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1 Introduction

1.1 Purpose
MOD-032, according to the NERC standard, is to “establish consistent modeling data requirements and reporting procedures for development of planning horizon cases necessary to support analysis of the reliability of the interconnected transmission system.” The purpose of this document is to outline the data requirements, schedules, and submission methods so that the various data owners can be compliant with the standard.

1.2 Background
The MOD-032 and MOD-033 standards are focused on system-level modeling and validation. MOD-032 replaces and consolidates MOD-010-0, MOD-011-0, MOD-012-0, MOD-013-0, MOD-014-0, and MOD-015-0.1. It requires various Functional Entities, as data owners, to submit data to their Transmission Planner(s) (TP) and Planning Coordinator(s) (PC). These data owners include Transmission Owners (TO), Load Serving Entities (LSE), and Generation Owners (GO). The data submitted is used to build steady state, dynamics, and short circuit models for various years and scenarios. MOD-033 is a new standard requiring every PC to put into place a process to validate the models for its area.

The latest version of the MOD-032 standard is available here: http://www.nerc.com/pa/Stand/Reliability%20Standards/MOD-032-1.pdf

1.3 Process Overview
PJM is the TP and PC for its region and therefore must develop data requirements, reporting procedures, and schedules for the data owners in its area to provide data to build steady state, dynamics, and short circuit cases. MOD-032 Requirement 1.2.4 states that the data must be submitted at least every 13 months.

The basic process is outlined in Figure 1 below. PJM will reach out using a variety of methods to the individual data owners. The outreach methods are targeted to the specific Functional Entities and will include email, compliance bulletins, and announcements at PJM committees. These announcements will include updated schedules and deadlines, an overview of expectations by Functional Entity, and links to this document.

Data owners will provide data annually and in a timely fashion consistent with that years required schedule. Upon data submission, PJM will review the data and respond to the Functional Entity with any technical concerns. For any data that has associated PJM technical concerns, PJM will follow the procedure in MOD-032 Requirement 3. The Functional Entity will have 90 days to respond with model updates or technical basis for maintaining the data as submitted.
PJM uses a feedback review process that gives Transmission Owners an opportunity to review the data after submission and review by PJM, but before the transmittal to the NERC designee.

<table>
<thead>
<tr>
<th>PJM</th>
<th>Data Owners</th>
<th>PJM</th>
<th>Data Owners</th>
<th>NERC Designee</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Send data request</td>
<td>• Submit topology/Generation/Load Data</td>
<td>• Review Data and use to build models</td>
<td>• Review models</td>
<td>• Build interconnection wide cases</td>
</tr>
<tr>
<td>• Post Compliance Bulletin</td>
<td></td>
<td>• Have data owners review models</td>
<td>• Provide feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1.4 Responsible Entities and expectations

Requirement 2 of MOD-032 requires GOs, TOs, and LSEs to submit steady state, dynamics, and short-circuit data to their TPs and PCs according to the requirements, schedules, and submission methods set out in this document. A brief description of these entities and their responsibilities:

#### 1.4.1 Load Serving Entity

LSEs, according to NERC, secure “energy and transmission service to serve the electrical demand and energy requirements of its end-use customers.” In regards to MOD-032 they will submit their forecasted load for the years and scenarios being developed.

It is expected LSEs will coordinate with their interconnected TO(s) to submit aggregate demand for each scenario listed in section 2.1. For steady state, LSEs are expected to provide aggregate demand at the bus level and location of future load additions. For
dynamics, LSEs are expected to coordinate with TOs to provide load composition and characteristics.

1.4.2 Generator Owner

Generation Owners (GOs), according to NERC are an “entity that owns and maintains generating units.” In regards to MOD-032 they are responsible to submit modeling data for existing and future generating units.

PJM expects GOs to be attentive for announcements at committees and on PJM.com for MOD-032 compliance announcements. To submit MOD-032 data to PJM, they are required to make a “My PJM” log in for pjm.com to annually provide and/or verify the accuracy of data located in Appendix 2. This data will aid in building steady state, dynamics, and short circuit cases. They will also have to provide dynamics files in dyr format.

An online data submission system is currently under development at PJM as of 2Q 2015 and is anticipated to be available for testing by GOs by 4Q 2015 and production prior to July 1, 2016.

1.4.3 Transmission Owner

TOs, according to NERC, are “The entity that owns and maintains transmission facilities.” In regards to MOD-032 they are responsible to submit modeling data for their existing and future transmission assets.

It is expected TOs will submit and coordinate tie and interchange data. They will also submit system topology information using the current Siemens Model on Demand (MOD) production system at PJM such that each scenario listed in section 2.1 can be built. Once the cases are built using MOD the TOs will be expected to review topology for accuracy and provide updates to correct the models. TOs will also be expected to provide data for short circuit case builds. TOs are expected to provide dynamics modeling information for any owned dynamics devices.

2 Deliverables

2.1 Load Flow

The load flow files developed for MOD-032 compliance is built using Siemens PTI PSS/E 33 and Model on Demand v9 software. Transmission Owners are given access to Model On Demand to upload project and profile files to aid in building the case years, seasons, and scenarios as defined by the NERC designee. Upon announcement of a change in the cases to be built, this section will be updated. The current case list developed by the MMWG annually is:

- Year 1 Fall Peak
- Year 1 Spring Light Load
• Year 1 Spring Peak
• Year 1 Shoulder Peak
• Year 1 Summer Peak
• Year 1 Winter Peak
• Year 2 Spring Peak
• Year 2 Summer Peak
• Year 2 Winter Peak
• Year 5 Spring Light Load
• Year 5 Summer Peak
• Year 5 Winter Peak
• Year 10 Summer Peak

For each of these season scenarios, the equipment and generation included in each should be in service by the following dates:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Peak</td>
<td>June 1&lt;sup&gt;st&lt;/sup&gt;</td>
</tr>
<tr>
<td>Winter Peak</td>
<td>January 15&lt;sup&gt;th&lt;/sup&gt;/&lt;sup&gt;(yyyy+1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Light Load</td>
<td>April 1&lt;sup&gt;st&lt;/sup&gt;</td>
</tr>
<tr>
<td>Shoulder Peak</td>
<td>July 15&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spring Peak</td>
<td>April 15&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fall Peak</td>
<td>October 15&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Topological changes modeled if in-service on or before this date in the target model year

• Note that “yyyy” = target model year

**Summer Peak Load (yyyySUM)** — is defined as the summer peak demand with load forecast defined in table B-1 of PJM’s Load Forecast Report, developed by PJM’s Resource Adequacy Planning Department. Topological modeling changes shall be incorporated into the model if they are to go into effect on or before June 1st. Summer interchange schedules should reflect transactions expected to be in place on June 1st. Planned summer maintenance of generation and transmission should be reflected in the operating year case.

**Winter Peak Load (yyyyWIN)** — is defined as the winter peak demand with load forecast defined in table B-2 of PJM’s Load Forecast Report, developed by PJM’s Resource Adequacy Planning Department. Topological modeling changes shall be incorporated into the model if they are to go into effect on or before January 15<sup>th</sup> of the following year (yyyy + 1). Winter interchange schedules should reflect transactions expected to be in place on January 15th. Planned winter maintenance of generation and transmission should be reflected in the operating year case.

**Light Load (yyyySLL)** — is defined as a typical early morning load level, modeling at or near minimum load conditions. Historically for PJM this is 50% of that year’s summer peak load.
as defined in table B-1 of PJM’s Load Forecast Report. Topological modeling changes shall be incorporated into the model if they are to go into effect on or before April 1st. Generation dispatch will be in line with PJM’s historical dispatch during these scenarios. Planned spring maintenance of generation and transmission should be reflected in this case. Summer or appropriate equipment ratings should be used.

Shoulder Peak Load (Summer) (yyyySSH) — is defined as 70% to 80% of summer peak load conditions. Dispatchable and pumped storage hydro units should be modeled consistent with the peak hour of a typical summer day with run-of-river hydro on-line. Generation dispatch and interchange schedules should be commensurate with the experience of the PC during such load periods, not just including firm transactions. Summer or appropriate equipment ratings should be used.

Spring Peak Load (yyyySPR) — is defined as typical spring peak load with load forecast defined in table B-3 of PJM’s Load Forecast Report, developed by PJM’s Resource Adequacy Planning Department. Topological modeling changes shall be incorporated into the model if they are to go into effect on or before April 15th. Pumped storage hydro units should be generally modeled on-line, but not necessarily at full generating capacity (generally not pumping). Dispatchable hydro units should generally be modeled on-line, but not necessarily at maximum generation, and run-of-river hydro should be modeled on-line. Generation dispatch and interchange schedules should be commensurate with the experience of the Regions during such load periods. Planned spring maintenance of generation and transmission should be reflected in this case. Summer or appropriate equipment ratings should be used.

Fall Peak Load (yyyyFAL) — is defined as typical fall peak load conditions with load forecast defined in table B-4 of PJM’s Load Forecast Report, developed by PJM’s Resource Adequacy Planning Department. Topological modeling changes shall be incorporated into the model if they are to go into effect on or before October 15th. Pumped storage hydro units should be generally modeled on-line, but not necessarily at full generating capacity (generally not pumping). Dispatchable hydro units should generally be modeled on-line, but not necessarily at maximum generation, and run-of-river hydro should be modeled on-line. Generation dispatch and interchange schedules should be commensurate with the experience of the Regions during such load periods. Planned fall maintenance of generation and transmission should be reflected in this case. Summer or appropriate equipment ratings should be used.

2.2 Dynamics

The dynamics cases will use the topology developed for the load flow series of cases as outlined above. Generation owners will need to provide generator exciter, governor, power system stabilizer, and protection equipment updates annually. Transmission Owners with dynamic devices will also need to provide PJM with dynamics modeling data.
2.3 Short Circuit

Short Circuit models will be developed in Aspen using input from TOs and GOs. PJM will keep model development in line with the current RTEP development schedule, submission methods, and level of modeling detail defined in PJM Manual 14B. PJM will amend this if deemed necessary.

3 Procedure

3.1 Schedules

Steady State

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Annual Completion Month</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kick off Conference Call</td>
<td>May</td>
<td></td>
</tr>
<tr>
<td>Tie line update</td>
<td>June</td>
<td></td>
</tr>
<tr>
<td>Interchange Update</td>
<td>June</td>
<td></td>
</tr>
<tr>
<td>Build Trial 1 Cases in MOD</td>
<td>June</td>
<td>Cases assembled by PJM in MOD based on latest available base case and project file information and disseminated to TOs by PJM</td>
</tr>
<tr>
<td>Case updates to Trial 1 in MOD</td>
<td>July</td>
<td></td>
</tr>
<tr>
<td>Finalize Tie line and Interchange</td>
<td>July</td>
<td></td>
</tr>
<tr>
<td>Build Trial 2 Cases in MOD</td>
<td>August</td>
<td></td>
</tr>
<tr>
<td>Case updates to Trial 2 in MOD</td>
<td>September</td>
<td></td>
</tr>
<tr>
<td>Build Trial 3 Cases in MOD</td>
<td>September</td>
<td>These cases will have topology, generation, interchange, load, generation dispatch</td>
</tr>
<tr>
<td>Case updates to Trial 3 in MOD</td>
<td>October</td>
<td></td>
</tr>
<tr>
<td>Post Final Cases</td>
<td>October</td>
<td></td>
</tr>
<tr>
<td>Send Cases to NERC designee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Short Circuit

The short circuit schedule presented below keeps with the current RTEP development cycle. The schedule set out by the NERC designee makes this schedule subject to change.
Two year case build

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Annual Completion Month</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send out Trial 1 case</td>
<td>November</td>
<td></td>
</tr>
<tr>
<td>Receive updates</td>
<td>January</td>
<td></td>
</tr>
<tr>
<td>Apply updates</td>
<td>January - March</td>
<td></td>
</tr>
<tr>
<td>Send out Trial 2 case</td>
<td>April</td>
<td></td>
</tr>
<tr>
<td>Finalize Case</td>
<td>May</td>
<td></td>
</tr>
</tbody>
</table>

Five year case build

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Annual Completion Month</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send out Trial 1 case (based on final year 2 case)</td>
<td>June</td>
<td></td>
</tr>
<tr>
<td>Receive and apply updates</td>
<td>June - July</td>
<td></td>
</tr>
<tr>
<td>Finalize Case</td>
<td>August</td>
<td></td>
</tr>
</tbody>
</table>

Generation Owners Data Submittal

Generation Owners are required to submit their data via a web form located on pjm.com at a location that is currently under development and anticipated in-service by 1Q 2016. The required data to be submitted is located in Appendix 2. Along with this data GOs are required to submit excitation, governor, and power system stabilizer. This data is submitted via the pjm.com portal.

For each year, the GO submitter has a window in which to submit data. For the first year, this window will be three months long. Each subsequent year the window will be one month. The reasoning for the initial three month window is twofold. One, the GO will have to complete the full form the first year. In subsequent years only data that has changed will need to be updated in the form. Second, additional time to deal with any issues with the new process has been built in.

Each subsequent year the window will be a month long. For existing generation year to year are expected to be minimal; however, the GO submitter still must log into the web form and verify that the data is still accurate.

For new units coming into service, they will have their information filled out based on the data entered during the queue process. The GO will have to verify the data each year the generator is active.
Year 1

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Window</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Information</td>
<td>May – July 2016</td>
<td>Additional time given for first years submittal</td>
</tr>
</tbody>
</table>

Year 2 – Beyond

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Window</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Information</td>
<td>July</td>
<td></td>
</tr>
</tbody>
</table>

**Transmission Owner Dynamics Submittal**
PJM will maintain a list of dynamics model contacts at its TOs and will request data updates annually. In keeping with the dynamics schedule for the GOs above, this data will be requested to be provided in July. If there are no updates, PJM will need written confirmation.

<table>
<thead>
<tr>
<th>Task</th>
<th>Anticipated Window</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Information</td>
<td>July</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2 Auxiliary data

#### 3.2.1 Ties

PJM will maintain a tie line database to be used in the creation of steady state and dynamics models. It will be distributed to the TOs at the beginning of each year’s build cycle for updates.

1) Tie lines will only be included in steady state and dynamics models if they are included in the tie line database
2) The bus names and associated data in steady state and dynamics models should match those in the tie line database
3) Tie lines must be agreed upon by both TO’s in order to be included
4) Tie line modeling should be consistent with the data requirements in Appendix 1
5) Include in service and out of commission dates for tie lines
6) Tie line database will be updated annually at the beginning of the case build cycle
7) TOs should only submit changes to the tie line database
8) Ties with an in-service/out-of-service date from 01/16/yyyy to 04/15/yyyy will be in-service/out-of-service in the spring model for the year yyyy.
9) Ties with an in-service/out-of-service date from 04/16/yyyy to 06/01/yyyy will be in-service/out-of-service in the summer model for the year yyyy.
10) Ties with an in-service/out-of-service date from 06/02/yyyy to 10/15/yyyy will be in-service/out-of-service in the fall model for the year yyyy.
11) Ties with an in-service/out-of-service date from 10/16/yyyy to 01/15/yyyy will be in-service/out-of-service in the winter model for the year yyyy.

3.2.2 Interchange

PJM will maintain an interchange spreadsheet for the creation of steady state and dynamics models. The spreadsheet will be based off of confirmed transactions in PJM’s Oasis system for the time of each case to be built. PJM will coordinate both with its own TOs and with the PCs these transactions source from or sink to.

Since PJM dispatches its resources as a pool, the interchange will be set for PJM as a whole for each case in question, the generation dispatched, and then solved with area interchange control off. When solved the interchanges for each of its TOs will be maintained with area interchange control turned on.

4 Power flow modeling requirements and guidelines

4.1 Data Format

Power Flow data for MOD-032 compliance will be uploaded via PJM’s implementation of the Siemens/PTI software Model On Demand. Every Transmission Owner will have access to MOD in order to upload project files and profile files to allow PJM to build the years and scenarios as defined by the NERC designee. A project (.prj) file will model future changes in transmission system topology, correct case modeling, and future generation projects. Profile files (.raw) model load profile, device settings on regulating equipment. Equipment ratings will be uploaded via comma separated value (.cvs) format into Model On Demand.

4.2 Level of Detail

The minimum level of detail that must be uploaded to Model On Demand in order to be included in steady state cases for MOD-032 compliance is:

Included in MOD base case or in project files

- Bulk Electric System and PJM Market Monitored facilities
  - Sub-BES facilities can be included at TO discretion
- All PJM Board approved Baseline projects
- All Supplemental projects presented at TEAC
- Interconnection projects with an executed ISA and their network upgrades
  - PJM as RP will coordinate with TO’s for project modeling

Included in MOD profile files

- Load profile for each season
  - PJM will scale load based on its load forecast as described in section 2.1
It is expected that LSE’s will coordinate with their TO to provide load profile data
- Settings on equipment such as transformers, shunts, HVDC data, etc
- Generation profile data will be provided via web interface by GOs. PJM will coordinate with TOs to ensure model compatibility

More in depth detail on individual equipment can be found in appendix 1.

### 4.3 Data Checks

The MMWG has established a set of Power Flow Data Checks, defined in the table below. PJM will run the data checking program which is capable of identifying all errors according to the criteria given in this table. All finalized power flow models shall be free of all such errors. Only specific exceptions from the table below are allowed and should be documented.

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Checked</th>
<th>Conditions Not Allowed</th>
<th>Exceptions Allowed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAW Read Warning</td>
<td>All Data</td>
<td>Warnings generated by PSS™E activity READ</td>
<td>Documented Exceptions Allowed</td>
<td>When reading in a case in RAW format, PSS™E performs certain checks to highlight suspect data that should be reviewed and corrected.</td>
</tr>
<tr>
<td>Duplicate Bus Names</td>
<td>Buses</td>
<td>Two or more buses in the same area with identical 12-char NAME and 4-char BASKV</td>
<td>No Exceptions</td>
<td>Dynamics data is referenced by bus names so they must be unique across each area.</td>
</tr>
<tr>
<td>Bus Number Out of Range</td>
<td>Buses</td>
<td>Bus number not in MMWG range</td>
<td>No Exceptions</td>
<td>The MMWG defines a range of bus numbers for each region in the interconnection. All buses must have a number in the range of one of the regions.</td>
</tr>
<tr>
<td>Owner Out of Range</td>
<td>Buses in Region</td>
<td>Bus number not in Regional owner number range</td>
<td>No Exceptions</td>
<td>Region is defined by a range of bus numbers. Owner number ranges are assigned to the Regions by the MMWG.</td>
</tr>
<tr>
<td>Zone Out of Range</td>
<td>Buses in Region</td>
<td>Zone number not in Regional zone number range</td>
<td>No Exceptions</td>
<td>Region is defined by a range of bus numbers. Zone Number ranges are assigned to the Regions by the MMWG.</td>
</tr>
<tr>
<td>Bus Voltage</td>
<td>Buses</td>
<td>VM &gt; 1.1 p.u., VM &lt; 0.9 p.u.</td>
<td>Documented buses normally operated at voltages higher or lower than their BASKV</td>
<td></td>
</tr>
<tr>
<td>Blank Voltage Fields</td>
<td>Buses</td>
<td>Blank BASKV field</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>Machines on Code 1 Buses</td>
<td>Buses; Generators</td>
<td>Generator at bus with IDE = 1</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Data Checked</td>
<td>Conditions Not Allowed</td>
<td>Exceptions Allowed</td>
<td>Comment</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Code 2 Buses Without Machines</td>
<td>Buses; Generators</td>
<td>No generator at bus with IDE = 2</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>Unrealistic PMAX and PMIN</td>
<td>Generators</td>
<td>PMAX &lt; PMIN, PMAX &gt; 2000, PMIN &lt; -1000</td>
<td>No Exceptions</td>
<td>Identifies machines with unreasonable PMAX or PMIN</td>
</tr>
<tr>
<td>Unrealistic QMAX and QMIN</td>
<td>Generators</td>
<td>QMAX &lt; QMIN, QMAX &gt; 1000, QMAX &lt; -1000</td>
<td>No Exceptions</td>
<td>Identifies machines with unreasonable QMAX or QMIN</td>
</tr>
<tr>
<td>PGEN Outside Range</td>
<td>Generators with STAT = 1 &amp; Bus IDE=2 or 3</td>
<td>PGEN &gt; PMAX, PGEN &lt; PMIN</td>
<td>No Exceptions</td>
<td>Identifies machines operating outside of their limits</td>
</tr>
<tr>
<td>Non-positive RMPCT</td>
<td>Generators</td>
<td>RMPCT ≤ 0</td>
<td>No Exceptions</td>
<td>RMPCT is the percent of the total Mvar required to hold the voltage at the bus controlled by the generator bus that are to be contributed by the generation at that bus. This value must be positive.</td>
</tr>
<tr>
<td>GTAP Out Of Range</td>
<td>Generators</td>
<td>GTAP &gt; 1.1, GTAP &lt; 0.9</td>
<td>No Exceptions</td>
<td>GTAP is the step up transformer off-nominal turns ratio.</td>
</tr>
<tr>
<td>Node Voltage Regulation</td>
<td>Switched Shunts; Generators; Transformers with COD1 = 1</td>
<td>Regulated bus more than one bus away from regulating bus</td>
<td>Three winding transformers modeled with star-point bus (unconverted); Zero impedance lines; Wind farms</td>
<td>Regulation of a distant bus can cause extra power flow solution iterations.</td>
</tr>
<tr>
<td>CNTB Errors</td>
<td>Switched Shunts; Generators; Transformers with COD1 = 1</td>
<td>Conflicting voltage objectives</td>
<td>Documented SMES units</td>
<td>This is performed using the activity CNTB which tabulates the voltage setpoints and desired voltage bands of voltage controlling equipment. It also performs certain checks on voltage controlling buses that are not themselves voltage controlled buses and includes those with suspect or conflicting voltage schedules or other errors.</td>
</tr>
<tr>
<td>Small Voltage Band Shunts</td>
<td>Switched Shunts</td>
<td>VSWHI – VSWLO &lt; 0.0005</td>
<td>No Exceptions</td>
<td>A small voltage band can cause unnecessary switched shunt toggling and may prevent power flow convergence.</td>
</tr>
<tr>
<td>Missing Block 1 Steps</td>
<td>Switched Shunts</td>
<td>Missing Block 1 steps</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>Transformer MAX below MIN</td>
<td>2-Winding Transformers with COD1 ≠ 0</td>
<td>VMA1 ≤ VMI1, RMA1 ≤ RMI1</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>Transformer Default R</td>
<td>2-Winding Transformers with COD1 ≠ 0</td>
<td>RMA1 = 1.5 and RMA2 = 0.51</td>
<td>No Exceptions</td>
<td>Checks for PSS™E default values.</td>
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<tr>
<td>Transformer Default V</td>
<td>2-Winding Transformers with COD1 ≠ 0</td>
<td>VMA1 = 1.5 and VMA2 = 0.51</td>
<td>No Exceptions</td>
<td>Checks for PSS™E default values.</td>
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<tr>
<td>Small Voltage Band Transformer</td>
<td>All Transformers with COD1 = 1</td>
<td>VMA – VMI &lt; 1.95 × Step Size²</td>
<td>No Exceptions</td>
<td>A small voltage band can cause unnecessary transformer tap toggling and extra power flow solution iterations.</td>
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<tr>
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<td>Exceptions Allowed</td>
<td>Comment</td>
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<td>-------------------------------</td>
<td>---------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Max or Min at 0</td>
<td>2-Winding Transformers with COD1 ≠ 0</td>
<td>RMA1 = 0, RMI1 = 0, VMA1 = 0, VMI1 = 0</td>
<td>No Exceptions</td>
<td></td>
</tr>
<tr>
<td>High Resistance Branches</td>
<td>Branches ≥ 100kV1; 2-Winding Transformers ≥ 100kV1</td>
<td>Branches: R &gt;</td>
<td>X</td>
<td>; Transformers: R1−2 &gt;</td>
</tr>
<tr>
<td>Rating Errors</td>
<td>Branches ≥ 100kV1; Transformers ≥ 100kV1</td>
<td>RATEB &lt; RATEA, RATEA = 0, RATEB = 0</td>
<td>Exception for branches with CKT = '99'/EQ' and for zero impedance branches</td>
<td>The MMWG defines RATEA as Normal and RATEB as Emergency.</td>
</tr>
</tbody>
</table>

4.4 Case Distribution

4.5 Model On Demand

5 Generation Owner Data Requirements and Guidelines

Generation Owners will be responsible for annually submitting data to PJM. The data to be submitted can be found in Appendix 2. Generation Owners will have to create a log in for pjm.com

6 Dynamics Data requirements and guidelines

6.1 Dynamics Data Format

Dynamics data is to be submitted in Siemens/PTI PSS/E dyr file. Any changes year to year would require a new .dyr file to be submitted. The dyr file is to be compatible with the current PJM PSS/E version.

6.2 Dynamic modeling Level of Detail

6.2.1 Generators

Generation Owners that meet the following criteria must submit detailed dynamics data for:

- Individual generating unit > 20 MVA and is directly connected to the Bulk Power System, or;
- Generating plant > 75 MVA when the entity has responsibility for any facility consisting of one or more units that are connected to the Bulk
  - Power System at a common bus with total generation above 75 MVA, or;
- Generation Owners are required to provide the information in their dyr file:
  - Generator Model
6.2.2 Transmission Owner Owned Equipment

Transmission Owners will be responsible to supply dynamics modeling information for any SVCs, FACTS devices, HVDV, and other dynamic reactive devices on their system. PJM will coordinate with dynamics contacts at its TOs in order for them to provide this information as appropriate for the schedule as determined by the NERC designee.

6.2.3 Dynamic Load Model Data

PJM expects TOs to coordinate with LSEs to provide dynamic load model data.

6.3 Accepted Dynamic Models

The following sections outline the dynamics models PJM will accept.

6.3.1 Accepted Generator Models

<table>
<thead>
<tr>
<th>Generators</th>
<th>IEEE - 2005</th>
<th>PSS/E V33.5</th>
<th>PSLF V18.1_02</th>
<th>Description</th>
<th>Notes:</th>
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<tbody>
<tr>
<td>CIMTR1</td>
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<td>Induction Generator</td>
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<td></td>
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<td>CIMTR3</td>
<td>motor1</td>
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<td>Induction Generator</td>
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<tr>
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<td></td>
<td>Grandfathered for existing models. May not be used for any new facility submitted</td>
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<td>genrou</td>
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<tr>
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<th>PSLF V18.1_02</th>
<th>Description</th>
<th>Notes:</th>
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<tbody>
<tr>
<td>DC1A</td>
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<td></td>
</tr>
<tr>
<td>DC2A</td>
<td>ESDC2A</td>
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<td></td>
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<tr>
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<td>IEEEX4</td>
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<td></td>
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<td>Model Code</td>
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<td>------------</td>
<td>-------------------</td>
<td>-------</td>
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</tr>
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<td></td>
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<td>Notes</td>
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<tr>
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<td>Notes</td>
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<td>-------------</td>
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<td></td>
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<tr>
<td>IVOEX</td>
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<td>Use of this model is grandfathered for existing models only, not to be used on new installations.</td>
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### Turbine/Governor

<table>
<thead>
<tr>
<th>IEEE - 2005</th>
<th>PSS/E V33.5</th>
<th>PSLF V18.1_02</th>
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<td>CRCMGV</td>
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<tr>
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<td>gast</td>
<td>Gas Turbine</td>
<td>Grandfathered for existing models. May</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>Description</td>
<td>Notes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td></td>
<td></td>
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</tr>
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<td></td>
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<td>pidgov</td>
<td>Hydro Turbine</td>
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</table>

### 6.3.2 Accepted Dynamic Load Models

### 6.3.3 Accepted Synchronous Condenser and Dynamic Device Models

### 6.3.4 Accepted FACTS Device Models

Includes HVDC/TCSC/STATCOM/SVC/ETC

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSVGN1</td>
<td>vwscc</td>
<td>SVC</td>
</tr>
<tr>
<td>CSVGN5</td>
<td>vwscc</td>
<td>SVC</td>
</tr>
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<td>SVSMO1U1</td>
<td>SVSMO1</td>
<td>SVC</td>
</tr>
<tr>
<td>SVSMO2U1</td>
<td>SVSMO2</td>
<td>SVC</td>
</tr>
<tr>
<td>SVSMO3U1</td>
<td>SVSMO3</td>
<td>SVC</td>
</tr>
</tbody>
</table>

### 6.3.5 Accepted Protection Equipment Models

### 6.3.6 Accepted Wind models

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### Type 1 Models

- `wt1p`, `wt1t`, `wt1g`, `wt12a`

### Type 2 Models

- `wt2e`, `wt2g`, `wt2p`, `wt2t`

### Type 3 Models

- `wt3g1`, `wt3g2`, `wt3e1`, `wt3t1`, `wt3p1`

### Type 4 Models

- `wt4e`, `wt4g`, `wt4p`, `wt4t`

### 6.4 Converting Legacy Models

PJM will convert the following legacy models:

<table>
<thead>
<tr>
<th>From Legacy Model</th>
<th>To Updated model</th>
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</thead>
<tbody>
<tr>
<td>IEEET1</td>
<td>ESDC1A</td>
</tr>
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<td>ESDC2A</td>
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<tr>
<td>IEEET3</td>
<td>ESST2A</td>
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<td>ESDC1A</td>
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<td>ESDC2A</td>
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<td>GGOV1</td>
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<td>WESGOV</td>
<td>GGOV1</td>
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<tr>
<td>GFT8WD</td>
<td>GGOV1</td>
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</table>

### 6.5 Dynamics Data Checks

The following data checks will be performed on all new dynamics modeling data. Data not consistent with the following data will be resolved with the data owner and corrected.

<table>
<thead>
<tr>
<th>Models Checked</th>
<th>Data Checked</th>
<th>Conditions Not Allowed</th>
<th>Good Condition</th>
<th>Exceptions Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Gen Model with inertia defined as H</td>
<td>H</td>
<td>H = 0</td>
<td>H &gt; 0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Model with S(1.0)</td>
<td>S(1.0)</td>
<td>S(1.0) &lt; 0</td>
<td>S(1.0) &gt; 0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Model with S(1.2)</td>
<td>S(1.2)</td>
<td>S(1.2) &lt; 0</td>
<td>S(1.2) &gt; 0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Model with S(1.0) and S(1.2)</td>
<td>S(1.0)</td>
<td>S(1.0) &gt; S(1.2)</td>
<td>S(1.0) &lt;= S(1.2)</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen/Exciter Model with S(E1)</td>
<td>S(E1)</td>
<td>S(E1) &lt; 0</td>
<td>S(E1) &gt;= 0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen/Exciter Model with S(E2)</td>
<td>S(E2)</td>
<td>S(E2) &lt; 0</td>
<td>S(E2) &gt;= 0</td>
<td>No Exceptions</td>
</tr>
</tbody>
</table>
### 6.6 Dynamics Initialization and checking procedure

Note: PSS\textsuperscript{TM}E activities relevant to the following steps are shown in brackets.

**Step 1:** Create a converged load flow case with as few limit violations and questionable data items as possible.

A. Solve the case after each set of major changes [FNSL, FDNS, SOLV, or MSLV] and save it to minimize rework if a change has unintended consequences. If all of the following constraints are satisfied, convergence within tolerance should not take more than the default number of iterations.

B. Generator checks using a list of all data to spot unrealistic, typically default, generator data values. [LIST, option 5] There is no checking activity listing only machines having suspect values of the following:

1. Machine MVA on the default base of 100. Although models will work if all load flow and dynamic model parameters are entered on this basis, limit checks will not work correctly.

2. Source impedance of 1.0 p.u. on machine MVA base. This value is substantially higher than normal for synchronous machines.

<table>
<thead>
<tr>
<th>All Gen/Exciter Model with S(E1) and S(E2)</th>
<th>S(E1)</th>
<th>S(E1) &gt; S(E2) if E1 &lt; E2</th>
<th>S(E1) &lt;= S(E2) if E1 &lt;= E2</th>
<th>No Exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Gen/Exciter Model with S(E1) and S(E2)</td>
<td>S(E1)</td>
<td>S(E1) &lt;= S(E2) if E1 &gt; E2</td>
<td>S(E1) &gt; S(E2) if E1 &gt; E2</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with reactance/transient reactance defined as Xd and X'd in D axis</td>
<td>Xd</td>
<td>Xd &lt;= X'd</td>
<td>Xd &gt; X'd</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with transient reactance/sub-transient reactance defined as X'd and X''d in D axis</td>
<td>X'd</td>
<td>X'd &lt;= X''d</td>
<td>X'd &gt; X''d</td>
<td>For hydraulic unit (GENSAL), the condition (X'd=X''d) is exception</td>
</tr>
<tr>
<td>All Gen Models with sub-transient reactance/leakage reactance defined as X''d and XL in D axis</td>
<td>X''d</td>
<td>X''d &lt;= XL</td>
<td>X''d &gt; XL</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with reactance/transient reactance defined as Xq and X'q in Q axis</td>
<td>Xq</td>
<td>Xq &lt;= X'q</td>
<td>Xq &gt; X'q</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with transient reactance/sub-transient reactance defined as X'q and X''q in Q axis</td>
<td>X'q</td>
<td>X'q &lt;= X''q</td>
<td>X'q &gt; X''q</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with reactance/transient reactance defined as X and X'</td>
<td>X</td>
<td>X &lt;= X'</td>
<td>X &gt; X'</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with transient reactance/sub-transient reactance defined as X' and X''</td>
<td>X'</td>
<td>X' &lt;= X'' if X''/=0 and T''/=0</td>
<td>X' &gt; X'' if X''/=0 and T''/=0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with sub-transient reactance/leakage reactance defined as X'' and XL</td>
<td>X''</td>
<td>X'' &lt;= XL if X''/=0 and T''/=0</td>
<td>X'' &gt; XL if X''/=0 and T''/=0</td>
<td>No Exceptions</td>
</tr>
<tr>
<td>All Gen Models with transient reactance/leakage reactance defined as X'' and XL</td>
<td>X''</td>
<td>X'' &lt;= XL if T''=0 or T''/=0</td>
<td>X'' &gt; XL if T''=0 or T''/=0</td>
<td>No Exceptions</td>
</tr>
</tbody>
</table>
3. Source impedances equal to or less than zero. These will cause generator conversion to fail.
4. Real and/or reactive power limits of +9999 or −9999.

C. Checks which report abnormal values
1. Branch flows exceeding normal ratings. [RATE or OLTL and OLTR]
2. Bus voltages below 0.95 p.u. except in the case of generator terminal voltage buses connected to the transmission bus by a step-up transformer with a tap ratio significantly off nominal. [VCHK]
3. Overloaded generators. [GEOL]. Note that this activity checks machine output against the machine MVA base, MBASE, not against PMAX, PMIN, QMAX, and QMIN.
4. Branches with extreme impedances or tap ratios [BRCH].
   Suggested options are:
   a. Small impedance. Note that very small impedances can be treated as zero impedance ties by selection of parameter THRSHZ and these will not be a problem.
   b. Negative reactance. These are typically found in Y representations of three winding transformers. Solution activity SOLV may not be used on cases containing such branches and MSLV may not be used if they are present at a Type 2 or 3 (generator) bus.
   c. Charging. Values exceeding the default upper check limit (5.0 p.u.) are normal on long EHV lines but others should be checked. Negative values are occasionally used for magnetizing impedance on transformers but this usage is not recognized in the PSS™E Program Operation Manual.
   d. Parallel transformers. Minor tap ratio differences may simply reflect field conditions, but differences exceeding one step should be checked to guard against inadvertent errors.
   e. High tap ratios.
   f. Low tap ratios.

D. Interactive checks: the user is asked to enter new value(s) for each exception, or hit “carriage return” for no change.
1. Generators dispatched outside their real power limits [SCAL].
   Scaling areas or zones should be used cautiously if generators having default PMAX (+9999) and PMIN (-9999) limits are present.
2. Inconsistent targets at a bus whose voltage is controlled by two or more system elements: local generation, switched shunts, and voltage controlling transformers. [CNTB]. There is a tendency not to recognize different summer and winter operating strategies where appropriate.
3. Questionable voltage or flow controlling transformer parameters. [TPCH]
4. Buses in “islands” not containing a system swing bus. [TREE]. Note that there can be multiple islands each of which does contain a system swing bus, with DC links connecting them.

Step 2: To confine the initialization to a subset of the original load flow, for instance the areas comprising one region, proceed as follows.
A. Create a raw data file containing only the area(s) of interest. [RAWD, AREA]
B. Read in the raw data file just created. [READ]
C. If no system swing bus is in the area kept, change the type of a generator bus from 2 to 3 to make it the system swing bus. [CHNG]
D. Locate any islands created by the subsetting operation and either connect or drop them. [TREE].
E. Replace flows on tie lines severed by the subsetting operation with equivalent loads (positive for flows out, negative for flows in). [BGEN]

Step 3: Net generation with load at any buses where a generator(s) exists for which no dynamic models are available. [GNET].

Step 4: Convert the generators in the load flow [CONG], solve, [ORDR, FACT, TYSL] and save converted case.[SAVE]

Step 5: From the dynamics entry point, read in the dynamic model data file [DYRE] (Load flow case must also be in memory.)
A. Specify CONEC, CONET, and COMPILE files.
B. It is highly desirable to include a SYSANG model in the DYRE file, although this makes it mandatory to recompile even if no user models are included. This model provides six monitoring output channels, which can be used to scan a no-disturbance simulation for stability without attempting to select individual machines to monitor.

Step 6: Concatenate FLECS code for user models onto CONEC or CONET files.
Step 7: Compile.
Step 8: Execute CLOAD4.
Step 9: Restart from the dynamics entry point, this time using “user dynamics”.
A. Read converted load flow [CASE].
B. Read in the dynamic data file [DYRE]
C. Specify channels to record appropriate states and variables as simulation outputs [CHAN]. Include SYSANG variables if this model was included in the dynamics data file as suggested above.
D. Check consistency of dynamic models [DYCH, option 1].
E. Initialize dynamic simulation [STRT]. The output of this activity may have several important parts and it is desirable to keep a log file for reference while debugging.

1. Warning messages for
a. Generators in the load flow for which there is no active machine model.
b. Models, usually of excitation systems or governors, initialized out of limits.
c. The number of iterations required to initialize the initial-conditions power flow.

2. A tabulation of conditions at each online machine
   a. Terminal voltage
   b. Exciter output voltage
   c. Real and reactive power output
   d. Power factor
   e. Machine angle in degrees
   f. Direct and quadrature axis currents on machine base.

3. A diagnosis of initial conditions, either
   a. “Initial conditions check OK”, or
   b. A listing of suspect initial conditions generally states whose time derivative is not “small” (relative to the value of the state). These may be caused by inconsistencies between the real and reactive power scheduled for a unit by the load flow (including automatic changes in reactive power to hold bus voltage at a target level) or by parameter errors.

4. For models flagged in steps i) through iii), consider using activity [DOCU] to identify parameters which may be causing problems. This activity will also give the automatically calculated values of exciter model parameters, which are derived if the corresponding parameters, as read in, are 0. Other warnings may indicate errors in the powerflow model.

F. Modify model parameters or the load flow as appropriate and repeat steps up to this point until there are no warning messages nor suspect initial conditions.

**Step 10:** Record a snapshot [SNAP] of dynamic state values prior to application of any disturbance or simulation of any time period.

**Step 11:** Simulate undisturbed operation [RUN] for at least 20 seconds. Printing the convergence monitor [RUN,CM] can indicate where problems are, but considerably increases the amount of output.

**Step 12:** Stop simulation. Review output values in tabular and/or graphical form.

**Step 13:** Validate exciter model response to a step change in set point. [ESTR] and [ERUN]. Field voltage and terminal voltage will be output for each exciter model and may be reviewed in tabular or graphical form. Satisfactory response is indicated if the terminal voltage settles to the specified value within a few seconds, if the field voltage is reasonable, and the response is free of

A. Excessive overshoot
B. Sustained oscillations
C. High frequency noise (may be caused by using too long a simulation time step.)
D. Unexpected discontinuities in the output variables or their derivatives (except IEEE Type 4 “non-continuous” regulator models).

**Step 14:** Validate governor model response to a step change. [GSTR] and [GRUN].
Mechanical power and speed deviation will be output for each shaft where a governor model is present and may be reviewed in tabular or graphical form. Models of cross-compound unit governors specify two machines so four output variables are used. Steam or combustion turbine unit governors may require up to 20 seconds to attain equilibrium, and hydro units even longer, even if they are well tuned. Satisfactory response is indicated if speed deviation settles to approximately \((- K) = (-1 / R)\), mechanical power to \((1-1/K)\) times the specified value, and the response variables are free of excessive overshoot or sustained oscillations.

### 6.7 Dynamics Case Acceptance Criteria

**A. 20 Second No-Fault Simulation**
This test consists of a 20 second simulation with no disturbance applied. The test will be considered to be passed if the following criteria are met:
1. No generator MW change of 0.1 MW or more
2. No generation MVAR change of 0.1 MVAR or more
3. No line flow changes of 0.3 MW or more
4. No voltage change of 0.0001 p.u. or more

**B. 60 Second Disturbance Simulation**
This simulation consists of the application of a 3-phase fault for a few cycles at a key transmission bus, followed by removal of the fault without any lines being tripped. The simulation is run for 60 seconds to allow the dynamics to settle and will be considered to be passed if the following criteria are met:
1. No generator MW change of 1 MW or more
2. No generator MVAR change of 1 MVAR or more, except for exciters with dead band control (typically IEEE Type 4)
3. No voltage change of 0.0001 p.u. or more, except in vicinity of exciters with dead band control

The no-fault and 60 second disturbance simulations can be readily checked by saving a converted power flow at the end of the simulation and then comparing against the initial converted power flow case. For any case that violates these criteria, the individual component models that are in proximity to such large changes should be scrutinized carefully to determine their nature.

**C. Dynamics Contingency Simulation**
This test consists of the simulation of two contingencies for each region which have been supplied by the Regional Coordinators. This test will be considered to be passed if the simulation exhibits stable performance.

7 Short Circuit Data Requirements and Guidelines

7.1 Short Circuit Data Format
PJM uses Aspen Oneline V12.5 as its short circuit modeling and analysis software which uses .olr format. For TOs using Aspen data shall be submitted either via .olr or change file (.chf) format. For TOs using Electrocon’s Cape software, changes will be accepted in .dxt format.

7.2 Short Circuit Level of Detail
Included in MOD base case or in project files
- Bulk Electric System and PJM Market Monitored facilities
  o Sub-BES facilities can be included at TO discretion
- All PJM Board approved Baseline projects
- All Supplemental projects presented at TEAC
- Interconnection projects with an executed ISA and their network upgrades
  o PJM as RP will coordinate with TO’s for project modeling

7.3 Short Circuit Submittal Procedure
PJM will maintain short circuit modeling contacts with each of its TOs. PJM will send out the previous year’s short circuit case and will ask for updates in the data formats outlined above to be emailed back according to that year’s model build schedule. An anticipated short circuit build schedule is included in section 3.1.

7.4 Short Circuit Data Checks
To be completed
Appendix 1: Detailed Data Requirements

Steady State
Power Flow data is to be submitted via PJM’s Model On Demand portal and include all BES and PJM Market Monitored facilities. It is left to the discretion of the TO to model additional sub-BES model detail.

1) Bus
   a. Data provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements
      i. Bus Voltage: All buses are required to have a non-zero nominal voltage. The nominal voltages of buses connected by lines, reactors or series caps should be the same.
      ii. Bus Names: All BES bus names and voltages should be unique for BES facilities
      iii. Bus Area, Zone, and Owner: All busses in PJM’s models must have area, zone, and owner fields completed
      iv. Bus Numbers: Transmission Owners will be required to follow the bus number guidelines for their area as outlined in Appendix 3.

2) Aggregate Demand (aka Load)
   a. Data provider: Load Serving Entities via Transmission Owners
      i. The demand is the load aggregated at each bus identified by the TO as a load bus. The LSE is responsible to provide this information, usually by coordinating with the TO.
   b. Data Submission: Model On Demand
      i. Load profiles will be uploaded via Bus/Load/Generation profiles. For more information, see PJM’s Model On Demand Procedure Manual
      ii. A different BLG profile will be required for each scenario (Year/Season) being built
   c. Data Requirements
      i. Bus number, load ID, Area and Zone number
      ii. Real and reactive power
      iii. In-service status
      iv. Conformity status

3) Generating Units
   a. Data Provider: Generator Owner
   b. Data Submission: Generator Data Portal
c. Data Requirements:  See Appendix 2 for full Generation data requirements. This section is solely for Steady State Generator Requirements

i. Plant Name

ii. Unit Number

iii. EIA Plant Code

iv. Pmax Summer Net (MW)

v. Pmin Summer Net (MW)

vi. Qmax Summer Net (MVAr)

vii. Qmin Summer Net (MVAr)

viii. Pmax Winter Net (MW)

ix. Pmin Winter Net (MW)

tax. Qmax Winter Net (MVAr)

txi. Qmin Winter Net (MVAr)

txii. Name Plate MVA

xiii. GSU 2 Winding

1.

xiv. GSU 3 Winding

1.

a. Data Provider: Transmission Owner

b. Data Submission: Model On Demand

c. Data Requirements:

i. Bus Number

ii. Machine ID

a. Data Provider: Resource Planner

b. Data Submission: Model On Demand

c. Data Requirements: The Recourse Planner will be responsible for providing the modeling data for future units

i. Bus Number

ii. Machine ID

iii. Pmax Summer Net (MW)

iv. Pmin Summer Net (MW)

v. Qmax Summer Net (MVAr)

vi. Qmin Summer Net (MVAr)

vii. Pmax Winter Net (MW)

viii. Pmin Winter Net (MW)

ix. Qmax Winter Net (MVAr)

x. Qmin Winter Net (MVAr)

xi. Name Plate MVA
4) AC Transmission Line
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
      i. Ratings sets for different seasons will be uploaded via Model On Demand. For more information, see PJM’s Model On Demand Procedure Manual
   c. Data Requirements
      i. From bus – To bus – Ckt id
      ii. Impedance data: Line R, X, and B in pu
          1. For Zero impedance lines, start circuit ID with Z and use R = 0.0000, X=0.0001, and B= 0.0000
      iii. In-service status
      iv. Ratings:
          1. Rate A: Normal Rating
          2. Rate B: Short Term Emergency
          3. Rate C: Not required

5) DC Transmission Systems
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements

6) Transformer
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements:
      i. From Bus – To Bus – ckt id
      ii. Nominal voltages of Windings
      iii. Impedance data: Specified R and X
      iv. Tap ratios
      v. Min and Max Tap position limits
      vi. Number of tap positions
      vii. Regulated bus
      viii. Ratings
          1. Rate A: Normal Rating
          2. Rate B: Short Term Emergency
      ix. In Service Status

7) Reactive Compensation
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
c. Data Requirements:
   i. Fixed Shunts
      1. G-Shunt (MW)
      2. B-Shunt (MVAr)
      3. In-service Status
   ii. Switched Shunts
      1. Voltage Limits (Vhi and Vlow)
      2. Mode of Operation (Fixed, Discrete, Continuous)
      3. Regulated Bus (If not fixed)
      4. Binit (MVAr)
      5. Steps and Step Sizes (MVAr)

8) Static Var Systems
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements
Appendix 2: Generator Owner Data Sheet Requirements

All data in this section is to be provided by Generator Owners via PJM.com’s MOD-032 Generator Data Sheet. This data is to be completed for each plant the company owns.

General Information Sheet

General Information (All Generators)
1. TO Area
2. Plant Name
3. Number of units at plant
4. Company Name
5. Name of Individual completing data
6. Email of Individual completing data
7. Phone of Individual completing data
8. Has any data been changed from previous year
9. EIA Plant Code
10. Commercial Operation Year
11. Prime Mover Code

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>Steam Turbine, including nuclear, geothermal and solar steam (does not include Combined Cycle)</td>
</tr>
<tr>
<td>GT</td>
<td>Combustion (Gas) Turbine</td>
</tr>
<tr>
<td>IC</td>
<td>Internal Combustion (diesel, piston) Engine</td>
</tr>
<tr>
<td>CA</td>
<td>Combined Cycle Steam Part</td>
</tr>
<tr>
<td>CC</td>
<td>Combined Cycle Total Unit (use only for plants/generators that are in planning stage, for which specific generator details cannot be provided)</td>
</tr>
<tr>
<td>CS</td>
<td>Combined Cycle Single Shaft (combustion turbine and steam turbine share a single generator)</td>
</tr>
<tr>
<td>CT</td>
<td>Combined Cycle Combustion Turbine Part (type of coal must be reported as energy source for integrated coal)</td>
</tr>
<tr>
<td>HY</td>
<td>Hydraulic Turbine (includes turbines associated with delivery of water by pipeline)</td>
</tr>
<tr>
<td>PS</td>
<td>Hydraulic Turbine – Reversible (pumped storage)</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>WT</td>
<td>Wind Turbine</td>
</tr>
<tr>
<td>CE</td>
<td>Compressed Air Energy Storage</td>
</tr>
<tr>
<td>FC</td>
<td>Fuel Cell</td>
</tr>
</tbody>
</table>
### Other
NA Unknown at this time (use only for plants/generators that are in planning stage, for which specific generator details cannot be provided)

#### Location (All Generators)
1. State
2. County
3. City
4. Zip Code

#### Energy Source Code (All Generators)
1. A
2. B
3. C
4. D
5. E

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT</td>
<td>Anthracite Coal, Bituminous Coal</td>
</tr>
<tr>
<td>LIG</td>
<td>Lignite Coal</td>
</tr>
<tr>
<td>SUB</td>
<td>Subbituminous Coal</td>
</tr>
<tr>
<td>WC</td>
<td>Waste/Other Coal (Anthracite Culm, Bituminous Gob, Fine Coal, Lignite Waste, Waste Coal)</td>
</tr>
<tr>
<td>SC</td>
<td>Coal-based Synfuel and include briquettes, pellets, or extrusions, which are formed by binding materials and processes that recycle material</td>
</tr>
<tr>
<td>DFO</td>
<td>Distillate Fuel Oil (includes all Diesel and No. 1, No. 2, and No. 4 Fuel Oils)</td>
</tr>
<tr>
<td>JF</td>
<td>Jet Fuel</td>
</tr>
<tr>
<td>KER</td>
<td>Kerosene</td>
</tr>
<tr>
<td>RFO</td>
<td>Residual Fuel Oil (includes No. 5 and No. 6 Fuel Oils and Bunker C Fuel Oil)</td>
</tr>
<tr>
<td>WO</td>
<td>Oil-Other and Waste Oil (Butane (Liquid), Crude Oil, Liquid Byproducts, Oil Waste, Propane (Liquid), Re-Refined Motor Oil, Sludge Oil, Tar Oil)</td>
</tr>
<tr>
<td>PC</td>
<td>Petroleum Coke</td>
</tr>
<tr>
<td>NG</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>BFG</td>
<td>Blast-Furnace Gas</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>OG</td>
<td>Other Gas (Butane, Coal Processes, Coke-Oven, Refinery, and other processes)</td>
</tr>
<tr>
<td>PG</td>
<td>Propane</td>
</tr>
<tr>
<td>NUC</td>
<td>Nuclear (Uranium, Plutonium, Thorium)</td>
</tr>
<tr>
<td>AB</td>
<td>Agriculture Crop Byproducts/Straw/Energy Crops</td>
</tr>
<tr>
<td>BLQ</td>
<td>Black Liquor</td>
</tr>
<tr>
<td>GEO</td>
<td>Geothermal</td>
</tr>
<tr>
<td>LFG</td>
<td>Landfill Gas</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal Solid Waste</td>
</tr>
<tr>
<td>OBS</td>
<td>Other Biomass Solids (Animal Manure and Waste, Solid Byproducts, and other solid biomass not specified)</td>
</tr>
<tr>
<td>OBL</td>
<td>Other Biomass Liquids (Ethanol, Fish Oil, Liquid Acetonitrile Waste, Medical Waste, Tall Oil, Waste Alcohol, and other biomass liquids not specified)</td>
</tr>
<tr>
<td>OBG</td>
<td>Other Biomass Gases (Digester Gas, Methane, and other biomass gases)</td>
</tr>
<tr>
<td>OTH</td>
<td>Other (Batteries, Chemicals, Coke Breeze, Hydrogen, Pitch, Sulfur, Tar Coal, and miscellaneous technologies)</td>
</tr>
<tr>
<td>PUR</td>
<td>Purchased Steam</td>
</tr>
<tr>
<td>SLW</td>
<td>Sludge Waste</td>
</tr>
<tr>
<td>SUN</td>
<td>Solar (Photovoltaic, Thermal)</td>
</tr>
<tr>
<td>TDF</td>
<td>Tires</td>
</tr>
<tr>
<td>WAT</td>
<td>Water (Conventional, Pumped Storage)</td>
</tr>
<tr>
<td>WDL</td>
<td>Wood Waste Liquids (Red Liquor, Sludge Wood, Spent Sulfite Liquor, and other wood related liquids not specified)</td>
</tr>
<tr>
<td>WND</td>
<td>Wind</td>
</tr>
<tr>
<td>NA</td>
<td>Not Available</td>
</tr>
</tbody>
</table>

Generator Capability (All Generators)

Note: Summer and Winter values are needed for all generator capability parameters

1. Name Plate (MW)
2. Unit Maximum
3. Unit Minimum
4. Total Gross Energy
5. Auxiliary Load (MW)
   a. Auxiliary Load is related to the operations of the plant (e.g. fans, pumps, etc.)
   b. Load will have to be designated as
1. Low voltage side of the GSU
2. High voltage side of the GSU
3. Location other than the two options above

6. Auxiliary load (MVAR)
   a. Auxiliary Load is related to the operations of the plant (e.g. fans, pumps, etc.

7. Station Load (MW)
   a. Station load is necessary to support facility of the plant
   b. Load will have to be designated as
      i. Low voltage side of the GSU
      ii. High voltage side of the GSU
      iii. Location other than the two options above

8. Station Load (MVAR)
   a. Station load is necessary to support facility of the plant

Total Reactive Power Capability at Max Gross Energy Output (All Generators)
Note Summer and Winter values are needed for all reactive power capability at max gross energy output parameters

1. Leading (MVAR) - Underexcited
2. Lagging (MVAR) – Overexcited

Synchronous Generator Sheet

1. Machine ID
   a. (e.g. ST, CT, CT1, CT2, ST2, etc.)
   b. Multiple Machines can be entered, 1 at a time
2. MVA Base (MVA)
3. Terminal Voltage (kV)
4. Nominal Power Factor
5. Unit maximum net capacity output (unit CIR) (MW)
6. Unit Gross Energy Output (MW)
   a. Summer and Winter Values
7. Unit reactive power capability at max gross energy output – leading (MVAR)
   a. Summer and Winter Values
8. Unit reactive power capability at max gross energy output – lagging (MVAR)
   a. Summer and Winter Values
9. Unit auxiliary load at max gross energy power output (MW and MVAR)
   a. Summer and Winter Values
10. Where is the auxiliary load being connected?
    a. Low voltage side of the GSU
    b. High voltage side of the GSU
    c. Location other than the two options above
11. Any additional comments on the capability (Aux Load)

Generator Parameters

Note: All reactances and resistance values in PU on Machine MVA Base

1. Combined turbine-generator-exciter inertia, H (kWs/kVA)
   a. $1 < H < 10$

2. Speed damping coefficient, D (PU)
   a. $0 \leq D < 3$

Generator Saturation

1. Generator Saturation at 1.0 PU voltage, S (PU)
   a. $0 < S_{1.0}$

2. Generator saturation at 1.2 PU voltage, S (PU)
   a. $S_{1.0} < S_{1.2}$

Unsaturated Reactances

1. Direct axis synchronous reactance, $X_d(i)$ (PU)
   a. $x_d < 2.5$

2. Direct axis transient reactance, $X'd(i)$ (PU)
   a. $x' < 0.5 \times x_d$

3. Direct axis sub-transient reactance, $X''d(i)$ (PU)
   a. $x''d < x'd$

4. Quadrature axis synchronous reactance, $X_q(i)$ (PU)
   a. $x_q < x_d$

5. Quadrature axis transient reactance, $X'q(i)$ (PU)
   a. $x'q < x_q$

6. Quadrature axis sub-transient reactance, $X''q(i)$ (PU)
   a. $x''q < x'q$

7. Stator leakage reactance, $X_l$

8. Negative sequence reactance, $X_2(i)$

9. Zero sequence reactance, $X_0(i)$

Saturated Reactances

1. Saturated subtransient reactance, $X''d(v)$ (PU)
   a. $X''d(v) < X''d(i)$

2. Negative sequence reactance, $X_2(v)$ (PU)

3. Zero sequence reactance, $X_0(v)$ (PU)

Resistances

1. DC armature resistance, $R_a$ (Ohms)

2. Positive sequence resistance, $R_1$ (PU)

3. Negative sequence resistance, $R_2$ (PU)

4. Zero sequence resistance, $R_0$ (PU)

Time Constraints

1. Direct axis transient open circuit, T-do (sec)
   a. $1 < T\text{do} < 10$

2. Direct axis sub-transient open circuit, T''do (sec)
   a. $0.01667 < T''do < 0.2$
3. Quadrature axis transient open circuit, T'qo (sec)  
   a. \( 0.2 \leq T'qo \leq 1.5 \)
4. Quadrature axis sub-transient open circuit, T''qo (sec)  
   a. \( 0.01667 \leq T''qo \leq 0.2 \)
5. Armature three phase short circuit, Ta3 (sec)  
   a. \( 0.025 \leq Ta \leq 0.1 \)

Control Systems
1. Exciter  
   - \text{IEEET1} - 1968 IEEE type 1 excitation system model.  
   - \text{IEEET2} - 1968 IEEE type 2 excitation system model.  
   - \text{IEEET3} - 1968 IEEE type 3 excitation system model.  
   - \text{IEEET4} - 1968 IEEE type 4 excitation system model.  
   - \text{IEEEX1} - 1979 IEEE type 1 excitation system model and 1981 IEEE type DC1 model.  
   - \text{IEEEX2} - 1979 IEEE type 2 excitation system model.  
   - \text{IEEEX2A} - 1979 IEEE type 2A excitation system model.  
   - \text{IEEEX3} - 1979 IEEE type 3 excitation system model.  
   - \text{EXAC1} - 1981 IEEE type AC1 excitation system model.  
   - \text{EXAC2} - 1981 IEEE type AC2 excitation system model.  
   - \text{EXAC3} - 1981 IEEE type AC3 excitation system model.  
   - \text{EXAC4} - 1981 IEEE type AC4 excitation system model.  
   - \text{EXDC2} - 1981 IEEE type DC2 excitation system model.  
   - \text{EXST1} - 1981 IEEE type ST1 excitation system model.  
   - \text{EXST2} - 1981 IEEE type ST2 excitation system model.  
   - \text{EXST3} - 1981 IEEE type ST3 excitation system model.  
   - \text{ESAC1A} - 1992 IEEE type AC1A excitation system model.  
   - \text{ESAC2A} - 1992 IEEE type AC2A excitation system model.  
   - \text{ESAC3A} - 1992 IEEE type AC3A excitation system model.  
   - \text{ESAC4A} - 1992 IEEE type AC4A excitation system model.  
   - \text{ESAC5A} - 1992 IEEE type AC5A excitation system model.  
   - \text{ESAC6A} - 1992 IEEE type AC6A excitation system model.  
   - \text{ESDC1A} - 1992 IEEE type DC1A excitation system model.  
   - \text{ESDC2A} - 1992 IEEE type DC2A excitation system model.  
   - \text{ESST1A} - 1992 IEEE type ST1A excitation system model.  
   - \text{ESST2A} - 1992 IEEE type ST2A excitation system model.  
   - \text{ESST3A} - 1992 IEEE type ST3A excitation system model.  
   - \text{UAC7B} - 2005 AC7B Excitation System  
   - \text{UAC8B} - 2005 AC8B Excitation System  
   - \text{UDC4B} - 2005 DC4B Excitation System  
   - \text{UST6B} - 2005 ST6B Excitation System
• ESAC8B - Basler DECS model.
• EXBAS - Basler static voltage regulator feeding dc or ac rotating exciter model.
• SCRX - Bus or solid fed SCR bridge excitation system model.
• EX2000 - EX2000 Excitation System.
• URST5T - IEEE proposed type ST5B excitation system.
• ESST4B - IEEE type ST4B potential or compounded source-controlled rectifier exciter.
• IEET1A - 1968 IEEE Modified type 1 excitation system model.
• IEET1B - 1968 IEEE Modified type 1 excitation system model.
• IEET5 - 1968 IEEE Modified type 4 excitation system model.
• IEET5A - 1968 IEEE Modified type 4 excitation system model.
• EXST2A - 1981 IEEE Modified type ST2 excitation system model.
• EXAC1A - Modified type AC1 excitation system model.
• EXPIC1 - Proportional/integral excitation system model.
• SEXS - Simplified excitation system model.
• EXELI - Static PI transformer fed excitation system model.
• Other - Please specify. Submit block diagram and parameter list and .obj/.lib file
• N/A - Not applicable. Please specify reason

2. Governor
• CRCMGV - Cross compound turbine-governor model.
• DEGOV - Woodward diesel governor model.
• DEGOV1 - Woodward diesel governor model.
• GAST - Gas turbine-governor model.
• GAST2A - Gas turbine-governor model.
• GASTWD - Gas turbine-governor model.
• GGOV1 - GE general purpose turbine-governor model.
• HYGOV - Hydro turbine-governor model.
• IEEEG1 - 1981 IEEE type 1 turbine-governor model.
• IEEEG2 - 1981 IEEE type 2 turbine-governor model.
• IEEEG3 - 1981 IEEE type 3 turbine-governor model.
• IEESGO - 1973 IEEE standard turbine-governor model.
• PIDGOV - Hydro turbine and governor model.
• SHAF25 - Torsional-elastic shaft model for 25 masses.
• TGOV1 - Steam turbine-governor model.
• TGOV2 - Steam turbine-governor model with fast valving.
• TGOV3 - Modified IEEE type 1 turbine-governor model with fast valving.
• TGOV5 - Modified IEEE type 1 turbine-governor model with boiler controls.
• WEHGOV - Woodward electronic hydro governor model.
• WESGOV - Westinghouse digital governor for gas turbine.
• WPIDHY - Woodward P.I.D. hydro governor model.
• BBGOV1 - Brown-Boveri turbine-governor model.
• HYGOV2 - Hydro turbine-governor model.
3. Power System Stabilizer (PSS)
   - IEEEST - 1981 IEEE power system stabilizer model.
   - PSS2B - 2005 IEEE type PSS2B Dual-Input Stabilizer Model
   - PSS3A - 2005 IEEE type PSS3B Dual-Input Stabilizer Model
   - STAB2A - ASEA power sensitive stabilizer model.
   - IEE2ST - Dual-input signal power system stabilizer model.
   - ST2CUT - Dual-input signal power system stabilizer model.
   - STAB3 - Power sensitive stabilizer model.
   - STAB4 - Power sensitive stabilizer model.
   - PTIST1 - PTI microprocessor-based stabilizer model.
   - PTIST3 - PTI microprocessor-based stabilizer model.
   - STAB1 - Speed sensitive stabilizer model.
   - STBSVC - WECC supplementary signal for static var system.
   - N/A - Not applicable. Please specify reason

4. Additional Information

Wind Farm Parameters

1. Specify manufacturer
2. Specify model
3. MW Value per turbine (nominal rating)
4. Number of wind turbines generators of the selected type
5. MVA base (MVA)
6. Terminal voltage
7. Nominal power factor
8. Stator resistance, R1 (Ohms)
9. Saturated sub-transient reactance, X"d(v) (PU on MVA base)
10. Control Mode
    a. Power Factor
    b. Voltage control
    c. Other
11. Voltage relays
   a. Yes
      i. If yes, provide voltage relay settings
   b. No

12. Frequency relays
   a. Yes
      i. If yes, provide frequency relay settings
   b. No

13. Additional windfarm compensation
   a. Yes
      i. Type of reactive compensation (e.g. fixed shunts, switchable shunt bank, dynamic)
      ii. Enter details related to compensation (e.g. number of caps, size, steps, etc)
   b. No

Inverter Based Parameters

1. Type of inverter based technology (e.g. solar, storage, etc.)
2. Specify manufacturer of inverter
3. Specify model
4. MW Value per inverter (MW)
5. Total number of inverters
6. MVA Base per inverter (MVA)
7. Terminal Voltage (kV)
8. Nominal power factor
9. Nominal output current at full load per inverter (Amps)
10. Maximum fault current output from the inverter (Amps or PU)
11. How fast can the inverter be disconnected from the system subsequent to a fault (Cycles)

Dynamic modeling
12. Description of dynamic performance of the inverter during a fault. Please describe how the selected inverter will behave dynamically with respect to real power, reactive power and tripping points for voltage and frequency
   a. Example: Constant real and reactive power injection during a fault. No tripping allowed. Fluctuations in real and reactive power depending on system conditions. Please submit dynamic model for an accurate representation.

13. Is the inverter designed with Low Voltage Ride-Through (LVRT) capability?
   a. Yes
   b. No

14. Voltage Relays
a. Yes
   i. If yes, provide voltage relay settings
b. No

15. Frequency Relays
   a. Yes
      i. If yes, provide frequency relay settings
   b. No

Circuit Breaker Parameters

1. Substation Name
2. Breaker Name
3. Manufacturer
4. Model Number
5. Nameplate Interrupting Rating (kA or MVA)
6. Nameplate Interrupting Time (Cycles)
7. Nameplate K-factor
8. Operating Voltage (kV)
9. Nameplate Max Design kV (kV)
10. Contact Parting Time (Cycles)
11. Reclosing Time (Cycles)
12. Protective Equipment 1 (e.g. generator, line, transformer)
   a. Specify specific protective equipment name (e.g. Peach Bottom unit 2 Generator, TMI- Hosensack 500 kV Circuit 1 Line)
13. Protective Equipment 2 (e.g. generator, line, transformer)
   a. Specify specific protective equipment name (e.g. Peach Bottom unit 2 Generator, TMI- Hosensack 500 kV Circuit 1 Line)
14. Interrupting Medium (e.g. Gas, Oil, Air, etc)

Main Transformers

Generator Step-Up (GSU) Transformer
1. MVA base (MVA)
2. Rating 1 (MVA)
3. Rating 2 (MVA)
4. Rating 3 (MVA)

Impedances (All values in PU on transformer MVA Base)
1. High-side to low-side (PU) (Two winding and three winding)
   a. R
   b. jX
   c. X/R
2. High-side to tertiary (Three winding only)
   a. R
b. jX
   c. X/R

3. Low-side to tertiary (Three winding only)
   a. R
   b. jX
   c. X/R

4. Winding Voltages (kV)
   a. High side (kV) (Two winding and three winding)
   b. Low side (kV) (Two winding and three winding)
   c. Tertiary (Three winding only)

5. Winding Connection Types (Delta, Wye, Wye Gnd, etc)
   a. High side (Two winding and three winding)
   b. Low side (Two winding and three winding)
   c. Tertiary (Three winding only)
   d. Tap Position (Two winding and three winding)
   e. Off-nominal turns ratio (Two winding and three winding)
   f. Number of taps (Two winding and three winding)
   g. Step size (Two winding and three winding)
   h. Any additional comments on the transformer (Two winding and three winding)
Appendix 3: Short Circuit

1) Bus
   a. Data provider: Transmission Owner
   b. Data Submission: Email
   c. Data Requirements:
      i. Bus Voltage: All buses are required to have a non-zero nominal voltage. The nominal voltages of buses connected by lines, reactors or series caps should be the same.
      ii. Bus Names: All BES bus names and voltages should be unique for BES facilities

2) Generating Units
   Existing Units
   a. Data Provider: Generator Owner
   b. Data Submission: Generator Data Portal
   c. Data Requirements: See Appendix 2 for full Generation data requirements.
      This section is solely for Short Circuit
      i. Generator MVA Base
      ii. Generator saturated sub-transient reactance $X''d(v)$ in pu
      iii. DC Armature resistance (Ra) in ohms
      iv. Negative sequence resistance (R2)
      v. Negative sequence saturated reactance (X2(v))
   Future Units
   a. Data Provider: Resource Planner
   b. Data Submission: Model On Demand
   c. Data Requirements: The Resource Planner will be responsible for providing the modeling data for future units
      i. Generator MVA Base
      ii. Generator saturated sub-transient reactance $X''d(v)$ in pu
      iii. DC Armature resistance (Ra) in ohms
      iv. Negative sequence resistance (R2)
      v. Negative sequence saturated reactance (X2(v))

3) AC Transmission Line
   a. Data Provider: Transmission Owner
   b. Data Submission: Email
   c. Data Requirements
      i. From bus – To bus – Ckt id
      ii. Impedance data: Line R, X, and B in pu
          1. Line R, X, and B in pu
          2. Positive, Negative, zero sequence data
iii. In-service status

4) DC Transmission Systems
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements

5) Transformer
   a. Data Provider: Transmission Owner
   b. Data Submission: Model On Demand
   c. Data Requirements:
      i. From Bus – To Bus – ckt id
      ii. Nominal voltages of Windings
      iii. Impedance data: Specified R and X

3. Positive, Negative, zero sequence data

6) Circuit Breakers
   a. Data Provider: Transmission Owners
   b. Data Submission: Email
   c. Data Requirements: For each BES circuit breaker the following data must be included in the data submittal:

1. Substation Name
2. Breaker Name
3. Manufacturer
4. Model Number
5. Nameplate Interrupting Rating (kA or MVA)
6. Nameplate Interrupting Time (Cycles)
7. Nameplate K-factor
8. Operating Voltage (kV)
9. Nameplate Max Design kV (kV)
10. Contact Parting Time (Cycles)
11. Reclosing Time (Cycles)
12. Protective Equipment 1 (e.g. generator, line, transformer)
   a. Specify specific protective equipment name (e.g. Peach Bottom unit 2 Generator, TMI- Hosensack 500 kV Circuit 1 Line)
13. Protective Equipment 2 (e.g. generator, line, transformer)
   a. Specify specific protective equipment name (e.g. Peach Bottom unit 2 Generator, TMI- Hosensack 500 kV Circuit 1 Line)
14. Interrupting Medium (e.g. Gas, Oil, Air, etc)
# Appendix 4: Transmission Owner Bus Range Allocations

<table>
<thead>
<tr>
<th>Area Number</th>
<th>Area Name</th>
<th>Buses in Range</th>
<th>Model</th>
<th>Bus Range Assignment</th>
<th>Zone Numbers</th>
<th>Owner Numbers</th>
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<td>201</td>
<td>AP</td>
<td>100</td>
<td>PJM Queue</td>
<td>235000 to 235099</td>
<td>1201-1205</td>
<td>201,255-258</td>
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<td>201</td>
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<td>235000 to 237999</td>
<td>1201-1205</td>
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<td>241900 to 241999</td>
<td>1230-1249</td>
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<td>ATSI</td>
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<td>TO topology</td>
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<td>1230-1249</td>
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Appendix 5: MOD-032 Attachment 1

Steady State

1) Each bus [TO]
   a. nominal voltage
   b. area, zone and owner

2) Aggregate Demand2 [LSE]
   a. real and reactive power*
   b. in-service status*

3) Generating Units3 [GO, RP (for future planned resources only)]
   a. real power capabilities - gross maximum and minimum values
   b. reactive power capabilities - maximum and minimum values at real power capabilities in 3a above
   c. station service auxiliary load for normal plant configuration (provide data in the same manner as that required for aggregate Demand under item 2, above).
   d. regulated bus* and voltage set point* (as typically provided by the TOP)
   e. machine MVA base
   f. generator step up transformer data (provide same data as that required for transformer under item 6, below)
   g. generator type (hydro, wind, fossil, solar, nuclear, etc)
   h. in-service status*

4) AC Transmission Line or Circuit [TO]
   a. impedance parameters (positive sequence)
   b. susceptance (line charging)
   c. ratings (normal and emergency)*
   d. in-service status*

5) DC Transmission systems [TO]

6) Transformer (voltage and phase-shifting) [TO]
   a. nominal voltages of windings
   b. impedance(s)
   c. tap ratios (voltage or phase angle)*
   d. minimum and maximum tap position limits
   e. number of tap positions (for both the ULTC and NLTC)
   f. regulated bus (for voltage regulating transformers)*
   g. ratings (normal and emergency)*
   h. in-service status*

7) Reactive compensation (shunt capacitors and reactors) [TO]
a. admittances (MVars) of each capacitor and reactor
b. regulated voltage band limits* (if mode of operation not fixed)
c. mode of operation (fixed, discrete, continuous, etc.)
d. regulated bus* (if mode of operation not fixed)
e. in-service status*

8) Static Var Systems [TO]
   a. reactive limits
   b. voltage set point*
   c. fixed/switched shunt, if applicable
   d. in-service status*

9) Other information requested by the Planning Coordinator or Transmission Planner necessary for modeling purposes. [BA, GO, LSE, TO, TSP]

Dynamics
1) Generator [GO, RP (for future planned resources only)]
2) Excitation System [GO, RP (for future planned resources only)]
3) Governor [GO, RP (for future planned resources only)]
4) Power System Stabilizer [GO, RP (for future planned resources only)]
5) Demand [LSE]
6) Wind Turbine Data [GO]
7) Photovoltaic systems [GO]
8) Static Var Systems and FACTS [GO, TO, LSE]
9) DC system models [TO]
10) Other information requested by the Planning Coordinator or Transmission Planner necessary for modeling purposes. [BA, GO, LSE, TO, TSP]

Short Circuit
1) Provide for all applicable elements in column “steady-state” [GO, RP, TO]
   a. Positive Sequence Data
   b. Negative Sequence Data
   c. Zero Sequence Data
2) Mutual Line Impedance Data [TO]
3) Other information requested by the Planning Coordinator or Transmission Planner necessary for modeling purposes. [BA, GO, LSE, TO, TSP]