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

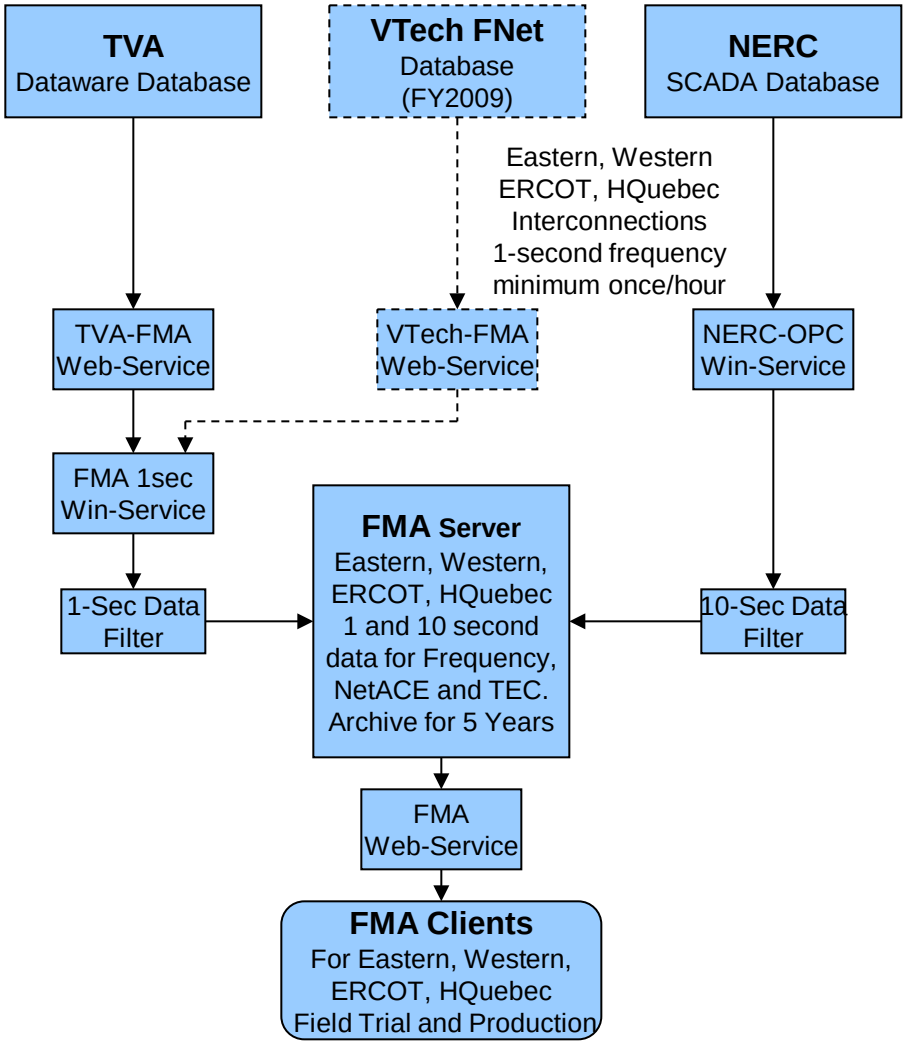
Data Communications, Functionality, and Navigation Overview
Data Availability and Case Studies

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)

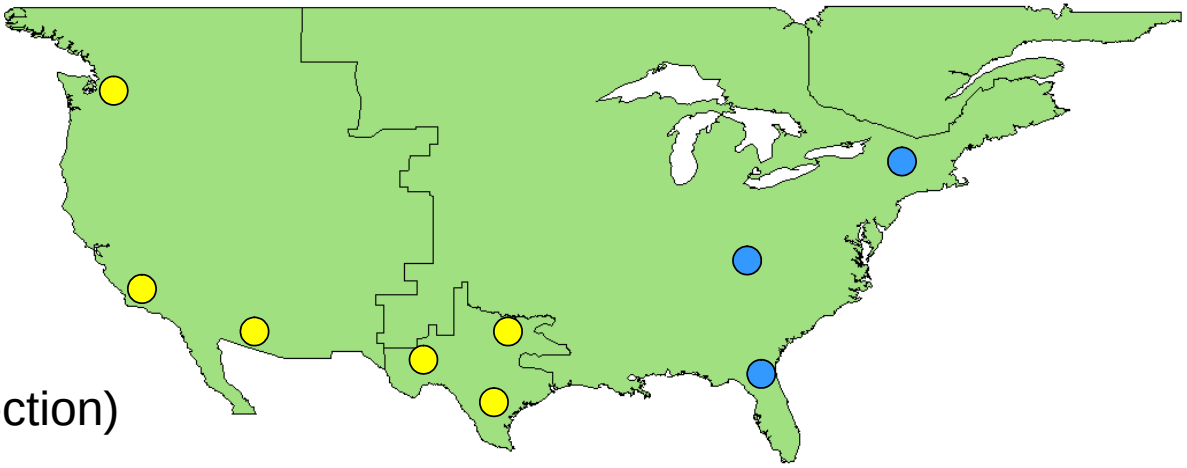
NERC Frequency Monitoring and Analysis (FMA) Data Communications Architecture



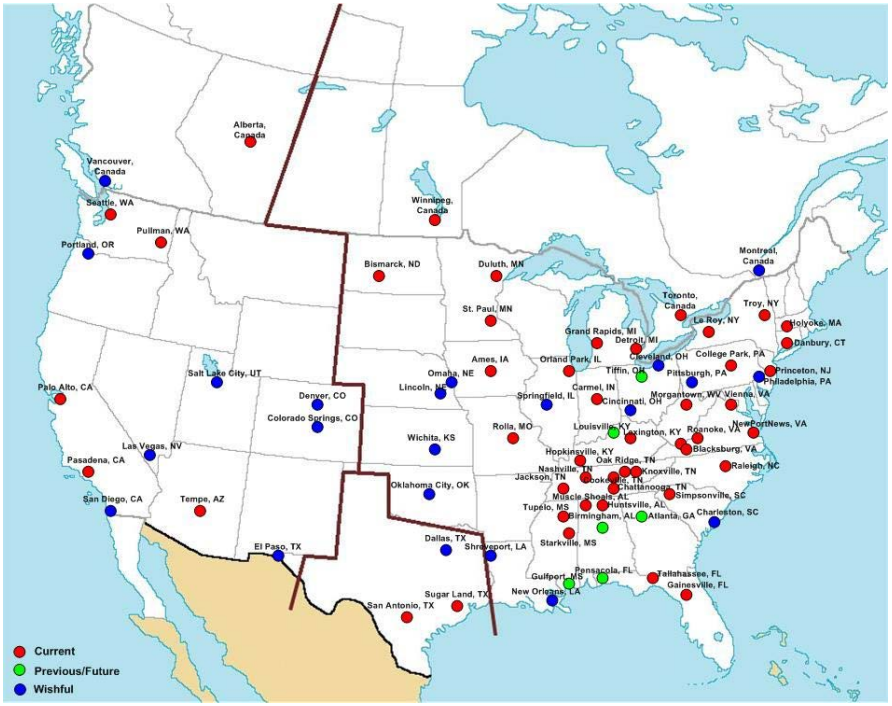
Phasor Data Sources Geographic Location

PMU Phasor Data Sources
(30 Samples/Sec.,3-Per Interconnection, averages Over 1-Sec)

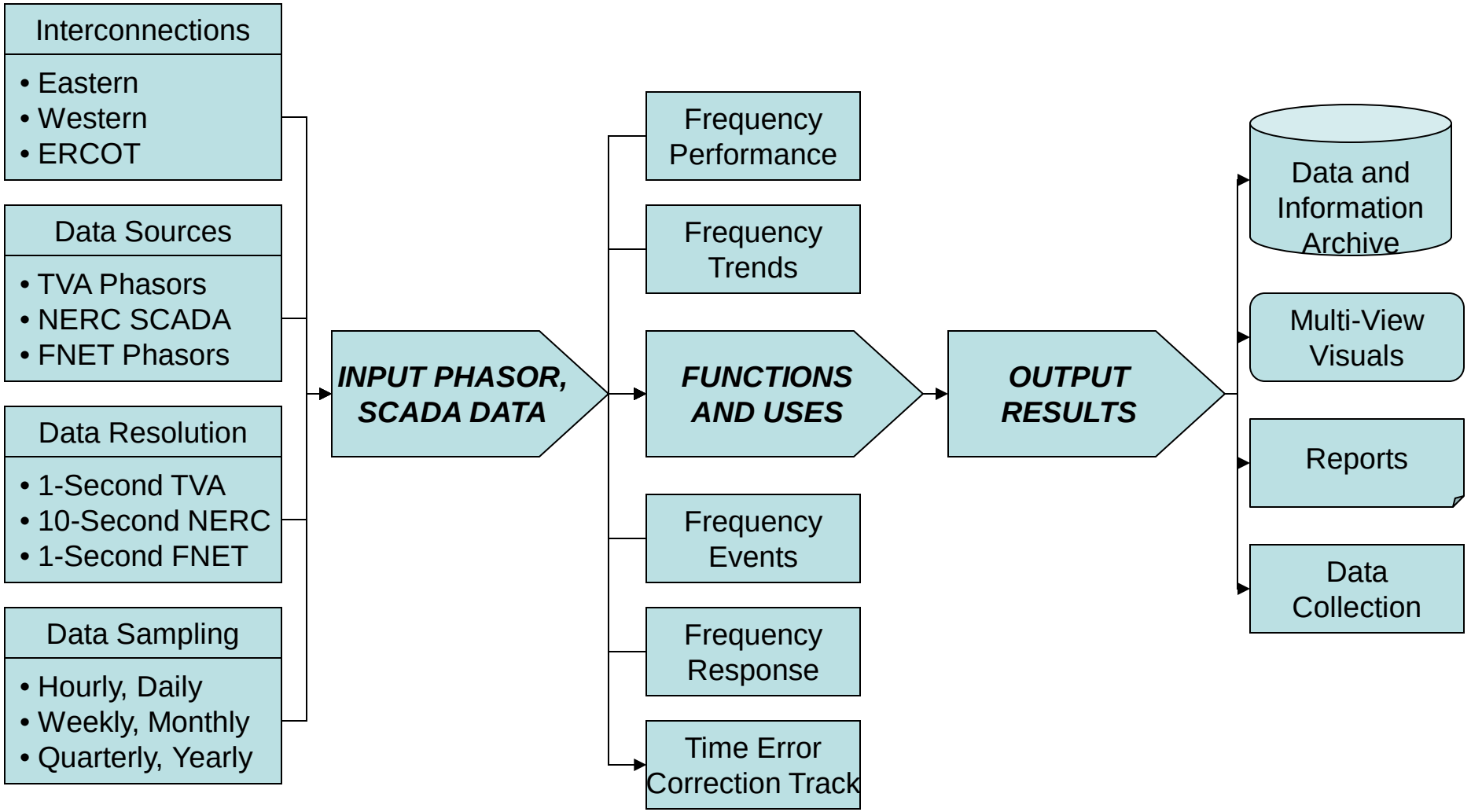
SCADA Balancing Authorities Data Sources
(10-Sec Data 3-Per Interconnection)



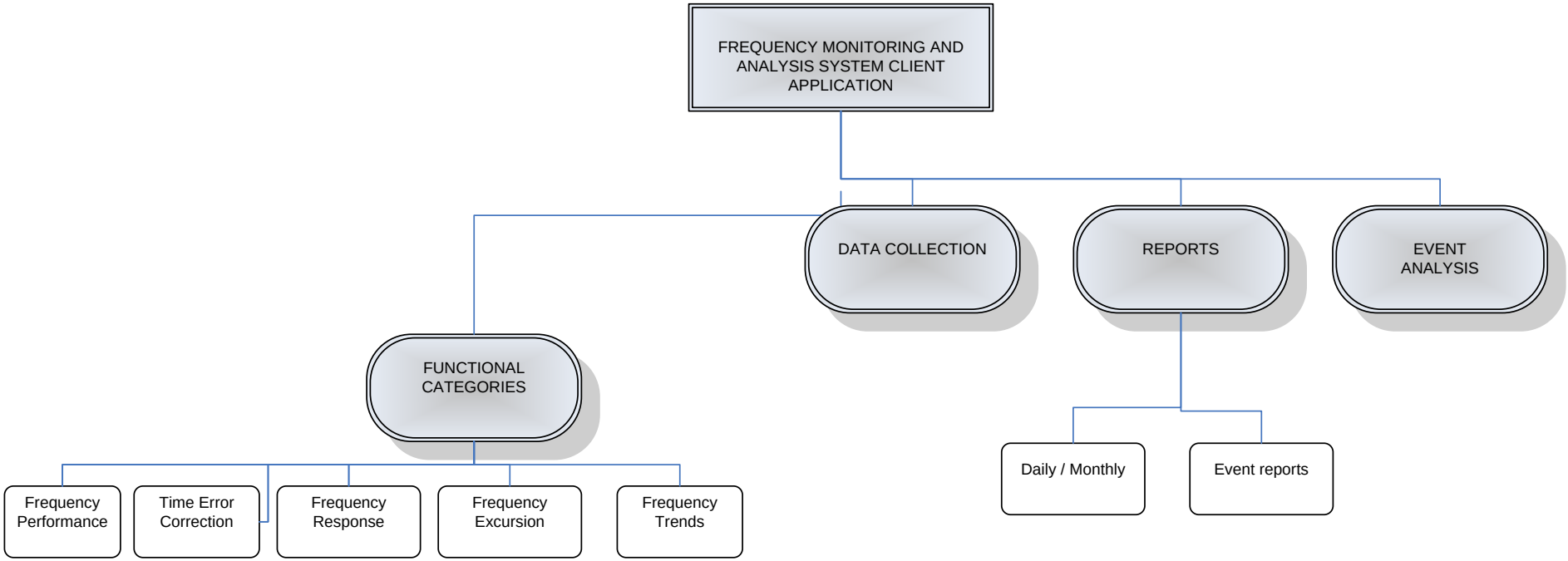
FUTURE – 2009
FNET Phasor Data Sources
(1-Sec from 10 Samples/Sec., 3-Per Interconnection – Future Currently in research mode)



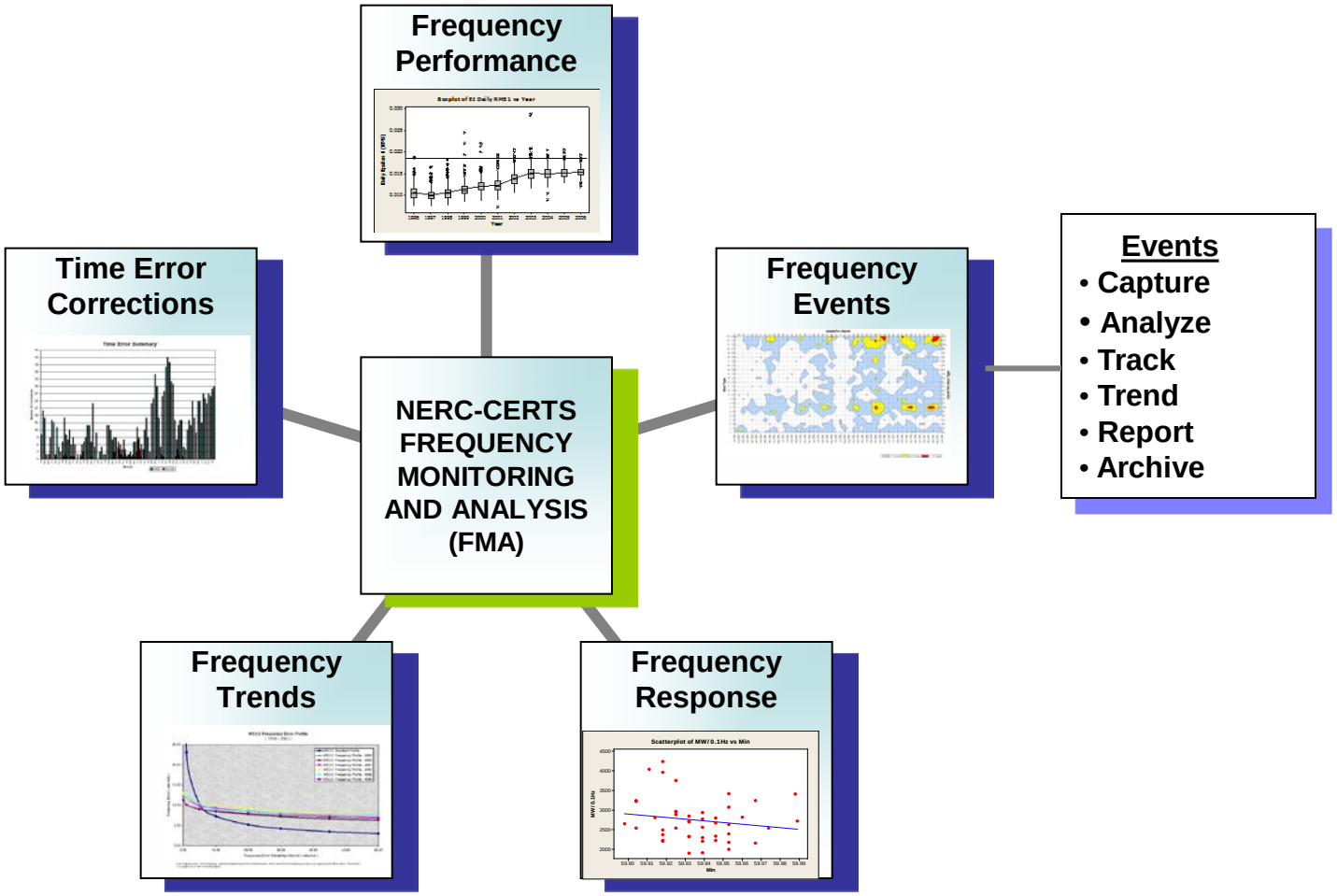
NERC FREQUENCY MONITORING AND ANALYSIS (FMA) FOR INTERCONNECTIONS – FUNCTIONAL OVERVIEW



FMA Navigation

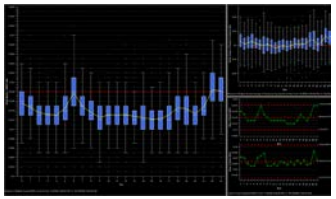
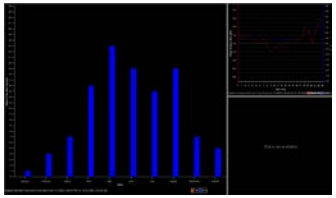
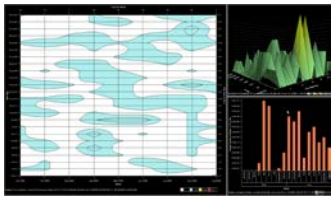
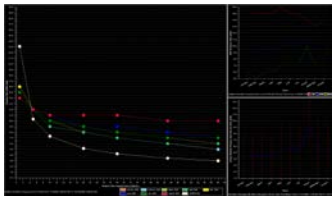
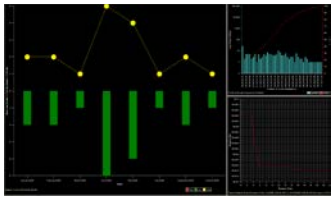
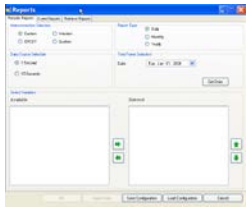
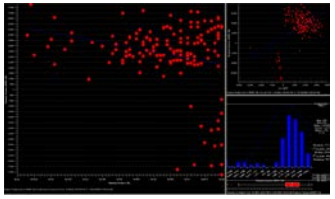
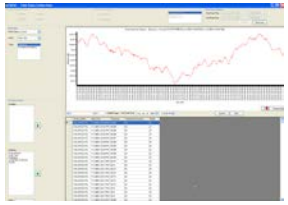
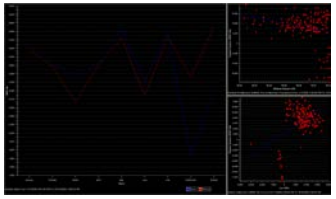
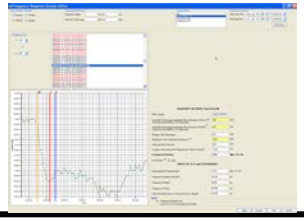


Frequency Analysis and Monitoring (FMA) Functions and Visualization Modules



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 Panel 2: Interconnection Average Frequency Panel 3: Interconnection Average Frequency	Time Error Collection Analysis		Panel 1: Schedule Frequency Panel 2: Schedule Frequency NA
Frequency Events Duration, Distribution		Panel 1: Frequency Events with Valid Status Panel 2: Frequency Events with Valid Status Panel 3: Frequency Events with Valid Status	Frequency Trend		Panel 1: Interconnection Average Frequency Panel 2: Interconnection Average Frequency Panel 3: Interconnection Average Frequency
Frequency Events Counts, Typical		Panel 1: Frequency Events with Valid Status Panel 2: Frequency Events with Valid Status Panel 3: Frequency Events with Valid Status	Reports		Periodic Reports: Interconnection Average Frequency Events Reports: Frequency Events with Valid Status Retrieve Reports: Interconnection Average Frequency
Frequency Response Response vs: MinFreq and Loss		Panel 1: Frequency Events with Valid Status Panel 2: Frequency Events with Valid Status Panel 3: Frequency Events with Valid Status	Data Collection		Frequency from Individual Frequency Source
Frequency Response Response vs: Date		Panel 1: Frequency Events with Valid Status Panel 2: Frequency Events with Valid Status Panel 3: 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.

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	*Eastern*	*Western*	*ERCOT*	*Quebec*
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	*Eastern*	*Western*	*ERCOT*	*Quebec*
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

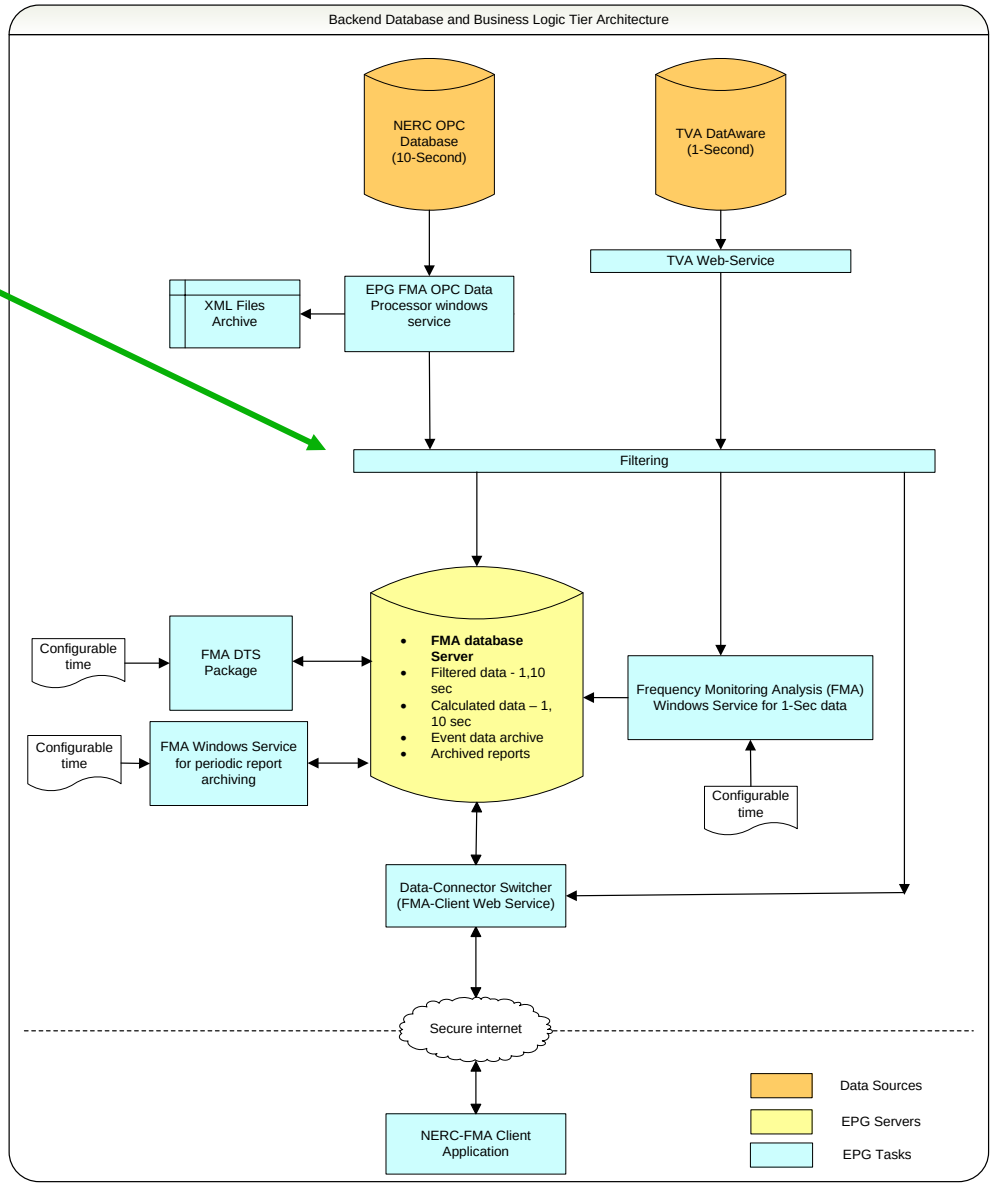
FMA data filtering (see diagram) only checks for abnormal frequency extremes. Frequencies exceeding a high of 62 Hz or low of 58 Hz will be filtered and will not stored in FMA database

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.

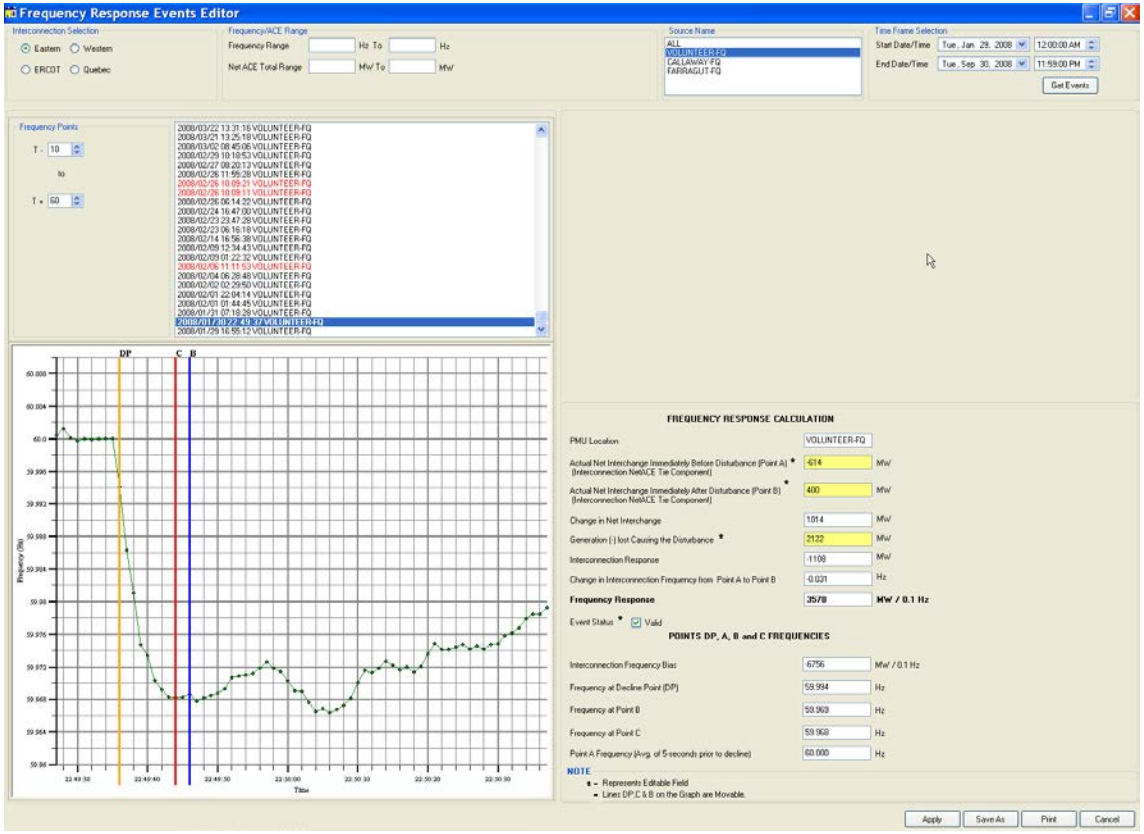
TVA Phasor Data Quality Code	
Good Data	29
Bad Data – Detected by TVA	14
Bad Data – Detected by CERTS-EPG	5

NERC SCADA Quality Code	
Good Data	192



NERC FMA
Event Frequency Response
Archive, Editor and Reports

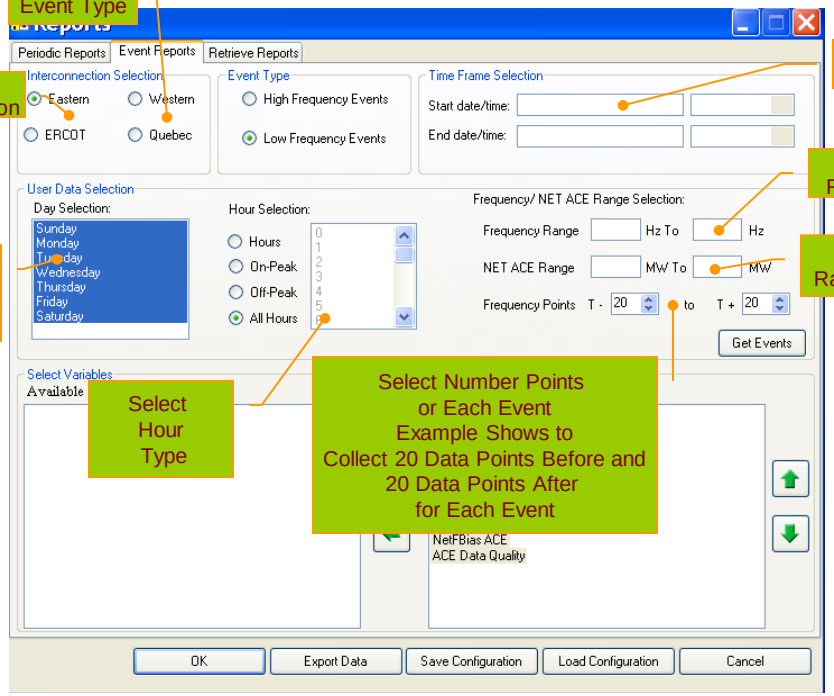
Events Frequency Response Editor Capability



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 UIsers.
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



Select Date Range

Select Range of Freq at Point C

Select Range of NetACE at Point C

Report Part 1: Report Header

NERC - FREQUENCY EVENTS REPORT - Created : 10
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

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	706	-1424	0
28106	9/26/2008	02:04:41	59.981	0	60	-718	570	-1288	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

Report Part 2: Selected Valid Frequency Response Events List

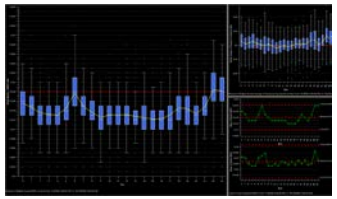
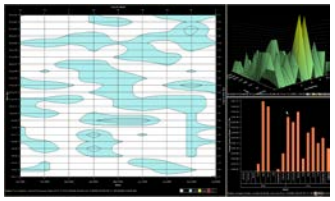
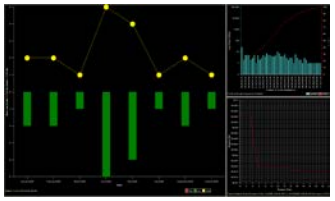
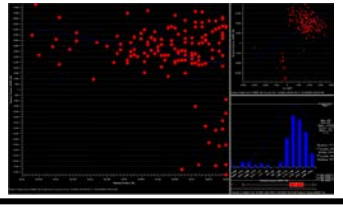
Requested Events Frequency (Hz) Points DP, A, B, C and Frequency Response (MW/0.1Hz)

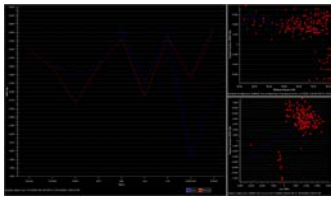
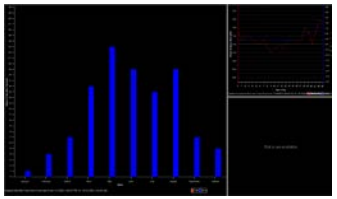
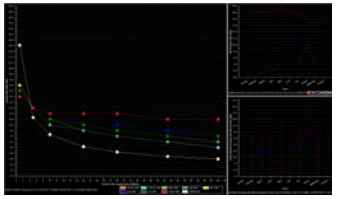
Event	SourceName	Date	Time	Point-DP	Time-DP	Frequency of point-A which is 5-second average value	Point-B	Time-B	Point-C	Time-C	FResponse
28106	VOLUNTEER-FQ	9/26/2008	02:04:39	59.987	05:04:38	59.986	59.973	05:04:49	59.973	05:04:48	4743
28110	VOLUNTEER-FQ	9/26/2008	15:46:03	59.984	18:46:02	59.984	59.977	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

Only **valid** Frequency Response Event is collected. The valid status of Frequency Response Events is editable through FR Event Editor.

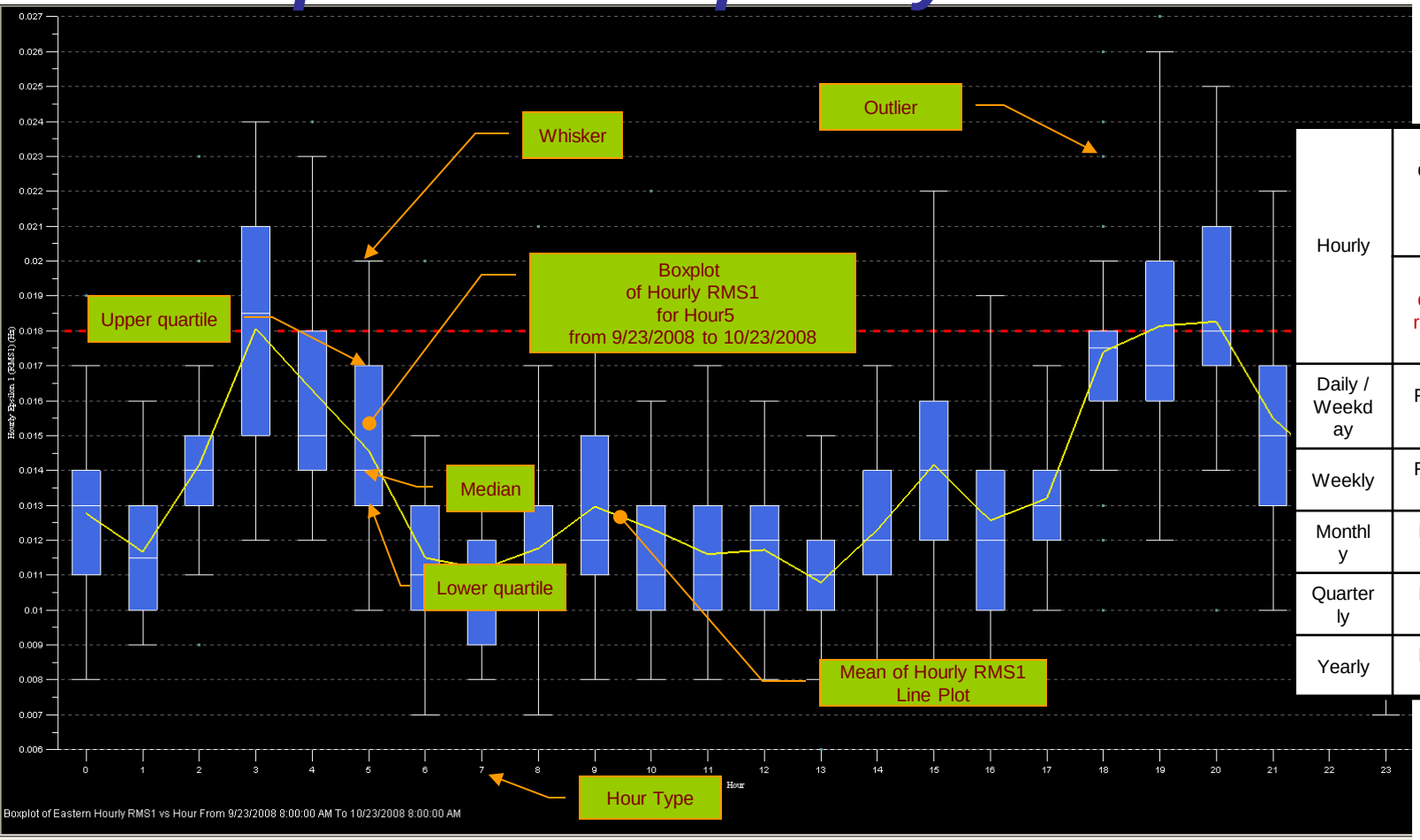
NERC FMA
Displays Data Sets
Detail Description and Utilization

FMA Display Sets Descriptions - Summary

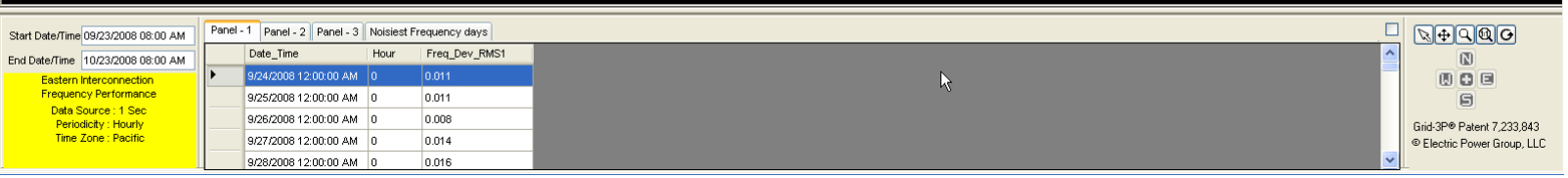
Function Set	Display Sample	Graphic Description
Frequency Performance		Panel 1: Box plot for RMS1 of Frequency Deviation Panel 2: Box plot for Average Frequency Deviation Panel 3: Xbar-R Chart for RMS1 of Frequency Deviation
Frequency Response Events Duration, Distribution		Panel 1: Contour Plot for Count of Frequency Response Events Panel 2: 3D Probability of Frequency Response Event Panel 3: Bar chart for Average Frequency Response Event Duration
Frequency Response Events Counts, Typical		Panel 1: Bar chart for Count of Frequency Response Events vs. Date Panel 2: Bar chart for Count of Frequency Response Events vs. Event Duration Panel 3: Line chart for Typical Frequency Response Event
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

Function Set	Display Sample	Graphic Description
Frequency Response Response vs. Date		Panel 1: Line chart for Frequency Response Panel 2: Scatter Plot of Frequency Response vs. Minimum Frequency Panel 3: Scatter Plot of Frequency Response vs. Loss
Time Error Collection Analysis		Panel 1: Bar chart for Count of Time Error Correction Panel 2: Line chart for Frequency Error and Time Error NA
Frequency Trend		Panel 1: Line chart for Frequency Error Profile Panel 2: line charts for frequency error RMS1 calculated using 1, 10 and 60 minutes sampling Panel 3: Line chart for Average Frequency Error from Mean

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	

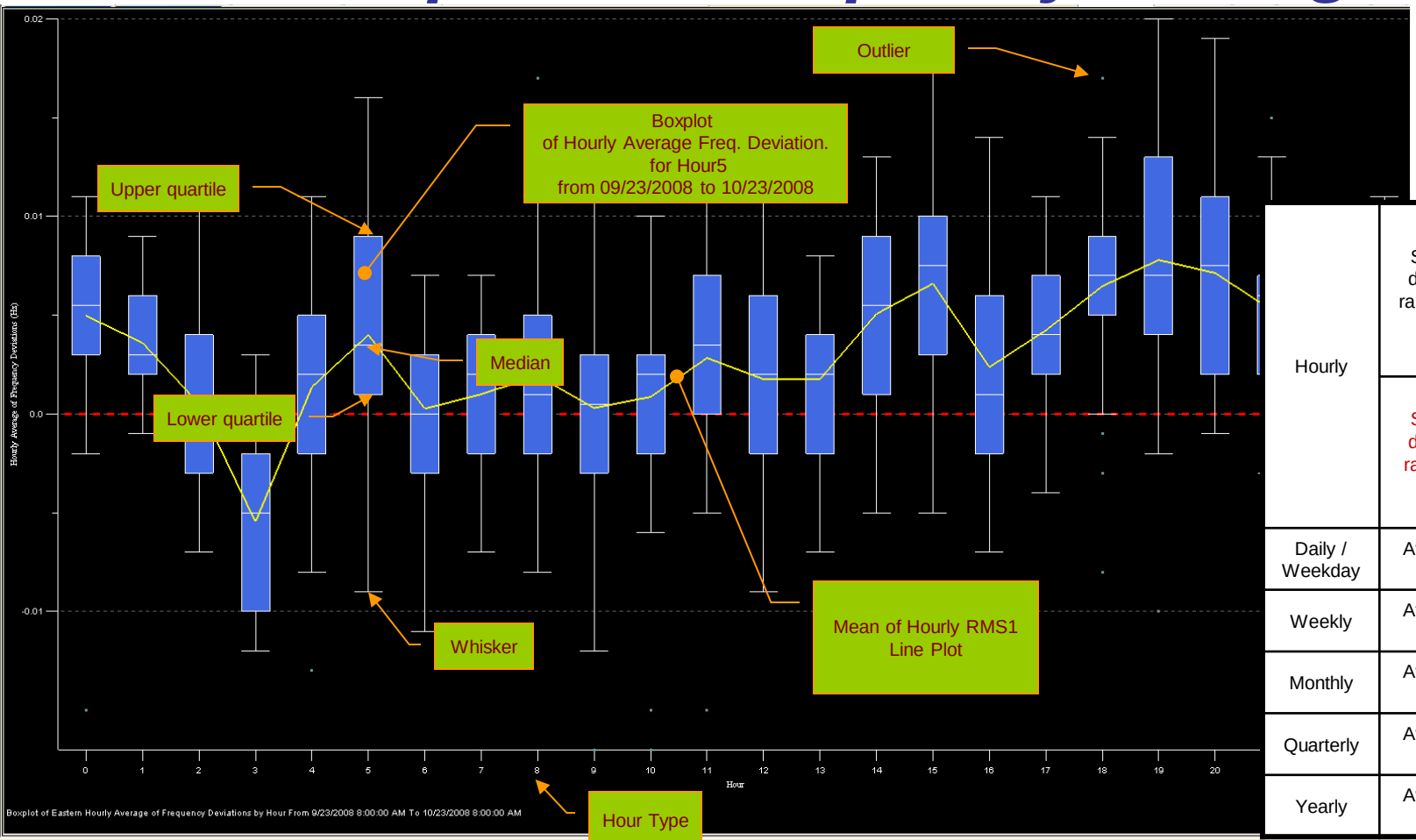


Boxplot Parameters – Boxplot produces a box and whisker plot using the sampling data for user selected timeframe. The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. Any data 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.

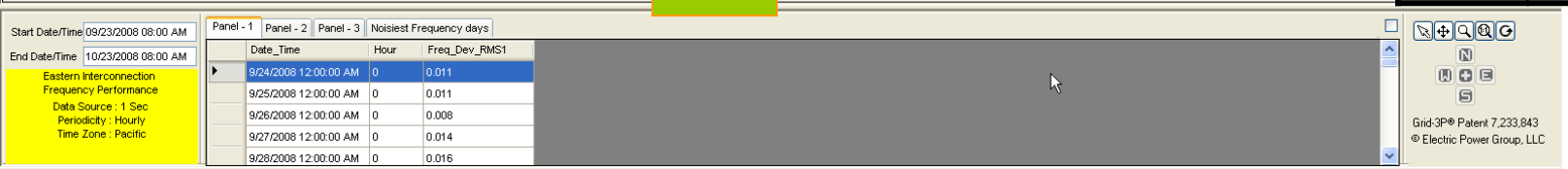
RMS1 - Root Mean Square of 1-Minute Average Frequency Deviation.

Frequency Deviation – The Deviation of Frequency from Scheduled Frequency.

Frequency Performance Displays Set Boxplot for Frequency Average



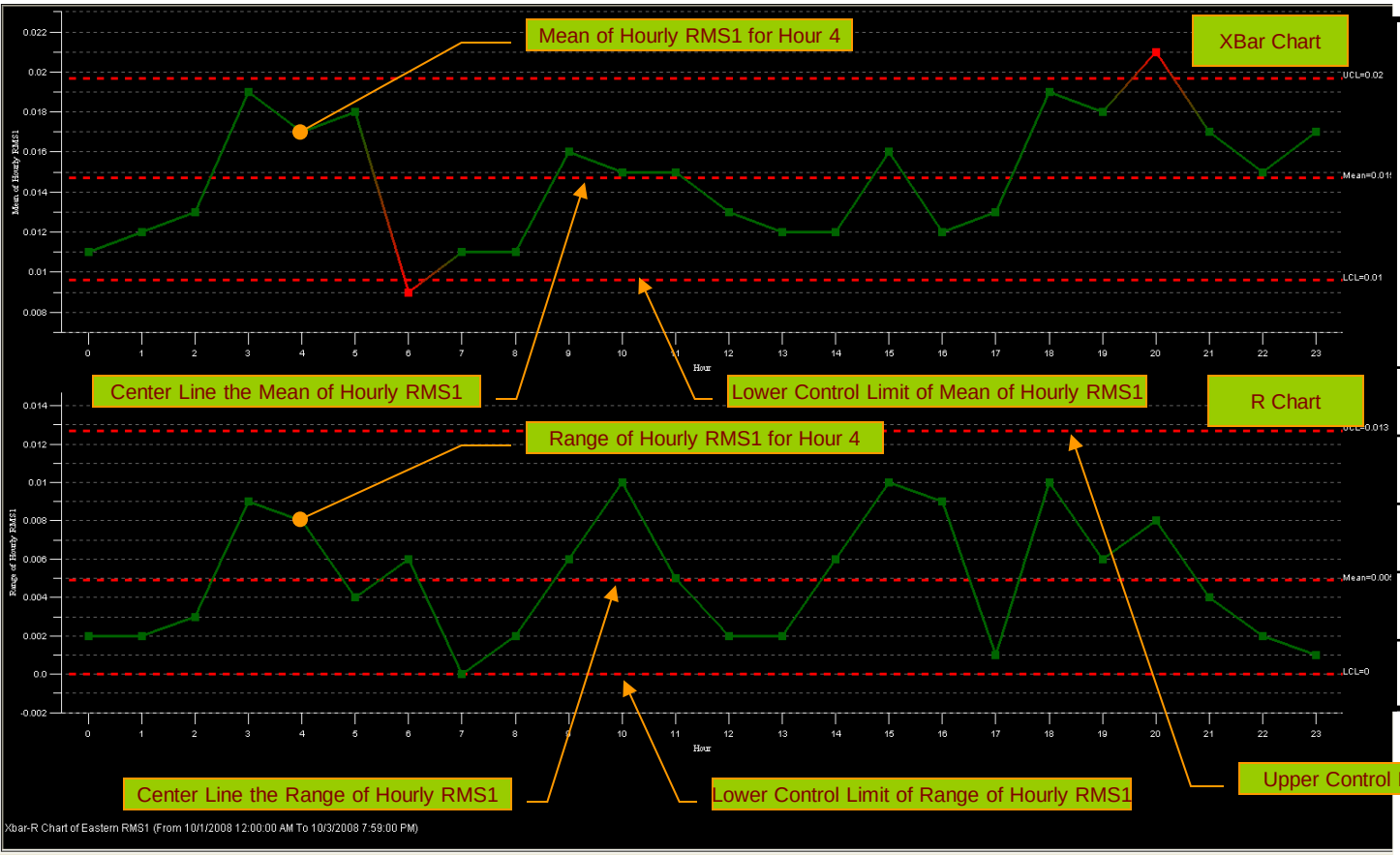
Hourly	Selected date/time range <=48 Hours	Average Freq. Dev. for each **10-minute period** of range selected
	Selected date/time range >48 Hours	Average Freq. Dev. of each **hour** of range selected
Daily / Weekday	Average Freq. Dev. of each **hour** of range selected	
Weekly	Average Freq. Dev. of each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

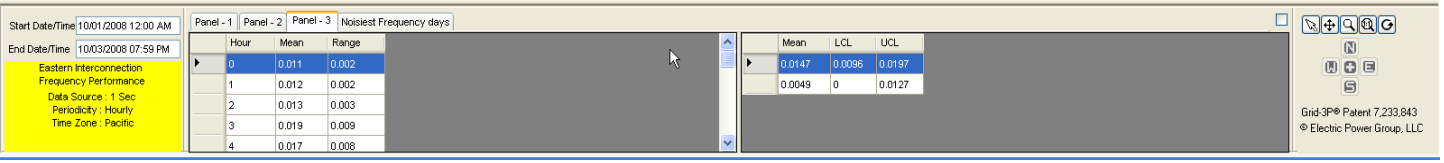


Boxplot Parameters – Boxplot produces a box and whisker plot using the sampling data for user selected timeframe. The box has lines at the lower quartile, median, and upper quartile values. The whiskers are lines extending from each end of the box to show the extent of the rest of the data. Any data 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

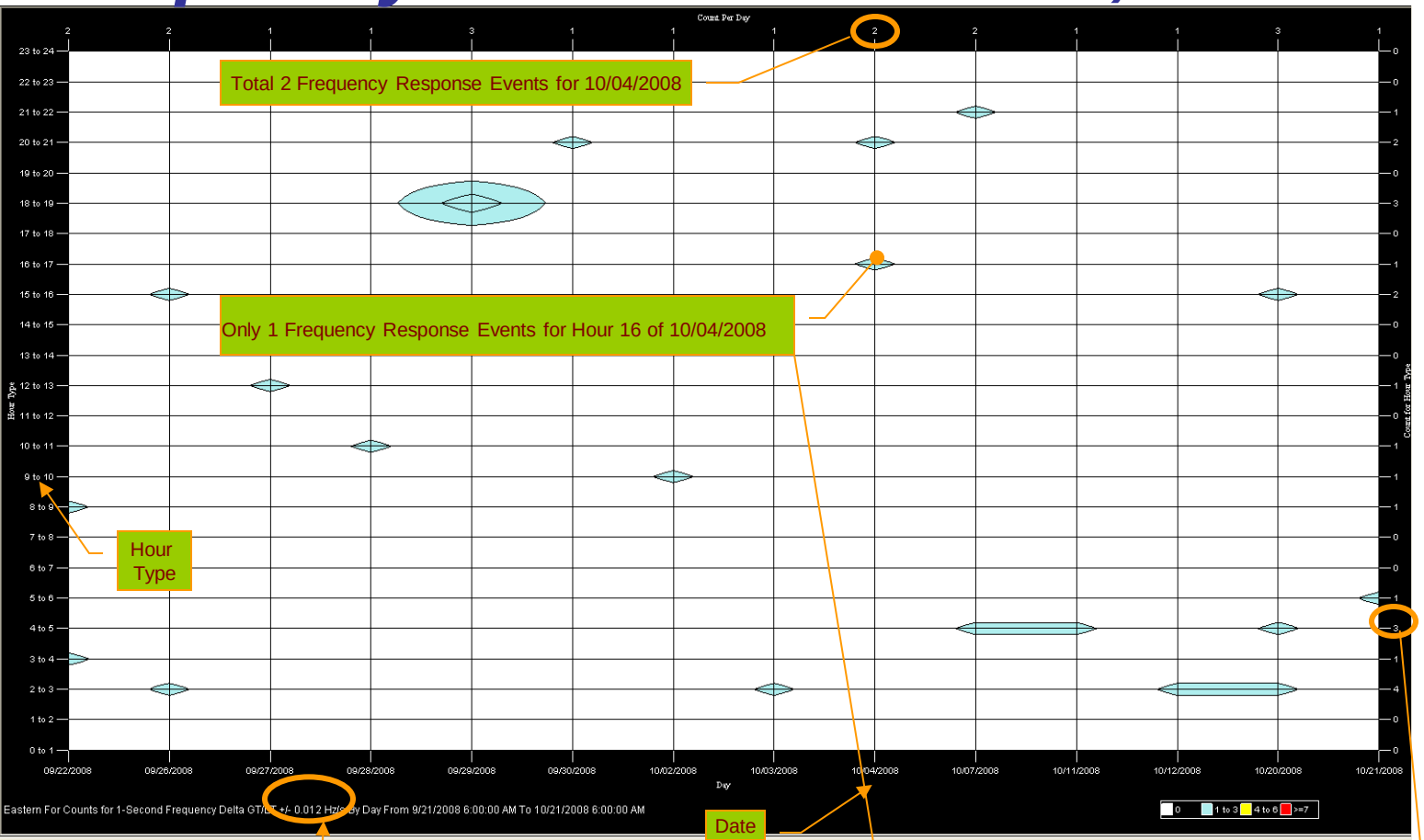




Hourly	Selected date/time range <=48 Hours	RMS1 for each **10-minute period** of range selected
	Selected date/time range >48 Hours	RMS1 for each **hour** of range selected
Daily / Weekday	RMS1 for each **hour** of range selected	
Weekly	RMS1 for each **hour** of range selected	
Monthly	RMS1 for each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

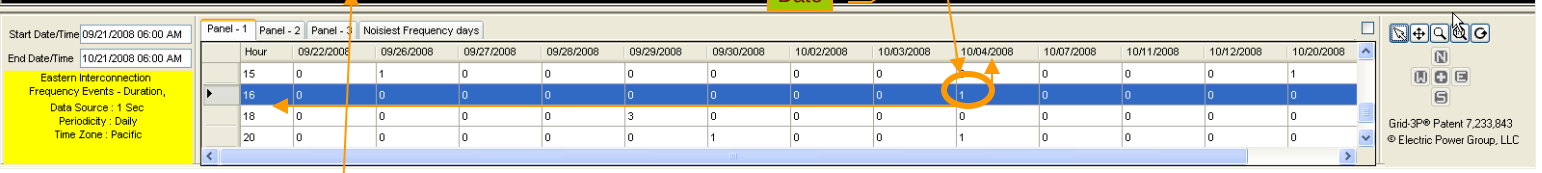
Xbar-R Chart – Xbar Chart depicts the sample means and R Chart depicts the sample ranges. The charts plot the means of the subgroups, a center line at the average of the means, and upper and lower control limits (UCL, LCL) is calculated values based on the size of sample subgroup (see http://www.qualityspctools.com/control.html 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

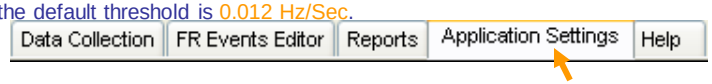


Hourly	NA
Daily / Weekday	Counter Plot for Number of Frequency Response Events Per **Day** Per Hour Type
Weekly	Counter Plot for Number of Frequency Response Events Per **Week** Per Hour Type
Monthly	Counter Plot for Number of Frequency Response Events Per **Month** Per Hour Type
Quarterly	Counter Plot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

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

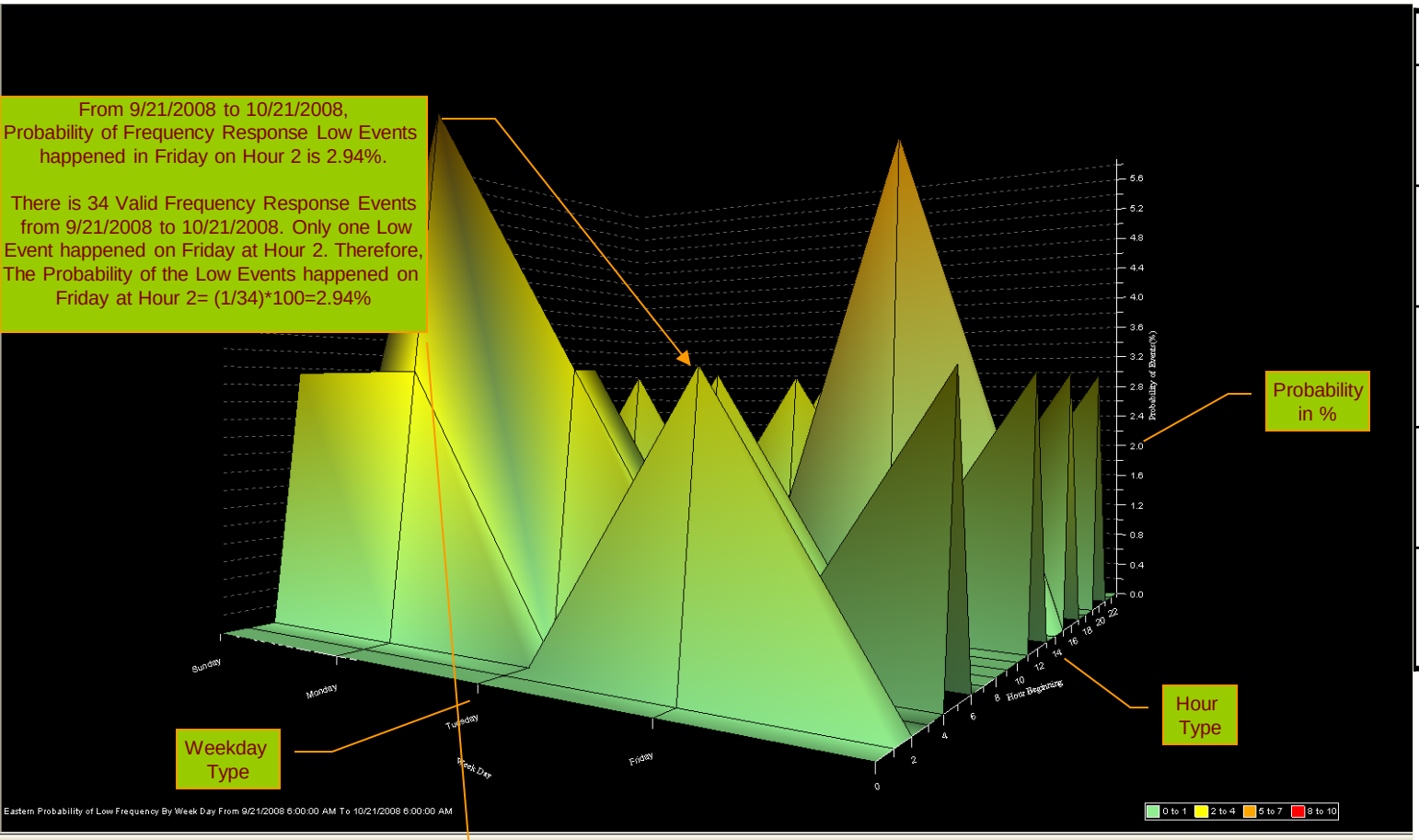


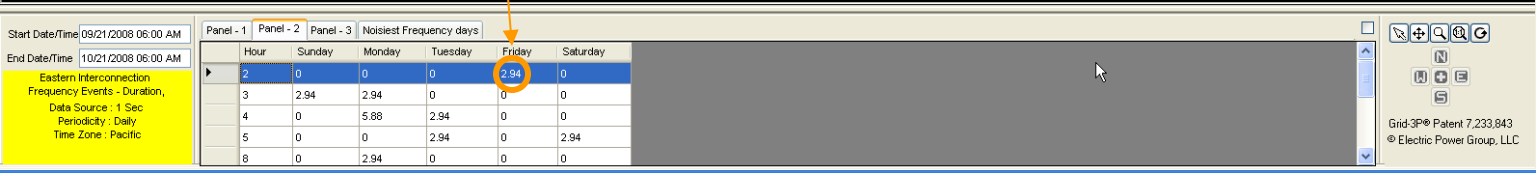
Frequency Response Events Count – In FMA, we consider there is a frequency response event when the standard deviation of eight consecutive frequencies is greater than FMA preset threshold. FMA preset threshold can be found in Server Setting of Application Setting and it is configurable. The current setting 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

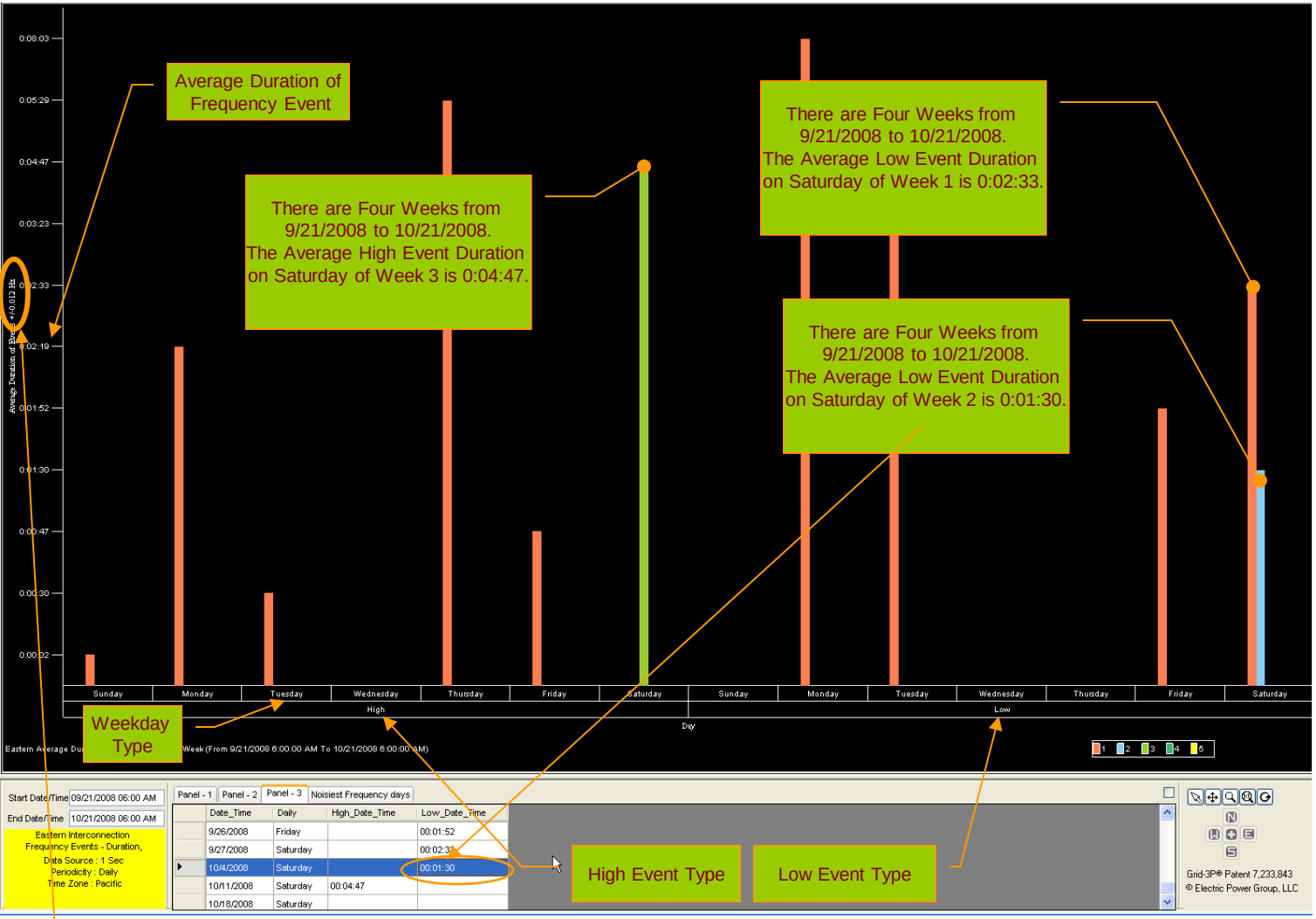




Hourly	NA
Daily / Weekday	3D Plot for Probability of Frequency Response Low Event Per **Weekday** Per Hour Type
Weekly	3D Plot for Probability of Frequency Response Low Event Per **Week** Per Hour Type
Monthly	3D Plot for Probability of Frequency Response Low Event Per **Month** Per Hour Type
Quarterly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

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

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

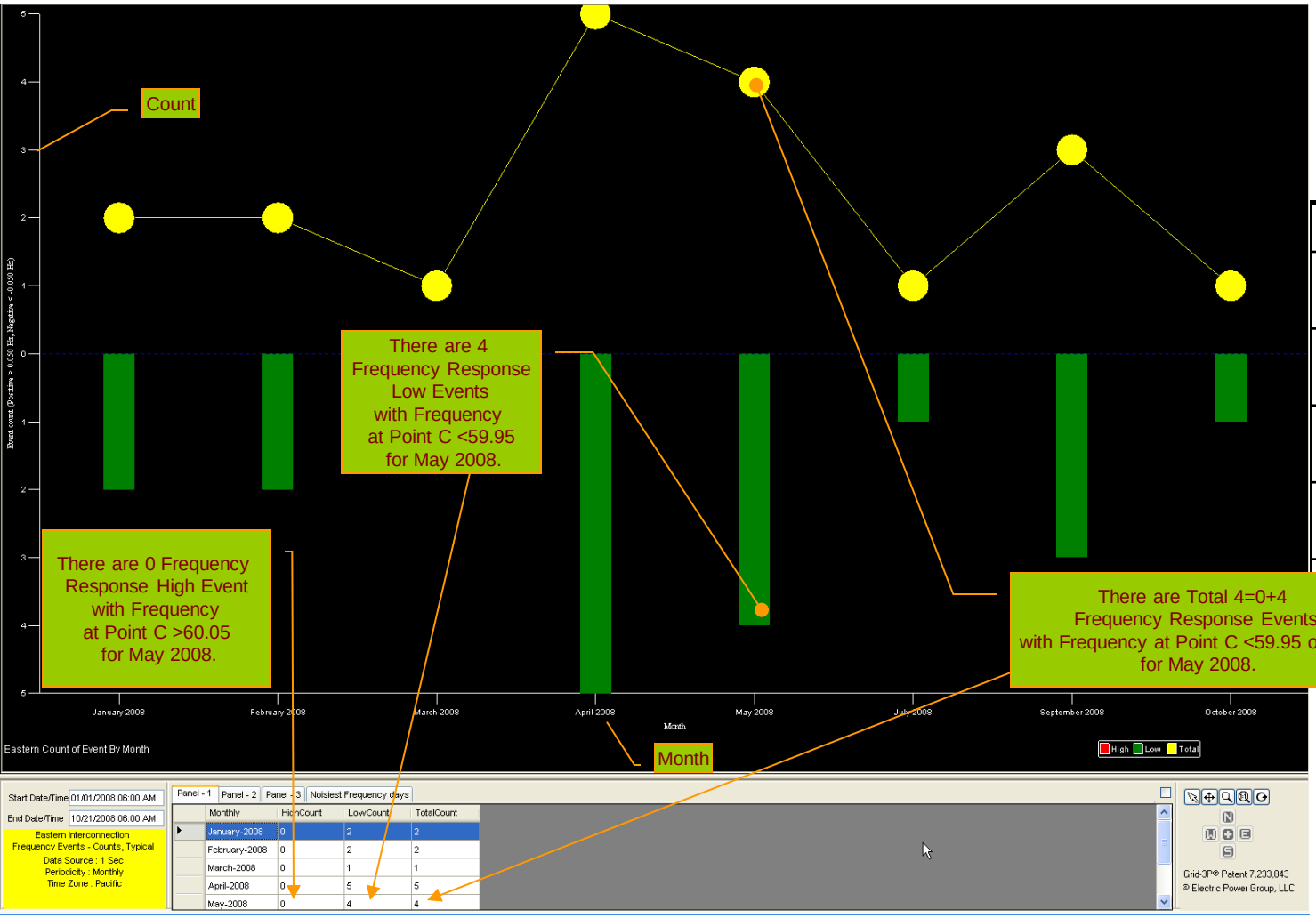
Frequency Response Events Count – In FMA, we consider there is a frequency response event when the standard deviation of eight consecutive frequencies is greater than FMA preset threshold. FMA preset threshold can be found in Server Setting of Application Setting and it is configurable. The current setting 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

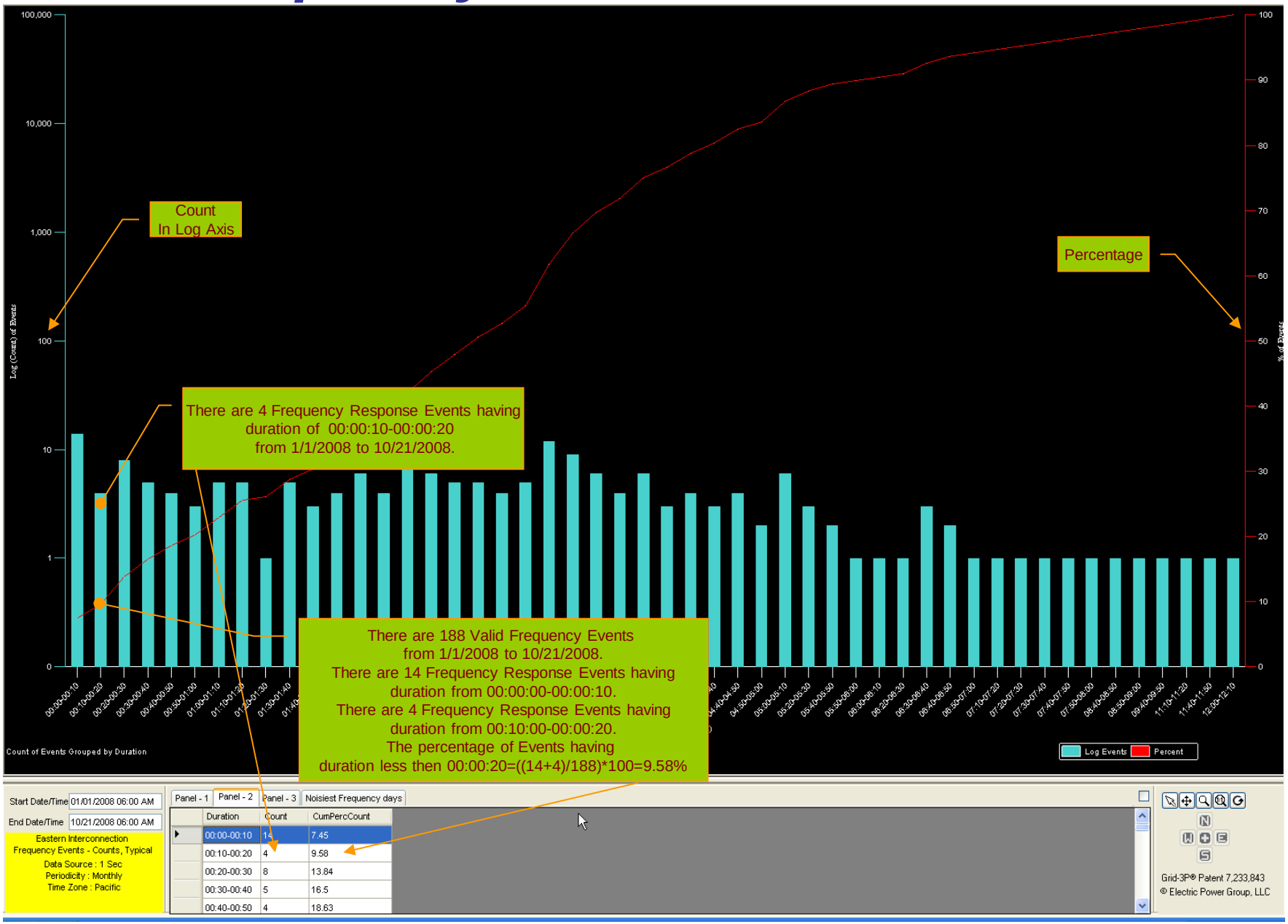
Frequency Events – Counts Set



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
y	**Yearly** High, Low and Total Events Counts for Frequency at Point C >60.05 or <59.95

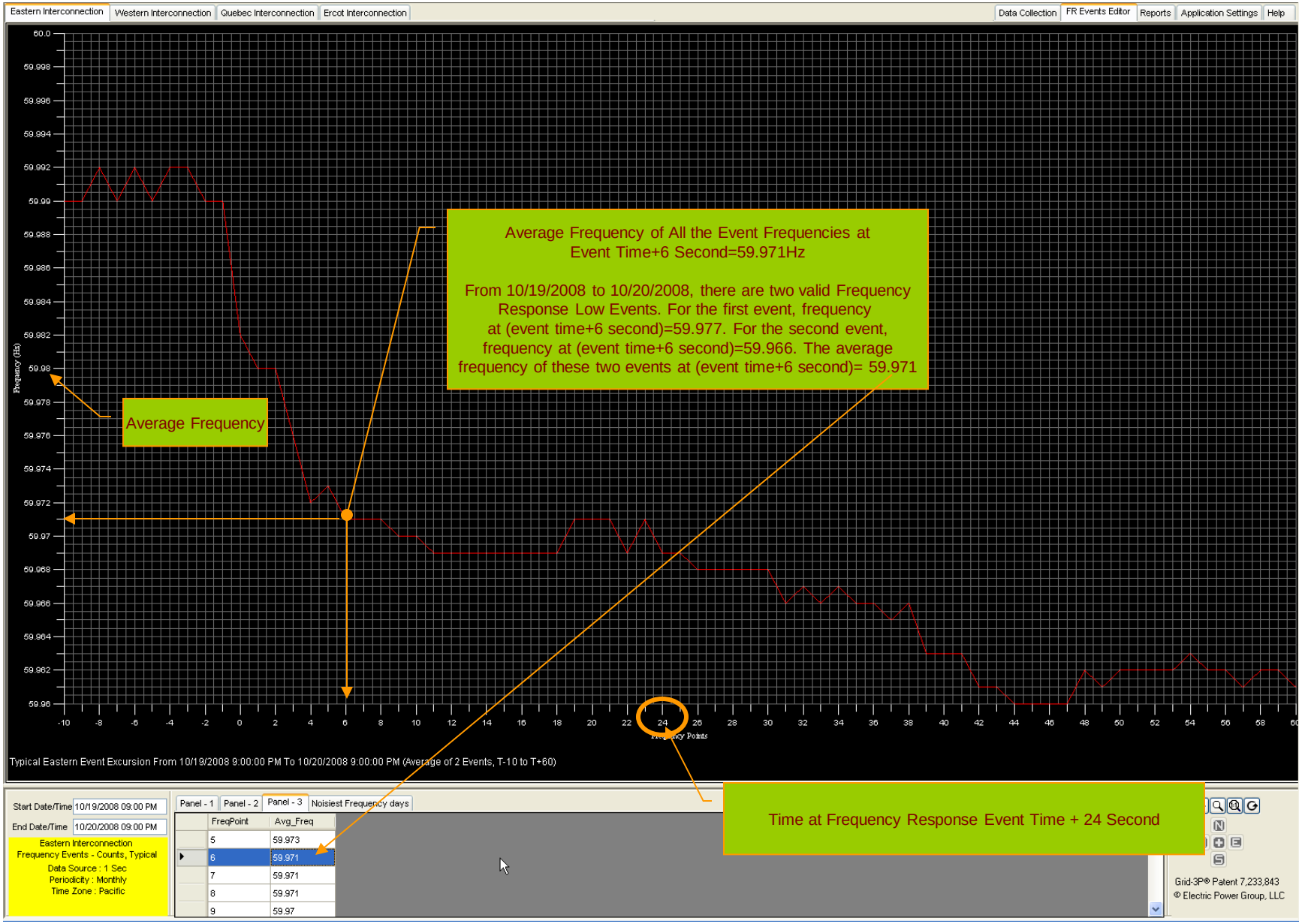
Frequency Response Low Event - is referring the frequency having negative change.
Frequency Response High Event - is referring the frequency having positive change.
Only **valid** Frequency Response Event with **Frequency at Point C<59.95 or >60.05** is considered in this Plot. The valid status of Frequency Response Events is editable through FR Event Editor

Frequency Events – Counts Set



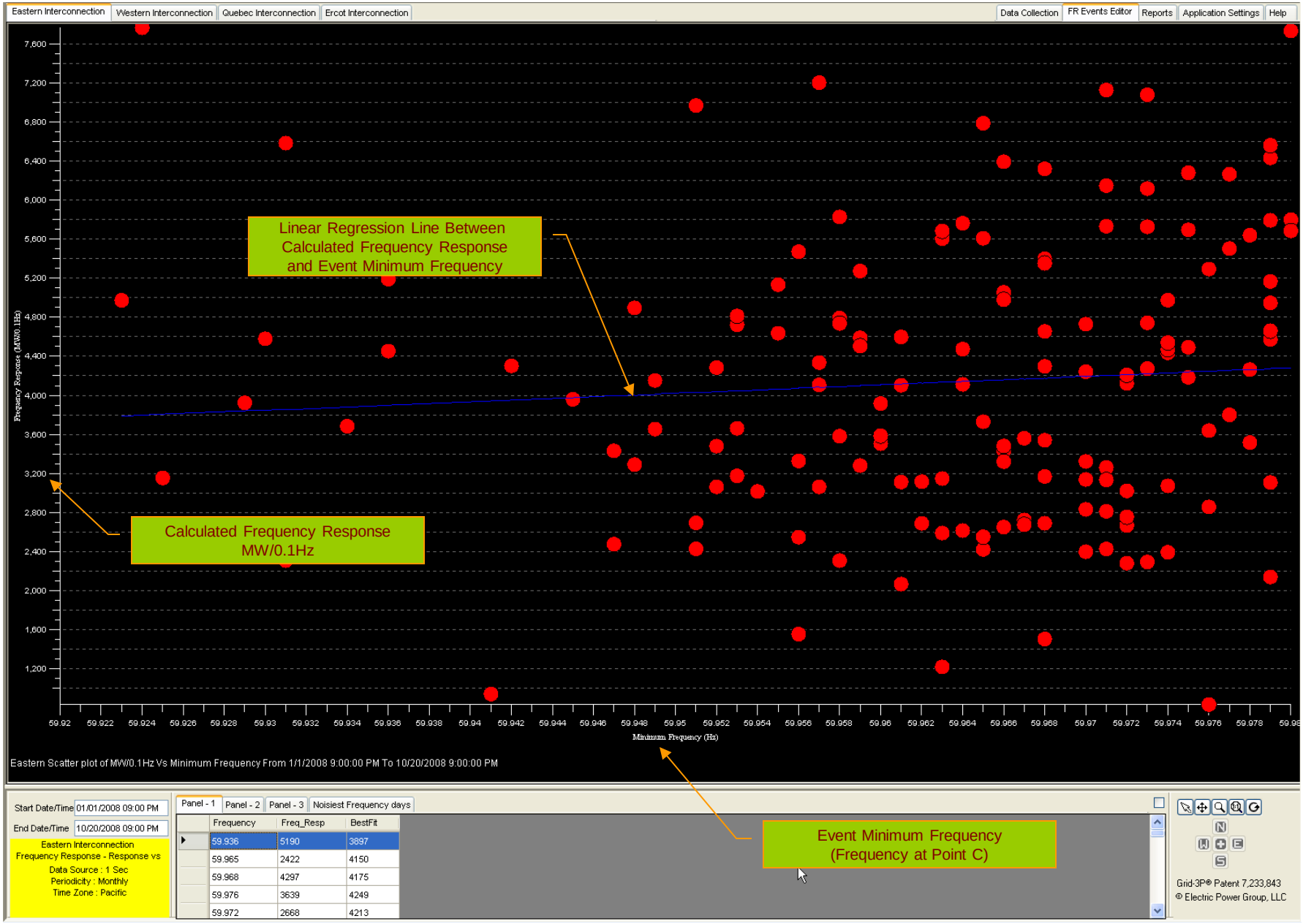
Frequency Duration – Time to pre-disturbance frequency or Scheduled Frequency, whichever is sooner.
Only **valid** Frequency Response Event is considered in this Plot. The valid status of Frequency Response Events is editable through FR Event Editor

Frequency Events – Counts Set



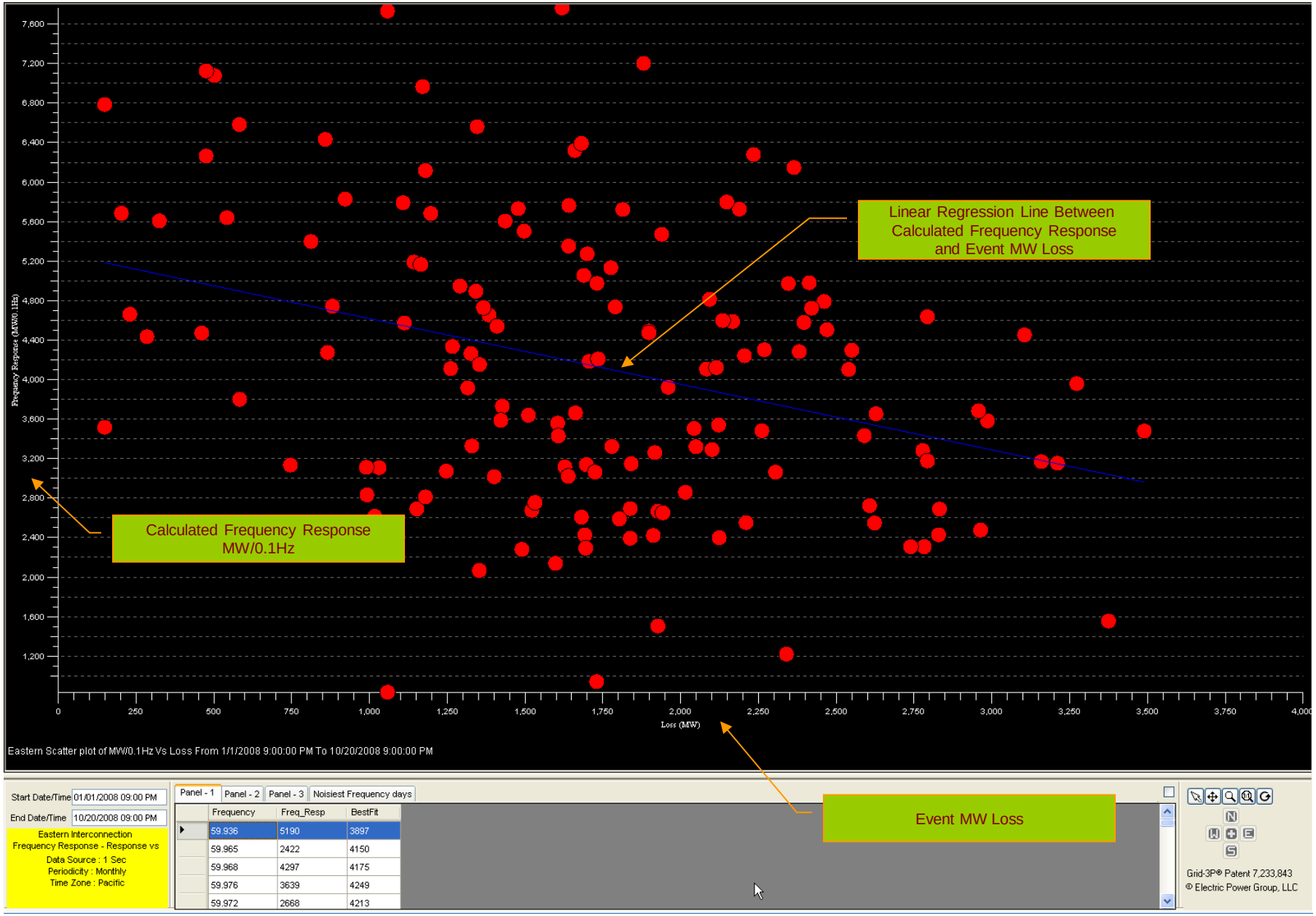
Only **valid** Frequency Response **Low** Event is considered in this Plot. The valid status of Frequency Response Events is editable through FR Event Editor

Events Freq. Response vs Minimum Freq.



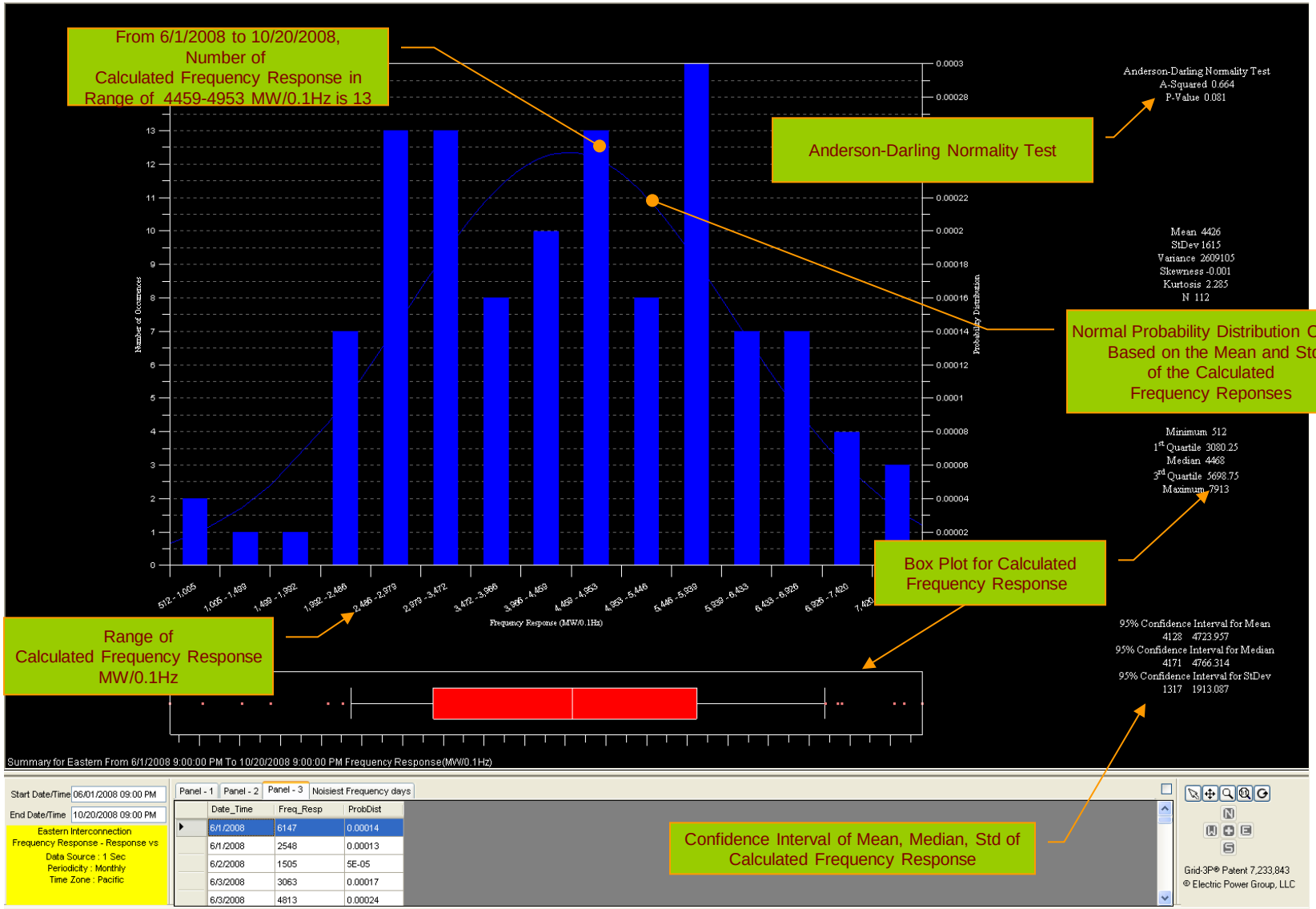
Only **valid** Frequency Response Event is considered in this plot. The valid status of Frequency Response Events is editable through FR Event Editor

Events Frequency Response vs Loss



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

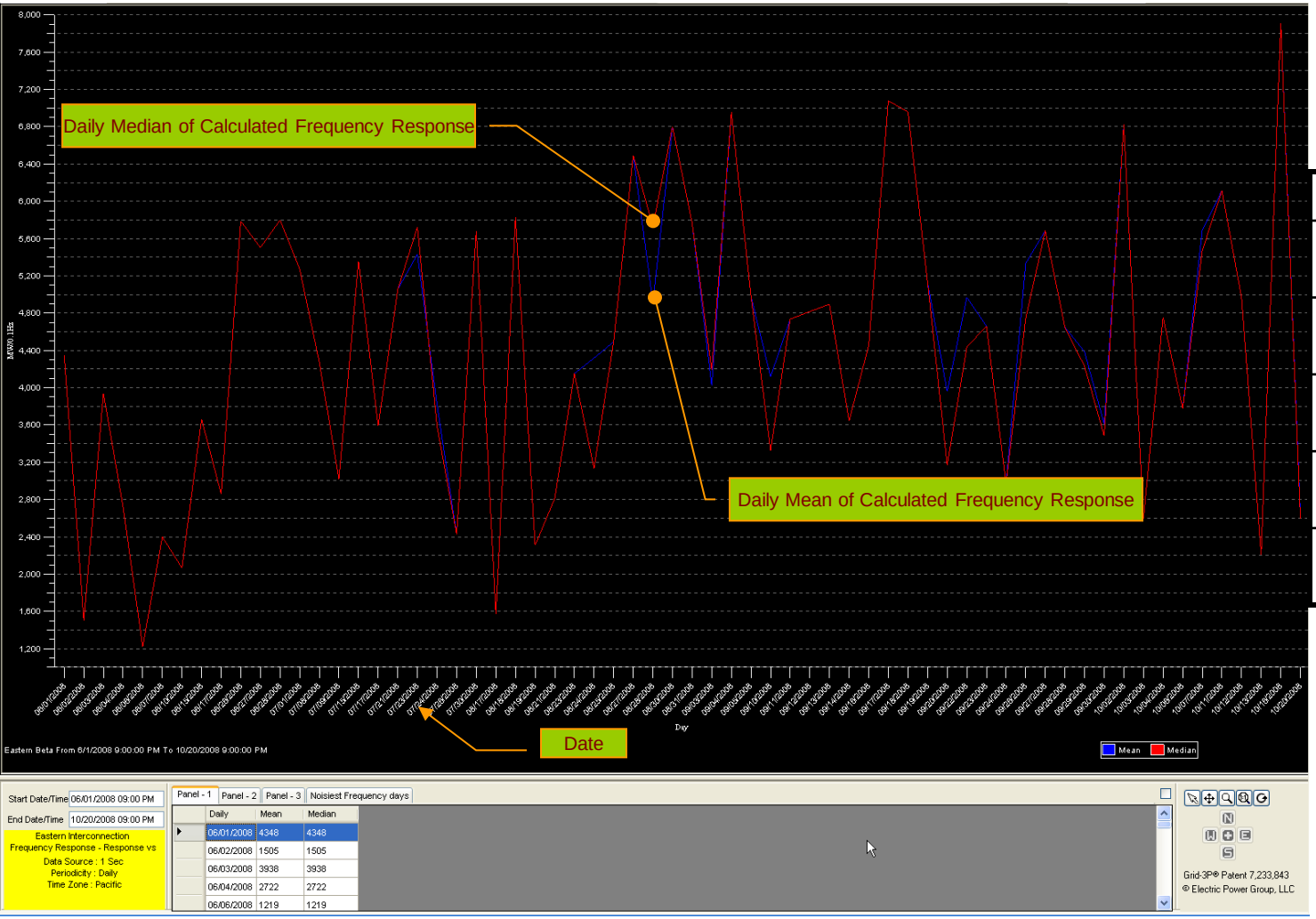
Events Frequency Response Statistics



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.

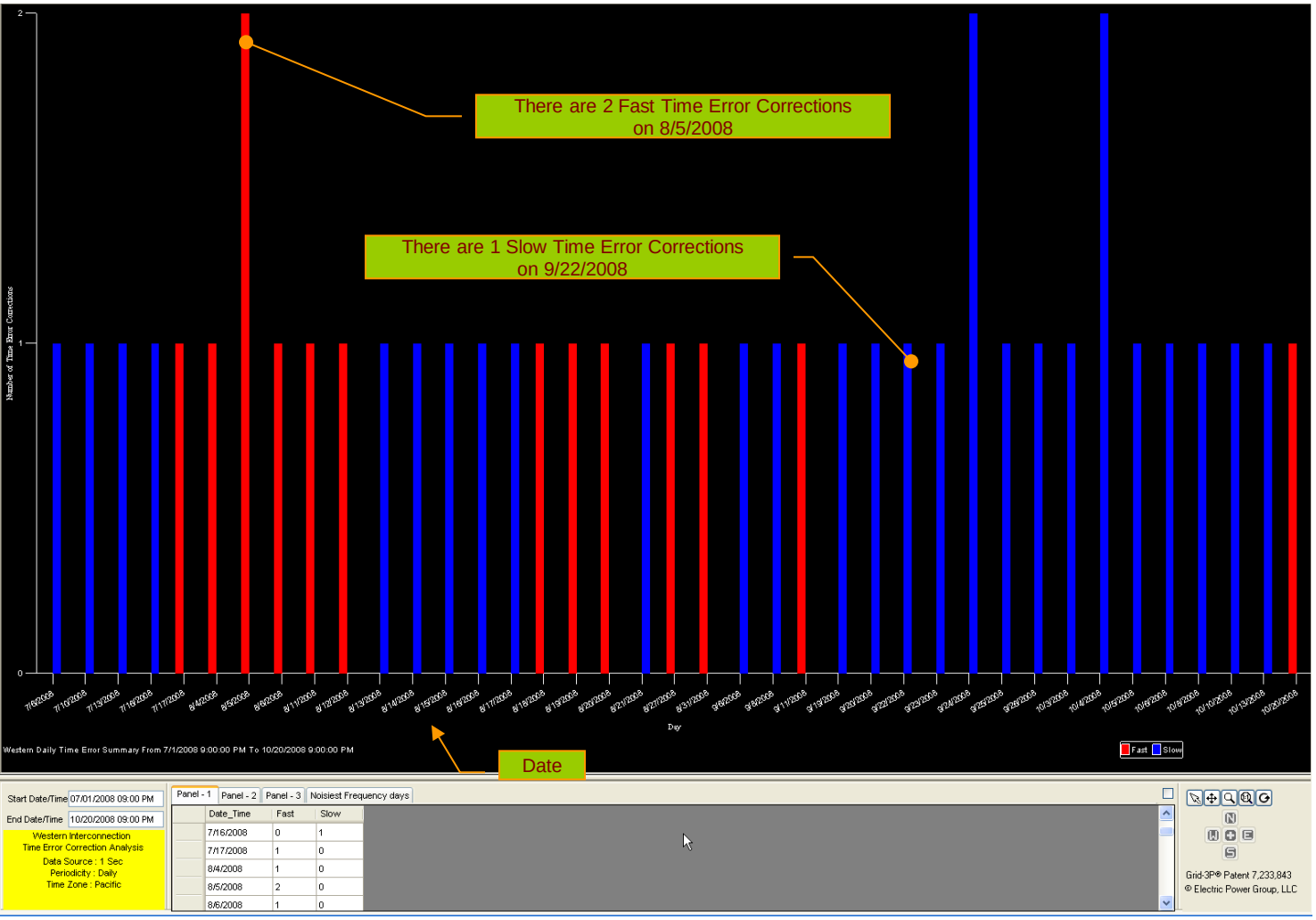
Events Frequency Response Mean/Median



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.

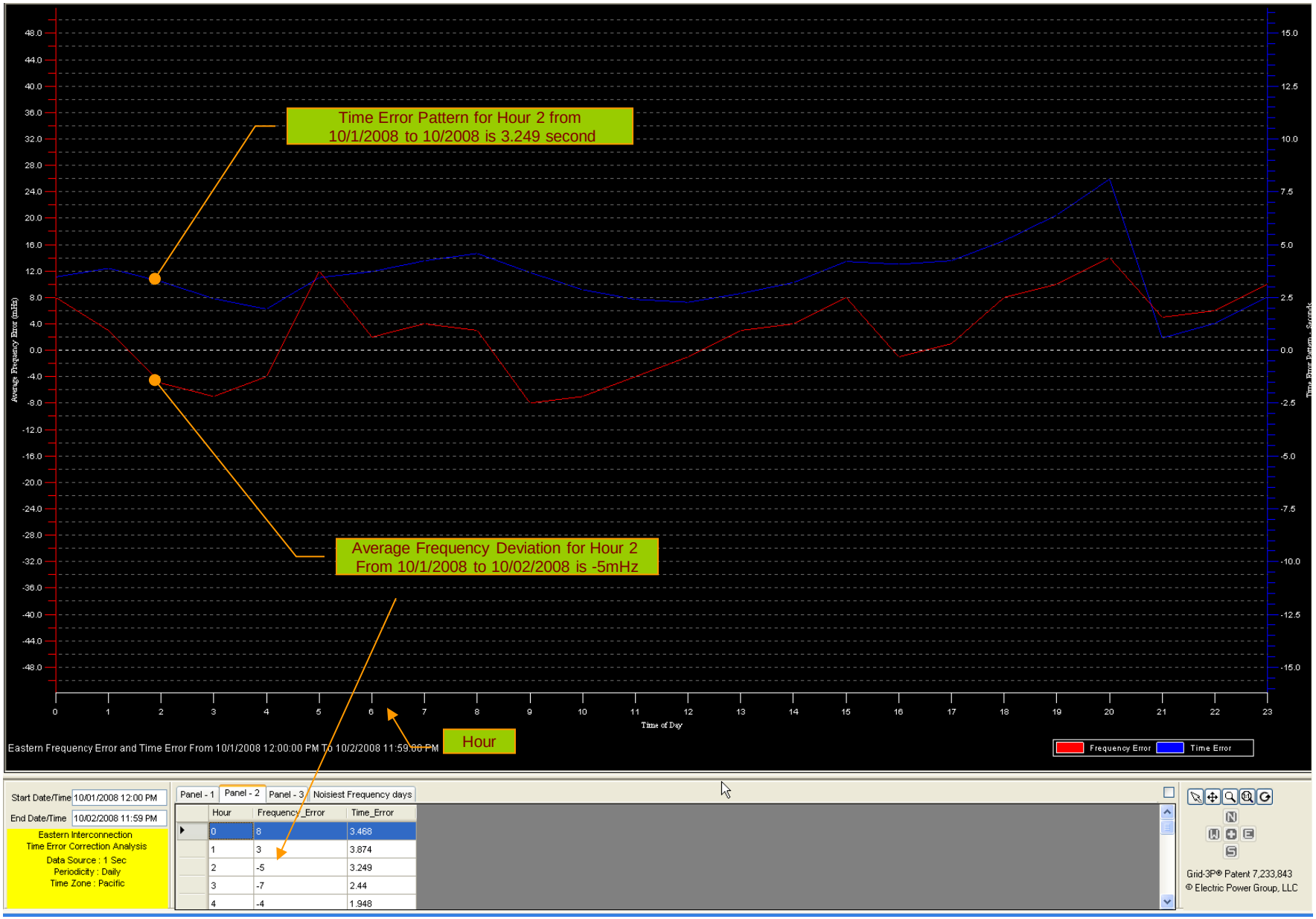
Time Error Corrections Summary



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

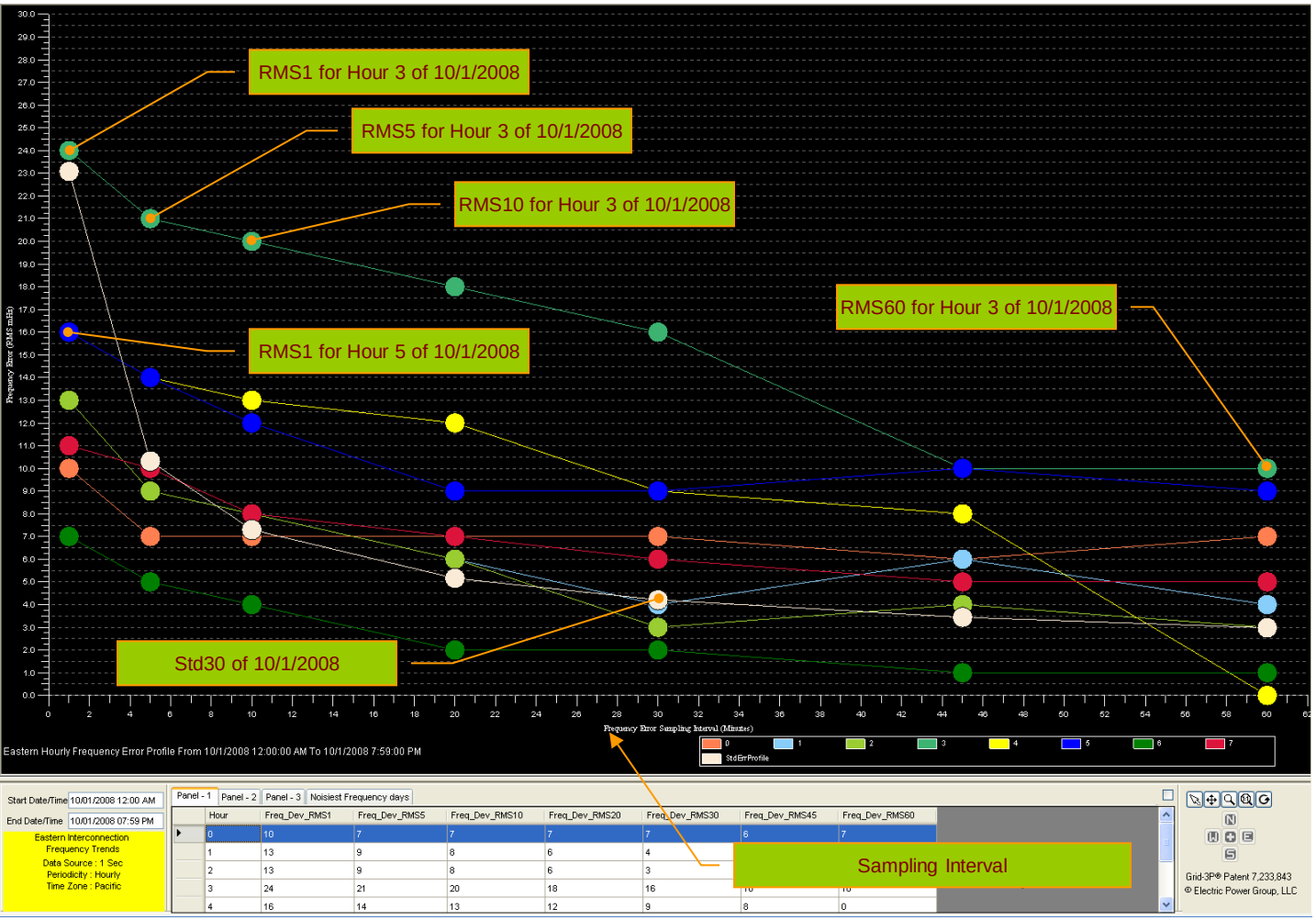
Fast Time Error Correction – When the scheduled frequency is 60Hz or more
Slow Time Error Correction – When the scheduled frequency is below 60 Hz.

Time Error Correction – Minutes Corrected



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

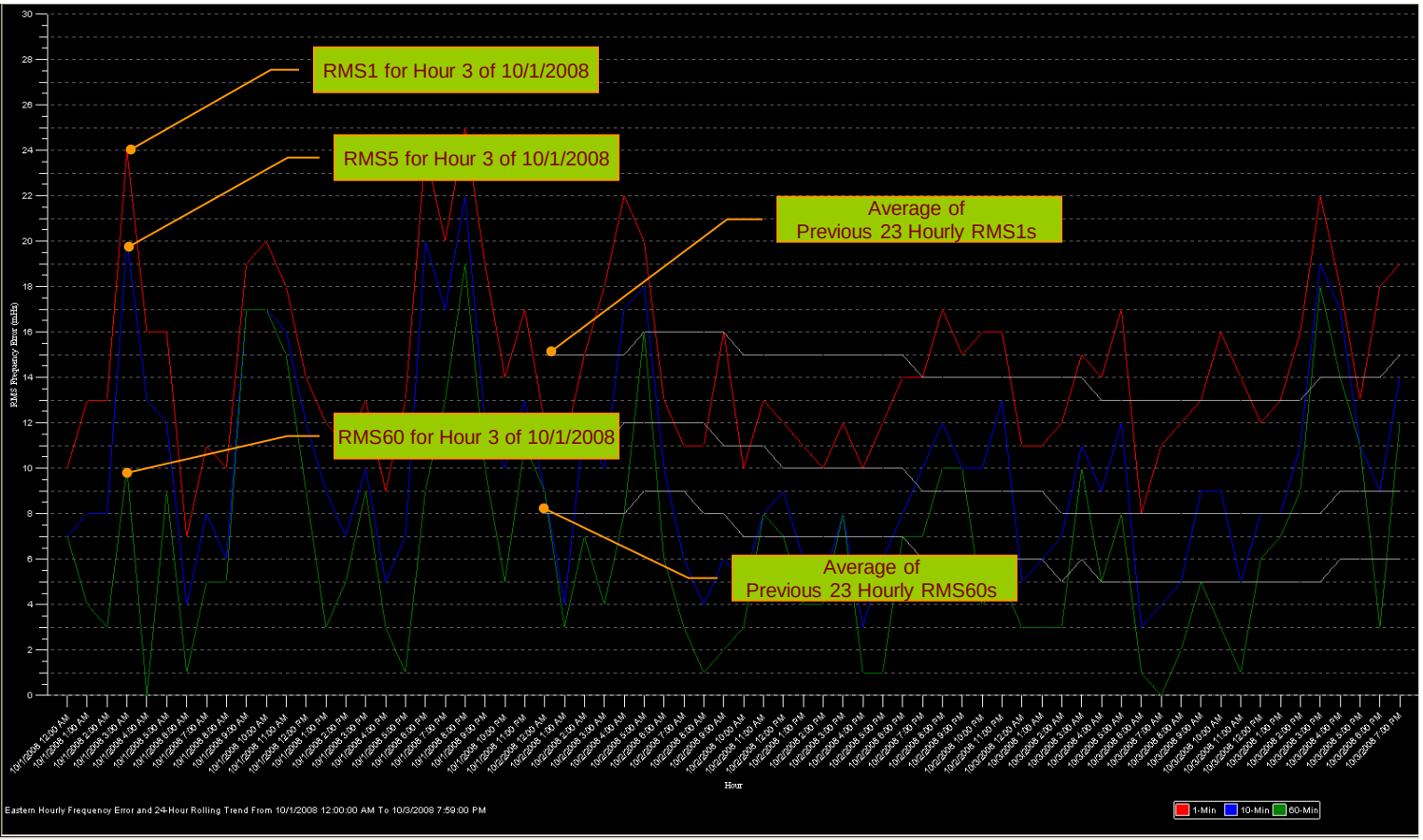
Frequency Error Patterns and Trends Set

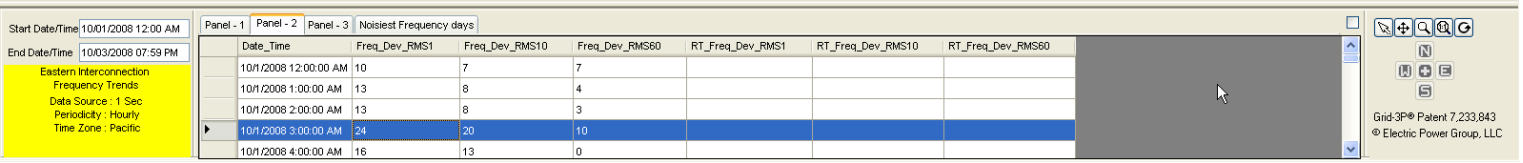


Hourly	Top 8 **Hourly** RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Daily / Weekday	Top 8 **Daily** RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error Profile
Weekly	NA
Monthly	Top 8 **Monthly** RMS1, RMS5, RMS10, RMS20, RMS30, RMS45, RMS60 and Standard Error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

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



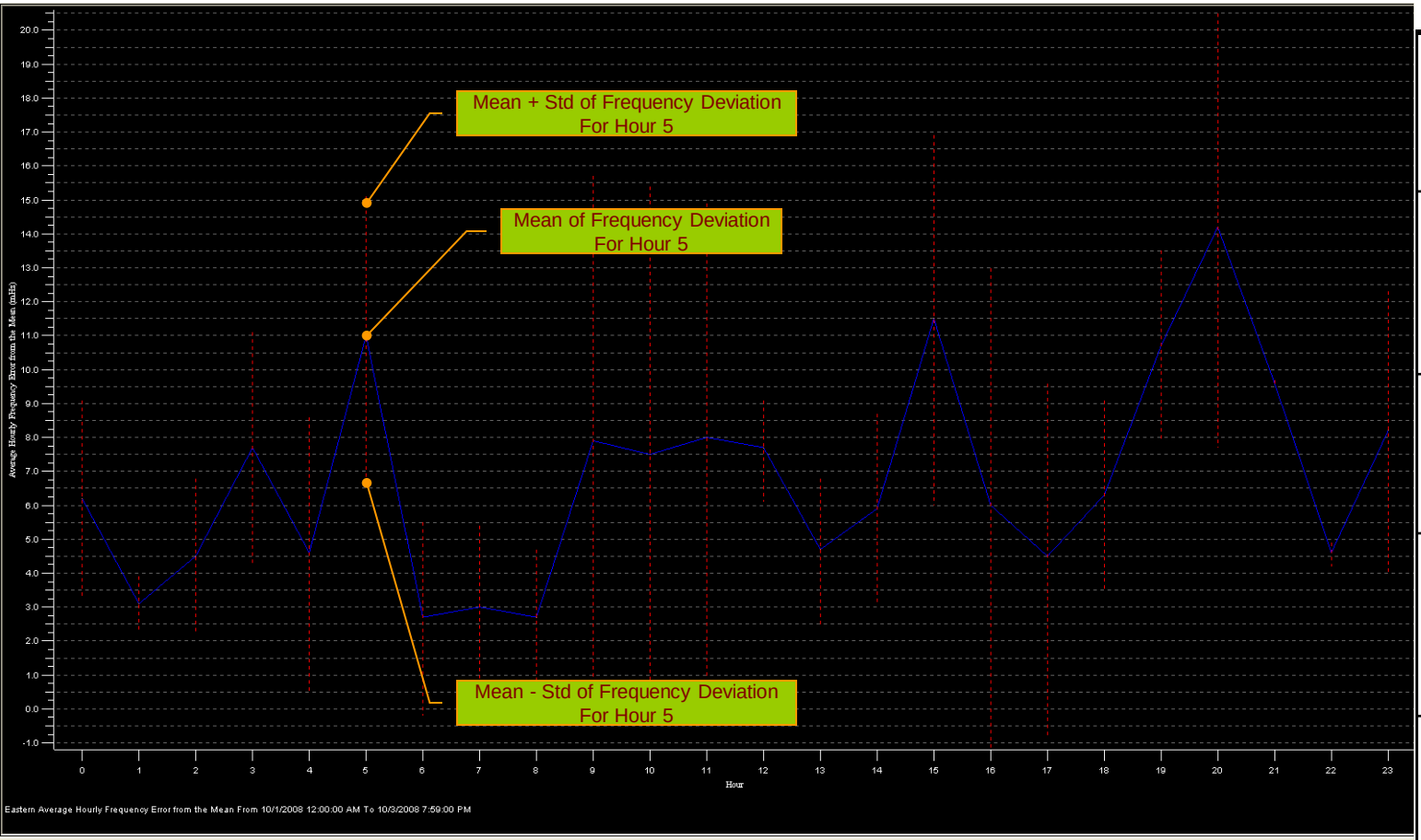


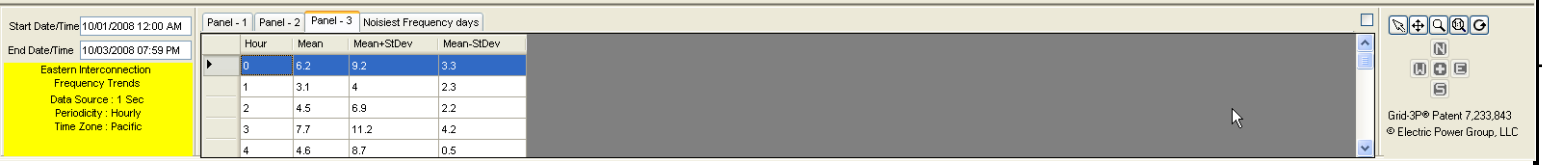
Date_Time	Freq_Dev_RMS1	Freq_Dev_RMS10	Freq_Dev_RMS60	RT_Freq_Dev_RMS1	RT_Freq_Dev_RMS10	RT_Freq_Dev_RMS60
10/1/2008 12:00:00 AM	10	7	7			
10/1/2008 1:00:00 AM	13	8	4			
10/1/2008 2:00:00 AM	13	8	3			
10/1/2008 3:00:00 AM	24	20	10			
10/1/2008 4:00:00 AM	16	13	0			

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

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

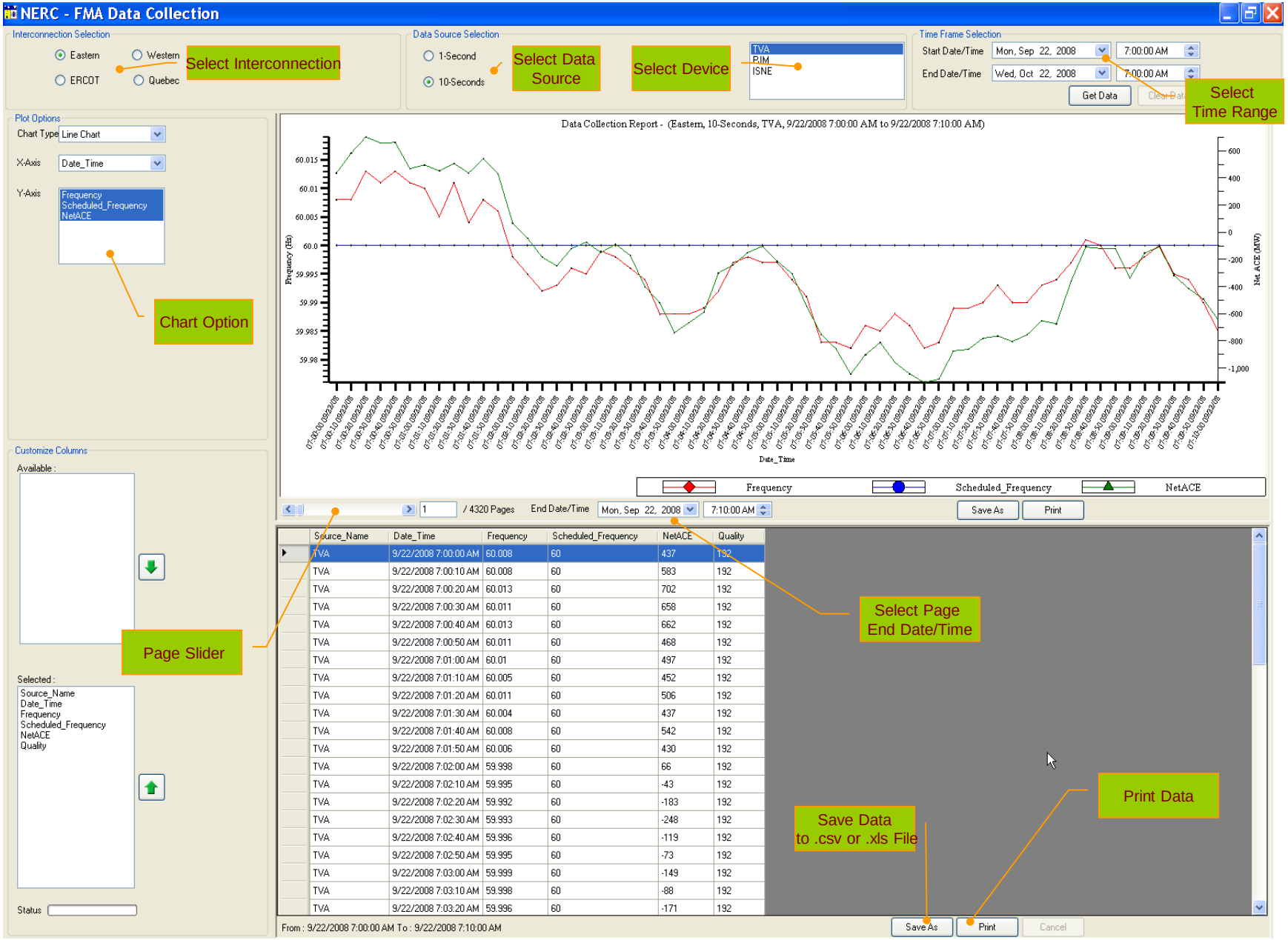




Hourly	**Hourly** Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Daily / Weekday	**Weekday** Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Weekly	**Weekly** Mean, Mean+Std and Mean-Std of Hourly Frequency Deviation
Monthly	**Monthly** Mean, Mean+Std and Mean-Std of Hourly Frequency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

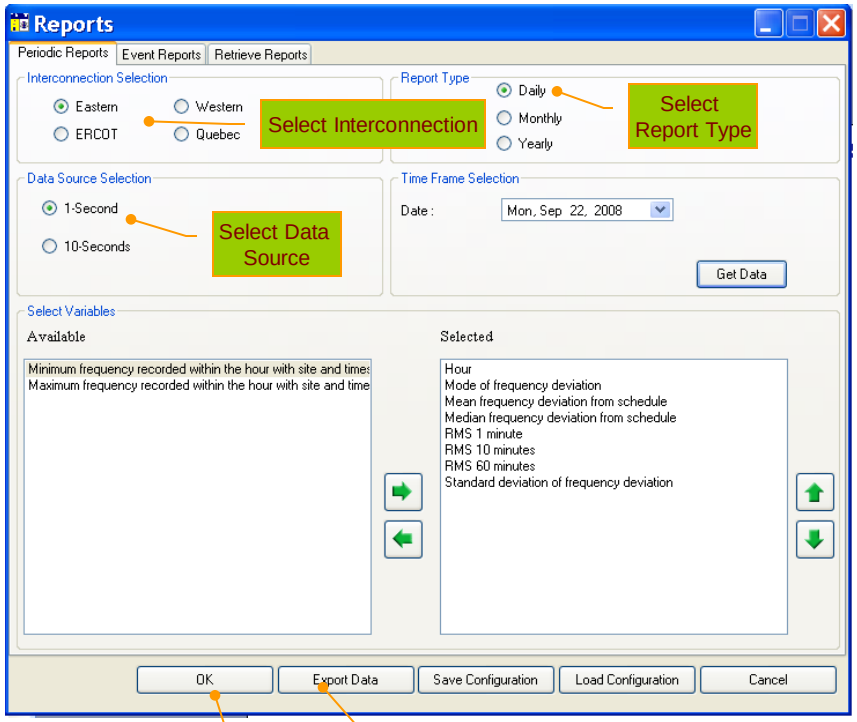
NERC FMA
Data Collection Capability

Data Collection Capability



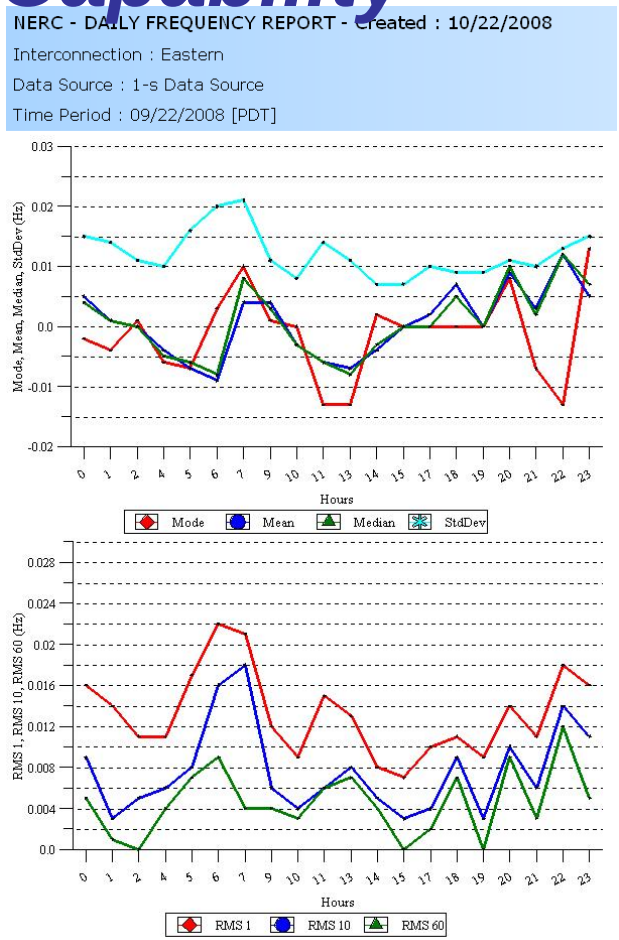
NERC FMA
Reports Overview

Periodic Reports Capability



Save Report to csv or xls File

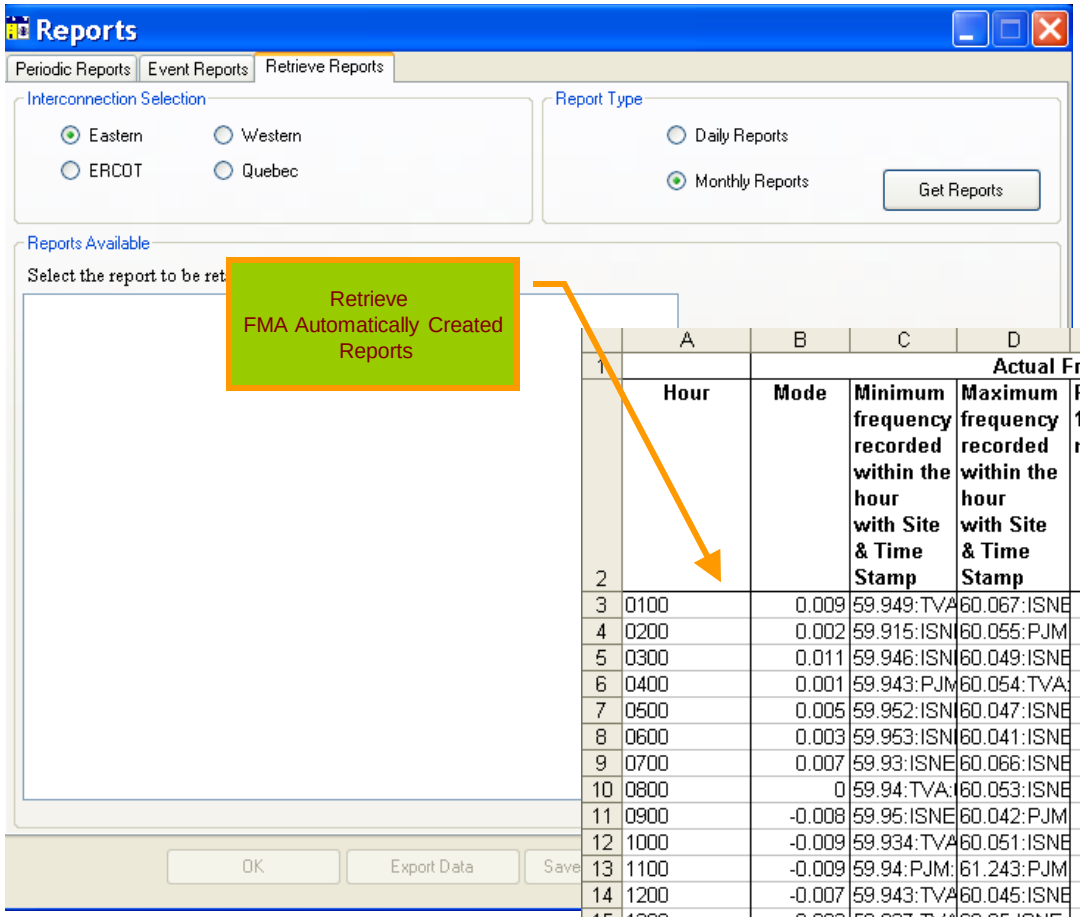
Show Report



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



	A	B	C	D	E	F	G	H	I	J
1		Actual Frequency						Frequency Deviation		
2	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
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	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%
	FARRAGUT-FQ-EI						0%	72%	41%	49%	61%	63%	79%	88%	91%	63%	89%	95%	92%	46%	0%	69%	95%	82%	80%	73%
ERCOT 2-second	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	10/23/2008 2:07:31	10/25/2008 7:15:09	53
8/4/2008 9:12:51	8/5/2008 16:10:19	30	10/25/2008 7:59	11/4/2008 9:59	242
8/13/2008 15:42:21	8/18/2008 5:16:19	109			
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

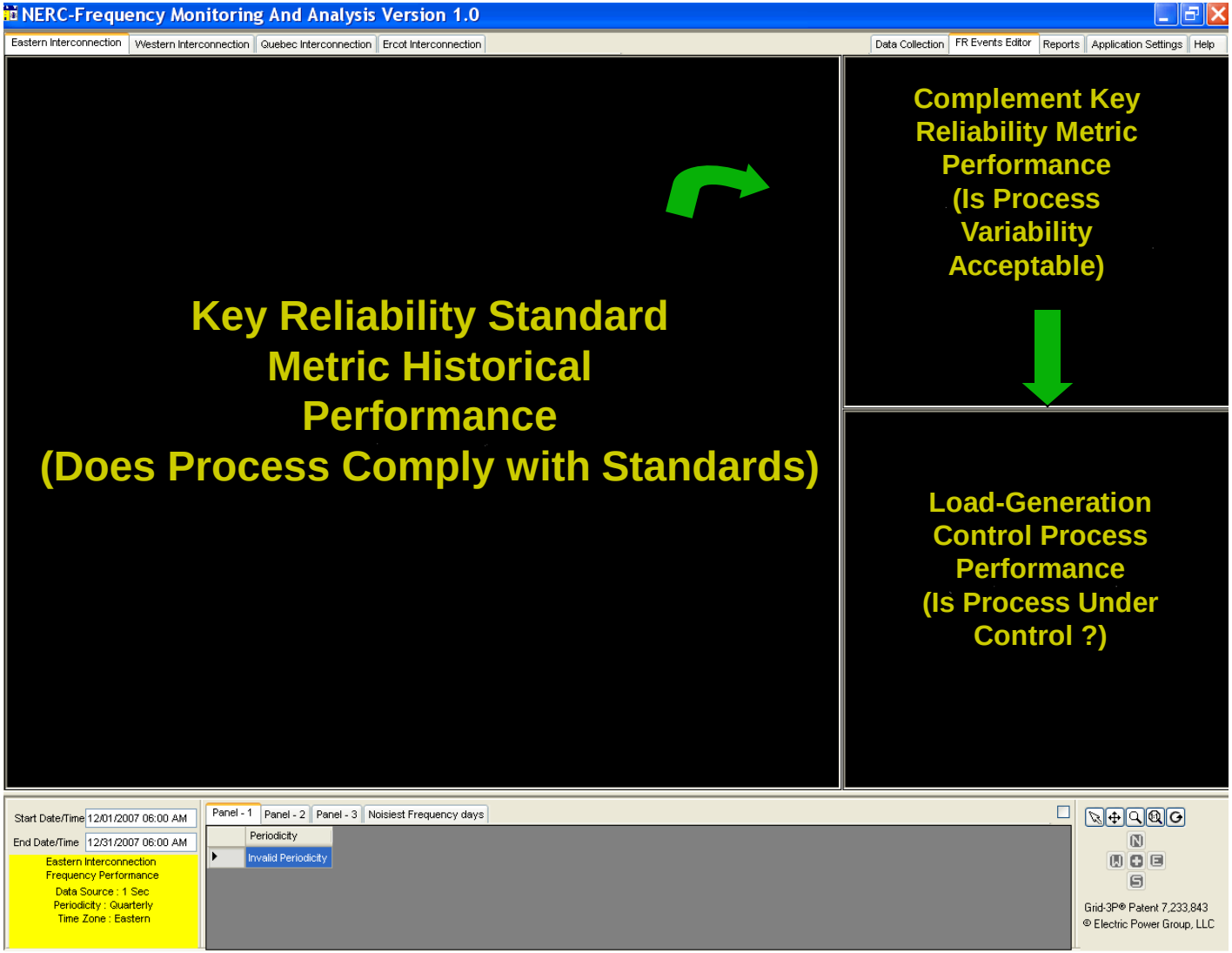
TEC-WI		
2007-05-23 00:00:00.000 ~Current		
Start Datetime	End Datetime	Missing Hours
9/8/2008 1:59	9/10/2008 0:59	47
9/17/2008 18:41	9/19/2008 16:14	45
9/30/2008 18:33	10/2/2008 10:46	40

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

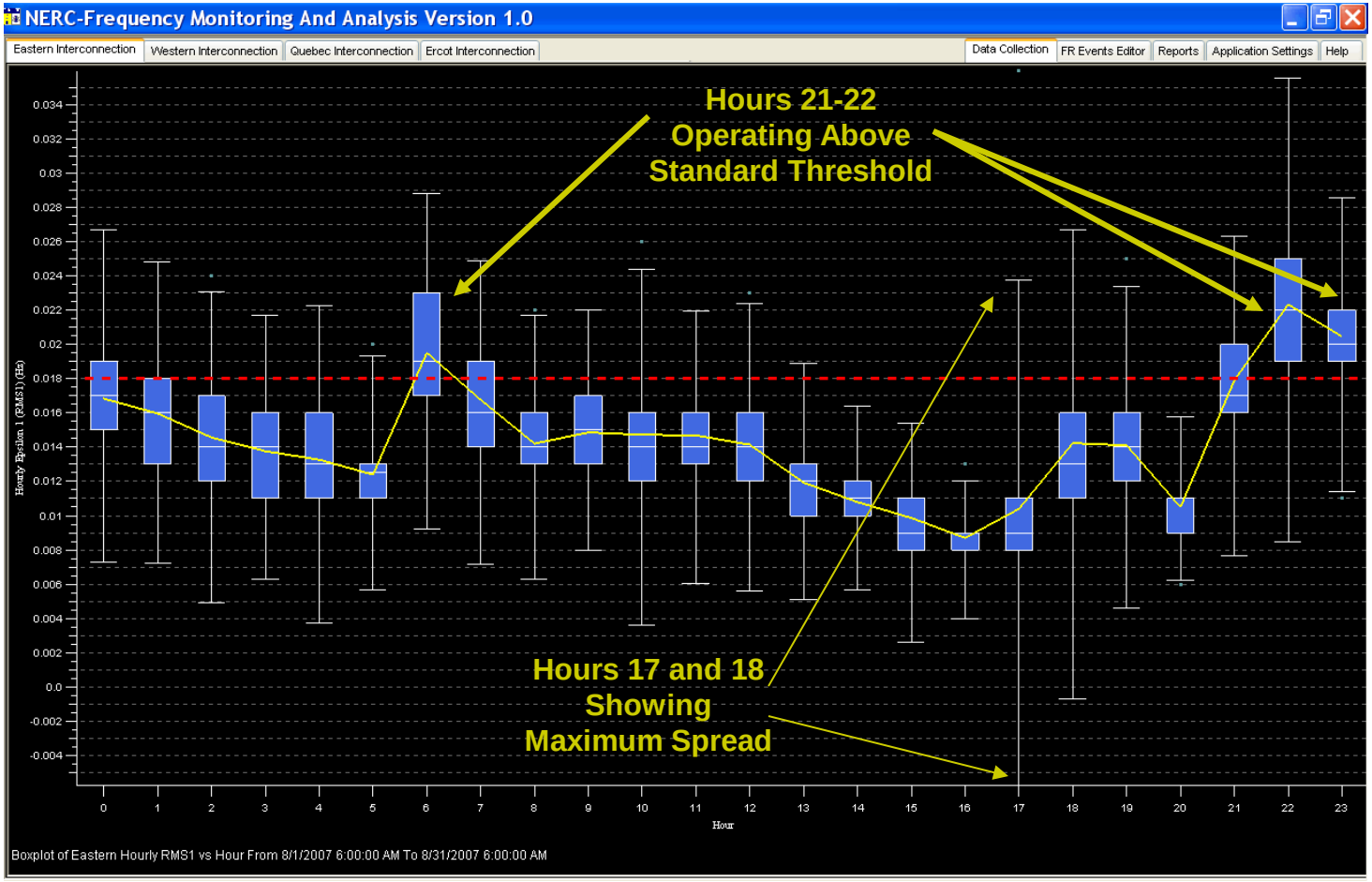


Case Study Description

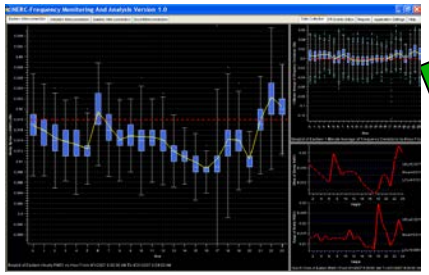
- On August 4, 2007 the Eastern Interconnection frequency reached 59.868 Hz the lowest value in 2007
- The event resulted in a five units outage for a total generation lost of about 4,300 MW with a load of about 500,000 MW
- Recovery of the event fell within the NERC DCS standard requirement of 15-minutes. 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

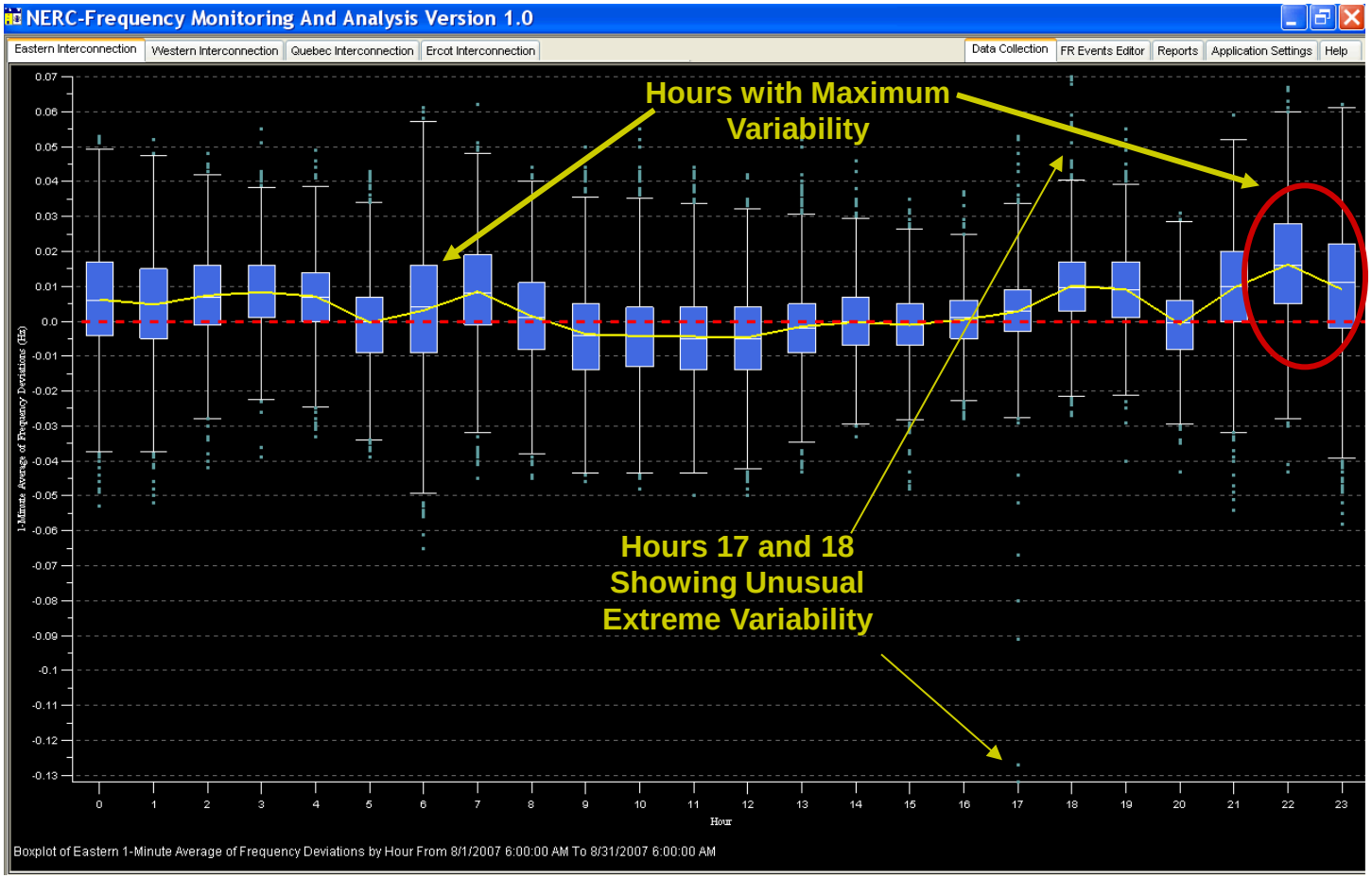
Evaluation of 1-Second Frequency Data Graphs for
Eastern Interconnection August, 2007



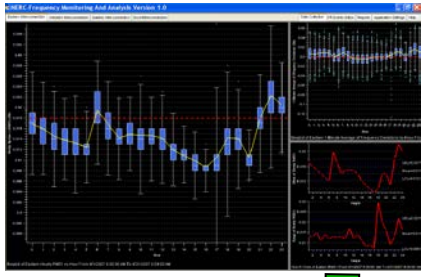
Utilization of FMA for Wide-Area Evaluation of Load-Generation Variability



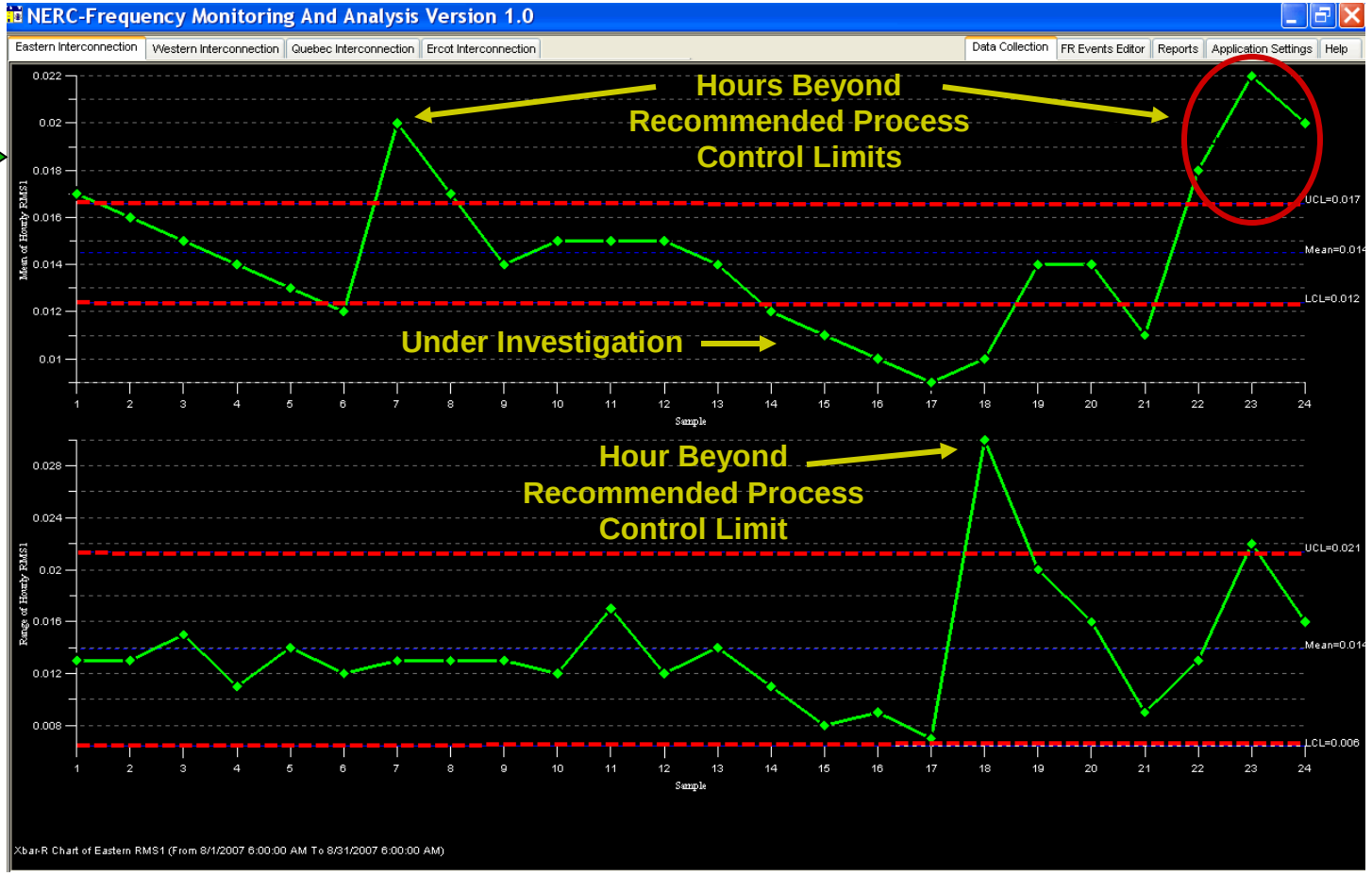
Evaluation of 1-Second Frequency Data Graphs for
Eastern Interconnection August, 2007



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



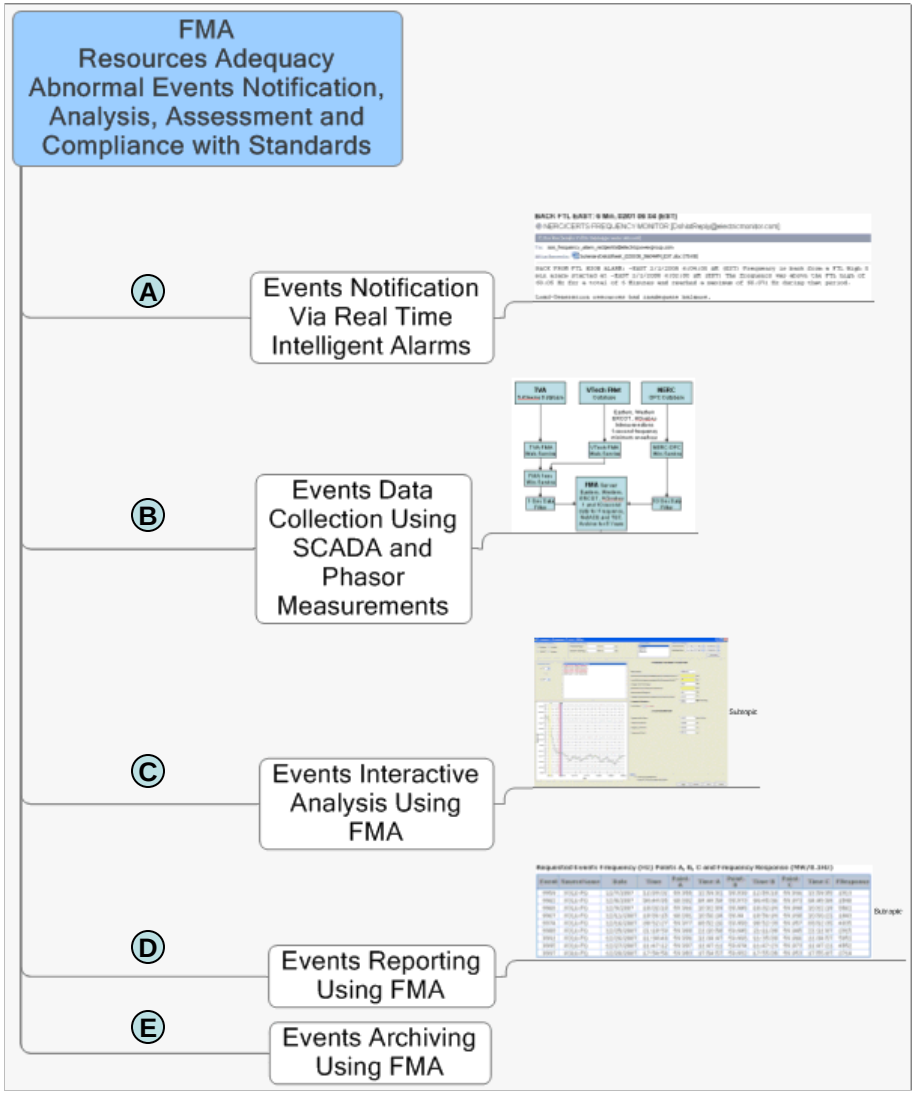
Evaluation of 1-Second Frequency Data Graphs for
Eastern Interconnection August, 2007



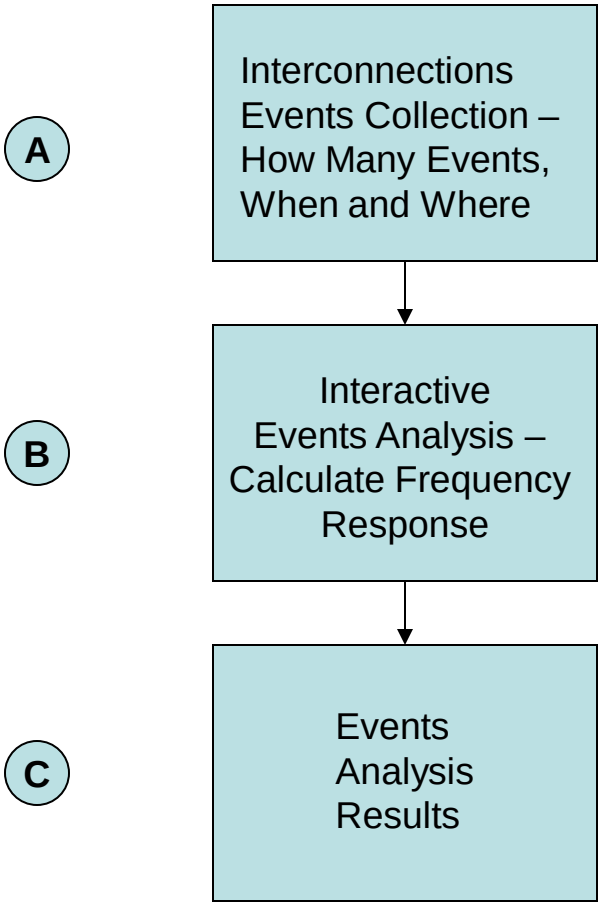
NERC FMA Application
Event Analysis
Function and Visuals

Case Study

Steps for Events Notification and Analysis Using FMA



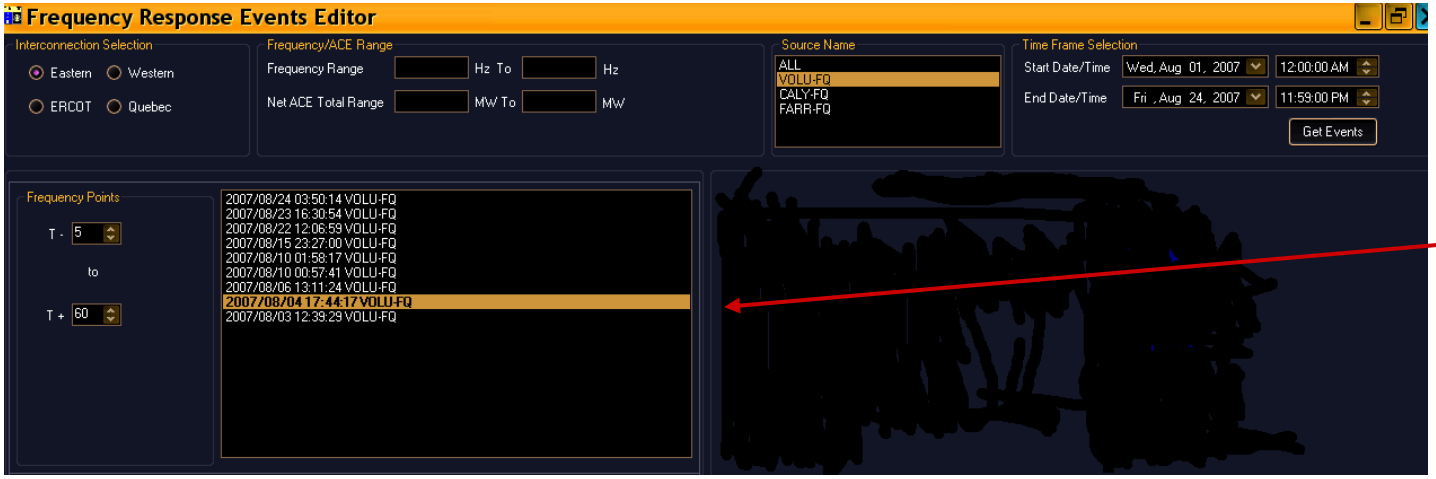
Utilization of FMA for Analysis of Frequency Response During Events - Steps



Utilization of FMA for Analysis of Frequency Response During Events

A

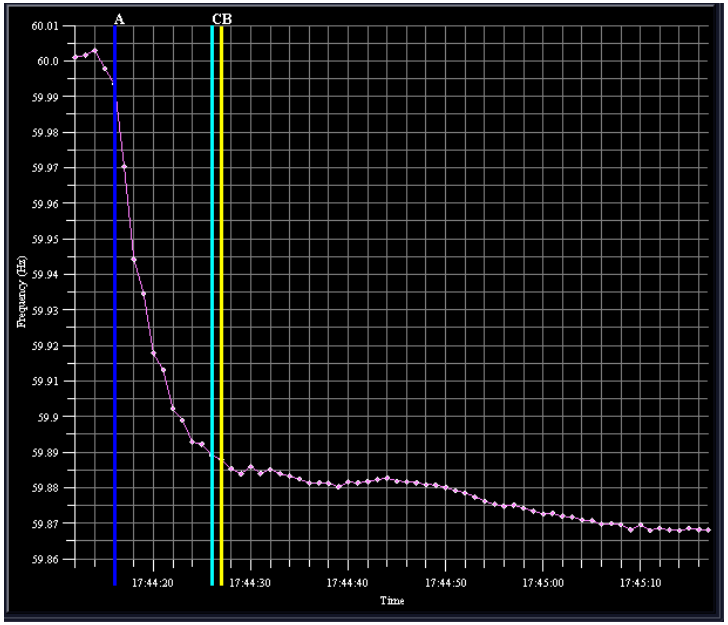
Events Phasor Data Collection

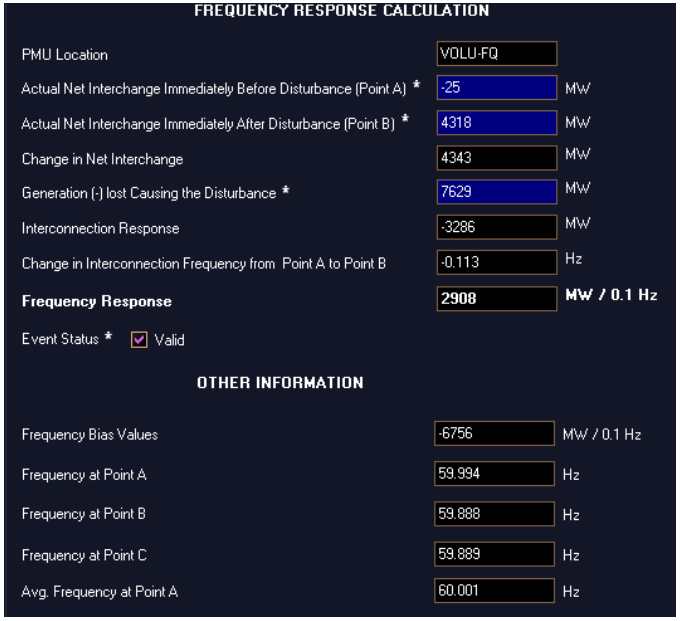


August 2007 Events

B

Interactive Events Analysis





C

Events Frequency Response Results

2908 MW/0.1Hz vs NERC-RS Estimate Of 3000