NERC MOD-025-2
Verification and Data Reporting of Generator Real and Reactive Power Capability and Synchronous Condenser Reactive Power Capability

Draft PJM Implementation Plan

SOS
June 25, 2014
Summary

- NERC MOD-025-2 Highlights
- PJM Intent for Proposed M14D Att. E revisions
- PJM implementation plan
- Comparison of PJM M14D Att. E and MOD-025-2
- Common items between MOD-025 and M14D Att. E
- Proposed enhancements to M14D Att. E
- PJM Contacts
• FERC Approved 3/20/14
• Applicable to Generation Owner (GO) or Transmission Owner (TO) that owns synchronous condenser(s)
• NERC effective date 7/1/16 but per the implementation plan, GOs (or TOs) must have 40% of their applicable facilities tested by 7/1/16
• GOs (or TOs) may elect to begin testing to meet this standard as soon as 7/1/14
• Requires “verification only” but in many cases a staged test will be required, including the first “verification” for GO’s (or TO’s) applicable facilities
• Intent is to define the limits of the unit’s Reactive Power capabilities
• Align M14D, Att. E (Generator Reactive Capability Testing Requirements) with NERC MOD-025-2 requirements to meet both the NERC and PJM requirements without requiring separate tests
• Certain differences will remain between M14D, Attachment E and NERC MOD-025-2 to provide continuity with existing PJM requirements and better operational data
• Review comparison and recommendations with RSCS, NGOUG, SOS, OC
  – Jun/July, 2014
• Post Compliance Bulletin
  – July 1, 2014
• Manual M14D revisions
  – Aug/Sept 2014 Committees
# Comparison of PJM M14D Att. E and MOD-025-2

<table>
<thead>
<tr>
<th>Unit size and type</th>
<th>PJM Manual M14D Att. E</th>
<th>MOD-025-2</th>
<th>PJM Recommendations</th>
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<tbody>
<tr>
<td>Individual Units &gt; 70 MW (&quot;nominal capacity&quot;)</td>
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<td>Individual unit &gt; 20 MVA (gross nameplate rating) connected to BES</td>
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</tr>
<tr>
<td>Wind Farms aggregated &gt; 70 MW (&quot;nameplate rating&quot;)</td>
<td>Generating plant/Facility &gt; 75 MVA (gross aggregate nameplate rating) connected to BES</td>
<td>Generating plant/Facility &gt; 75 MVA (gross aggregate nameplate rating) connected to BES – includes variable resources such as wind and solar</td>
<td>Generating plant/Facility &gt; 75 MVA (gross aggregate nameplate rating) – including variable resources such as wind and solar (not limited to BES)</td>
</tr>
</tbody>
</table>
### Comparison of PJM M14D Att. E and MOD-025-2 (continued)

<table>
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<tr>
<td>All black start units</td>
<td>All black start units</td>
<td>Black start units not mentioned</td>
<td>All black start units</td>
</tr>
<tr>
<td>Synchronous condensers not currently included</td>
<td>Synchronous condensers &gt; 20 MVA (gross nameplate) connected to BES</td>
<td>Not applicable to any other units</td>
<td>Synchronous condensers &gt; 20 MVA (gross nameplate) connected to BES</td>
</tr>
<tr>
<td>All units “verify” reactive capability every six months by reviewing eDART “D” curves.</td>
<td></td>
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## Comparison of PJM M14D Att. E and MOD-025-2 (continued)

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<tr>
<td>Max Lagging – 1 hr “at or above demonstrated (MW) capability”</td>
<td>Max Lagging – 1 hr “expected maximum real power output at time of verification”</td>
<td>Max Lagging – 1 hr at “expected maximum real power output at time of verification” (e.g. Economic Maximum)</td>
<td></td>
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<tr>
<td>Max Leading – record data when limit reached “at or above demonstrated (MW) capability”</td>
<td>Max Leading – record data when limit reached at “expected maximum real power output at time of verification”</td>
<td>Max Leading – record data when limit reached at “expected maximum real power output at time of verification” (e.g. Economic Maximum)</td>
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<tr>
<td>No MVAR tests required at “minimum” real power output</td>
<td>Max Lagging and Max Leading at “minimum real power output at which they are expected to operate” – record data when maximum leading and lagging levels are reached</td>
<td>Max Lagging and Max Leading at “minimum real power output at which they are expected to operate” (e.g. Economic Minimum) – record data when maximum leading and lagging levels are reached</td>
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<td>Exception Criteria: Units with hot start time &gt; 8 hr - require a Max Lagging test and a “zero” test only</td>
<td>No exception for these units</td>
<td>Nuclear units - require Max Lagging and Max Leading at expected maximum real power only – no testing at minimum real power output</td>
<td>Eliminate this exception – complete testing required</td>
</tr>
<tr>
<td>Nuclear Units – require a Max Lagging test and a “minimum” MVAR test only – no max lead test</td>
<td>Nuclear units - require Max Lagging and Max Leading at expected maximum real power only – no testing at minimum real power output</td>
<td>Nuclear units - require Max Lagging and Max Leading at expected maximum real power only (e.g. Econ Max) – no testing at minimum real power output</td>
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### Comparison of PJM M14D, Att. E and MOD-025-2 (continued)

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<td>Wind units included (Type 3 &amp; Type 4) – no other variable resources included. Wind units must be operating at 50% or more than wind farm's aggregated nameplate rating. Record data when the Max Lag and Max Lead outputs are achieved.</td>
<td>Variable resources (e.g. wind, solar, run of river hydro) - Record data as soon as the Max Lag limit is reached based on max real power output at time of test. At least 90% of the wind turbines or photovoltaic inverters a site must be on-line during test.</td>
<td>All wind &amp; solar resources - Record data as soon as the Max Lag limit is reached based on max real power output at time of test. At least 90% of the wind turbines or photovoltaic inverters at site must be on-line during test. All hydro resources required to do full test.</td>
<td></td>
</tr>
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<td>Test to within 5% of previously stated limits</td>
<td>Test to within at least 50% of units’ theoretical generator reactive capability curve</td>
<td>For Max Lag test at max real power output (e.g. Econ max) – if tested to within 5% of previously stated limits – no D-curve change required. For all other tests – GOs must update D-curve data in eDART to reflect expected operational reactive capability.</td>
<td></td>
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<td>Frequency of Test/Verification</td>
<td>PJM Manual M14D Att. E</td>
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<td>Once per 5 years. Approximately 20% of assets per year. Complete 100% of resources over a 5 year period</td>
<td>Once per 5 years – no more than 66 months between verifications. Implementation plan requires 40% of applicable GO assets tested by 7/1/16 effective date and remaining tested by 7/1/19 (~20% /yr)</td>
<td>Once per 5 years – no more than 66 months between verifications. Approximately 20% of applicable GO assets per year. Transition plan similar to NERC’s for newly included Facilities</td>
<td>New or changed Facility - test as soon as practical after change</td>
</tr>
<tr>
<td>New or changed Facility - test within 12 months of change</td>
<td>New or changed Facility - test within 6 months of change. (Provide interim eDART D curve data)</td>
<td>New or changed Facility - test within 6 months of change. (Provide interim eDART D curve data)</td>
<td></td>
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<tr>
<td>Test/Verification Scheduling</td>
<td>PJM Manual M14D Att. E</td>
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<td>May 1 – Sept 30, Mon - Fri, 0900 – 1100, other test periods considered depending on system conditions</td>
<td>Time advantageous to demonstrate its reactive capability while TOP takes measures to maintain the plant’s system bus voltage within acceptable tolerance</td>
<td>Max Lag test at max real power output (e.g. Econ max) - May 1 – Sept 30, on peak hours. Other tests - time advantageous to demonstrate reactive capability while TOP and TO take measures to maintain the plant’s system bus voltage within acceptable tolerance</td>
<td></td>
</tr>
<tr>
<td>Test/Verification notification requirements</td>
<td>Proposed testing dates/times should be communicated to PJM Dispatch, PJM Reliability Engineer and TO’s LCC no later than noon 3 business days prior to the test. Reactive test ticket must be submitted via eDART</td>
<td>None specified in standard</td>
<td>Proposed testing dates/times should be communicated to PJM Dispatch, PJM Reliability Engineer and TO’s LCC no later than noon 3 business days prior to the test. Reactive test ticket must be submitted via eDART. If testing to be done in phases separate tickets req’d</td>
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Comparison of PJM M14D Att. E and MOD-025-2 (continued)

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<tr>
<td>Submit data to PJM at <a href="mailto:reactivetesting@pjm.com">reactivetesting@pjm.com</a> within 30 days of test</td>
<td>Submit data to TP within 90 days of verification</td>
<td>Submit data to PJM at <a href="mailto:reactivetesting@pjm.com">reactivetesting@pjm.com</a> within 30 days of test. Refer to slides 19 &amp; 20 for additional details</td>
<td></td>
</tr>
<tr>
<td>Data form requirements</td>
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<tr>
<td>Report data on PJM test form report</td>
<td>Submit Attachment 2 (or a form containing the same information as identified in Attachment 2)</td>
<td>Report data on PJM test form which will include all data listed on MOD-025-2 Attachment 2 and some additional data (e.g. eDART MVAR test ticket number, telemetry location, etc.)</td>
<td></td>
</tr>
</tbody>
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Common items between MOD-025-2 & M14D Att. E

• PJM Recommends no change to the items below:
  – Tests performed with the station auxiliary equipment in normal alignment
  – Tests performed with the unit(s) AVR in automatic mode
  – Tests performed as the TOP and TO take measures to maintain the system voltage at the unit location within acceptable tolerances
  – Engineering estimates and calculations are acceptable if metering equipment is not available at a specific measurement point
  – Operational data is acceptable as long as it meets test requirements (note: for NERC standard initial verification must be done by a staged test)
  – Remarks are to be included in the test forms describing reasons why the test values did not reach the expected unit capability
Testing in phases:

• If portions of the test are completed on separate days (e.g. tests at Econ Min completed on day 1 and tests at Econ Max 90 days later) all test data shall be submitted within 30 days after each portion of the test. Also, updates to eDART D curves shall be made if required. This ensures PJM has most accurate and timely data.

• If portions of the test are completed on separate days, use the earliest of those dates as the test/verification date for record and periodicity purposes.
Proposed enhancements to M14D Att. E (continued)

Elapsed time to complete test sequence:

• All portions of reactive testing on a facility shall be completed within six calendar months after the initial test, otherwise PJM will consider the test unsuccessful and retesting will be required.
  • Provides flexibility in test scheduling
  • Meets desire for tests to be completed under somewhat similar seasonal conditions
  • Meets desire for tests to be completed prior to potential significant changes in unit physical or operational characteristics
  • Meets desire to put in place a finite date to fully complete test requirements
Tracking of tests:

- Starting on or before January 31\textsuperscript{st} 2015 the GO shall submit to PJM a listing of the units successfully tested within the prior five years (including test date).
- Continue to submit to PJM a listing of the units successfully tested within the prior five years (including test date) annually on or before January 31\textsuperscript{st} of each subsequent year.
- On or before January 31\textsuperscript{st} of each year submit a non-binding test schedule for the next four years which includes the applicable unit to be tested and the year the test is proposed to be completed.
PJM Contacts:

- Ray Lee, 610-666-4608, ray.lee@pjm or
- Matthew Nutter, 610-666-4342, matthew.nutter@pjm.com or
- reactivetesting@pjm.com