Frequency Response Analysis Tool (FRAT)

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North American SynchroPhasor Initiative Working Group Meeting
March 23-24, 2015

Frequency Response

FERC defines in RM13-11:

"*Frequency response* is a measure of an Interconnection's ability to stabilize frequency immediately following the sudden loss of generation or load, and is a *critical component of the reliable operation* of the Bulk-Power System, particularly during disturbances and recoveries."

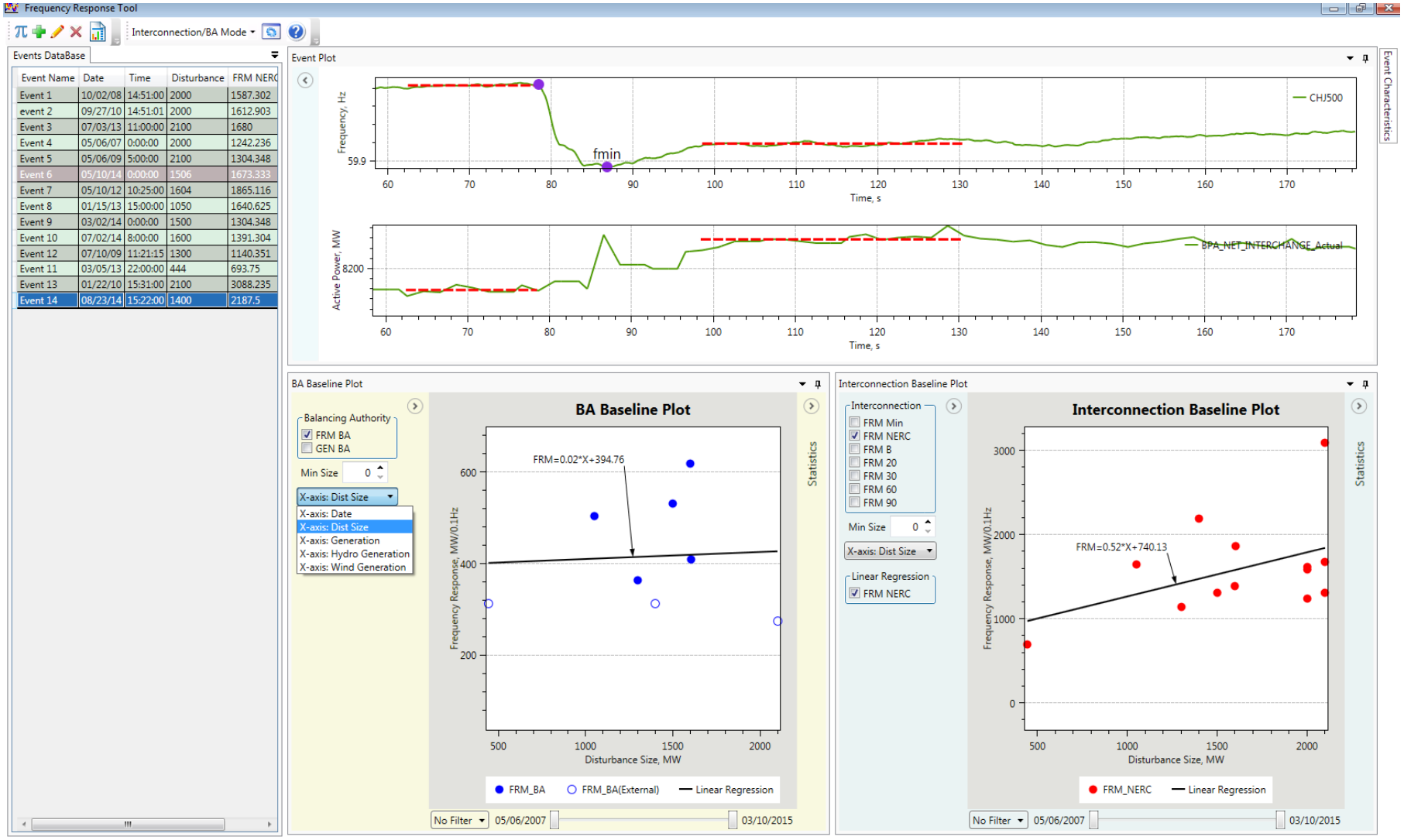
- The frequency response measure (FRM) can be computed from the single event frequency response data (SEFRD).
- FRM is expressed in MW/0.1Hz

Frequency Response Analysis Tool (FRAT)

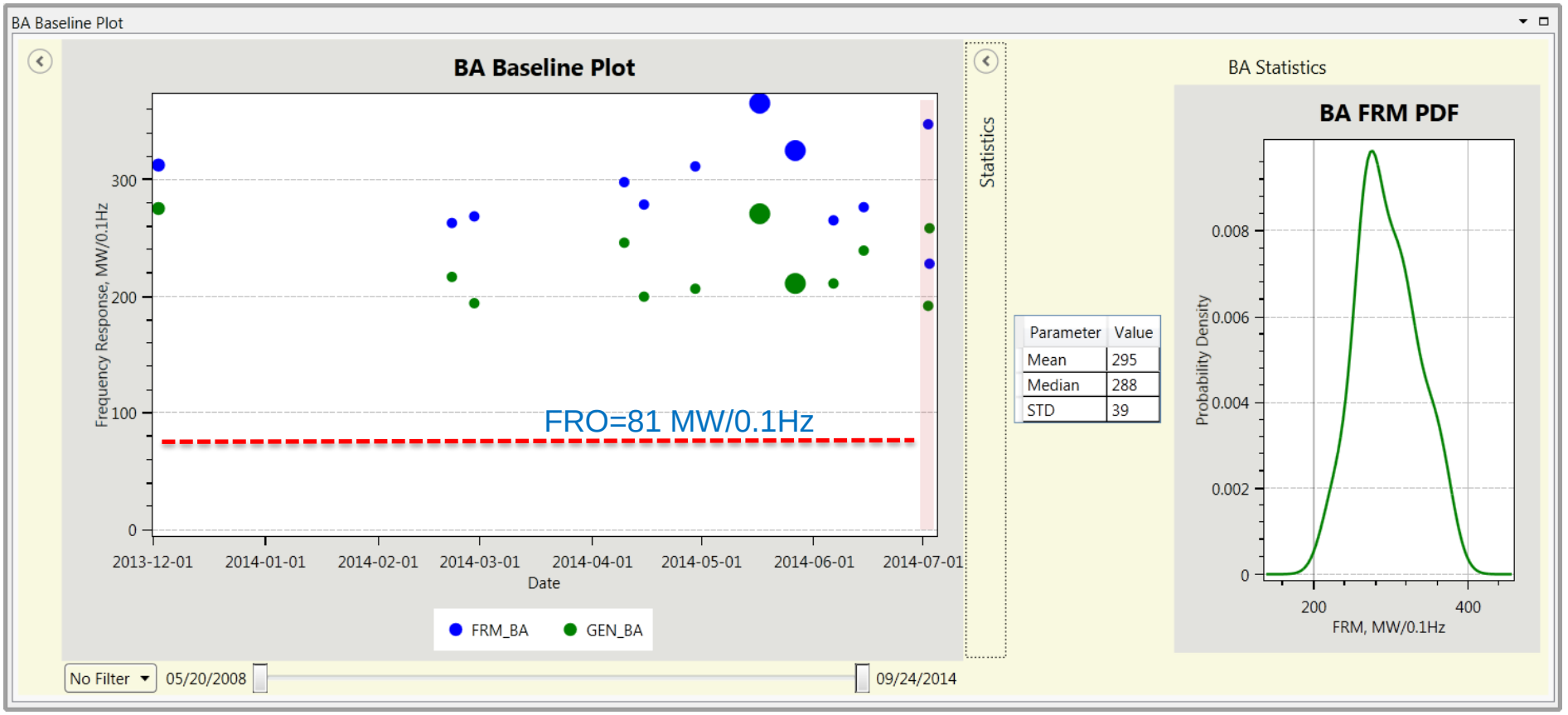
- Developed under BPA guidance by PNNL
- Development is co-funded by US DOE and BPA
- **Frequency response monitoring**
  - **Interconnection**
    - **Balancing Authority**
      - Power Plant (*Under development*)
        - Individual Unit (*Under development*)
- Calculation NERC FRM using PMU and SCADA measurements
- Compliance reporting
- Baselining frequency response for interconnection and BA
- Supporting different data formats (csv, xml, OSIsoft PI, COMTRADE)
- Statistical Analysis

Graphical User Interface

Interconnection and BA Baselining

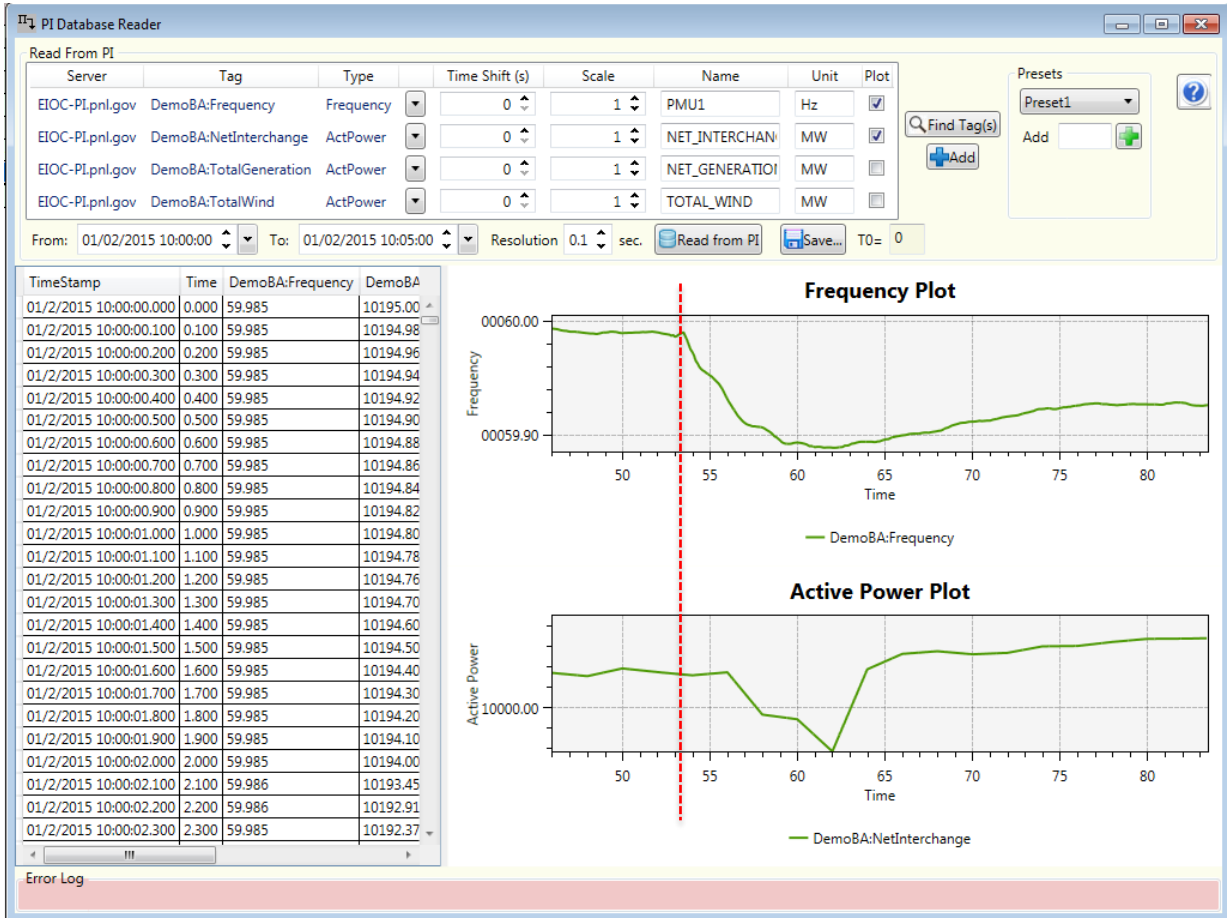


Statistics


BA Baseline Plot
BA Baseline Plot
Frequency Response, MW/0.1Hz
300
200
100
0
2013-12-01
2014-01-01
2014-02-01
2014-03-01
2014-04-01
2014-05-01
2014-06-01
2014-07-01
Date
FRO=81 MW/0.1Hz
FRM_BA
GEN_BA
Statistics
Parameter
Value
Mean
295
Median
288
STD
39
BA Statistics
BA FRM PDF
Probability Density
0.008
0.006
0.004
0.002
0
200
400
FRM, MW/0.1Hz
No Filter
05/20/2008
09/24/2014

OSIsoft PI database support

- Read information from PI server
- Configurable presets
- Time-series aligning



Automated reporting

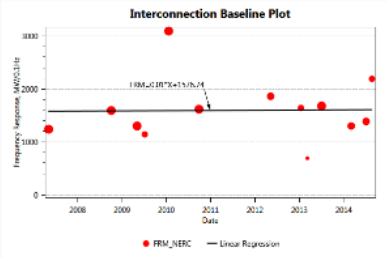
Report

Add Event Plot | FR Report | NERC FRS1

3/10/2015 3:52:38 PM

Frequency Response Analysis Report

Event Name	Event Date	Event Time	Disturbance Size	Load Loss	Time of Load Loss	FRM NERC	FRM BA	Gen Response BA
Event 1	10/2/2008	14:51:00	2000	1000	5	1587.302	0	0
event 2	9/27/2010	14:51:01	2000	444	10	1612.903	0	0
Event 3	7/3/2013	11:00:00	2100			1680	0	0
Event 4	5/6/2007	0:00:00	2000	500	11	1242.236	0	0
Event 5	5/6/2009	5:00:00	2100			1304.348	0	0
Event 6	5/10/2014	0:00:00	1506			1673.333	-216.913	246.667
Event 7	5/10/2012	10:25:00	1604	650	5	1865.116	409.552	260.349
Event 8	1/15/2013	15:00:00	1050	700	5	1640.625	504.166	398.767
Event 9	3/2/2014	0:00:00	1500	100		1304.348	531.81	441.43
Event 10	7/2/2014	8:00:00	1600			1391.304	619.288	529.079
Event 12	7/10/2009	11:21:15	1300			1140.351	363.338	273.039
Event 11	3/5/2013	22:00:00	444			693.75	312.608	213.155
Event 13	1/22/2010	15:31:00	2100			3088.235	274.337	192.643
Event 14	8/23/2014	15:22:00	1400			2187.5	312.336	208.523

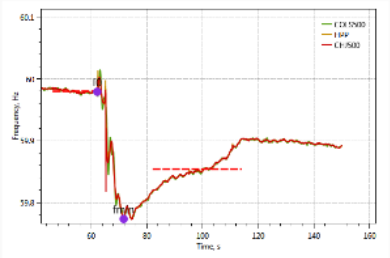


Event1: "Event 1"

Event Characteristics Table

Event Name	Event 1	Event Date	10/2/2008	Event Time	14:51:00
Disturbance Size	2000				
Load Loss	5	Load Loss Size	1000		
Time Initial	62.15	Initial Frequency	59.979		
Frequency point A NERC	59.98	Frequency point B NERC	59.854	FRM NERC	1587.302
Minimum Time	9.517	Minimum Frequency	59.773	FRM Min	485.437

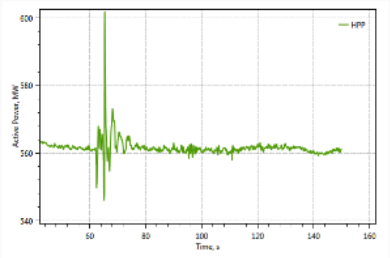
Frequency Plot

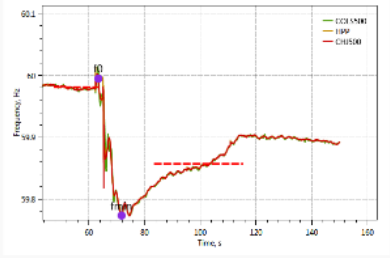


Time Initial	63.363	Initial Frequency	59.995		
Frequency point A NERC	59.981	Frequency point B NERC	59.857	FRM NERC	1612.903
Minimum Time	8.304	Minimum Frequency	59.773	FRM Min	900.901

Frequency Plot

Active Power Plot



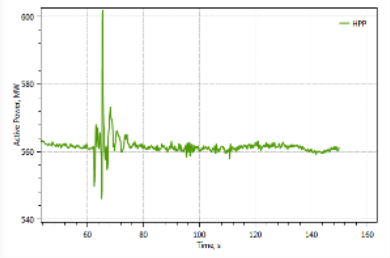


Active Power Plot

Event2: "event 2"

Event Characteristics Table

Event Name	event 2	Event Date	9/27/2010	Event Time	14:51:01
Disturbance Size	2000				
Load Loss	10	Load Loss Size	444		



1 of 10

Power Plant Performance (under development)

FRAT web page

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