	-0.006	-0.006	0.013	
12	1000	-0.009	59.934:TVA	60.051:ISNE	0.017	0.013	0.01	-0.008	-0.009	0.014	
13	1100	-0.009	59.94:PJM	61.243:PJM	0.033	0.025	0.014	-0.007	-0.004	0.033	
14	1200	-0.007	59.943:TVA	60.045:ISNE	0.016	0.012	0.009	-0.006	-0.006	0.015	
15	1300	-0.003	59.937:TVA	60.05:ISNE	0.017	0.013	0.011	-0.007	-0.007	0.015	
16	1400	-0.003	59.943:PJM	60.048:ISNE	0.015	0.012	0.01	-0.005	-0.005	0.014	
17	1500	0	59.947:PJM	60.038:PJM	0.014	0.012	0.01	-0.004	-0.004	0.014	
18	1600	-0.005	59.948:ISN	60.036:PJM	0.013	0.011	0.01	-0.003	-0.004	0.013	
19	1700	0	59.934:TVA	60.038:PJM	0.014	0.011	0.01	-0.003	-0.004	0.013	
20	1800	0.007	59.952:TVA	60.038:TVA	0.012	0.009	0.007	-0.001	-0.002	0.012	
21	1900	0.01	59.953:ISN	60.049:ISNE	0.013	0.011	0.01	0.006	0.005	0.012	
22	2000	0.007	59.961:ISN	60.053:ISNE	0.014	0.01	0.008	0.006	0.006	0.012	
23	2100	0.004	59.943:TVA	60.06:PJM	0.014	0.009	0.007	0	0	0.014	
24	2200	0.008	59.946:TVA	60.055:ISNE	0.015	0.011	0.007	0	-0.001	0.015	
25	2300	0.003	59.938:PJM	60.063:ISNE	0.02	0.015	0.011	0.009	0.009	0.017	
26	2400	0.01	59.922:ISN	60.065:ISNE	0.02	0.015	0.009	0.007	0.005	0.019	
27											

Archive Phasor and SCADA Data Availability

RECOMMENDATION – Before Setting the time-window and type of data to use for your analysis, check the percentage data availability from the tables in the next five slides, and adjust your analysis results accordingly

FMA Phasor 1-Second and SCADA 10-Second Source Devices Data Availability

Revision: 12.22.08

FMA Data Type	Data Source Name	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	2008
TVA Phasor 1-second	VOLUNTEER-FQ-EI						1%	90%	98%	98%	100%	100%	98%	96%	98%	59%	99%	100%	100%	98%	100%	98%	99%	84%	98%	95%
	CALLAWAY-FQ-EI						1%	97%	98%	98%	99%	99%	97%	94%	98%	59%	98%	99%	99%	97%	99%	98%	99%	84%	98%	94%
ERCOT 2-second	FARRAGUT-FQ-EI						0%	72%	41%	49%	61%	63%	79%	88%	91%	63%	89%	95%	92%	46%	0%	69%	95%	82%	80%	73%
	ERCOT2Sec													100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	67%	0%	100%
NERC SCADA 10-second	ISNE-EI							69%	100%	99%	92%	92%	99%	98%	91%	98%	100%	100%	100%	99%	98%	90%	81%	100%	99%	95%
	PJM-EI							69%	99%	99%	92%	92%	99%	98%	92%	99%	100%	100%	100%	99%	99%	90%	81%	100%	99%	96%
	TVA-EI							60%	100%	99%	92%	90%	99%	98%	92%	99%	98%	100%	100%	99%	99%	90%	80%	100%	99%	95%
	BCTC-WECC							68%	99%	98%	92%	92%	99%	95%	92%	99%	100%	100%	99%	98%	99%	83%	76%	100%	98%	94%
	PNM-WECC							68%	99%	99%	92%	92%	100%	96%	92%	100%	99%	100%	98%	98%	99%	83%	76%	100%	98%	94%
	HQT							68%	99%	99%	92%	92%	100%	98%	91%	99%	100%	100%	100%	99%	77%	90%	80%	100%	99%	95%
	ERCOT(Start 10/08)																					19%	62%	82%	91%	40%
FNET Phasor 1-second (In Progress)	LA-WECC	0%	0%	3%	84%	95%	91%	86%	77%	88%	85%	94%	84%	96%	97%	97%	99%	98%	98%	100%	45%				91%	
	EPRI-WECC	94%	90%	99%	21%	57%	50%	85%	76%	85%	81%	93%	82%	96%	94%	96%	98%	99%	98%	99%	45%				91%	
	NewWSU-WECC																		3%	100%	45%				49%	
	Alberta-WECC													1%	18%										9%	
	Seattle-WECC	47%	42%	35%	26%	12%	0%	0%	0%	0%	0%	0%	0%												0%	
	Houston-ERCOT	94%	84%	99%	83%	91%	91%	30%	75%	86%	69%	64%	10%		3%	96%	97%	97%	99%	99%	45%				77%	
	UTSA-ERCOT														3%	93%	93%	90%	80%	44%	26%				61%	
	UMR-EI													3%	98%	95%	94%	97%	99%	88%	34%	10%			77%	
	IMPA-EI	95%	90%	99%	83%	95%	88%		22%	87%	85%	94%	88%	99%	95%	43%	21%	99%	30%	71%	24%				60%	
	VT-EI	95%	91%	99%	77%	96%	86%	87%	76%	87%	84%	85%	87%	95%	3%	94%	97%	97%	3%	97%	45%				67%	
	FSU-EI																		3%	97%	0%	40%				35%
	UF-EI	86%	88%	80%	34%	96%	92%	83%	69%	78%	71%														0%	

RECOMMENDATION – Before Setting the time-window and type of data to use for your analysis, check the percentage data availability from the above and next four slides tables, and adjust your analysis results accordingly

FMA Missing Data for More Than 24-Hour for Eastern Three PMU Phasor Devices

Revision: 12.22.08

VOLUNTEER-FQ			CALLAWAY-FQ			FARRAGUT-FQ		
2007-06-30 20:00:00 ~Current			2007-06-30 20:00:00 ~Current			2007-06-30 22:41:35 ~ Current		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
7/21/2007 1:04:50	7/23/2007 11:49:19	58	3/3/2008 15:02:52	3/9/2008 14:45:36	143	7/26/2007 5:46:21	8/7/2007 10:44:20	292
3/3/2008 15:02:52	3/9/2008 14:47:58	143	3/13/2008 13:44:28	3/19/2008 18:23:55	148	8/7/2007 10:44:31	8/8/2007 17:06:59	30
3/13/2008 10:21:19	3/19/2008 18:23:55	152	11/19/2008 0:00:00	11/20/2008 23:59:59	47	8/10/2007 10:01:01	8/14/2007 15:37:16	101
11/19/2008 0:00:00	11/20/2008 23:59:59	47	11/22/2008 13:00:00	11/24/2008 14:59:59	49	8/17/2007 5:14:36	8/21/2007 11:23:58	102
11/22/2008 13:00:00	11/24/2008 14:59:59	49				9/1/2007 5:38:39	9/7/2007 11:06:05	149
						9/12/2007 10:11:50	9/13/2007 11:04:59	24
						9/15/2007 14:45:25	9/18/2007 11:24:59	68
						9/22/2007 6:12:56	9/24/2007 10:13:58	52
						10/18/2007 0:40:14	10/23/2007 9:13:58	128
						10/25/2007 10:35:30	10/29/2007 11:14:59	96
						11/22/2007 8:35:35	11/26/2007 9:09:58	96
						11/28/2007 8:55:09	12/4/2007 9:29:58	144
						1/7/2008 15:08:15	1/9/2008 10:41:59	43
						3/2/2008 12:45:12	3/9/2008 6:01:46	161
						3/17/2008 8:41:09	3/19/2008 3:45:17	43
						7/16/2008 8:49:32	9/9/2008 9:38:59	576
						11/19/2008 0:00:00	11/20/2008 23:59:59	47
						11/22/2008 12:00:00	11/24/2008 14:59:59	50
						12/5/2008 6:00:00	12/7/2008 22:59:59	64

FMA Missing Data for More Than 24-Hour for Western and ERCOT FNET Phasor Devices

Revision: 12.22.08

UTSA-ERCOT			Houston-ERCOT		
2008-02-29 00:00:50 ~ 2008-08-14 15:46:40			2007-01-01 05:00:36 ~ 2007-07-25 17:25:15		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
7/16/2008 12:34:55	8/4/2008 5:35:07	449	2/2/2007 18:56:01	2/4/2007 17:17:59	46
			2/18/2007 12:22:16	2/20/2007 8:37:06	44
			4/7/2007 1:00:51	4/8/2007 1:00:51	24
			5/7/2007 21:20:19	5/9/2007 23:04:59	49
			7/8/2007 21:29:15	7/29/2007 17:04:29	499
			8/22/2007 1:00:51	8/23/2007 22:22:30	45
			10/27/2007 8:13:56	11/6/2007 22:03:59	253
			11/16/2007 22:21:02	11/20/2007 18:54:05	92
			11/30/2007 21:19:34	12/2/2007 20:11:18	46
			12/5/2007 22:06:56	2/29/2008 0:00:49	601

LA-WECC			Seattle-WECC			ERPI-WECC		
2007-03-31 01:00:52 ~ 2008-08-15 01:00:51			2007-01-01 05:00:36 ~ 2007-07-25 17:25:15			2007-01-01 00:00:53 ~ 2008-08-15 01:00:51		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
4/7/2007 1:00:52	4/8/2007 1:00:52	24	1/12/2007 21:47:23	1/16/2007 15:58:05	90	2/2/2007 18:55:59	2/4/2007 17:17:59	46
8/22/2007 1:00:52	8/23/2007 22:22:32	45	2/2/2007 12:52:53	2/4/2007 17:14:22	52	4/6/2007 22:49:39	4/8/2007 1:00:52	26
11/30/2007 21:19:34	12/2/2007 20:11:20	46	2/16/2007 15:16:29	2/20/2007 18:17:02	99	4/10/2007 8:19:58	4/12/2007 22:15:27	61
			3/9/2007 2:03:34	3/13/2007 2:00:24	95	4/12/2007 22:55:43	4/18/2007 17:40:59	138
			3/13/2007 14:28:03	3/16/2007 7:08:10	64	4/18/2007 23:41:14	4/20/2007 11:31:53	35
			3/23/2007 17:47:49	3/26/2007 16:25:59	70	4/20/2007 14:37:07	4/24/2007 1:00:51	82
			4/6/2007 15:46:28	4/8/2007 2:48:32	35	4/24/2007 22:10:52	4/30/2007 10:55:29	132
			4/9/2007 17:17:40	4/11/2007 1:33:23	32	5/9/2007 8:54:48	5/10/2007 8:56:31	24
			4/14/2007 0:56:58	4/15/2007 0:57:32	24	5/13/2007 4:07:55	5/17/2007 9:36:10	101
			4/24/2007 15:40:23	4/27/2007 16:56:39	73	5/19/2007 12:34:30	5/25/2007 17:48:45	149
			4/27/2007 18:24:19	5/1/2007 5:44:13	83	6/4/2007 17:44:28	6/8/2007 13:45:46	92
			5/1/2007 17:44:21	5/5/2007 8:20:46	86	6/8/2007 16:45:41	6/12/2007 11:45:24	90
			5/7/2007 20:18:03	5/12/2007 6:55:09	106	6/17/2007 9:33:59	6/18/2007 10:29:22	24
			5/14/2007 12:55:16	5/15/2007 18:06:43	29	6/18/2007 15:43:34	6/21/2007 10:25:19	66
			5/16/2007 0:57:19	5/18/2007 8:30:25	55	6/21/2007 10:58:39	6/23/2007 21:47:40	58
			5/21/2007 18:18:05	5/24/2007 16:56:09	70	8/22/2007 1:00:52	8/23/2007 22:22:32	45
			5/24/2007 20:53:24	7/25/2007 15:53:53	43	11/30/2007 21:19:34	12/2/2007 20:11:20	46

FMA Missing Data for More Than 24-Hour for Eastern FNET Phasor Devices

Revision: 12.22.08

VT-EI			FSU-EI		
2007-01-01 00:00:52 ~ 2008-08-15 01:00:50			2008-05-31 01:00:53 ~ 2008-08-15 19:59:58		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
2/2/2007 18:59:59	2/4/2007 17:14:21	46	6/30/2008 20:00:00	7/27/2008 18:32:27	646
4/13/2007 19:59:59	4/16/2007 10:46:22	62	7/27/2008 18:32:38	8/2/2008 11:28:33	136
8/22/2007 19:59:59	8/23/2007 22:22:50	26			
9/15/2007 20:00:00	9/16/2007 20:59:37	24			
10/31/2007 20:00:00	11/2/2007 17:20:02	45			
12/1/2007 19:00:00	12/2/2007 20:16:01	25			
1/31/2008 19:00:00	2/29/2008 0:00:49	677			
3/7/2008 18:59:59	3/8/2008 19:07:40	24			
5/31/2008 19:59:59	6/30/2008 1:00:48	701			

UF-EI			UMR-EI			IMPA-EI		
2007-01-01 00:00:53 ~ 2007-10-30 13:57:26			2007-12-31 00:00:50 ~ 2008-08-15 19:59:58			2007-01-01 00:00:53 ~ 2008-08-08 22:28:56		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
1/25/2007 12:00:09	1/27/2007 21:47:28	57	3/7/2008 18:59:59	3/8/2008 19:07:40	24	2/2/2007 18:55:58	2/4/2007 17:14:22	46
2/2/2007 18:55:57	2/4/2007 17:17:59	46	7/11/2008 19:59:59	7/22/2008 10:58:36	254	4/7/2007 1:00:52	4/8/2007 1:00:52	24
4/7/2007 0:57:31	4/8/2007 1:01:08	24	7/27/2008 19:59:59	8/9/2008 12:49:39	304	6/30/2007 0:11:40	8/20/2007 9:01:32	488
4/21/2007 19:57:18	4/24/2007 1:00:50	53				8/22/2007 1:00:52	8/23/2007 22:22:31	45
8/22/2007 1:00:51	8/23/2007 22:22:31	45				11/30/2007 21:19:34	12/2/2007 20:11:19	46
						3/14/2008 12:40:43	3/20/2008 20:17:35	151
						3/22/2008 23:40:45	3/26/2008 16:26:35	88
						3/28/2008 9:21:56	3/29/2008 20:40:05	35
						3/30/2008 6:31:41	3/31/2008 13:31:29	30
						4/1/2008 11:02:11	4/24/2008 15:05:05	556
						6/10/2008 14:26:48	7/8/2008 21:08:05	678

FMA Missing Data for More Than 24-Hour for Eastern and Western SCADA Devices

Revision: 12.22.08

TVA-EI			PJM-EI			ISNE-EI		
2007-07-03 11:37:50 ~Current			2007-07-01 00:00:00 ~Current			2007-07-01 00:00:00 ~Current		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
9/8/2008 1:59:51	9/10/2008 0:59:59	47	9/8/2008 1:59:51	9/10/2008 0:59:59	47	9/8/2008 1:59:51	9/10/2008 0:59:59	47

BCTC-WI			PNM-WI		
2007-07-01 00:00 ~Current			2007-07-03 11:37:50 ~Current		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
9/8/2008 1:59:51	9/10/2008 0:59:59	47	9/8/2008 1:59:51	9/10/2008 0:59:59	47
9/17/2008 18:41:31	9/19/2008 16:14:29	45	9/17/2008 18:41:31	9/19/2008 16:14:29	45

HQT			ERCOT		
2007-07-01 00:00 ~Current			2008-09-24 17:00:00 ~Current		
Start Datetime	End Datetime	Missing Hours	Start Datetime	End Datetime	Missing Hours
8/4/2008 9:12:51	8/5/2008 16:10:19	30	10/23/2008 2:07:31	10/25/2008 7:15:09	53
8/13/2008 15:42:21	8/18/2008 5:16:19	109	10/25/2008 7:59	11/4/2008 9:59	242
9/8/2008 1:59:51	9/10/2008 0:59:59	47			

ERCOT Missing Data for More Than 24-Hour for ERCOT2Sec Devices

Revision: 12.22.08

ERCOT2Sec-ERCOT		
2008-01-01 01:00:00.000 ~ 2008-11-20 00:59:58.000		
Start Datetime	End Datetime	Missing Hours
1/1/2008 1:00:00	11/20/2008 0:59:58	0

FMA Missing Data for More Than 24-Hour for Eastern, Western and ERCOT Time Error Correction

Revision: 12.22.08

TEC-EI		
2007-01-01 00:00:00 ~Current		
Start Datetime	End Datetime	Missing Hours
9/8/2008 1:59	9/10/2008 0:59	47

TEC-WI		
2007-05-23 00:00:00.000 ~Current		
Start Datetime	End Datetime	Missing Hours
9/8/2008 1:59	9/10/2008 0:59	47
9/17/2008 18:41	9/19/2008 16:14	45
9/30/2008 18:33	10/2/2008 10:46	40

TEC-ERCOT		
2008-01-01 01:00:00.000 ~ 2008-11-20 00:59:58.000		
Start Datetime	End Datetime	Missing Hours
1/1/2008 1:00:00	11/20/2008 0:59	0

***NERC FMA Application
Frequency Performance
Function and Visuals***

Case Study

Utilization of FMA for Wide-Area Load-Generation Control Performance

The screenshot displays the NERC-Frequency Monitoring And Analysis Version 1.0 software interface. The main content area is divided into three panels:

- Panel 1 (Left):** Key Reliability Standard Metric Historical Performance (Does Process Comply with Standards). A green arrow points from this panel to the right.
- Panel 2 (Top Right):** Complement Key Reliability Metric Performance (Is Process Variability Acceptable). A green arrow points down from this panel to the bottom panel.
- Panel 3 (Bottom Right):** Load-Generation Control Process Performance (Is Process Under Control ?).

The bottom status bar includes the following information:

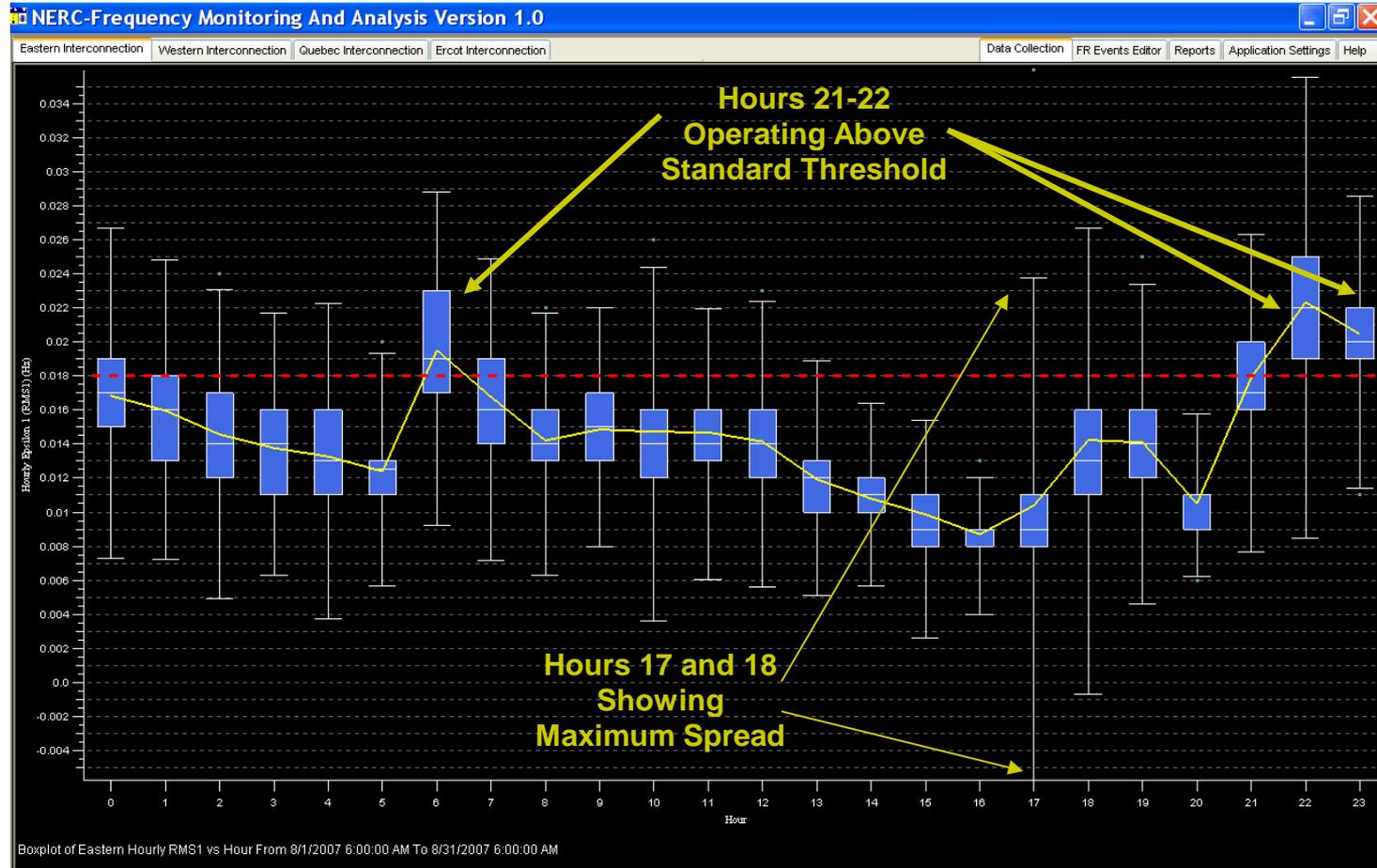
- Start Date/Time: 12/01/2007 06:00 AM
- End Date/Time: 12/31/2007 06:00 AM
- Eastern Interconnection Frequency Performance
- Data Source: 1 Sec
- Periodicity: Quarterly
- Time Zone: Eastern
- Panel - 1 | Panel - 2 | Panel - 3 | Noisiest Frequency days
- Periodicity: Invalid Periodicity
- Grid-3P® Patent 7,233,843 © Electric Power Group, LLC

Case Study Description

- On August 4, 2007 the Eastern Interconnection frequency reached 59.868 Hz the lowest value in 2007
- The event resulted in a five units outage for a total generation lost of about 4,300 MW with a load of about 500,000 MW
- Recovery of the event fell within the NERC DCS standard requirement of 15-minutes. The interconnection frequency was restored to 60 Hz in 8-minutes.
- The interconnection frequency recovery over-responded, reaching 60.06 Hz in 14-minutes.

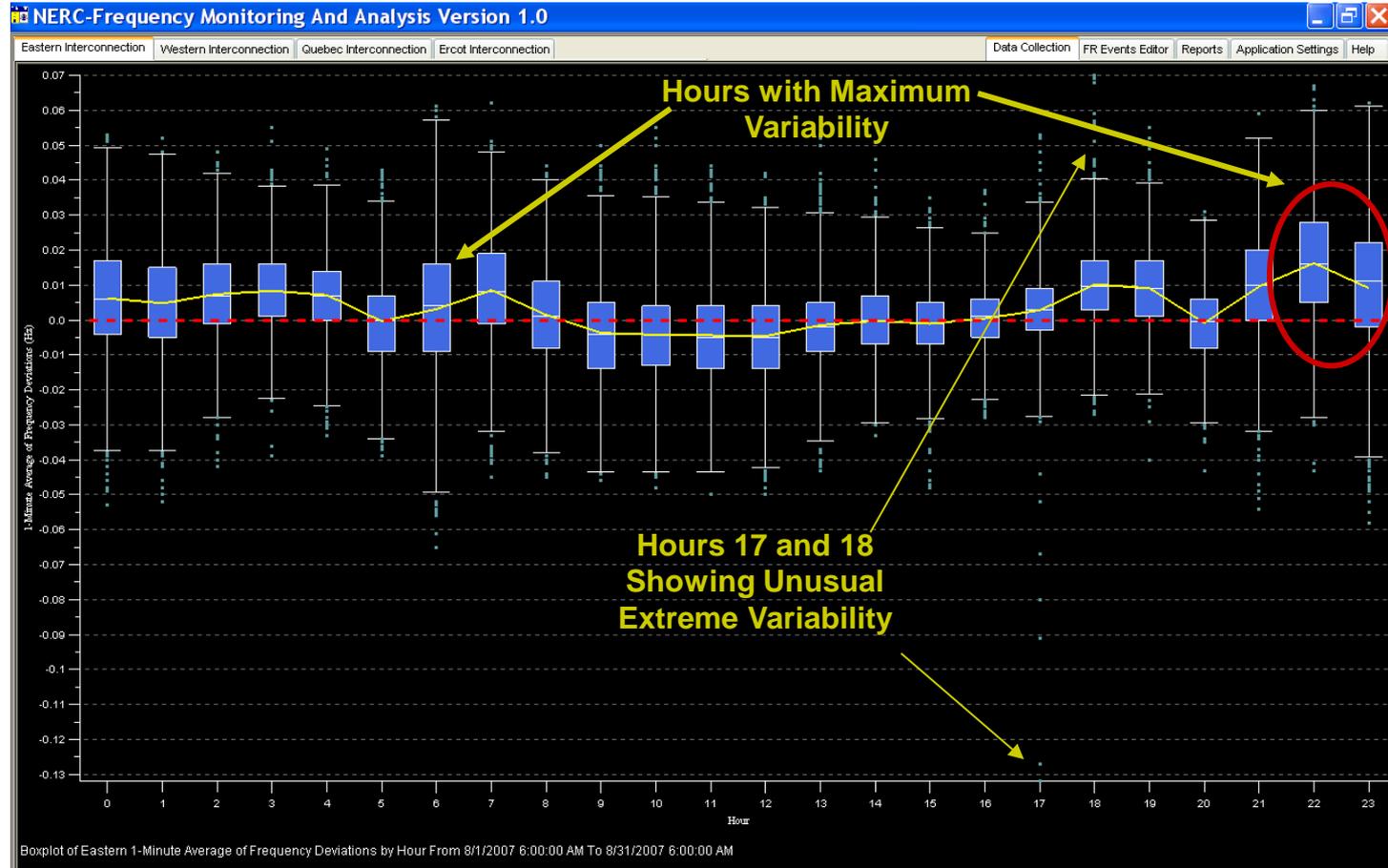
Utilization of FMA for Evaluating Load-Generation Control Compliance with Standard

Evaluation of 1-Second Frequency Data Graphs for Eastern Interconnection August, 2007



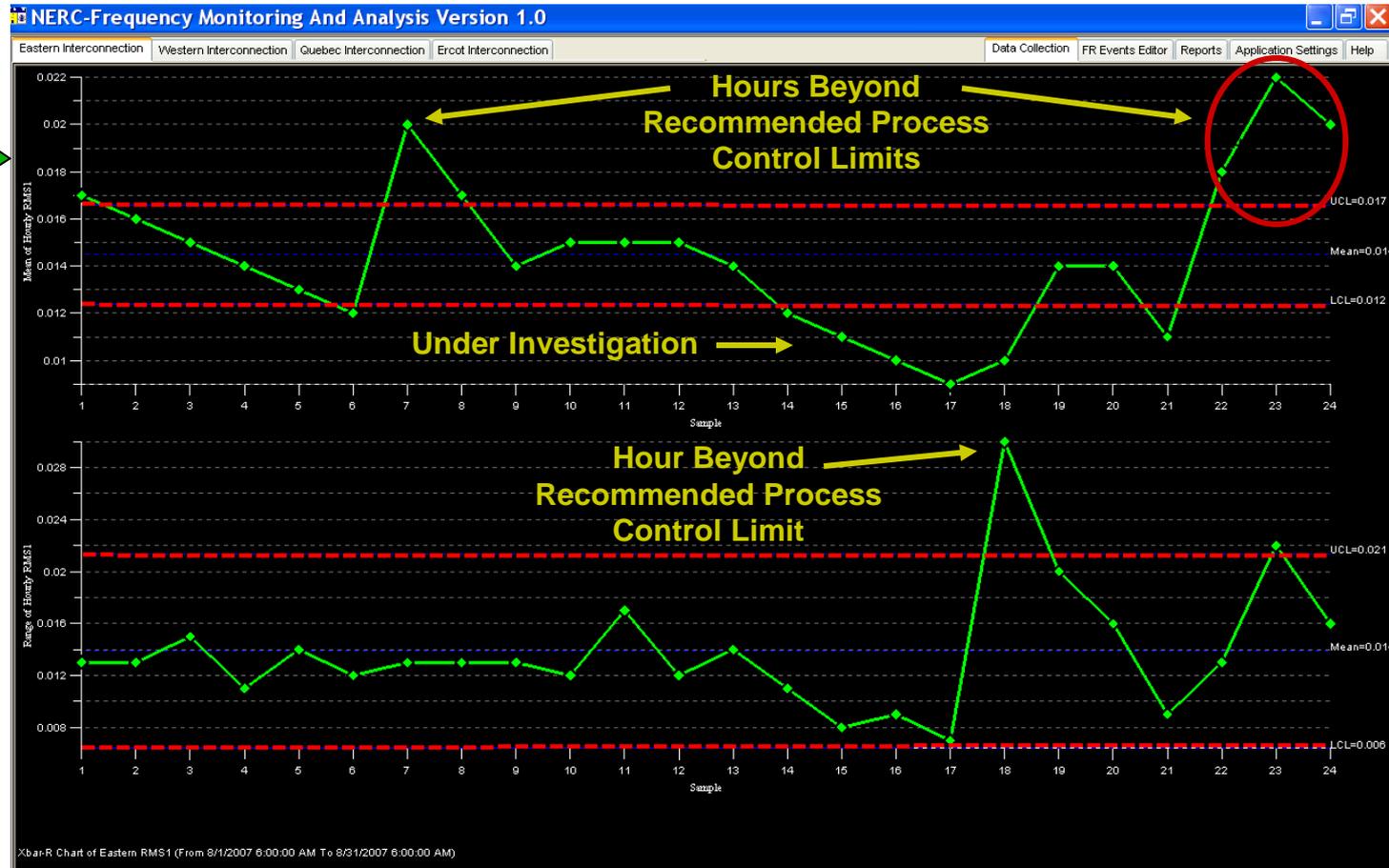
Utilization of FMA for Wide-Area Evaluation of Load-Generation Variability

Evaluation of 1-Second Frequency Data Graphs for
Eastern Interconnection August, 2007



Utilization of FMA for Wide-Area Load-Generation Control Performance Analysis

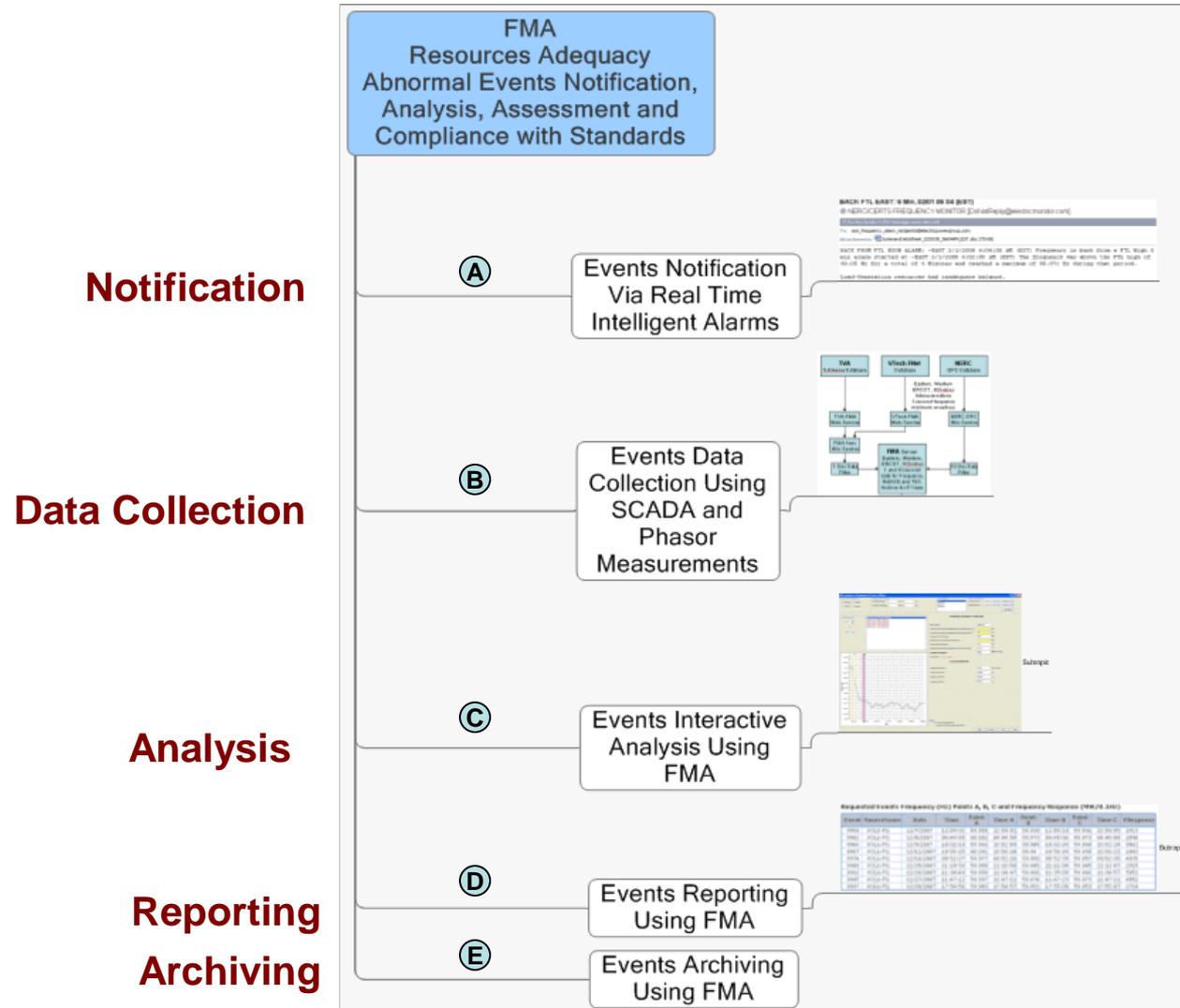
Evaluation of 1-Second Frequency Data Graphs for Eastern Interconnection August, 2007



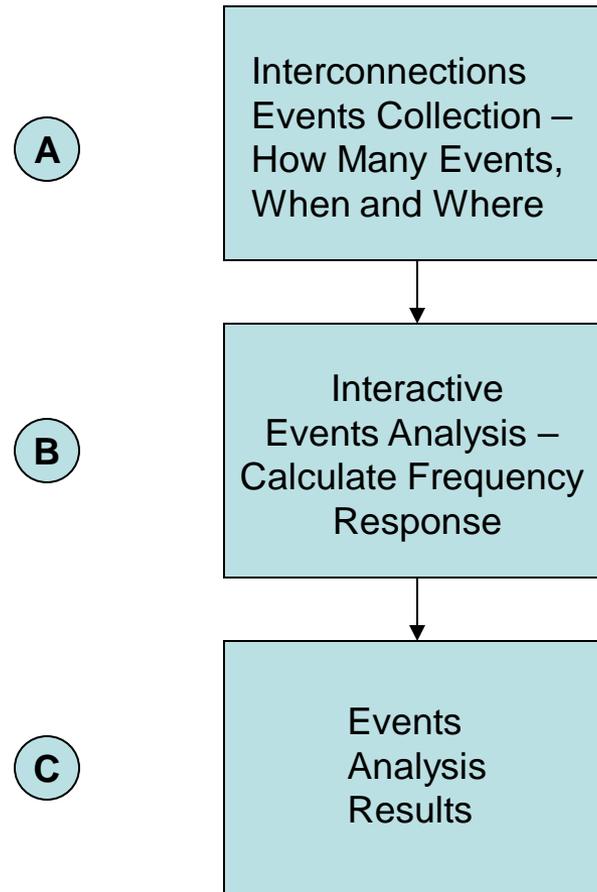
***NERC FMA Application
Event Analysis
Function and Visuals***

Case Study

Steps for Events Notification and Analysis Using FMA



Utilization of FMA for Analysis of Frequency Response During Events - Steps



Utilization of FMA for Analysis of Frequency Response During Events

Frequency Response Events Editor

Interconnection Selection: Eastern Western ERCOT Quebec

Frequency/ACE Range: Frequency Range [] Hz To [] Hz; Net ACE Total Range [] MW To [] MW

Source Name: ALL, **VOLU-FQ**, CALY-FQ, FARR-FQ

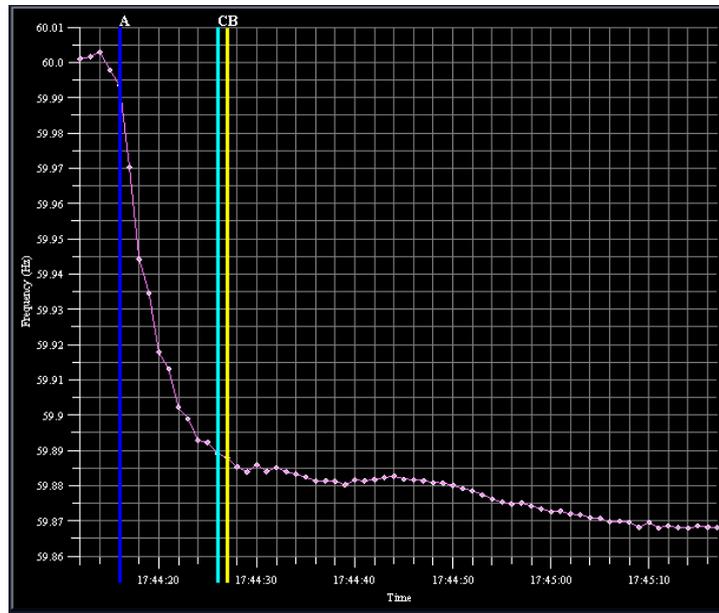
Time Frame Selection: Start Date/Time: Wed, Aug 01, 2007 12:00:00 AM; End Date/Time: Fri, Aug 24, 2007 11:59:00 PM; **Get Events**

Frequency Points: T - 5 to T + 60

2007/08/24 03:50:14 VOLU-FQ
 2007/08/23 16:30:54 VOLU-FQ
 2007/08/22 12:06:59 VOLU-FQ
 2007/08/15 23:27:00 VOLU-FQ
 2007/08/10 01:58:17 VOLU-FQ
 2007/08/10 00:57:41 VOLU-FQ
 2007/08/06 13:11:24 VOLU-FQ
2007/08/04 17:44:17 VOLU-FQ
 2007/08/03 12:39:29 VOLU-FQ

August 2007 Events

A
 Events Phasor Data Collection



FREQUENCY RESPONSE CALCULATION

PMU Location: VOLU-FQ

Actual Net Interchange Immediately Before Disturbance (Point A) * -25 MW

Actual Net Interchange Immediately After Disturbance (Point B) * 4318 MW

Change in Net Interchange 4343 MW

Generation (-) lost Causing the Disturbance * 7629 MW

Interconnection Response -3286 MW

Change in Interconnection Frequency from Point A to Point B -0.113 Hz

Frequency Response 2908 MW / 0.1 Hz

Event Status * Valid

OTHER INFORMATION

Frequency Bias Values -6756 MW / 0.1 Hz

Frequency at Point A 59.994 Hz

Frequency at Point B 59.888 Hz

Frequency at Point C 59.889 Hz

Avg. Frequency at Point A 60.001 Hz

C
 Events Frequency Response Results
2908 MW/0.1Hz
 VS
NERC-RS Estimate Of 3000

B
 Interactive Events Analysis