Performance Assessment for Primary Frequency Response Update

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When will assessment take place?

- 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 outsides +/- 40mHz
    - 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)
Pass/Fail Assessment

• 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
Additional Considerations

• 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.
Unit Ramping and PFR - Option 1

Expected Response = Unit Ramp Rate when ramping PFR direction, or Unit MW when not ramping PFR direction
Unit Ramping and PFR- Option 2

Actual Response = (AvgMW_{20-52sec} – AvgMW_{-16-0sec}) - RampRate MW_{20-52sec}
Tool Overview- Setup & Initial Information

- 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
Tool Overview - Data Collection

• 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

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Frequency</th>
<th>Unit Output</th>
<th>Spin Max</th>
<th>FR Capacity</th>
<th>Droop Coefficient</th>
<th>Expected Response</th>
<th>EcoBP</th>
<th>Regulation</th>
<th>Output Before Event</th>
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<td>60.00350189</td>
<td>178.6999909</td>
<td>605</td>
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<td>1.33%</td>
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<td>178.3999939</td>
</tr>
</tbody>
</table>
Tool Overview- Point A and B Calculation

- 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 0 sec before the event
  - Expected and Actual response at Point B, measured from 20 to 52 sec after the event
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 Response

- 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
    \[ MW_{PrimaryControl} = \left( \frac{HZ_{actual} - 60 + DB}{60 \times Droop - DB} \right) \times (FrequencyResponsiveCapacity) \times (-1) \]
  – Frequency above governor deadband
    \[ MW_{PrimaryControl} = \left( \frac{HZ_{actual} - 60 - DB}{60 \times Droop - DB} \right) \times (FrequencyResponsiveCapacity) \times (-1) \]
  – 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

- x > 5 minutes: 8
- 5 min > x > 4 min: 7
- 4 min > x > 3 min: 11
- 3 min > x > 2 min: 9
- 2 min > x > 1 min: 37
- 1 min > x > 30 sec: 59
- x < 30 seconds: 156

- Low Freq: 2060
- High Freq: 3525

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