

Performance Assessment for Primary Frequency Response Update

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PFRSTF
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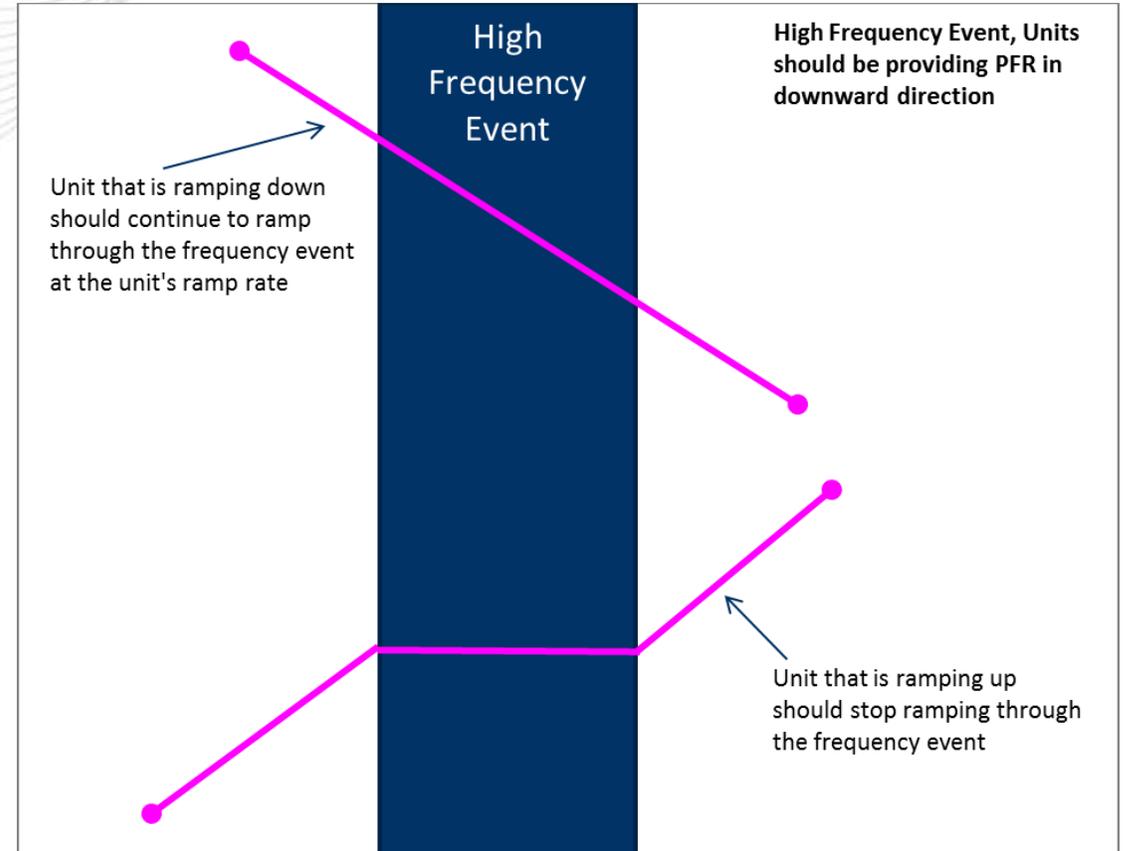
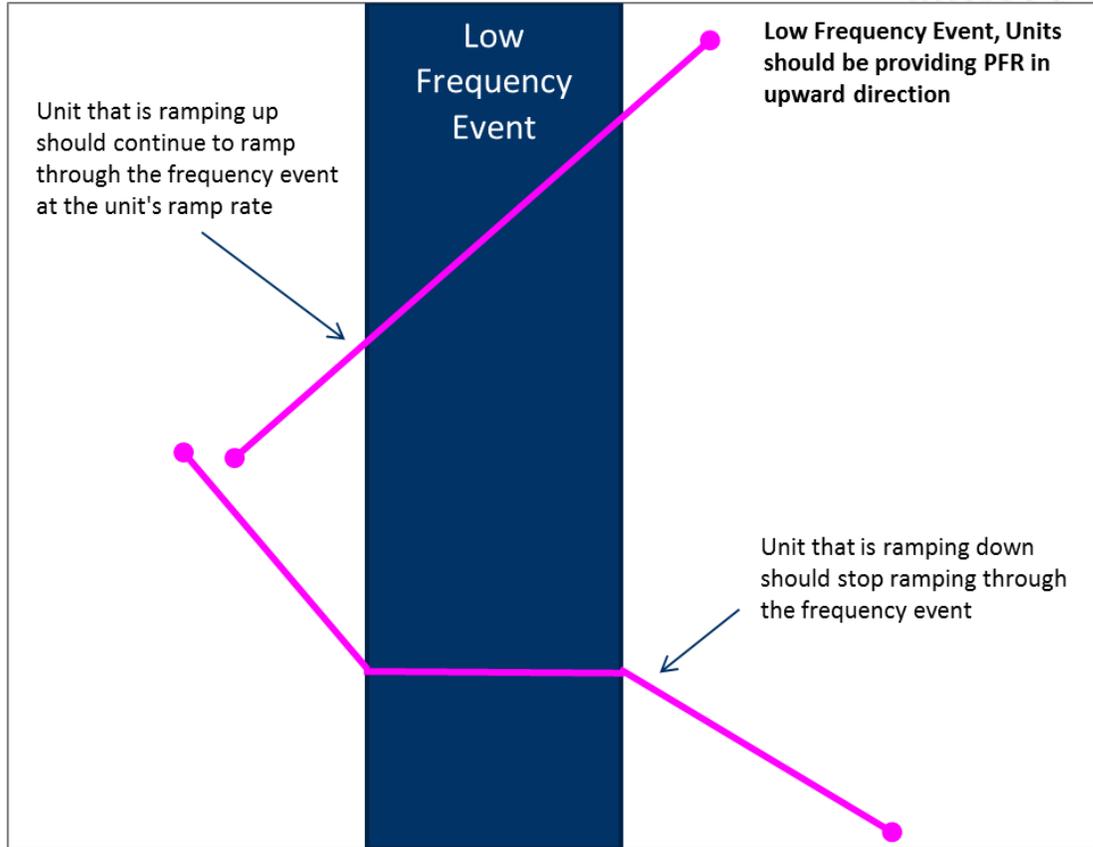


- PJM will reserve the right to perform performance assessment between 20-30 times a year
 - PJM will aim to find 2-3 frequency events per month for performance assessments, however system conditions may provide less opportunities
 - no set number of events will be prescribed
 - Events selected will be ‘clean’ frequency excursions where frequency went outside the deadband and engaged governors
 - Frequency outside $\pm 40\text{mHz}$
 - Frequency stays outside of deadband for 60 seconds
 - PJM will aim to select events in both directions
 - Events with high frequency (above 60.04) and events with low frequency (below 59.96)

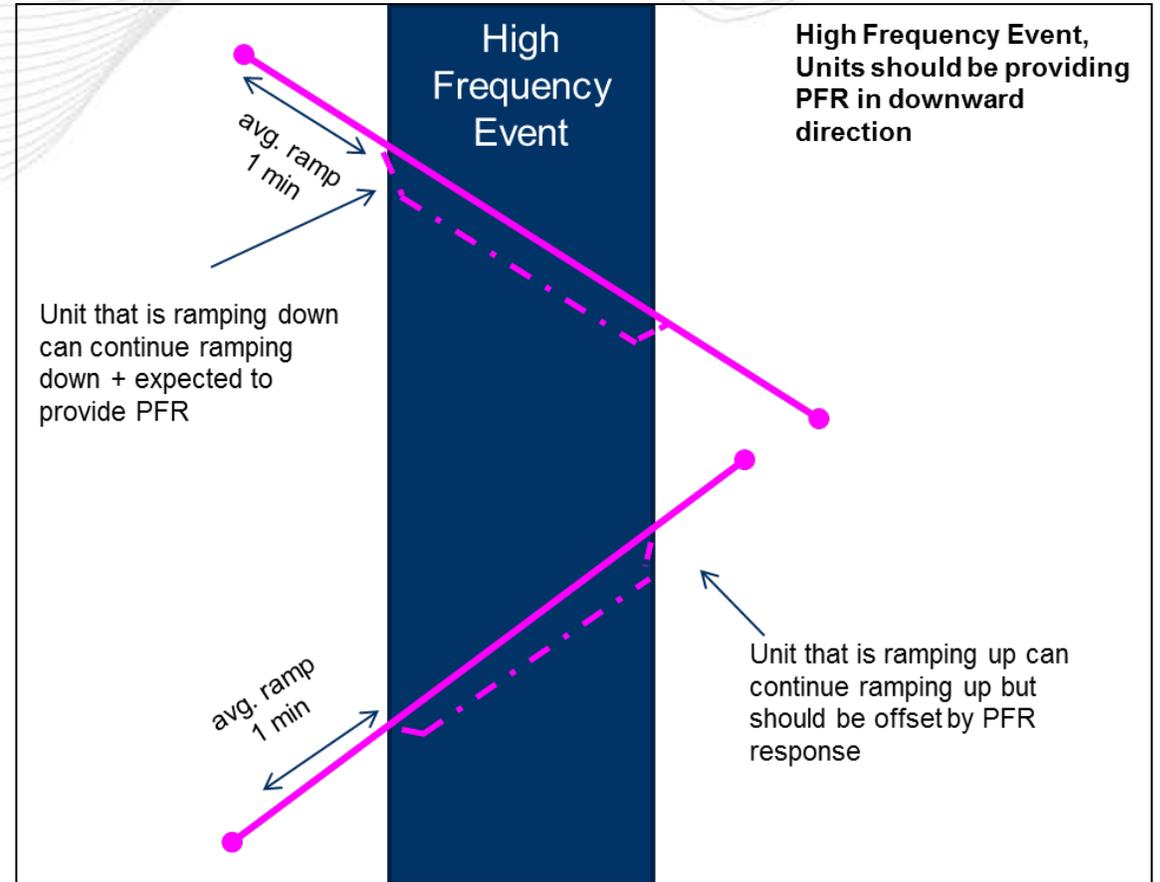
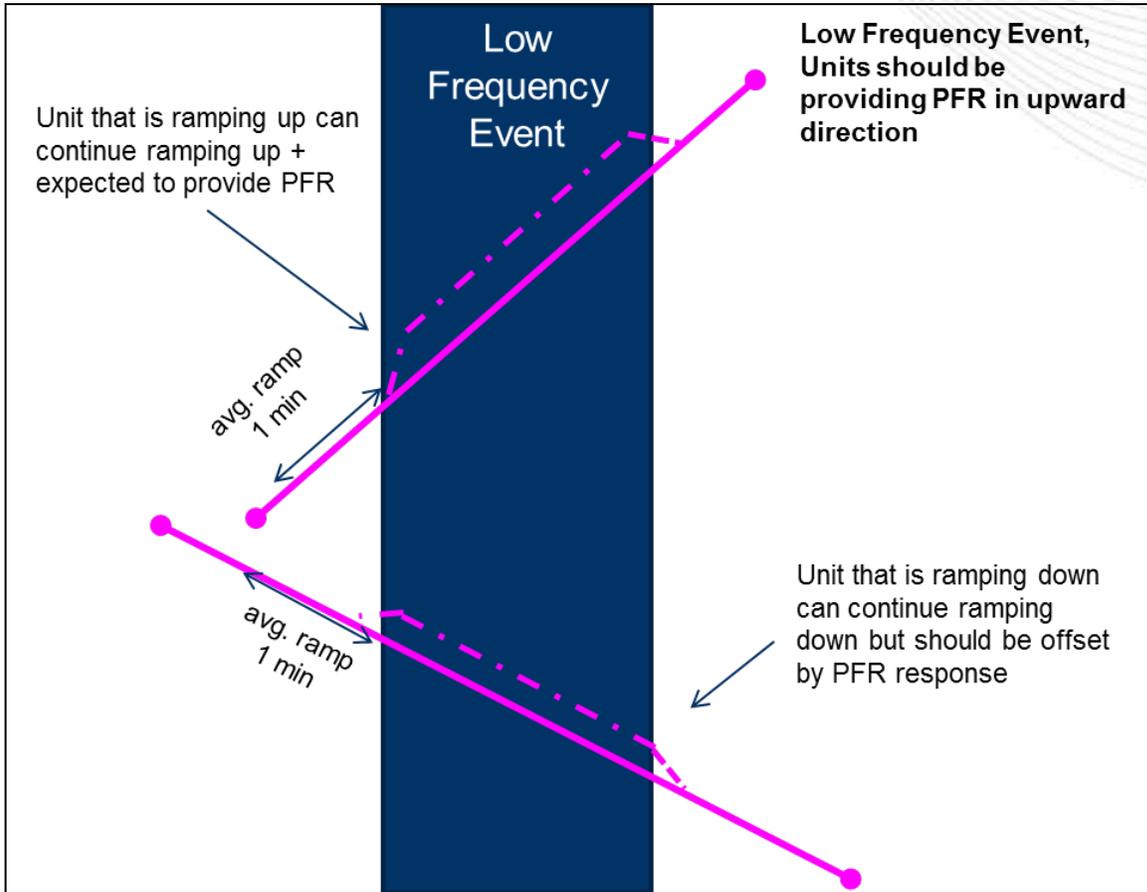
- Scoring will be evaluated as average performance over 12 month window
 - Pass/Fail assessment will be down on a quarterly basis looks at a 12 month rolling window
 - Resources will need a minimum of 6 events for quarterly assessment
 - PJM will look back further than 12 months if needed for 6 events
 - Each event will be evaluated separately and then performance will be average for pass/fail determination
 - 50% or greater average performance will be considered passing
 - Events for which a resource is evaluated will be determined on if the unit was expected to respond during the selected events
 - Headroom, Online, Regulation status, etc

- Units will be measured on the droop and dead band PJM has documented
 - Initial verification will be performed
 - Default parameters will be set to 5% droop and 36mHz dead band
- Units without RT telemetry (per M-01)
 - Performance Assessment will not be performed with RT data
 - Required to submit data from a selected event or test results to demonstrate frequency response capability at least 1x per year.

- When will performance assessments start?
 - The requirement to have Frequency Response capability would not be effective for 2 years after approval which is when “official” assessments will begin.
 - As part of the transition, “field trial” performance assessments will begin shortly after approval and results will be shared with unit owners.
 - This will allow for time to work out any data discrepancies.



Expected Response = Unit Ramp Rate when ramping PFR direction, or Unit MW when not ramping PFR direction



$$\text{Actual Response} = (\text{AvgMW}_{20-52\text{sec}} - \text{AvgMW}_{-16-0\text{sec}}) - \text{RampRate MW}_{20-52\text{sec}}$$

Appendix

- Initial Data need to set up performance assessment
 - Additional data for awareness (ex. fuel type, unit zone, etc.)
- EcoMax/SpinMax data coming from Markets Gateway
 - Important this data is accurate
- Droop/Deadband will be set to PJM requirements (5%/36mHz) unless exception documented

Unit Name	Test Unit	
Frequency:	\\DOR\ca_rt_fq\pjmc:freq-agc freq:hz	} Pi Tags for telemetry Data used in performance evaluation
Unit MW:		
Spin Max:		
Econ. BP:		
Governor Settings		
Mode of Operation:	Droop	} Unit's Droop and Deadband settings
Droop (%):	5%	
Deadband (Hz):	0.036	
Econ. Max		
Resource ID:		
Unit Zone:		
Regulation:		■ If the unit is on for Reg
Current Econ. Max		} Used to calculate headroom
Current Spin Max		
RPM Installed Capacity:		
Status:	Available	■ Unit Status
Fuel Type		

- Data is collected from 1 minute before the event T0 to 5 minutes after the event
 - Frequency, Unit Output, Spin Max, and EcoBP are all collected data
 - FR Capacity is a headroom calculation (EcoMax – Unit Output) for low frequency and (Unit Output – EcoMin) for high frequency
 - Droop Coefficient and Expect Response is the calculated response
 - Regulation and Output Before Event used for situational awareness to make sure the performance assessment is done correctly

	Date/Time	Frequency	Unit Output	Spin Max	FR Capacity	Droop Coefficient	Expected Response	EcoBP	Regulation	OUTPUT BEFORE EVENT
17:30:37	05-Dec-15 17:30:37	60.00350189	178.6999969	605	426.300003	1.33%	178.6999969	179	0	178.1999969
17:30:39	05-Dec-15 17:30:39	60.00422668	178.6999969	605	426.300003	1.36%	178.6999969	179		178.1999969
17:30:41	05-Dec-15 17:30:41	60.00427628	178.6999969	605	426.300003	1.36%	178.6999969	179		178.226944
17:30:43	05-Dec-15 17:30:43	60.00301743	178.6999969	605	426.300003	1.32%	178.6999969	179		178.3999939
17:30:45	05-Dec-15 17:30:45	60.00273895	178.6999969	605	426.300003	1.31%	178.6999969	179		178.3999939
17:30:47	05-Dec-15 17:30:47	60.00299835	178.6999969	605	426.300003	1.32%	178.6999969	179		178.3999939

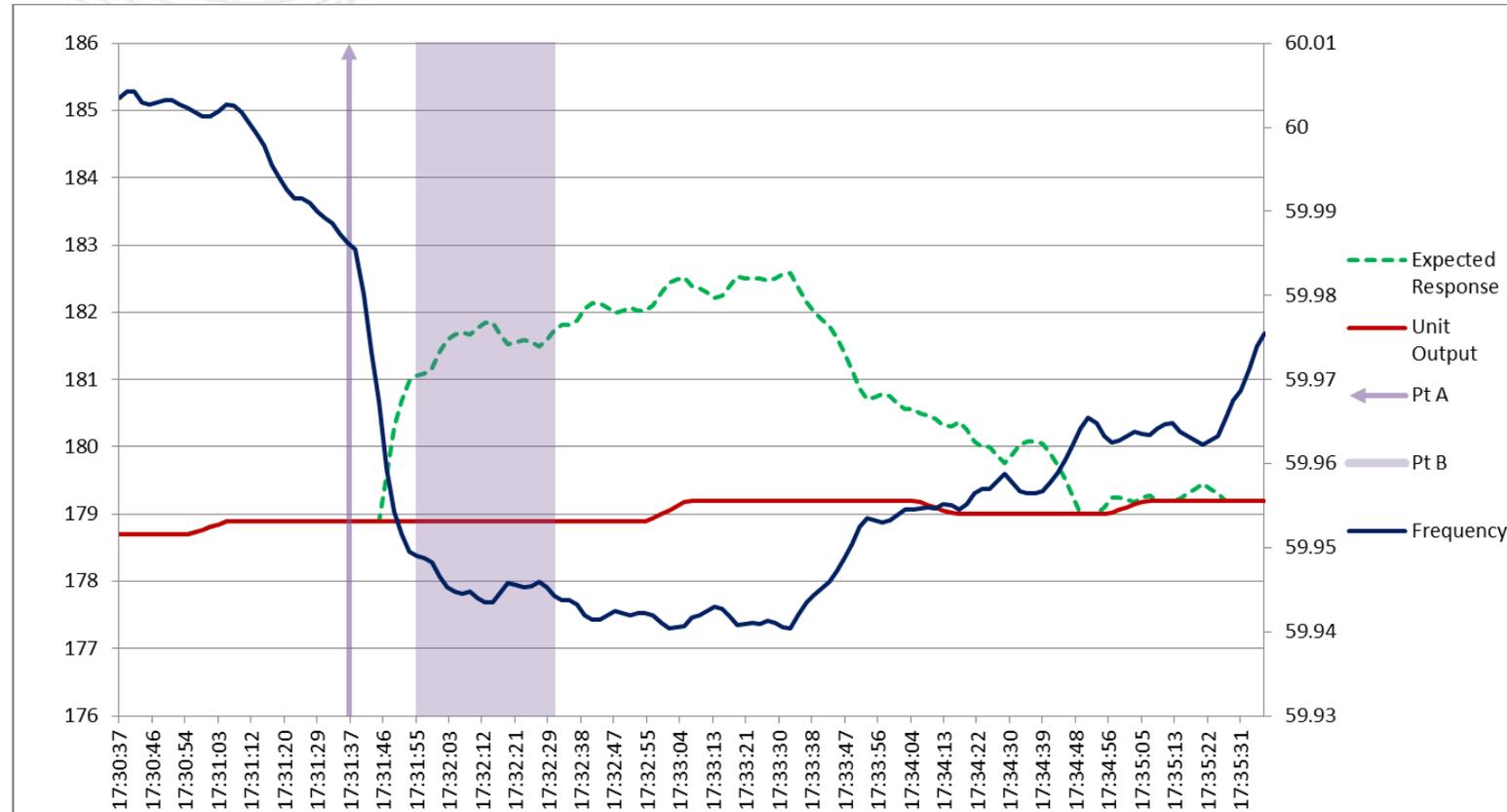
- Two points within the data are calculated to be used in the performance evaluation
 - Expected and Actual response at Point A, measured from -16 to 0sec before the event
 - Expected and Actual response at Point B, measured from 20 to 52 sec after the event

Time	Date	Time	Value 1	Value 2	Value 3	Value 4	Value 5	Value 6
17:31:23	05-Dec-15	17:31:23	59.99150085	178.8999939	605	426.100006	0.93%	
17:31:25	05-Dec-15	17:31:25	59.99150085	178.8999939	605	426.100006	0.93%	
17:31:27	05-Dec-15	17:31:27	59.9910202	178.8999939	605	426.100006	0.91%	
17:31:29	05-Dec-15	17:31:29	59.99001694	178.8999939	605	426.100006	0.88%	
17:31:31	05-Dec-15	17:31:31	59.98925781	178.8999939	605	426.100006	0.85%	
17:31:33	05-Dec-15	17:31:33	59.98851776	178.8999939	605	426.100006	0.83%	
17:31:35	05-Dec-15	17:31:35	59.98727417	178.8999939	605	426.100006	0.79%	
17:31:37	05-Dec-15	17:31:37	59.98625946	178.8999939	605	426.100006	0.75%	
17:31:39	05-Dec-15	17:31:39	59.98551178	178.8999939	605	426.100006	0.73%	
17:31:41	05-Dec-15	17:31:41	59.9801445	178.8999939	605	426.100006	0.54%	
17:31:43	05-Dec-15	17:31:43	59.97330856	178.8999939	605	426.100006	0.31%	
17:31:45	05-Dec-15	17:31:45	59.96741867	178.8999939	605	426.100006	0.12%	
17:31:47	05-Dec-15	17:31:47	59.95941925	178.8999939	605	426.100006	-0.15%	
17:31:49	05-Dec-15	17:31:49	59.95429611	178.8999939	605	426.100006	-0.33%	
17:31:51	05-Dec-15	17:31:51	59.95155334	178.8999939	605	426.100006	-0.42%	
17:31:53	05-Dec-15	17:31:53	59.9495163	178.8999939	605	426.100006	-0.49%	
17:31:55	05-Dec-15	17:31:55	59.94900131	178.8999939	605	426.100006	-0.51%	
17:31:57	05-Dec-15	17:31:57	59.94875717	178.8999939	605	426.100006	-0.51%	
17:31:59	05-Dec-15	17:31:59	59.94825745	178.8999939	605	426.100006	-0.53%	
17:32:01	05-Dec-15	17:32:01	59.94653702	178.8999939	605	426.100006	-0.59%	
17:32:03	05-Dec-15	17:32:03	59.94524384	178.8999939	605	426.100006	-0.63%	
17:32:05	05-Dec-15	17:32:05	59.94477463	178.8999939	605	426.100006	-0.65%	
17:32:07	05-Dec-15	17:32:07	59.9444809	178.8999939	605	426.100006	-0.66%	
17:32:09	05-Dec-15	17:32:09	59.94475937	178.8999939	605	426.100006	-0.65%	
17:32:11	05-Dec-15	17:32:11	59.9440155	178.8999939	605	426.100006	-0.67%	
17:32:13	05-Dec-15	17:32:13	59.94350052	178.8999939	605	426.100006	-0.69%	
17:32:15	05-Dec-15	17:32:15	59.94350052	178.8999939	605	426.100006	-0.69%	
17:32:17	05-Dec-15	17:32:17	59.94470978	178.8999939	605	426.100006	-0.65%	
17:32:19	05-Dec-15	17:32:19	59.945755	178.8999939	605	426.100006	-0.62%	
17:32:21	05-Dec-15	17:32:21	59.94549942	178.8999939	605	426.100006	-0.62%	
17:32:23	05-Dec-15	17:32:23	59.94525909	178.8999939	605	426.100006	-0.63%	
17:32:25	05-Dec-15	17:32:25	59.94548416	178.8999939	605	426.100006	-0.62%	
17:32:27	05-Dec-15	17:32:27	59.94599915	178.8999939	605	426.100006	-0.61%	
17:32:29	05-Dec-15	17:32:29	59.94527054	178.8999939	605	426.100006	-0.63%	

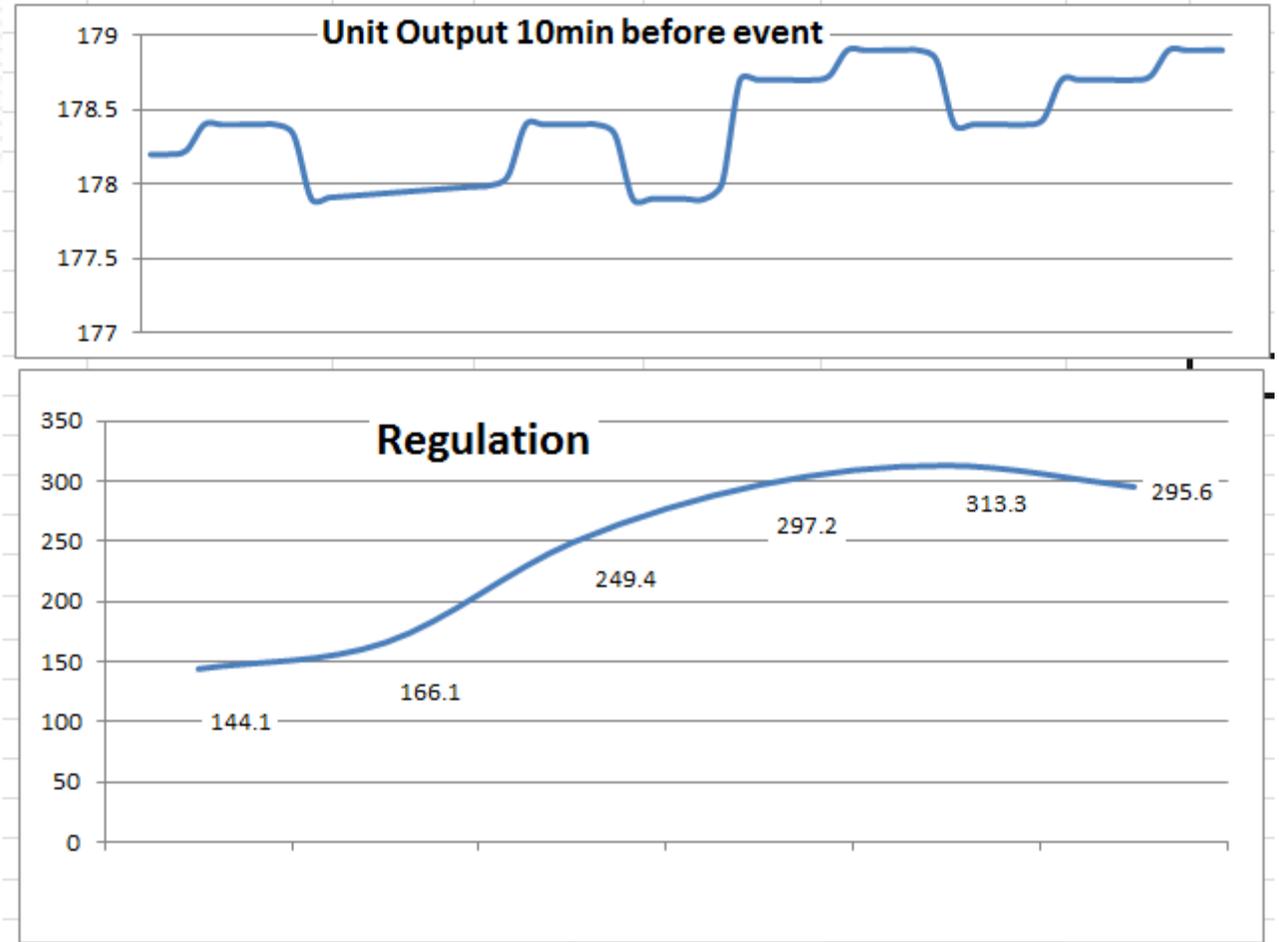
Expected Actual Point A
178.9 178.9

Point B
181.6 178.9

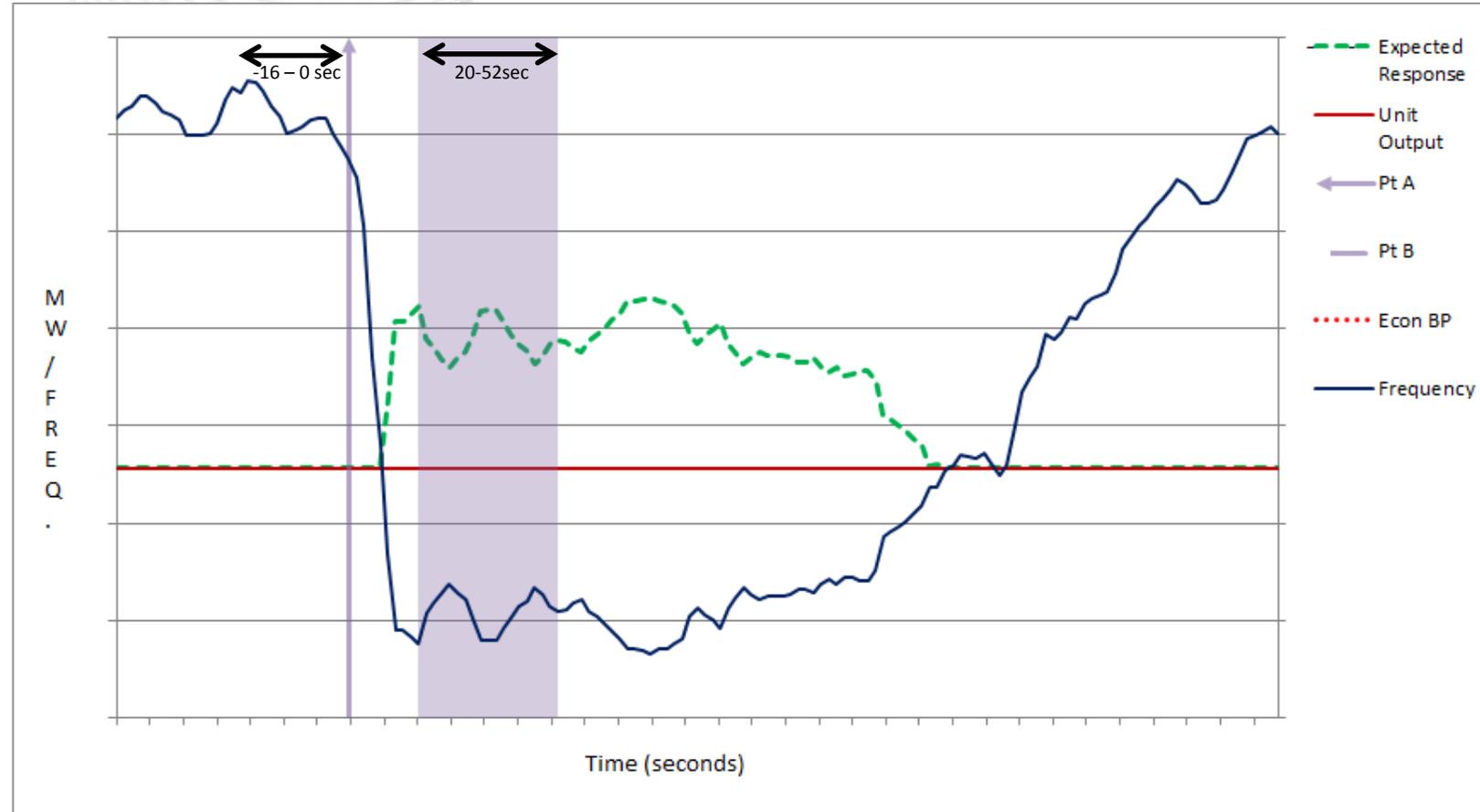
- The full set of data is graphed
 - Event Data: Frequency Profile and Point A and Point B of the event
 - Unit Data: Unit output and Expected response



- The addition data is also graphed
 - Unit Output 10min before the event shows the unit behavior before the event (ramping, etc.)
 - Regulation graph shows if the unit was providing regulation during the event time period



- Example Data
- Low Frequency Event
- No requested ramping, unit will be evaluated on droop characteristics
- Evaluation done on average actual output at 20-52 sec AFTER frequency event compared to average expected output 20-52 sec AFTER frequency event
 - **Expected response= average MW of green dotted curve in purple band**



- Resources expected performance will be calculated with the primary frequency control calculation

- Frequency below governor deadband

$$MW_{PrimaryControl} = \left[\frac{(HZ_{actual} - 60 + DB)}{(60 * Droop - DB)} \right] * (FrequencyResponsiveCapacity) * (-1)$$

- Frequency above governor deadband

$$MW_{PrimaryControl} = \left[\frac{(HZ_{actual} - 60 - DB)}{(60 * Droop - DB)} \right] * (FrequencyResponsiveCapacity) * (-1)$$

- 36mHz deadband (or less), 5% droop (or less)

- Calculation will be performed with 36mHz and 5% droop unless different settings are communicated to PJM

Frequency Profile Nov 2016 – Oct 2017

