Compliance Bulletin – MOD-032 and ISO New England's

Model Data Requirements and Reporting Procedures

ISO New England Inc.
Reliability and Operations Compliance
February 7, 2020

In case of a discrepancy between this Compliance Bulletin and a NERC Reliability Standard or an ISO New England Operating Document, the NERC Reliability Standard or the ISO New England Operating Document shall govern.

ISO New England Compliance Bulletin-MOD-032

ISO New England Model Data

Requirements and Reporting Procedures

EFFECTIVE DATE: July 1, 2015

REFERENCES:

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

NERC Standard MOD-026-1 — Verification of Models and Data for Generator Excitation Control System or Plant Volt/Var Control Functions

NERC Standard MOD-027-1 —Verification of Models and Data for Turbine/Governor and Load Control or Active Power/Frequency Control Functions

NERC Standard MOD-032-1 — Data for Power System Modeling and Analysis

NERC Standard PRC-001-1.1(ii) – System Protection Coordination

NERC Standard TPL-007-1 Transmission System Planned Performance for Geomagnetic Disturbance Events

ISO New England Transmission, Markets and Services Tariff, Market Rule 1, Section III.1.5.1: Claimed Capability Audits

OATT II.16.2 Application Procedures (*for Regional Network Service)*

ISO New England Transmission, Markets and Services Tariff, Section II, Attachment K, Supply of Information and Data Required for Regional System Planning

Schedule 22 to the ISO New England Open Access Transmission Tariff – Large Generator Interconnection Procedures

Schedule 23 to the ISO New England Open Access Transmission Tariff – Small Generator Interconnection Procedures

Schedule 25 to the ISO New England Open Access Transmission Tariff, Elective Transmission Upgrade Interconnection Procedures

(Continued)

REFERENCES (Continued)

ISO New England Transmission, Markets and Services Tariff Section I.3.9

ISO New England Operating Procedure No. 5 Generator, Dispatchable Asset Related Demand and Alternative Technology Regulation Resource Maintenance and Outage Scheduling (OP 5)

ISO New England Operating Procedure No. 12 Voltage and Reactive Control (OP 12)

ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources, Asset Related Demands and Alternative Technology Regulation Resources (OP 14)

ISO New England Operating Procedure No. 16, Transmission System Data (OP 16)

ISO New England Operating Procedure No. 23, Generator Resource Auditing (OP 23)

ISO New England Planning Procedure 5-1, Procedure for Review of Governance Participant's Proposed Plans (Section I.3.9 Applications: Requirements, Procedures and Forms)

ISO New England Planning Procedure 5-6 Interconnection Planning Procedure for Generation and Elective Transmission Upgrades

ISO New England Planning Procedure PP-7, Procedures for Determining and Implementing Transmission Facility Ratings in New England

ISO New England Planning Procedure PP-11, Planning Procedure to Support Geomagnetic Disturbance Analysis (Pending Approval).

Table of Contents

Contents

1.0 Introduction

The ISO New England Transmission, Markets and Services Tariff and NERC Standard MOD-032 require ISO New England, as a Planning Coordinator and Transmission Planner, to work with other entities registered in New England as Transmission Planners to develop data requirements for steady state, dynamic and short circuit transmission system studies. In accordance with NERC Standard MOD-032 and certain provisions of the ISO New England Transmission, Markets and Services Tariff, this Compliance Bulletin, along with associated procedures and applications, sets forth the means for entities to provide accurate modeling information.

For many years, ISO New England has had a number of documents and processes in place that provide much of the data required under NERC Standard MOD-032. This Compliance Bulletin describes how entities shall reference and use those documents and processes to meet the requirements of NERC Standard MOD-032. In some cases, however, ISO New England and the New England Transmission Planners need additional requirements to comply with NERC Standard MOD-032. This Compliance Bulletin sets forth those additional requirements.

For existing equipment model recertification, ISO New England will provide the models and backup documentation that it currently maintains. For new and proposed equipment, ISO Tariff language dictates format as summarized within this document.

Models that are "on-file" with ISO or updated for NERC standards must not be listed on the Obsolete Model Listing in Section 7.0

2.0 Steady State Information

Generator Owners and Transmission Owners provide much of the required steady state data to ISO New England using the NX-9 forms for existing equipment. Appendix B shows some typical steady state information and indicates the level of detail to be provided. Generator Owners and Transmission Owners shall provide site-specific information in accordance with referenced procedures for New England transmission system studies.

Unless otherwise noted below, for existing equipment with no planned modifications, Generator Owners and Transmission Owners (Owners) shall provide annual recertification of data. ISO New England shall initiate annual recertification. Owners shall provide the information to ISO New England for existing facilities that Owners are modifying, prior to making the changes in accordance with relevant provisions of, but not limited to, Section I.3.9 and Schedules 22, 23 and 25 to the ISO New England Open Access Transmission Tariff. Transmission studies in the planning horizon include new or modified facilities once approved by ISO New England as the Resource Planner.

2.1 Steady State - Bus Data Nominal Voltage, Area, Zone, Owner (MOD-032 A1-1a,b, TO)

For existing equipment, Transmission Owners provide bus numbers and bus nominal voltagewith information for area, zone and owner on the NX-9 form and provide updates using the NX application per OP-16. Note that for system changes, ISO New England provides a range of bus numbers with zones and owners to New England Transmission Planners. These Transmission Planners provide information back to ISO New England through the ISO/Transmission Planner Base Case Working Group (BCWG). This working group manages bus number assignments and other information for this requirement, such as area, zone, and owner. Outside of the regularly scheduled working group meetings, upon request of ISO New England, Transmission Planners shall also provide information by e-mail to ISO New England.

2.2 Steady State - Aggregate Demand (MOD-032 A1-2a, b, LSE)

ISO New England does not request aggregate demand data from LSE's for MOD-032. ISO-NE develops a regional load forecast and has aggregate demand data based on revenue quality hourly meter readings. ISO-NE posts meter requirements in Operating Procedure 18 - Metering and Telemetering Criteria (OP-18). Note that New England Transmission Planners provide load distribution by bus including real and reactive load to ISO New England. ISO New England Load Forecasting develops a New England total load forecast and individual state forecasts that sum to New England. ISO New England uses load distribution to allocate its state load forecasts. New England Transmission Planners must ensure that reactive capability is consistent with Sections 6 and 7 of the ISO New England Planning Technical Guide, which is available at http://www.iso-ne.com/static-assets/documents/2014/12/planning_technical_guide_2014-12-2_clean.pdf, and the Load Modeling Guide for ISO New England Network Model, which is available at http://www.iso-ne.com/static-assets/documents/rules_proceds/isone_plan/othr_docs/load_modeling_guide.pdf. Any dedicated loads such as large mill facilities are reviewed annually by the BCWG.

2.3 Steady State - Generator Unit Min/Max Real Power Capability (MOD-032 A1-3aGO, RP)

When performing Seasonal Claimed Capability Audits used to determine Qualified Capacity, Generator Owners shall provide necessary real power information for existing units. This testing shall be conducted in accordance with Section III of the ISO New England Transmission, Markets and Services Tariff (Market Rule 1) using the CCAT Application, ISO New England Operating Procedure OP-23 Generator Resource Auditing and the NX-12 form. Specific sections of Market Rule 1 that apply are Section III.1.5 and Section III.1.7. Note that Planning Studies, in addition to Qualified Capacity, may also consider maximum power from Generator Interconnection Agreements and Pmin from Day-Ahead Market submissions.

Prospective Generator Owners and existing Generator Owners shall provide real power capability information for proposed units as called for in accordance with ISO Planning Procedure PP 5-1 Attachment 1 and Attachment 2 as required and through their Generator Interconnection Agreements.

2.4 Steady State - Generator Unit Min/Max Reactive Power Capability (MOD-032 A1-3b)

With reactive capability audits, Generator Owners provide Reactive Power Capability to ISO New England in accordance with ISO New England Operating Procedure No. 12 – Voltage and Reactive Control and OP-12 Appendix B, ISO Operating Procedure OP-23 Generator Resource Auditing and OP-14 Appendix B (NX-12D form using the NX-Application and MOD-025 data sheet for synchronous condensors). Capability testing results shall be in accordance with the Generator Interconnection Agreements. If a change to reactive capability occurs prior to an audit then Generator Owners shall report the change to ISO.

Prospective Generator Owners and existing Generator Owners shall provide reactive power capability information for proposed units in accordance with ISO Planning Procedure PP 5-1 Attachment 1 and Attachment 2 as required and through their Generator Interconnection Agreements.

2.5 Steady State - Generator Unit station service auxiliary load (MOD-032 A1-3c)

Generator Owners shall provide station service auxiliary load information for existing units via the OP-14 Technical Requirements for Generators, Demand Resources and Asset Related Demands Appendix B (NX-12D).

Prospective Generator Owners and existing Generator Owners shall provide information corresponding to unit station service auxiliary load for proposed units by completing ISO Planning Procedure PP 5-1 Attachment 1 and the Attachment 2 form as required.

2.6 Steady State - Generator Unit regulated bus and setpoint voltage (MOD-032 A1-3d)

Generator Owners shall provide Steady State Generator Unit regulated bus voltage in accordance with ISO New England Operating Procedure No. 12 – Voltage and Reactive Control and its Appendix B and D. The NX-12D form includes an entry for Generator Owners to include the Voltage Schedule.

New unit regulated bus and set-point voltage are determined and documented via System Impact Studies.

2.7 Steady State - Generator Unit machine MVA base (MOD-032 A1-3e)

Generator Owners shall provide Generator Unit MVA base for existing units using the Dynamics Database Application (DDMS). This shall be consistent with the existing NX-12D form and Generator Interconnection Agreements. Appendix A to this Compliance Bulletin contains information on how to use the DDMS to enter and confirm generator information.

Prospective Generator Owners and existing Generator Owners shall provide MVA rating for proposed units by completing ISO Planning Procedure PP 5-1 Attachment 1 and the Attachment 2 form as required, and through their Generator Interconnection Agreements.

2.8 Steady State - Generator Unit step-up transformer (MOD-032 A1-3f)

Generator Owners shall provide Generator Unit step-up transformer characteristics for existing units using the ISO New England NX application and ISO Operating Procedure No. 16, Transmission System Data.

Prospective Generator Owners and existing Generator Owners shall provide step-up transformer characteristics for new units by completing ISO New England Planning Procedure 5-1, Attachment 3.

2.9 Steady State - Generator Unit generator type - hydro, wind, fossil, solar,etc. (MOD-032 A1-3g)

Generator Owners shall provide Generator Unit generator type using the NX-12 form (ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources, Asset Related Demands and Alternative Technology Regulation Resources, along with associated Appendices, contain information on filling out the NX-12 form).

Prospective Generator Owners and existing Generator Owners shall provide Generator Unit type for proposed units by completing ISO Planning Procedure PP 5-1 Attachment 1 and 2 as required and the information required by the Generator Interconnection Agreement.

2.10 Steady State - Generator Unit in-service status (MOD-032 A1-3h)

Regarding outages, Generator Owners shall provide outage data in accordance with ISO New England Operating Procedure No. 5 Generator, Dispatchable Asset Related Demand and Alternative Technology Regulation Resource Maintenance and Outage Scheduling and Control Room Operating Window (CROW) outage scheduling.

With respect to retirement, Generator Owners shall submit retirement plans for retirement according to Planning Procedure PP5-1 Section 3.

Proposed units are included as appropriate in study cases once approved by ISO New England.

2.11 Steady State - AC Transmission Lines or Circuits (MOD-032 A1-4a-h)

Transmission Owners shall provide Transmission Line or Circuit characteristics using the ISO New England NX application. ISO New England Operating Procedure No. 16, Transmission System Data explains how to enter information in the NX application. Information provided shall be consistent with ISO New England Planning Procedure PP-7, Procedures for Determining and Implementing Transmission Facility Ratings in New England. Outages for transmission lines or circuits shall be reported by Transmission Owners directly to ISO or through the LCC using the ISO New England Control Room Operations Window (CROW) application and in accordance with ISO New England Operating Procedure No. 3 Transmission Outage Scheduling.

Prospective Transmission Owners and existing Transmission Owners shall provide information for proposed transmission lines or circuits by completing ISO Planning Procedure PP 5-1 Attachment 3 and also including the line MVA ratings, line impedance (positive sequence) and charging (susceptance) or if appropriate a Schedule 25 Appendix 1 Interconnection Request.

2.12 Steady State - DC Transmission Systems (MOD-032 A1-5)

Transmission Owners shall provide DC Transmission (HVDC) information for existing facilities using the Dynamics Database Application. Appendix A to this Compliance Bulletin contains information on how to use the DDMS to enter and confirm HVDC device information. Transmission Owners shall report outages using the ISO New England Control Room Operations Window (CROW) application and per ISO New England Operating Procedure No. 3, Transmission Outage Scheduling.

Prospective Transmission Owners and existing Transmission Owners shall provide information for proposed HVDC Transmission facilities using a Schedule 25 Appendix 1 Interconnection Request.

2.13 Steady State - Transformers (MOD-032 A1-6a-h)

Transmission Owners shall provide transformer characteristics using the ISO New England NX application. Refer to ISO New England Operating Procedure No. 16, Transmission System Data for entering information in the NX application. Entries shall be consistent with ISO New England Planning Procedure PP-7, Procedures for Determining and Implementing Transmission Facility Ratings in New England. Transmission Owners shall report outages using the ISO New England Control Room Operations Window (CROW) application and in accordance with Operating Procedure No. 3 Transmission Outage Scheduling.

Prospective Transmission Owners and existing Transmission Owners shall provide information for a proposed transformer facility by completing ISO Planning Procedure PP 5-1 Attachment 3 along with transformer impedances, tap ratios, minimum and maximum tap position, number of tap positions and emergency ratings or if appropriate, a Schedule 25 Appendix 1 Interconnection Request. Regulated bus voltage is determined during the interconnection study.

2.14 Steady State - Reactive Compensation Devices

Transmission Owners shall provide information concerning existing Reactive Compensation Devices using the NX application and ISO New England Operating Procedure No. 16 Transmission System Data. Transmission Owners shall report outages using the ISO New England Control Room Operations Window (CROW) application. Transmission Owners who own reactive compensation devices shall also review information directly from PSS/E.

Prospective Transmission Owners and existing Transmission Owners shall provide information for proposed reactive devices by completing ISO Planning Procedure PP 5-1 Attachment 3 along with the facility MVA rating, mode of operation, regulated bus and variable reactor tap range or provide a Schedule 25 Appendix 1 Interconnection Request as appropriate.

2.15 Steady State - Static VAR Systems

Transmission Owners shall provide steady state information for existing Static VAR Systems using the NX Application. Transmission Owners shall report outages using the ISO New England Control Room Operations Window (CROW) application. Transmission Owners who own Static VAR devices shall also review information directly from PSS/E.

Prospective Transmission Owners and existing Transmission Owners shall provide information for proposed reactive devices by completing ISO Planning Procedure PP 5-1 Attachment 3 along with the facility MVA rating or when appropriate, a Schedule 25 Appendix 1 Interconnection Request.

2.16 Steady State - Sensitivity Cases

ISO New England provides sensitivity cases for the Eastern Interconnection Planning Collaborative (EIPC) MWG and studies based on different case types/scenarios for planning base-cases including:

Summer Peak	Shoulder Peak	Fall Peak
Winter Peak	Spring Light Load	Spring Peak

ISO New England builds cases for these scenarios for (1-10) year out configurations depending on the study and case requested.

3.0 Dynamics Information

The Dynamics Database Application shall be used by Generator Owners and Transmission Owners to provide dynamic characteristic information for equipment listed below. The listings also include the ISO Operating Procedure (OP) and NERC functional registration associated with the characteristic. The level of detail for dynamics data is illustrated in Appendix C.

Models must be compatable with the latest PSSe version that ISO is using for operations and planning studies. Siemens PSSe library models are preferred and acceptable but cannot be obsolete models as listed in Section 7. User written models that were accepted by ISO prior to January 1, 2017 are allowed (See Planning Procedure 5-6). When new library model characteristics are provided, they must be provided with dyr and raw files for PSSe along with PDF backup materials for the model.

a. Generators (OP-14, GO)
b. Excitation Systems (OP-14, GO)
c. Governor Modeling (OP-14, GO)
d. Power System Stabilizers (OP-14, NX-12D includes entry for PSS commissioning, GO)
e. Demand (OP-16, Dynamic Load Modeling, LSE – removed from NERC Functional Registration)
f. Wind Turbines (OP-14, GO)
g. Photovoltaic systems (OP-14, GO)
h. Static VAR systems (OP-16, GO, TO, LSE – see above)
i. FACTS Devices (OP-16, GO, TO, LSE)
j. DC System (HVDC) (per OP-16, TO)
k. Protective Relaying and Control Characteristics (Note: Future part of the application)

For existing facilities, annual recertification of dynamics data is in accordance with the Operating Procedure referenced. In addition to annual recertification, for the dynamic characteristic information listed above, Generator Owners or Transmission Owners shall provide information to ISO New England prior to existing systems being modified. Appendix A contains information on how to use the Dynamics Database Application to enter and confirm information for equipment listed above. For existing equipment, ISO New England provides the modeling documentation that is on file for Owner recertification. For new equipment, applicable entities make data submissions in accordance with Tariff documents. Generator Owners and Transmission Owners shall include test reports and equipment manufacturers modeling information as back up for dynamics models. For new or modified equipment, developers or equipment owners shall shall enter dynamics data into DDMS once the System Impact Study (SIS) is complete.

In 2014, Lawrence Livermore National Laboratory provided New England State Dynamic Load Characteristics. The Dynamic Load Characteristic development was coordinated for New England Transmission Planners with ISO New England and the NPCC SS-38 Working Group on Inter-Area Dynamics. Load Serving Entities shall review the 2014 Dynamic Load Modeling information in accordance with OP-16.

PSCAD models may be required for generators using power electronic equipment per ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources, Asset Related Demands and Alternative Technology Regulation Resources. PSCAD modeling is dependent on generator location as proximity of power electronic devices may cause interference affecting performance of power electronic equipment.

4.0 Short Circuit Data Collection Process

ISO Operating Procedure OP-16 governs the provision of short circuit information. Transmission Owners and Generator Owners shall provide short circuit data in accordance with OP-16 Appendix K. Appendix D of this Complinace Bulletin shows the level of detail associated with short circuit information. ISO also provides forms for short circuit data updates.

5.0 Generators 20 MW or less

In accordance with Schedule 23 to the ISO New England Open Access Transmission Tariff, generators above 5 MW shall submit models to ISO New England during construction. PSCAD models may be required for generators using power electronic equipment per ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources, Asset Related Demands and Alternative Technology Regulation Resources. PSCAD modeling is dependent on generator location as proximity of power electronic devices may cause interference affecting performance of power electronic equipment.

6.0 Inverter Based Resources (IBRs)

In 2018, NERC issued a number of recommendations regarding modeling of IBRs. These recommendations were summarized in NERC's ERO Enterprise CMEP Practice Guide: Information to be Considered by CMEP Staff Regarding Inverter-Based Resources, January 24, 2019. A best practice is to review that document and other NERC recommendations to ensure that existing and new IBR are adequately modeled for planning and operations studies. ISO Planning Procedure PP5-6 - Interconnection Planning Procedure for Generation and Elective Transmission Upgrades also includes specific ISO requirements for IBR.

7.0 Data Collection Schedule

In all cases for existing equipment, ISO New England will initiate data collection. When ISO schedules existing equipment recertification, it will provide the equipment owner with the information that is on file. ISO New England will collect data according to specific Operating Procedures. Table 1 summarizes the data collection schedule. For new equipment installations or modifications to existing equipment characteristics, Owners shall provide equipment characteristics to ISO as soon as possible and under appropriate ISO Tariff provisions. For new equipment, ISO New England as the Resource Planner for New England enters information into the base case when it approves new installations. Appendix E includes process flow diagrams illustrating the provision and review of data associated with MOD-032 and ISO procedures.

Table 1 – Data Recertification Schedule for Existing Equipment

Equipment Type	Per Document/Process	Annual Recertification *
Steady State (S.S.) – Bus Data	OP-16/NX Application	by ISO request at least once every 13 calendar months
S.S. – Aggregate Demand	LSE function eliminated	
S.S. – Generator Min/Max Real Power	Market Rule 1/CCAT	Seasonal **
S.S. – Generator Min/Max Reactive	ISO OP-14/NX Application	Generator updates when change occurs
Steady State Generator Aux Load	ISO OP-14/NX Application	Januaryby ISO request at least once every 13 calendar months
S.S. Generator Unit Regulated Bus	ISO OP-14/NX Application	by ISO request at least once every 13 calendar months

Table 1 – Data Recertification Schedule for Existing Equipment		
Equipment Type	**Per Document/Process**	**Annual Recertification ***
Steady State Generator MVA base	This document/DDMS	by ISO request at least once every 13 calendar months
S.S. Generator Unit Type	ISO OP-14/CAMS	November ***
S.S. Generator Unit In-Service Status	OP-5/CROW	Outage Specific
S.S. AC Lines	OP-16/NX Application	by ISO request at least once every 13 calendar months
S.S. DC Transmission System	This document/DDMS	With Dynamics
S.S. Transformer	OP-16/NX	by ISO request at least once every 13 calendar months
S.S. Reactive Compensation	OP-16/NX	by ISO request at least once every 13 calendar months
S.S. Static VAR Systems	OP-16/NX	by ISO request at least once every 13 calendar months
Dynamics - Generator	OP-14/DDMS	by ISO request at least once every 13 calendar months
Dynamics - Excitation System	OP-14/DDMS	by ISO request at least once every 13 calendar months
Dynamics – Governor Modeling	OP-14/DDMS	by ISO request at least once every 13 calendar months

Table 1 – Data Recertification Schedule for Existing Equipment		
Equipment Type	**Per Document/Process**	**Annual Recertification ***
Dynamics – Power System Stabilizer	OP-14/DDMS	by ISO request at least once every 13 calendar months
Dynamics – Demand	LSE function eliminated	by ISO request at least once every 13 calendar months
Dynamics – Wind Turbine	OP-14/DDMS	by ISO request at least once every 13 calendar months
Dynamics – Photovoltaic Systems	OP-14/DDMS	by ISO request at least once every 13 calendar months
Dynamics – Static VAR Systems	OP-16/DDMS	by ISO request at least once every 13 calendar months
Dynamics – FACTS Devices	OP-16/DDMS	by ISO request at least once every 13 calendar months
Dynamics - DC System (HVDC)	OP-16/DDMS	by ISO request at least once every 13 calendar months
Short Circuit Data Collection Process	OP-16/e-mail/SCWG	by ISO request at least once every 13 calendar months
Geomagnetic Characteristics	PP-11/Notification	by ISO request

* - Month that ISO initiates annual recertification. If equipment performance becomes degraded or changes, Owners shall notify ISO New England immediately using the NX application or DDMS unless otherwise noted.

** - Generator Owners schedule individual Seasonal Claimed Capability Testing with ISO-NE

*** - CAMS implementation of NX-12

If a registered entity believes an ISO data request is overdue then please contact ISO Customer Service and describe the item pertaining to NERC Standard MOD-032.

8.0 Acceptable Models

ISO New England accepts models that are available in latest version of PSS/E simulation software that ISO uses to represent the dynamic behavior of equipement and can provide information to obtain those models from Siemens. These models can be used as long as they are not obsolete. Over time, significant improvements to models may occur and models may become obsolete though the models are still available for PSS/E. When that occurs, models must be replaced with more current models even though the model may still be available in PSS/E. Table 2 includes a listing of models that are obsolete and required replacement dates. In addition, models must not be obsolete as listed by NERC in the NERC List of Acceptable Models for Interconnection-Wide Modeling (also below).

Table 2 – ISO New England List of Obsolete Models

Model to be replaced	Required replacement date	Basis for Replacement
GENSAL	For new and modified generators per I.3.9, along with NERC MOD-026 and MOD-027 submissions the GENSAL model shall not be used. The GENTPJ or another acceptable model shall be selected that represents the generator as currently configured and analyzed*.	NERC Modeling Notification Use of GENTPJ Generator Model Distribution Date: November 18, 2016 and Subsequent Webinar Industry Webinar: Modeling Notifications EX2000 and GENTPJ December 2016
GENSAL	For all generators effective March 1, 2022 the GENSAL model shall be replaced with an analyzed* GENTPJ or another acceptable model that represents the generator as currently configured.	NERC Modeling Notification Use of GENTPJ Generator Model Distribution Date: November 18, 2016 and Subsequent Webinar Industry Webinar: Modeling Notifications EX2000 and GENTPJ December 2016
GENROU	For new and modified generators per I.3.9, along with NERC MOD-026 and MOD-027 submissions the GENROU model shall only be used if rotor generator data has been analyzed* and verified where a suitable match of simulations to the available measured data is achieved. The GENTPJ or another acceptable model that represents the generator as currently configured* is	NERC Modeling Notification Use of GENTPJ Generator Model Distribution Date: November 18, 2016 and Subsequent Webinar Industry Webinar: Modeling Notifications EX2000 and GENTPJ December 2016

Table 2 – ISO New England List of Obsolete Models		
Model to be replaced	**Required replacement date**	**Basis for Replacement**
	recommended as a replacement if GENROU cannot match simulations.	
GENROU	For all generators effective July 1, 2024 the GENROU model shall only be used if round rotor generator data has been analyzed * and verified where a suitable match of simulations to the available measured data is achieved. The GENTPJ or another acceptable model that represents the generator as currently configured* is recommended as a replacement if GENROU cannot match simulations.	NERC Modeling Notification Use of GENTPJ Generator Model Distribution Date: November 18, 2016 and Subsequent Webinar Industry Webinar: Modeling Notifications EX2000 and GENTPJ December 2016
EX-2000	Commence immediate replacement – complete by January 1, 2019	Modeling Notification, EX2000 Dynamics Component Model for Excitation Systems, Initial Distribution: March 21, 2016 indicates the field current limiter portion of this model is suspect. And the NERC List of Acceptable Models for Interconnection-Wide Modeling lists this model as obsolete
GAST, GAST2A, GASTWD, GFT8WD, and WESGOV	Generators required to perform MOD-027 reviews or generators making I.3.9 modifications - models listed at left are not to be used for representing new generators and applicable existing generators when control systems have been replaced with digital controls. Transition to GGOV1 (or GGOV1DU if deadband is used) with MOD-027 reviews or I.3.9 modifications. Complete phase out by July 1, 2024 with MOD-027 testing.	Modeling Notification Gas Turbine Governor Modeling Initial Distribution: August 2017

Table 2 – ISO New England List of Obsolete Models		
Model to be replaced	**Required replacement date**	**Basis for Replacement**
GAST, GAST2A, GASTWD, GFT8WD, and WESGOV	Generators not required to perform MOD-027 reviews or making I.3.9 modifications shall verify the model by July 1, 2024 and replace with analyzed* GGOV1 or GGOV1DU (or GGOV1DU if deadband is used)	Modeling Notification Gas Turbine Governor Modeling Initial Distribution: August 2017
*- The model that is submitted shall be analyzed to ensure that parameters match the actual characteristics of the generator and analysis shall be provided illustrating that a suitable match of simulations to the available measured data is achieved.		

In addition, models shall be as listed in the latest version of the NERC List of Acceptable Models for Interconnection-Wide Modeling. The current version at the time of publication of this guide follows. It is also available on-line at http://www.nerc.com/comm/PC/Pages/System-Analysis-and-Modeling-Subcommittee-(SAMS)-2013.aspx as listed under "NERC Acceptable Model List".

NERC LIST OF ACCEPTABLE MODELS FOR INTERCONNECTION-WIDE MODELING

Purpose

The purpose of this list of acceptable models is to develop and maintain a repository of models deemed acceptable by the ERO and industry stakeholders for use in developing interconnection-wide models developed by the MOD-032 Designee. The NERC System Analysis and Modeling Subcommittee (SAMS) maintains and coordinates activities to address any modeling issues and will reflect any updates in this list of acceptable models on a periodic basis, or as needed.

This list seeks to bring together multiple sources of data to ensure uniformity in the use of models across interconnections. While models may be deemed 'obsolete' or 'deprecated' due to known issues, those models are not removed from the software vendor libraries for various reasons. However, those models should not be used for developing interconnection-wide models.

Table Legend

Yellow: Use of this model is not recommended. Other models may be more appropriate for use. While existing models in the cases may still use these models, their future use is discouraged. Resubmission of models as per MOD-026-1 and MOD-027-1 for existing resources should convert the existimg model to a more representative model.

Orange: Use of this model for new resources or resources re-certifying their models as per MOD-026-1 and MOD-027-1 should be prohibited, unless specifically acceptable by the Modeling Designee for interconnection-wide base case creation. Known modeling issues, errors, or deficiencies exist with this model. Modeling Designees should consider proactive actions to move towards more representative and accurate models.

Blue: These models are industry-accepted (e.g., IEEE standard models) that have not yet been implemented by the software vendors. Therefore they are listed on the list of acceptable models for tracking purposes using this color and will be updated accordingly once implemented by the software vendors. This is intended to provide direction to software vendors on which models industry recommends being implemented with higher priority.

Disclaimers and Notes

> Some of the models in this list may not be acceptable for use by all Modeling Designees. Modeling requirements as specified for each interconnection by the Modeling Designees supercede this list and those Designees should be consulted directly.

> 'Black box' models (e.g., no block diagrams, no source code, no documentation) are prohibited for use in interconnection-wide models.

> This list of models may not be comprehensive of all models available in the various commercial software platforms. Additional models may exist in the software platforms and are not addressed in this list of acceptable models. Models not listed on this list of acceptable models (e.g., available in later versions of the software, or manufacturer-specific models) are considered acceptable assuming they are not "black box" models.

> User-defined models are not acceptable unless either 1) the Modeling Designee allows them, or 2) a currently available generic model cannot be demonstrated with documentation to adequately represent the resource (e.g., wind power plants). Some exceptions to this exist such as HVDC circuits.

  > In PSS®E, the "U1" versions of models are not considered user-defined models.

  > Standard library models are not considered user-defined models.

Questions

Please direct any questions to NERC System Analysis (SystemAnalysis@nerc.net).

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Round Rotor Generator Model (IEEE Std 1110 §5.3.2 Model 2.2)		GENROU	genrou	X	X	X	X	X	X	Treatment of saturation. Use GENTPJ. See Modeling Notification.	Modeling Notification - Use of GENTPJ
	Salient Pole Generator Model (IEEE Std 1110 §5.3.1 Model 2.1)	✓	GENSAL	gensal	X	X	X	X	X	X	Treatment of saturation. Use GENTPJ. See Modeling Notification.	Modeling Notification - Use of GENTPJ
	Round Rotor Generator Model (IEEE Std 1110 §5.3.2 Model 2.2)		GENROE	--	X	--	X	--	X	--	Treatment of saturation. Use GENTPJ. See Modeling Notification.	Modeling Notification - Use of GENTPJ
	Salient Pole Generator Model (IEEE Std 1110 §5.3.1 Model 2.1)	☐	GENSAE	--	X	--	X	--	X	--	Treatment of saturation. Use GENTPJ. See Modeling Notification.	Modeling Notification - Use of GENTPJ
	Round Rotor Generator with DC Offset Torque Component		GENDCO	gensdo	X	--	--	--	--	--		
Machine Model	Cross Compound WECC Type F		--	gencc	--	X	--	X	--	X		

					Power World		PowerTech		V&R Energy			
Model Type	**Model Description**	**Unacceptable**	**Siemens PTI**	**GE PSLF**	**PSSE**	**PSLF**	**PSSE**	**PSLF**	**PSSE**	**PSLF**	**Comments**	**Reference**
	Generator Type F		--	gentpf	--	X	--	X	--	X		
	Generator Type J		GENTPJU1	gentpj	--	X	X	X	--	X		
	Classical Generator Model (IEEE Std 1110 §5.4.2)	✓	GENCLS	gencls	X	X	X	X	X	X	Does not allow for representation of excitation system and turbine/speed governor models.	SME input.
	Third Order Generator Model	☐	CGEN1	--	--	--	X	--	--	--	Specialized model (Ontario-Hydro model (and IEEE Std. 1110)) that goes to sub-sub-transient effects (up to 3 windings in the d- or q-axis) for special cases.	
	Transient Level Generator Model	✓	GENTRA	--	X	--	X	--	--	--	Simplified model without subtransient effects; prone to numerical problems.	PSS/E PAG V2, Section 14.4.5.4
	Salient Pole Frequency Changer Model	☐	FRECHG	--	--	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	"Two-cage" or "One-Cage" Induction Generator		CIMTR1, CIMTR3	genind	X	X	--	--	--	--		
Signal Playback Models	Play-In of Voltage and/or Frequency Signal		PLBVFU1	--	X	--	X	X	--	--		
	Frequency Playback Model		TSTGOV1	--	X	--	X	X	--	--		
	Play-In of Generator Field Voltage		--	plefd	X	--	X	X	--	--		
	Delivers Played-In Signal to Dynamic Simulation Models		--	plnow	--	--	X	X	--	--		
	Play-In of Voltage Regulator and Governor Reference Settings		--	plref	X	--	X	X	--	--		
	Play-In Turbine Power		--	pltp	X	--	X	X	--	--		
	Thevenin Source of Defined Voltage Amplitude and Frequency		--	gthev	--	--	X	X	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
Renewable Energy Resource Models	Generic Type 1 WTG Generator Model (Fixed-speed induction generator)		WT1G1	wt1g	X	X	X	X	X	X		
	Generic Type 2 WTG Generator Model (Variable slip induction generator with variable rotor resistance)		WT2G1	wt2g	X	X	X	X	X	X		
	Generic Type 3 WTG Generator/Converter Model - PSSE (Doubly-fed induction generator)	✓	WT3G1	--	X	--	X	--	X	--	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline
	Generic Type 3 WTG Generator/Converter Model - PSLF (Doubly-fed induction generator)	✓	WT3G2	wt3g	X	X	X	X	X	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline
	Generic Type 4 WTG Generator/Converter Model - PSSE	✓	WT4G1	--	X	--	X	--	X	--	2nd Generation Renewable Models	WECC Wind Modeling Guideline

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	(Variable speed generator with full converter)										replace these; numerical issues in base cases.	
	Generic Type 4 WTG Generator/Converter Model - PSLF (Variable speed generator with full converter)	✓	WT4G2	wt4g	--	X	--	X	X	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	[WECC Wind Modeling Guideline]()
	Generic Type 2 WTG Rotor Resistance Control Model	☐	WT2E1	wt2e	X	X	X	X	X	X		
	Generic Type 3 WTG Electrical Control Model	✓	WT3E1	wt3e	X	X	X	X	X	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	[WECC Wind Modeling Guideline]()
	Generic Type 4 WTG Electrical Control Model - PSSE	✓	WT4E1	--	X	--	X	--	X	--	2nd Generation Renewable Models replace these; numerical issues in base cases.	[WECC Wind Modeling Guideline]()
	Generic Type 4 WTG Electrical Control Model - PSLF	✓	WT4E2	wt4e	--	X	--	X	X	X	2nd Generation Renewable Models	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
											replace these; numerical issues in base cases.	
	Generic Type 1 Two Mass Turbine Model		WT12T1	wt1t	X	X	X	X	X	X		
	Generic Type 2 Two Mass Turbine Model		WT12T1	wt2t	X	X	X	X	X	X		
	Generic Type 3 WTG Turbine Model	✓	WT3T1	wt3t	X	X	X	X	X	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline
	Generic Type 3 and 4 WTG Drive Train Model		WTDTAU1	wtgt_a	X	X	X	X	X	X		
	Generic Type 3 WTG Pitch Control Model	✓	WT3P1	wt3p	X	X	X	X	X	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline
	Generic Type 3 and 4 WTG Pitch Control Model		WTPTAU1	wtgp_a	X	X	X	X	X	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Generic Type 1 and 2 WTG Pitch Control Model	✓	WT12A1	wt1p	X	X	X	X	X	X	Does not accurately represent Type 1 WTG pitch controls.	SME input.
	Generic Type 2 and 2 WTG Pitch Control Model		--	wt1p_b	--	X	--	--	--	--		
	Generic Type 3 and 4 WTG Aerodynamics Model		WTARAU1	wtga_a	X	X	X	X	X	X		
	Generic Type 3 and 4 WTG Torque Control Model		WTTQAU1	wtgq_a	X	X	X	X	X	X		
	Generic Type 4 WTG Power Converter Model	✓	--	wt4t	--	X	--	X	--	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline
	Generic Type 4 Pitch Control Model	✓	--	wt4p	--	--	--	X	--	X	2nd Generation Renewable Models replace these; numerical issues in base cases.	WECC Wind Modeling Guideline

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Linearized Model of PV Panel Output Curve		PANELU1	--	--	--	--	--	--	--		
	Linearized Model of PV Panel Solar Irradiance Profile		IRRADU1	--	--	--	--	--	--	--		
	Generic Phase 2 Renewable Energy Generator/Converter Model		REGCAU1	regc_a	X	X	X	X	--	--		
	Generic Phase 2 Renewable Energy Electrical Controls Model		REECAU1	reec_a	X	X	X	X	X	X		
	Generic Phase 2 Renewable Energy Plant Controller		REPCAU1	repc_a	X	X	X	X	X	X		
	Generic Plant Control Model		PLNTBU1	repc_b	--	--	--	--	--	--	This should be used in coordination with the auxiliary control models "AXBU1"; otherwise, use REPCA.	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Generic Phase 2 PV Electrical Controls Model		REECBU1	reec_b	X	X	X	X	X	X	Use REEC_A to represent equipment. This model lacks the VDL logic, namely momentary cessation	[Modeling Notification]()
	Generic Phase 2 Energy Storage Electrical Controls		--	reec_c	--	X	--	X	--	--		
	Generic Phase 2 Renewable Energy Auxiliary Control Model - Type 3 WTGs		REAX3BU1	--	--	--	--	--	--	--		
	Generic Phase 2 Renewable Energy Auxiliary Control Model - Type 4 WTGs and Solar PV		REAX4BU1	--	--	--	--	--	--	--		
	Generic Phase 2 Renewable Energy Auxiliary Control Model - SVC		SVCAXBU1	--	--	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Generic Phase 2 Renewable Energy Auxiliary Control Model - FACTS Device		FCTAXBU1	--	--	--	--	--	--	--		
	Generic Phase 2 Renewable Energy Auxiliary Control Model - Synchronous Condenser		SYNAXBU1	--	--	--	--	--	--	--		
	Vestas Model of Wound-Rotor Induction Generator (with Variable External Rotor Resistance)	☐	--	genwri	--	X	--	X	--	X	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	
	Vestas Model of Rotor Resistance Control for Wound-Rotor Induction WTG	☐	--	exwtg1	--	X	--	X	--	X	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	GE Wind Turbine Control Model - Doubly Fed Induction Generator (DFIG) and Full Converter (FC) Models	☐	--	wndtge	--	X	--	X	--	X	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	
	GE Wind Turbine Generator/Converter - DFAG and FC Models	☐	--	gewtg	--	X	--	X	--	X	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	
	GE Wind Turbine Excitation (converter) Control Model for DFAG Generators	☐	--	exwtge	--	X	--	X	--	X	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	
	GE Wind Turbine Plant-Level Supervisory Voltage/VAR Control	☐	--	wndvar	--	--	--	--	--	--	2nd Generation Renewable Models should replace these; potential numerical issues in base cases.	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Solar Photovoltaic Generator/Converter Model		PVGU1	pv1g	--	X	--	X	--	--		
	Solar Photovoltaic Electrical Control Model		PVEU1	pv1e	--	X	--	X	--	--		
	Distributed photovoltaic system		--	pvd1	--	X	--	--	--	--		
	Distributed Energy Resource Generator/Converter Model		DERAU1	der_a	X	X	X	X	--	--		https://www.wecc.org/Reliability/DER_A_Final_061919.pdf
Excitation System Models	IEEE Std 421.5 Type AC1A		ESAC1A	esac1a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC1C											
	Modified IEEE Std 421.5 Type AC1A		ESURRY	--	--	--	X	--	X	--		
	IEEE Std 421.5 Type AC2A		ESAC2A	esac2a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC2C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	remote Bus Voltage Signal Model		ESAC3A	esac3a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC3C											
	IEEE Std 421.5 Type AC4A		ESAC4A	esac4a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC4C											
	IEEE Std 421.5 Type AC5A		ESAC5A	esac5a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC5C											
	IEEE Std 421.5 Type AC6A		ESAC6A								Issue in implementation of the VAMAX and VAMIN limits. Implementation does not match IEEE Standard.	https://siemens.force.com/SEMC2/s/article/PSS-E-User-Support
	IEEE Std 421.5 Type AC6A		AC6A	esac6a	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC6C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Modified IEEE Std 421.5 Type AC6A (added speed multiplier)		USAC6AU	exac6a	--	X	--	--	--	--	PSLF esac6a should be used instead of exac6a, since PSLF esac6a has the speed flag and is a standard IEEE model.	
	IEEE Std 421.5 Type AC7B*		AC7B	esac7b	X	X	X	X	X	X		
	IEEE AC7B Excitation System Model w/ OEL for Brushless Exciters and GE EX2100 Controls		--	ex21br	--	--	--	--	--	--		
	IEEE Std 421.5 Type AC7C											
	IEEE Std 421.5 Type AC8B		AC8B	esac8b	X	X	X	X	X	X		
	Modified IEEE Std 421.5 Type AC8B		ESAC8B	exac8b	X	X	X	X	X	X		
	IEEE Std 421.5 Type AC8C											
	IEEE Std 421.5 Type AC9C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	IEEE Std 421.5 Type AC10C											
	IEEE Std 421.5 Type AC11C											
	IEEE Std 421.5 Type DC1A		ESDC1A	esdc1a	X	X	X	X	X	X		
	IEEE Std 421.5 Type DC1C											
	IEEE Std 421.5 Type DC2A		ESDC2A	esdc2a	X	X	X	X	X	X		
	IEEE Std 421.5 Type DC2C											
	IEEE Std 421.5 Type DC3A		DC3A	esdc3a	X	X	X	X	X	X		
	IEEE Std 421.5 Type DC4B		DC4B	esdc4b	X	X	X	X	X	X		
	IEEE Std 421.5 Type DC4C											
	IEEE Std 421.5 Type ST1A		ESST1A	esst1a	X	X	X	X	X	X		
	IEEE Std 421.5 Type ST1C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	IEEE Std 421.5 Type ST2A		ESST2A	esst2a	X	X	X	X	X	X		
	IEEE Std 421.5 Type ST2C											
	IEEE Std 421.5 Type ST3A		ESST3A	esst3a	X	X	X	X	X	X		
	IEEE Std 421.5 Type ST3C											
	IEEE Std 421.5 Type ST4B		ESST4B	esst4b	X	X	X	X	X	X		
	Modified IEEE Std 421.5 Type ST4B (without OEL & UEL inputs and Vgmax)		--	exst4b	--	X	--	X	--	X		
	IEEE Std 421.5 Type ST4C											
	IEEE Std 421.5 Type ST5B**		ST5B	esst5b	X	X	X	X	X	X		
	IEEE Proposed Type ST5B Excitation System		URST5T	--	X	--	X	--	X	--		
	IEEE Std 421.5 Type ST5C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	IEEE Std 421.5 Type ST6B		ST6B	esst6b	X	X	X	X	X	X		
	IEEE Std 421.5 Type ST6C											
	IEEE Std 421.5 Type ST7B		ST7B	esst7b	X	X	X	X	X	X		
	IEEE Std 421.5 Type ST7C											
	IEEE Std 421.5 Type ST8C											
	IEEE Std 421.5 Type ST9C											
	IEEE Std 421.5 Type ST10C											
	1968 IEEE Type 1+B127		IEEET1	ieeet1	X	X	X	X	X	X		
	Modified 1968 IEEE Type 1		IEET1A	--	X	--	X	--	X	--		
	Modified 1968 IEEE Type 1		IEET1B	--	X	--	X	--	X	--		
	1968 IEEE Type 2		IEEET2	--	X	--	X	--	X	--		
	1968 IEEE Type 3		IEEET3	--	X	--	X	--	X	--		
	1968 IEEE Type 4		IEEET4	exdc4	X	X	X	X	X	--		

					Power World		PowerTech		V&R Energy			
Model Type	**Model Description**	**Unacceptable**	**Siemens PTI**	**GE PSLF**	**PSSE**	**PSLF**	**PSSE**	**PSLF**	**PSSE**	**PSLF**	**Comments**	**Reference**
	Modified 1968 IEEE Type 4		IEEET5	--	X	--	X	--	X	--		
	Modified 1968 IEEE Type 4		IEET5A	--	X	--	X	--	X	--		
	1981 IEEE Type AC1		EXAC1	exac1	X	X	X	X	X	X		
	Modified 1981 IEEE Type AC1 (modified rate feedback source and with added speed multiplier)		EXAC1A	exac1a	X	X	X	X	X	X		
	Modified 1981 IEEE Type AC1		--	exac1m	--	--	--	--	--	--		
	1981 IEEE Type AC2		EXAC2	exac2	X	X	X	X	X	X		
	1981 IEEE Type AC3		EXAC3	exac3	X	X	X	X	X	--		
	Modified 1981 IEEE Type AC3		ESAC3A	exac3a	--	X	--	X	--	X		
	1981 IEEE Type AC4		EXAC4	exac4	X	X	X	X	X	X		
	1981 IEEE Type DC1		IEEEX1	exdc1	X	X	X	X	X	X		
	Modified 1981 IEEE Type DC1		IEEEX2	--	X	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Modified 1981 IEEE Type DC1		IEEX2A	--	X	--	X	--	X	--		
	1981 IEEE Type DC2		EXDC2	exdc2a	X	X	X	X	X	X		
	Modified 1981 IEEE Type DC2		IEEEX2	exdc2	--	X	--	X	--	X		
	1981 IEEE Type DC3		IEEEX4	exdc4	X	X	X	X	X	X		
	1981 IEEE Type ST1		EXST1	exst1	X	X	X	X	X	X		
	1981 IEEE Type ST2		EXST2	exst2	X	X	X	X	X	X		
	Modified 1981 IEEE Type ST2		EXST2A	exst2a	X	X	X	X	X	X		
	Modified 1981 IEEE Type ST2		IEEEX3	--	X	--	X	--	X	--		
	1981 IEEE Type ST3		EXST3	exst3	X	X	X	X	X	X		
	Modified 1981 IEEE Type ST3		ESST3A	exst3a	--	X	--	X	--	X		
	General Purpose Rotating Excitation System Model		REXSYS	rexs	X	X	X	X	X	X		
	General Purpose Rotating Excitation System Model		REXSY1	--	X	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Proportional/Integral Excitation System Model		EXPIC1	expic1	X	X	X	X	X	X		
	Manual Excitation Control with Field Circuit Resistance		--	mexs	--	X	--	--	--	X		
	General Purpose Transformer Fed Excitation System	✓	--	texs	--	X	--	X	--	X	Simplified, early generation model considered obsolete; other models more suitable.	SME input, IEEE Std. 421.5
	Bus or Solid Fed SCR Bridge Excitation System Model		SCRX	scrx	X	X	X	X	X	X		
	Bus or Solid Fed SCR Bridge Excitation System Model Type NEBB (NVE)		EXNEBB	--	--	--	--	--	--	--		
	Bus or Solid Fed SCR Bridge Excitation System Model Type NI (NVE)		EXNI	--	--	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Simplified Excitation System	✓	SEXS	sexs	X	X	X	X	X	X	Simplified, early generation model considered obsolete; other models more suitable.	SME input, IEEE Std. 421.5
	IVO Excitation System Model		IVOEX	exivo	X	X	X	--	X	X		
	ELIN Excitation System		CELIN	--	--	--	X	--	X	--		
	Basler Static Voltage Regulator Feeding DC or AC Rotating Exciter		EXBAS	--	X	--	X	--	X	--		
	Brown-Boveri Transformer-Fed Static Excitation System Model		BBSEX1	exbbc	X	X	X	X	X	X		
	Static PI Transformer Fed Excitation System		EXELI	exeli	X	X	X	X	X	X		
	VATECH (ELIN) Static Excitation System with PSS		--	exeli2	--	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	GE EX2000 Excitation System	✓	EX2000	--	X	--	X	--	X	--	Field current limiter latch issue. Replace with AC7B in PSSE and ex21br in PSLF.	NERC EX2000 Modeling Notification
	AEP Rockport excitation system		EMAC1T	--	X	--	X	--	X	--		
	Czech Proportional/Integral Excitation System Model		BUDCZT	--	--	--	--	--	--	--		
	High Dam Excitation System Model		URHIDT	--	--	--	--	--	--	--		
Power System Stabilizer	Transient Excitation Boosting Stabilizer Model		BEPSST	--	--	--	--	--	--	--		
	Dual-Input Signal Power System Stabilizer Model		IEE2ST	--	X	--	X	--	X	--		
	1981 IEEE Power System Stabilizer		IEEEST	ieeest	X	X	X	X	X	X		
	IVO Stabilizer Model		IVOST	--	X	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Ontario Hydro Delta-Omega Power System Stabilizer		OSTB2T	--	--	--	X	--	--	--		
	Ontario Hydro Delta-Omega Power System Stabilizer		OSTB5T	--	--	--	X	--	--	--		
	IEEE Std 421.5-2005 Single-Input Stabilizer Model		PSS1A	pss1a	X	X	--	X	--	X		
	1992 IEEE Type Dual-Input Signal Stabilizer Model		PSS2A	pss2a	X	X	X	X	X	X		
	IEEE Std 421.5-2005 PSS2B Dual-Input Stabilizer Model		PSS2B	pss2b	X	X	X	X	X	X		
	IEEE Std 421.5-2016 PSS2C Dual-Input Stabilizer Model											
	IEEE Std 421.5-2005 PSS3B Dual-Input Stabilizer Model		PSS3B	pss3b	--	X	--	X	X	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	IEEE Std 421.5-2016 PSS3C Dual-Input Stabilizer Model											
	IEEE Std 421.5-2005 PSS4B Dual-Input Stabilizer Model		PSS4B	--	--	--	--	--	--	--		
	IEEE Std 421.5-2016 PSS4C Dual-Input Stabilizer Model											
	IEEE Std 421.5-2016 PSS5C Dual-Input Stabilizer Model											
	IEEE Std 421.5-2016 PSS6C Dual-Input Stabilizer Model											
	IEEE Std 421.5-2016 PSS7C Dual-Input Stabilizer Model											
	PTI Microprocess-Based Stabilizer Model		PTIST1	--	--	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	PTI Microprocess-Based Stabilizer Model		PTIST3	--	--	--	X	--	X	--		
	Speed Sensitive Stabilizer Model		STAB1	--	X	--	X	--	X	--		
	ASEA Power Sensitive Stabilizer Model		STAB2A	--	X	--	X	X	X	--		
	Power Sensitive Stabilizer Model		STAB3	--	X	--	X	--	X	--		
	Power Sensitive Stabilizer Model		STAB4	--	X	--	X	--	X	--		
	Dual-Input Signal Power System Stabilizer Model		ST2CUT	wsccst	X	X	X	X	X	X		
	Dual Input Stabilizer (IEEE Type PSS2A) + Voltage Boost Signal Transient Stabilizer and Vcutoff		--	psssb	--	X	--	X	--	X		
	WECC Supplementary		STBSVC	--	X	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Signal for Static Var System											
	Synchronous Condenser Auxiliary Control Model		SYNAXBU1	--	--	--	--	--	--	--		
	Single Input PSS for SVSMO1, SVSMO2, and SVSMO3		--	psssvc	--	--	--	--	--	--		
Current Compensation Models	Cross-Current Compensation Model with Reactive Current Feedback		CCOMP4U1	ccomp4	--	X	--	--	--	--		
	Voltage Regulator Compensating Model		COMP	**	X	--	X	--	X	--		
	Cross and Joint Current Compensation Model		COMPCC	ccomp	X	X	--	--	X	--		
	IEEE Std 421.5 Current Compensator		IEEEVC	†	X	†	X	†	X	†		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Remote Bus Voltage Signal Model		REMCMP	**	X	--	X	--	X	--		
Turbine-Governor Models	Steam Plant Boiler Turbine-Governor Model		--	ccbt1	--	X	--	--	--	X	Similar but different than TGOV5.	
	Combined Cycle Plant Steam Turbine Model		UCBGT	ccst3	--	--	--	--	--	X		
	GE Frame 6, 7, and 9 Gas Turbine Model		--	gegt1	--	--	--	--	--	--	Detailed model. Encouraged to use generic model - GGOV1 - for interconnection-wide modeling.	
	General Purpose (Gas Turbine & Single Shaft CC) Turbine-Governor Model		GGOV1^	ggov1	X	X	X	X	X	X		
	General Governor Model with Frequency-Dependent Fuel Flow Limit		--	ggov2	--	X	--	--	--	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	General Governor Model with GE Gas Turbine Control Features		--	ggov3	--	X	--	X	--	X		
	LM 2500 Aero-Derivative Gas Turbine Governor Model	✓	--	lm2500	--	--	--	--	--	--	No supporting documentation (block diagrams), proprietary model. Use GGOV1.	
	LM 6000 Aero-Derivative Gas Turbine Governor Model	✓	--	lm6000	--	--	--	--	--	--	No supporting documentation (block diagrams), proprietary model. Use GGOV1.	
	Single Shaft Combined Cycle Plant Model		--	stag1	--	--	--	--	--	--		
	Woodward 2301 Governor and Basic Turbine Model		--	w2301	--	X	--	X	--	X		
	Brown-Boveri Turbine-Governor Model		BBGOV1	--	--	--	--	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Cross Compound Turbine-Governor Model		CRCMGV	crcmgv	X	X	X	X	X	X		
	Woodward Diesel Governor Model		DEGOV	--	X	--	--	--	X	--		
	Woodward Diesel Governor Model		DEGOV1^	degov1	X	--	X	--	X	--		
	WECC Gas Turbine Governor Model	✓	URGS3T	gast	X	X	X	X	X	X	Simplistic representation of steam turbine-governor system. Insufficient model capability of modern digital controls.	
	Gas Turbine-Governor Model	✓	GAST^	--	X	--	X	--	X	--	simple representations of a turbine-governor control system. Insufficient model capability and flexibility for most modern digital gas turbine-governor control systems.	Modeling Notification - Gas Turbine Governor Modeling

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Gas Turbine-Governor Model	✓	GAST2A^	--	X	--	X	--	X	--	simple representations of a turbine-governor control system. Insufficient model capability and flexibility for most modern digital gas turbine-governor control systems.	Modeling Notification - Gas Turbine Governor Modeling
	Gas turbine-governor	✓	GASTWD^	--	X	--	X	--	X	--	simple representations of a turbine-governor control system. Insufficient model capability and flexibility for most modern digital gas turbine-governor control systems.	Modeling Notification - Gas Turbine Governor Modeling
	Hydro Turbine-Governor Model		HYGOV^	hygov	X	X	X	X	X	X		
	Hydro Turbine-Governor Model		HYGOV2^	--	X	--	X	--	X	--	Superceded by hygov4 or any other updated hydro model.	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Hydro Turbine-Governor Lumped Parameter Model		HYGOVM	--	--	--	--	--	--	--		
	Fourth Order Lead-Lag Hydro-Turbine Model		HYGOVR1	hygovr	X	X	X	X	X	X		
	Hydro Turbine-Governor Traveling Wave Model		HYGOVT	--	--	--	--	--	--	--		
	Hydro Turbine-Governor Model		--	h6b	--	--	--	X	--	--		
	Model to Manage Parameter Data for h6b Hydro Turbine-Governor Model		--	h6bd	--	X	--	--	--	--		
	Hydro Governor Model for up to 4 Units on Common Penstock		--	hygov8	--	--	--	--	--	--		
	Hydro Turbine-Governor (plants w/ straightforward penstock config +		--	hypid	--	X	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	PID governor, blade angle for Kaplan)											
	Hydro Turbine w/ Woodward Electro-Hydraulic PID Governor, Penstock, Surge Tank, and Inlet Tunnel		--	hyst1	--	--	--	--	--	--		
	1981 IEEE Type 1 General Steam Turbine-Governor Model	☐	IEEEG1^	--	X	--	X	--	X	--	Use the WSIEG1 model instead. PSS/E WSIEG1 = PSLF IEEEG1.	
	1981 IEEE Type 2 General Approx. Linear Ideal Hydro Model	✓	IEEEG2	--	X	--	X	--	X	--	Model does not have an effective turbine model and an oversimplified governor model applicable only to first swing stability. Outdated. Typically recommend using a hygov model instead (no parameter-by-	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
											parameter replacement though.)	
	1981 IEEE Type 3 General Mechanical-Hydraulic Model		IEEEG3^	ieeeg3	X	X	X	X	X	X		
	Hydro Turbine-Governor (plants with straightforward penstock config + hydraulic govs of 'dashpot' type)		IEEEG3	hygov4	--	X	--	X	--	X		
	1973 IEEE General Steam Non-Reheat	☐	IEESGO^	--	X	--	X	--	X	--	Should be converted to WSIEG1 (PSS/E) or IEEEG1 (PSLF); does not represent rate limits for	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
											control valve or intentional deadband.	
	IVO Turbine-Governor Model		IVOGO	--	--	--	--	--	X	--		
	Hydro Turbine-Governor Model		PIDGOV^	pidgov	X	X	X	X	X	X		
	Pratt & Whitney Turboden Turbine-Governor Model		PWTBDU1	--	--	--	--	--	--	--		
	Torsional-Elastic Shaft Model for 25 Masses		SHAF25	--	--	--	--	--	--	--		
	Steam Turbine-Governor Model		TGOV1^	tgov1	X	X	X	X	X	X		
	Steam Turbine-Governor Model w/ Fast Valving	☐	TGOV2	--	X	--	X	--	X	--	Detailed model used for special cases.	
	1973 Modified IEEE Type 1 General Steam Turbine-	☐	TGOV3^	tgov3	X	X	X	X	X	X	Detailed model used for special cases.	

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Governor Model w/ Fast Valving											
	Modified IEEE Type 1 General Steam Turbine-Governor Model w/ PLU and EVA	☐	TGOV4	--	--	--	--	--	--	--	Detailed model used for special cases.	
	Modified IEEE Type 1 General Steam Turbine-Governor Model w/ Boiler Controls	☐	TGOV5	--	X	--	--	--	X	--	Detailed model that includes boiler controls; used for special studies.	
	Czech Hydro or Steam Turbine-Governor Model		TURCZT	--	--	--	--	--	--	--		
	Tail Water Depression Hydro Governor Model 1		TWDM1T	--	--	--	--	--	--	--		
	Tail Water Depression Hydro Governor Model 2		TWDM2T	--	--	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Combined Cycle - Single Shaft Turbine-Governor Model		URCSCT	--	--	--	--	--	--	--		
	Woodward Electronic Hydro Governor Model		WEHGOV	--	X	--	X	--I196	X	--		
	Westinghouse Digital Governor Model for Gas Turbines	✓	WESGOV^	--	X	--	X	--	X	--	simple representations of a turbine-governor control system. Insufficient model capability and flexibility for most modern digital gas turbine-governor control systems.	Modeling Notification - Gas Turbine Governor Modeling
	Woodward PID Hydro Governor Model		WPIDHY^	--	X	--	X	--	X	--		
	WECC Double Derivative Hydro Governor Model		WSHYDD	g2wscc	X	X	X	X	X	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	WECC GP Hydro Turbine-Governor Model		--	gpwscc	X	X	X	X	X	X	Use hyg3 or WSHYGP model.	WECC Approved Dynamic Model Library
	PID Governor, Double-Derivative Governor, and Turbine (WECC GP governor, WECC G2 turbine-governor)		WSHYGP	hyg3	--	X	--	X	--	X		
	Modified IEEE Type 1 General Steam Turbine-Governor Model w/ Speed Deadband		WSIEG1	ieeeg1	X	X	X	X	X	--		
Load Controller Models	Turbine Load Controller Model		LCFB1	lcfb1	X	X	X	X	X	X		
Load Models	Induction Generator Model with Rotor Flux Transients		CIMTR1	--	X	--	X	--	X	--		
	Induction Motor Model with Rotor Flux Transients		CIMTR2	--	X	--	X	--	X	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Induction Generator Model with Rotor Flux Transients		CIMTR3	genind	X	--	X	--	X	--		
	Induction Motor Model with Rotor Flux Transients		CIMTR4	motor1	X	X	X	X	X	X		
	Induction Motor Model		CIM5BL	--	--	--	--	--	--	--		
	Induction Motor Model		CIM6BL	--	--	--	--	--	--	--		
	Induction Motor Model		CIMWBL	motorw	--	X	X	X	X	X		
	IEEE Load Model		IEEL__	_lwscc	X	--	X	X	X	--		
	Load Frequency Model		LDFR__	--	X	--	X	--	X	--		
	Extended-Term Load Reset Model		EXTLBL	--	--	--	--	--	--	--		
	Complex Load Model		CLOD__	--	X	--	X	--	X	--		
	Composite Load Model		CMLDBLU1	cmpldw	--	X	X	X	X	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Composite Load Model w/ DER Component		--	cmpldwg	--	--	--	--	--	--		
	Composite Load Model w/ Modular Capability		--	cmpldw2	--	X	--	--	--	--		
	Performance-Based Model of Single Phase Air Conditioner Motor Model		ACMTBLU1	ld1pac	--	X	--	--	--	--		
	Phasor Model of Single-Phase Air-Conditioner Compressor Motor	✓	--	motorc	--	X	--	--	--	--	Experimental model.	PSLF Manual
Static Var Systems and FACTS	WECC Generic Continuous Control SVC Model		SVSMO1U2	svsmo1	--	X	X	X	--	X		
	WECC Generic Discrete Control SVC Model		SVSMO2U2	svsmo2	--	X	X	X	--	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	WECC Generic STATCOM-Based SVC Model		SVSMO3U2	svsmo3	--	X	X	X	--	X		
	SCR Controlled Static VAR Source Model		CSVGN1	--	X	--	X	--	X	--		
	SCR Controlled Static VAR Source Model		CSVGN3	--	X	--	X	--	X	--		
	SCR Controlled Static VAR Source Model		CSVGN4	--	X	--	X	--	X	--		
	WECC Controlled Static VAR Source Model		CSVGN5	vwscc	X	X	X	X	X	X		
	WECC Controlled Static VAR Source Model		CSVGN6	--	X	--	X	--	--	--		
	Switched Shunt Model		SWSHNT	msc1	X	X	X	--	--	--		
	American Superconductor DSMES Device		CDSMS1	--	--	--	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Static Condenser FACTS Model		CSTATT	--	X	--	X	--	X	--		
	Static Condenser (modeled as FACTS in power flow)		CSTCNT	--	--	--	X	--	--	--		
	ABB SVC Model		ABBSVC1	--	--	--	X	--	--	--		
	SVC for Switched Shunt		CHSVCT	--	--	--	X	--	X	--		
	SVC for Switched Shunt		CSSCST	--	X	--	X	--	X	--		
	EPRI Superconducting Electromagnetic Energy Storage FACTS Model		CSMEST	--	--	--	--	--	--	--		
	EPRI Battery Energy Storage FACTS Model		CBEST	--	X	--	--	--	X	--		
Protection and Other Models	Generic Generator Protection System		--	gp1	--	X	--	X	--	X		
	Generic Generator Protection System		--	gp2	--	X	--	--	--	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Under-/Over-Frequency Generator Bus Disconnection Relay		FRQTPAT	lhfrt	X	X	X	X	--	X		
	Under-/Over-Frequency Generator Trip Relay		FRQDCAT	--	X	--	X	--	--	--		
	Under-/Over-Voltage Generator Bus Disconnection Relay		VTGTPAT	lhvrt	X	X	X	X	X	X		
	Under-/Over-Voltage Generator Trip Relay		VTGDCAT	--	X	--	X	--	X	--		
	Time-Inverse Overcurrent Relay		TIOCR1	locti	X	X	x	--	X	X		
	Definite Time Underfrequency Load Shedding Relay		LDS3BL	lsdt1	X	X	X	X	--	X		
	Definite Time Undervoltage Load Shedding Relay		LDS3BL	lsdt2	--	X	X	X	--	X		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Definite Time Undervoltage Load Shedding Relay		LDS3BL	lsdt9	--	X	X	X	--	X		
	Out-of-Step Relay with 3 Zones (Lens, Tomato, or Circle)		--	ooslen	--	X	--	--	--	X		
	Out-of-Step Relay with 3 Zones (Lens, Tomato, Circle, or Rectangle)		--	ooslnq	--	X	--	--	--	--		
	Out-of-Step Mho Relay with Blinders		--	oosmho	--	X	--	--	--	--		
	Metal Oxide Varistor and Bypass Protection for Series Capacitor		--	scmov	--	X	--	--	--	--		
	Switched Capacitor Bank Model		SWCAPT	--	--	--	--	--	--	--		
	Mechanically Switched Capacitor		--	msc1	--	X	--	--	--	--		
	Mechanically Switched Reactor		--	msr1	--	X	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Mechanically Switched Line Reactor		--	mslr1	--	X	--	--	--	--		
	Mechanically Switched Shunt		--	mss1	--	--	--	--	--	--		
	Mechanically Switched Shunt		--	mss2	--	--	--	--	--	--		
	Over-Excitation Limiter for Synchronous Machine Excitation System		--	oel1	--	X	--	X	--	X		
	IEEE Std 421.5-2016 OEL1B Overexcitation Limiter											
	IEEE Std 421.5-2016 OEL2C Overexcitation Limiter											
	IEEE Std 421.5-2016 OEL3C											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	Overexcitation Limiter											
	IEEE Std 421.5-2016 OEL4C Overexcitation Limiter											
	IEEE Std 421.5-2016 OEL5C Overexcitation Limiter											
	IEEE Std 421.5-2016 UEL1 Underexcitation Limiter											
	IEEE Std 421.5-2016 UEL2 Underexcitation Limiter											
	IEEE Std 421.5-2016 UEL2C Underexcitation Limiter											

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World PSSE	Power World PSLF	PowerTech PSSE	PowerTech PSLF	V&R Energy PSSE	V&R Energy PSLF	Comments	Reference
	IEEE Std 421.5-2016 SCL1C Stator Current Limiter											
	IEEE Std 421.5-2016 SCL2C Stator Current Limiter											
	IEEE Std 421.5-2016 DEC1A Discontinuous Excitation Control											
	IEEE Std 421.5-2016 DEC2A Discontinuous Excitation Control											
	IEEE Std 421.5-2016 DEC3A Discontinuous Excitation Control											
	Load Tap Changer Model		OLTC1T	ltc1	--	X	--	--	--	--		
	Variable Frequency Transformer or		OLPS1T	vft	--	X	--	--	--	--		

Model Type	Model Description	Unacceptable	Siemens PTI	GE PSLF	Power World		PowerTech		V&R Energy		Comments	Reference
					PSSE	PSLF	PSSE	PSLF	PSSE	PSLF		
	Rotary Phase Shift Regulator											

† - Current compensator is part of the generator model
** - Built into generator model in PSLF
* PSSE: Area-based: __=AR; Bus-based: __=BL; Zone-based: __=ZN; All: __=AL
* PSLF: Area-based: __=a; Bus-based: __=b; Zone-based: __=z; All: __=w

^ For Siemens PTI PSS®E implementation, the "DU" version of the model is also acceptable.

Applicable Reference Materials and Additional Reading:

[1] "IEEE Guide for Synchronous Generator Modeling Practices and Applications in Power System Stability Analyses," IEEE Std 1110-2002.

[2] Undrill, J., "The gentpj model," November 19, 2007 (updated June 19, 2012). http://www.wecc.biz/

[3] "IEEE Recommended Practice for Excitation System Models for Power System Stability Studies," IEEE Std 421.5-2005.

[4] "Computer Representation of Excitation Systems," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-87, No. 6, pp. 1460-1468, 1968 (Committee Report).

[5] "Excitation System Models for Power System Stability Studies," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-100, No. 2, pp. 494-509, 1981 (Committee Report).

[6] IEEE Task Force on Overall Plant Response, "Dynamic Models for Steam and Hydro Turbines in Power System Studies", IEEE Trans. on PAS, Vol PAS-92, Nov-Dec 1973, pp. 1904-1915.

[7] Task Force on Turbine-Governor Modeling, "Dynamic Models for Turbine-Governors in Power System Studies," IEEE Technical Report, PES-TR1, Jan. 2013.

[8] WECC M&VWG, "Composite Load Model for Dynamic Simulations" Ver 1.0, June 12, 2012.

[9] WECC M&VWG, "WECC Wind Power Plant Dynamic Modeling Guide," November 2010.

[10] EPRI, "Specification of the Second Generation Generic Models for Wind Turbine Generators," September 20, 2013. and WECC M&VWG, "Generic Solar Photovoltaic System Dynamic Simulation Model Specification," September 2012.

[11] WECC, "Generic Static Var System Models for the Western Electricity Coordinating Council" April 18, 2011.
[12] W. I. Rowen, “Simplified Mathematical Representations of Heavy Duty Gas Turbines”, ASME Paper 83-GT-63 and ASME Journal of Engineering for Power, October 1983, pages 865-869. [GAST2A reference]

[13] Periera, L. et al, "A New Thermal Governing Approach in the WECC," IEEE Transaction on Power System, Vol. 18, No. 2, pp. 819-829, May 2003.

[14] WECC M&VWG, "Cross-current Compensation Model Specification," August 2015.

[15] EPRI, "Simple Model Specification for Battery Energy Storage System," March 6, 2015.
[W1] WECC Approved Dynamic Model Library. http://www.wecc.biz/
[W2] WECC M&VWG, "WECC Wind Power Plant Dynamic Modeling Guide," April 2014.

[W3] WECC M&VWG, "WECC PV Power Plant Dynamic Modeling Guide," April 2014.

[E1] EPRI, "Proposed Changes to the WECC WT3 Generic Model for Type 3 Wind Turbine Generators," September 27, 2013.

[E2] EPRI, "Proposed Changes to the WECC WT4 Generic Model for Type 4 Wind Turbine Generators," January 23, 2013.

Appendix A – Dynamics Data Management System (DDMS)

Please refer to the ISO DDMS User Guide that is available at
https://www.iso-ne.com/static-assets/documents/2016/12/ddmsexternaluserguide.pdf

Appendix B – Sample Steady State Data

Steady-State	Units	Example	Description
1. Each Bus [TO,GO]			
Bus name, location, description, etc.			Discuss Parameters with Base Case Working Group (BCWG)
a. nominal voltage	kV	345 kV	Nominal bus voltage (e.g, 138, 230, 345, etc.)- not the voltage that the bus is operated at or scheduled to. BCWG developed
b. area, zone, and owner	area	101	Discuss Parameters with Base Case Working Group
c. bus number where available	#no	101999	Range Assignment to BCWG
	zone	1	BCWG
	owner	1	BCWG
2. Aggregate Demand at each bus [LSE]			
a. real power*	MW	85 MW	Discuss Parameters with Base Case Working Group
b. reactive power*	MVArMVAr	15 MVAr	Discuss Parameters with Base Case Working Group (cross check with Planning Guide)
c. in-service status (normal status)*	[online/ offline]	1/0; on/off	Discuss Parameters with Base Case Working Group
d. load type (e.g., firm, interruptible, scalable, etc.)	type load	firm, interruptible, scalable, temperature sensitive, etc.	Discuss Parameters with Base Case Working Group
e. Load location identifier (Station and load name or bus number and load ID)		ASTATION/ALOAD or ABus#/ID	Discuss Parameters with Base Case Working Group

3. Generating Units [GO, proposed Generation Facility Owner]			
a. real power capabilities - gross maximum and minimum values	Gross Max	450 MW	Sustained real power output (generally stated as megawatts, MW) at the generator terminals under the expected peak seasonal operating conditions (e.g., Summer, Winter, Spring, and Fall) at its gross continuous capability.
	Gross Min	75 MW	For dispersed Hydro, Solar and Wind Gen: Discuss Parameters with Base Case Working Group
b. reactive power capabilities - maximum and minimum values at real power capabilities in 3a above			Maximum sustained overexcited and underexcited reactive output at the generator terminals, at the real power capability (3a above) or capability curve under the expected seasonal operating conditions and at rated MW power of generator. These values should be based on the most limiting constraints as shown in PRC-019 coordination curves
At max MW gross	MVAr	+200 MVAr/-100 MVAr	
At min MW gross	MVAr	+250 MVAr/-150 MVAr	
c. station service (SS) auxiliary load (provide data in the same manner as that required for aggregate Demand under item 2, above).	See item 2	15 MW, 2 MVAr	typical, see NX-12D
d. regulated bus* and voltage set point* (as typically provided by the TOP)			See OP-12 and OP-12 Appendix B
e. machine rated MVA (specify cooling conditions that correspond to rated MVA below as applicable)	MVA	500 MVA	Nameplate MVA Base

f. generator step up transformer data (provide same data as that required for transformer under item 6, below)			See NX-9 Form
g. generator type (hydro, wind, fossil, solar, nuclear, etc)			GDDM Application
h. in-service status*			CROW Outage Application or PPA retirement status
4. AC Transmission Line or Circuit (series capacitors and reactors shall be explicitly modeled as individual line segments) [TO,GO]			
a. impedance (positive sequence)			positive sequence impedance of transmission line - see ISO-NE NX-9A instructions
Base Voltage	kV	345 kV	
Base MVA	MVA	100 MVA	
length of line	mi	80 mi	
i. resistance	100 MVA Base	0.0192	Transmission Line Resistance - see ISO-NE NX-9A instructions
ii. reactance	100 MVA Base	0.0575	Transmission Line Reactance - see ISO-NE NX-9A instructions
b. susceptance (line charging) Total	100 MVA Base	0.0264	Transmission Line Susceptance (B) - see ISO-NE NX-9A instructions
c. ratings (normal and emergency, two seasons)*			Transmission Line Ratings - see ISO-NE NX-9A instructions and OP-16
Normal	MVA	100	
LTE	MVA	120	
STE	MVA	133	
DAL	MVA	140	
d. equipment status (normal equipment status)*	[1, in service/ 0, out-of-service]	1, in service	Enter outage information in CROW. Retirement PPA.
e. other information			
5. DC Transmission systems – identified by DC line name or number [TO]			
a. System Description			Identify # of terminals, line configuration (monopole, bipole) and location of rectifier and inverter

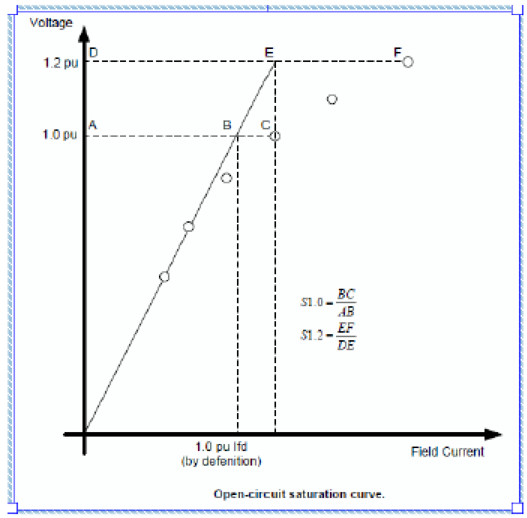
b. line parameters			scheduled DC voltage, control mode (blocked, power, current), power order, dc resistance
c. converter transformer parameters			transformer ratio, tap setting, tap step
d. rectifier and inverter data			firing angles, firing angle limits, # of bridges
e. filter/shunt bank data			Provide information on any filter or shunt banks at the rectifier or inverter
f. equipment status (normal equipment status)*	[1, in service/ 0, out-of-service]	1, in service	Realtime - EMS System
6. Transformer (voltage and phase-shifting) [TO,GO]			
a. nominal voltages of windings			Transformer Nameplate (See OP-16 Appendix B and C)
High Side	kV	220	
Low Side	kV	100	
Tertiary	kV	44	
b. impedance(s)			Transformer Impedance at fixed tap setting and nominal tap setting. Specify the Base MVA for each impedance.
High - Low	P.U.@__MVA	0.005 + j 0.1012 @ 100 MVA	Resistance and Reactive values are calculated for the current tap settings from these impedances and other information on the test report. These impedance values are calculated as shown in the OP-16 Appendix documents.
High - Tertiary	P.U.@__MVA	0.002 + j 0.0702 @ 100 MVA	
Low - Tertiary	P.U.@__MVA	0.002 + j 0.0533 @ 100 MVA	
c. tap ratios (voltage or phase angle)*			NX-9
voltage	P.U.	1.0375	
phase angle	degrees	3 degrees	
d. minimum and maximum tap position limits			Transformer Nameplate (See OP-

			16 Appendix for instructions)
minimum	P.U. or degrees	0.95	
maximum	P.U. or degrees	1.05	
e. number of tap positions (for both the Under Load Tap Changer and No Load Tap Changer)		1 - 5	Transformer Nameplate (See OP-16 Appendix for instructions); For non-linear tap positions, add a transformer and impedance corrections tables.
f. regulated bus (for voltage regulating transformers)*			Transformer Nameplate (See OP-16 Appendix for instructions)
g. regulated voltage limits or MW band limits*			Transformer Nameplate (See OP-16 Appendix for instructions)
Vmax			
Vmin			
g. MVA ratings (normal and emergency)*			See OP-16 Appendix for instructions; If 3 winding, there should be separate ratings for each winding.
Normal	MVA	100	
LTE	MVA	133	
STE		166	
DAL	MVA	170	
h. in-service status*			Outages per CROW/Retirements per FCA/PPA
i. mode of operation (fixed, discrete, continuous, etc.)	Mode	fixed	Transformer Nameplate (See OP-16 Appendix for instructions)
j. equipment status (normal equipment status)*	[1, in service/ 0, out-of-service]	1, in service	Outages per CROW/Retirements per FCA/PPA
k.. Transformer identifier (Station/Transformer name or High/Low/Tertiary bus numbers and ID)		ASTATION/ATRANSFORMER or HBus#/LBus#/TBus#/ID	Discuss Parameters with ISO Base Case Working Group
7. Reactive compensation (shunt capacitors and reactors) [TO]			See ISO Operating Procedure OP-16 Appendix D
Nominal voltage	kV	34.5	

a. admittances (MVAr) of each capacitor and reactor	MVAr	50 MVAr	See ISO Operating Procedure OP-16 Appendix D
b. regulated voltage band limits	[kV max, kV min] P.U. or kV	[1.05, 0.95]	See ISO Operating Procedure OP-16 Appendix D
c. mode of operation (fixed, discrete, continuous, etc.)	mode	discrete	See ISO Operating Procedure OP-16 Appendix D
d. regulated bus*		HS	See ISO Operating Procedure OP-16 Appendix D
e. in-service status*			
f. share of reactive contribution for voltage regulation*	%	100	See ISO Operating Procedure OP-16 Appendix D
g. Shunt location identifier (Station and device name or bus number and ID)		ASTATION/ASHUNT or ABus#/ID	See ISO Operating Procedure OP-16 Appendix D
8. Static Var Systems [TO]			
a. reactive limits	MVAr	+50, -40 MVAr; or 50 MVAr capacitive, 40 MVAr inductive	See OP-16 Appendix Z
b. voltage set point*	P.U. / kV	1.025 pu, 235.75 kV	See OP-16 Appendix Z
c. fixed shunt switching, if applicable			
d. share of reactive contribution for voltage regulation*			
e. equipment status (normal equipment status)*	[1, in service/ 0, out-of-service]	1, in service	Realtime - EMS System/Outages per CROW/Retirements per FCA/PPA
f. Shunt location identifier (Station and device name or bus number and ID)		ASTATION/ASHUNT or ABus#/ID	See this document Appendix A

Appendix C – Dynamics

Dynamics:	Units	Example	Description
1. Generator [GO,RP(for planned resources only)] a. Synchronous machines, including, as appropriate to the model:			
i. Base MVA	MVA	100 MVA	Generator Nameplate Base MVA
i. inertia constant - H	unitless	4.3	Generator Data - Valid Manufacturers Databook or Expert Generator Consultant Report; Looking for the full shaft constant including generator, turbine, and rotating exciter masses.
ii. saturation parameters			Generator Data - Valid Manufacturers Databook or Expert Generator Consultant Report. The figure below may be used to determine actual data points

S1.0	unitless	0.1	 Open-circuit saturation curve.
S1.2	unitless	0.45	
Dynamics: While the following information is typically needed for most dynamic models, need to include description about GO and PC/TP working together on specifics			“Best available data,” until the first round of MOD-026 and MOD-027 testing has been completed. .
xd (unsaturated synchronous reactance, direct axis)	P.U.	1.67	
xq (unsaturated synchronous reactance, quadrature axis)	P.U.	1.6	
x'd (unsaturated transient synchronous reactance, direct axis)	P.U.	0.265	

x'q (unsaturated transient synchronous reactance, quadrature axis)	P.U.	0.46	
x"d (unsaturated subtransient synchronous reactance, direct axis)	P.U.	0.205	
x"q (unsaturated subtransient synchronous reactance, quadrature axis)	P.U.	0.205	
xl (leakage reactance, over/under excited)	P.U.	0.15	
v. generator time constants			"Best available data," until the first round of MOD-026 and MOD-027 testing has been completed; If Generator has been rewound, update this information post rewind.
T'd0 (Open Circuit, Direct axis time constant)	s	3.7	"Best available data," until the first round of MOD-026 and MOD-027 testing has been completed.
T"d0 (Open Circuit, subtransient direct axis time constant)	s	0.032	
T'q0 (Open Circuit, Quadrature axis time constant)	s	0.47	
T"q0 (Open Circuit, subtransient quadrature axis time constant)	s	0.06	

			Note: any occurrence of a non-zero "D" associated with any generator model (GENROU, GENSAL, GENCLS, etc.) will cause unintended interference in the frequency response of PSS/E case or model. Reason is in PSSE the damping coefficient is referenced against the nominal frequency such that it will not only add a damping but a governing effect as well. GENCLS shouldn't be used in dynamic case except as an equivalent generator on the opposite end of a HVDC tie.
b. Other technologies, including, as appropriate to the model:	see 1a above		Generator Data - Valid Manufacturers Databook or Expert Generator Consultant Report
i. inertia constant (Combined Turbine-Generator - H)			
ii. damping coefficient set to zero if not provided by mfg			
iii. saturation parameters (S/1.0, S/1.2)			
iv. direct and quadrature axes reactances and time constants	See 1a above		
2. Excitation System [GO] (See example block diagram below)	model definition parameters	See IEEE 421.5 as well as sample excitation system model below.	"Manufacturer or Expert Consultant data," until the first round of MOD-026 and MOD-027 testing has been completed.

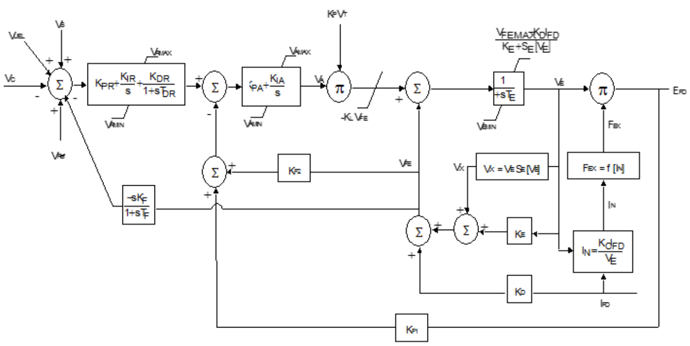
3. Governor [GO]	model definition parameters	See sample governor model below.	Model - Valid Manufacturers Databook or Expert Generator Consultant Report; **Note**: It is recommended Governor models be accompanied by baseload descriptions. For example: 0-Valves are free to move with frequency, 1- governor shall close valves, but not open them, 2- governor shall not change valve position. 3 – governor shall open valves but not close them, (and reported separately for max, min and intermediate load). The gas turbine engines of a combined cycle plant for example would then be a 1 when on firing temperature control, a 3 at min load and a 0 in-between. A combined cycle steam turbine would be a 1 at full load (VWO) and a 0 at other loads.
a. Response Limiting		ramp rate limiters/ degree-of-response caps	These cause the actual reaction to a disturbance to be less than that dictated by the governor alone. Such "outer loop controls" are often not included in the model data one receives from an OEM but must be indicated. Reference NERC Alert – February 5, 2015, Generator Governor Frequency Response
4. Power System Stabilizer [GO]	model definition parameters	See sample PSS model below.	"Manufacturer's or Expert Consultant data," until the first round of MOD-026 and MOD-027 testing has been completed.
5. Demand [LSE] - consistent with system load representation (composite load model) and components as a function of frequency and voltage			ISO New England worked with NPCC SS-38 to develop a specific dynamic load model for New England. This provided New England state specific dynamic load models for peak and light loading.
6. Wind Turbine Data [GO]	model definition parameters		"Manufacturer's or Expert Consultant data," until the first round of MOD-026 and MOD-027 testing has been completed.

7. Photovoltaic systems [GO]	model definition		"Manufacturer's or Expert Consultant data," until the first round of MOD-026 and MOD-027 testing has been completed.
	parameters		
8. Static Var Systems and FACTS [GO, TO, LSE]	model definition		"Manufacturer's or Expert Consultant data," until the first round of MOD-026 and MOD-027 testing has been completed.
	parameters		
9. DC system models	model definition		"Manufacturer's or Expert Consultant data,"
	parameters		
10. Model Name and Parameters		IEEE421.5	If a standardized model from the approved library of models is not used, provide block diagram below.
11. Source of Model		IEEE Exciter Models	Source of the Model being used
12. Voltage regulator compensation (line drop or reactive droop)	%	Rc + jXc	Note- Reactive droop is typically only used for generators tied to a common generator bus (ie, no dedicated GSU for each generator). See Line Drop Compensation diagram below.

Sample Excitation System Modeling Data

IEEE AC7B		
CON	Value	DESCRIPTION
J		T_R (s) regulator input filter time
J+1		K_{PR} (pu) regulator proportional gain
J+2		K_{IR} (pu) regulator integral gain
J+3		K_{DR} (pu) regulator derivative gain
J+4		T_{DR} (s) regulator derivative block time constant
J+5		V_{RMAX} (pu) regulator output maximum limit
J+6		V_{RMIN} (pu) regulator output minimum limit
J+7		K_{PA} (pu) voltage regulator proportional gain
J+8		K_{IA} (pu) voltage regulator integral
J+9		V_{AMAX} (pu) regulator output maximum limit
J+10		V_{AMIN} (pu) regulator output minimum limit
J+11		K_P (pu)
J+12		K_L (pu)
J+13		K_{F1} (pu)
J+14		K_{F2} (pu)
J+15		K_{F3} (pu)
J+16		T_F (s) time constant (>0)
J+17		K_C (pu) rectifier loading factor proportional to commutating
J+18		K_D (pu) demagnetizing factor, function of AC exciter reactances
J+19		K_E (pu) exciter constant related to self-excited field
J+20		T_E (s) exciter time constant
J+21		V_{FEMAX} (pu) exciter field current limit (>0)
J+22		V_{EMIN}
J+23		E1
J+24		S_E(E1)
J+25		E2
J+26		S_E(E2)

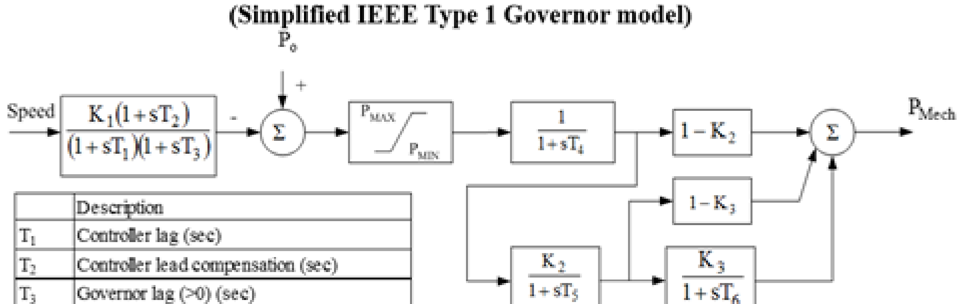
IEEE AC7B



1

Sample Governor model for generator

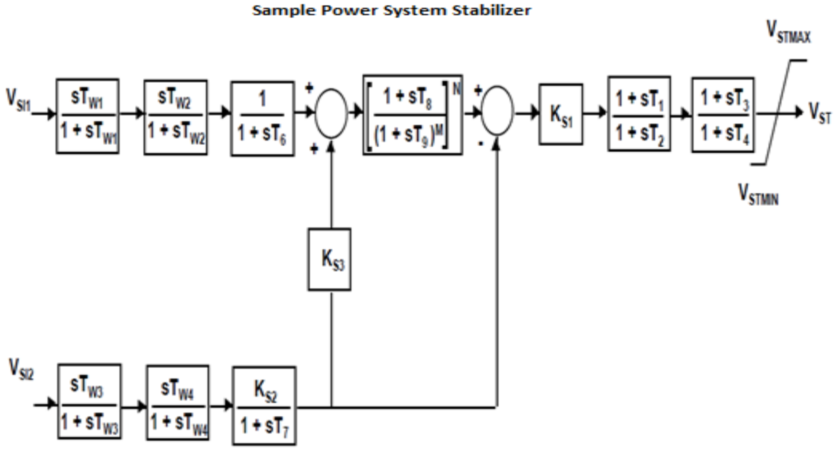
IEESGO
(Simplified IEEE Type 1 Governor model)



	Description
T_1	Controller lag (sec)
T_2	Controller lead compensation (sec)
T_3	Governor lag (>0) (sec)
T_4	Delay due to steam inlet volumes associated with steam chest and inlet piping (sec)
T_5	Reheater delay including hot and cold leads (sec)
T_6	Delay due to IP-LP turbine, crossover pipes, and LP end hoods (sec)
K_1	1/per unit regulation
K_2	Fraction
K_3	Fraction
P_{MAX}	Upper power limit
P_{MIN}	Lower power limit

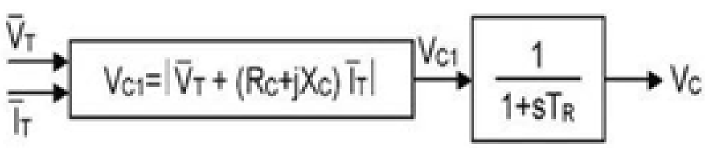
2

Sample Power System Stabilizer



IEEE Type PSS2A Dual Input Stabilizer Model

Line Drop Compensation Diagram



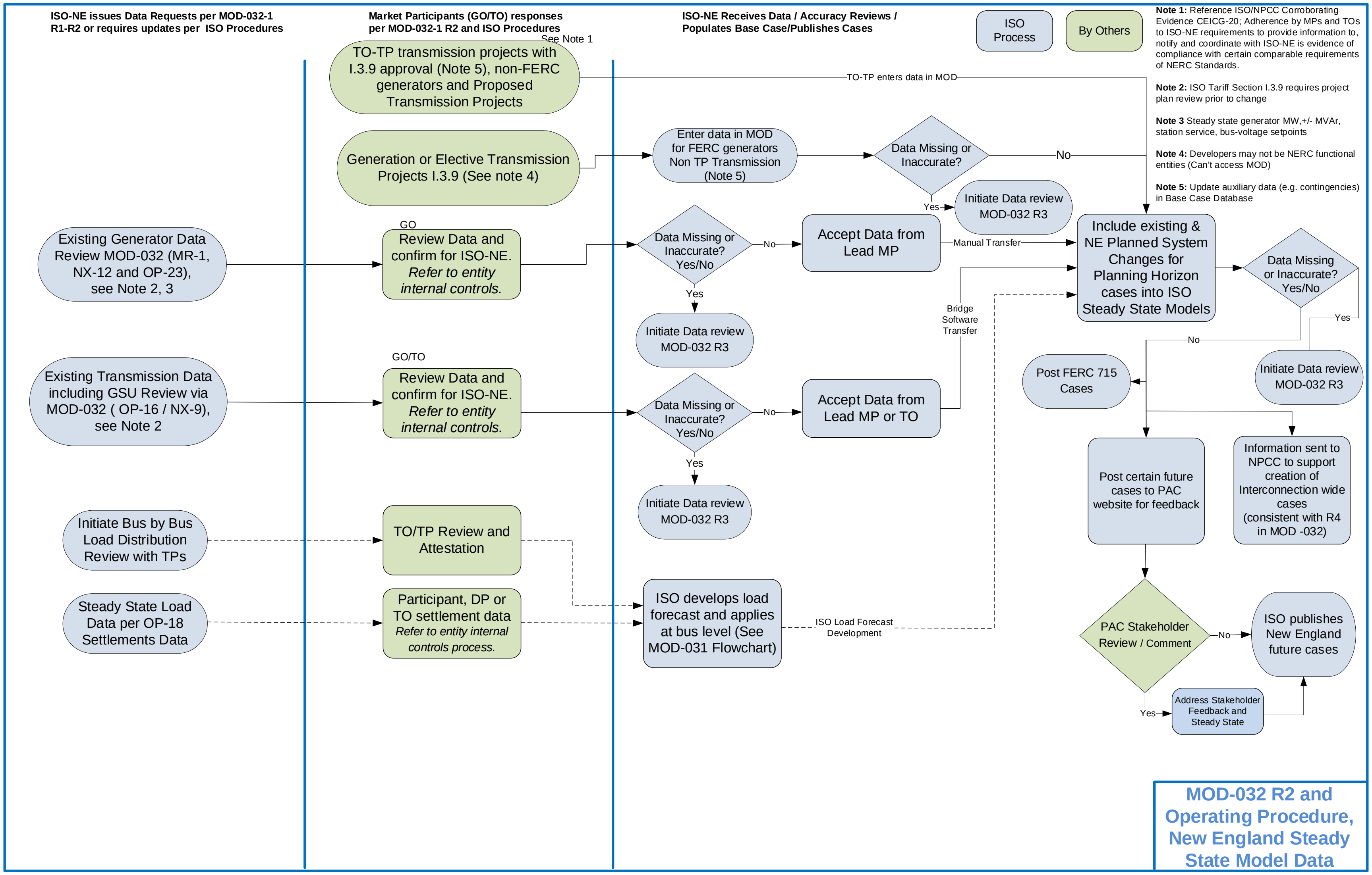
Appendix D – Short Circuit

Short-circuit	**Units**	**Example**
1. Short Circuit Impedance Data		
a. Positive Sequence Data – provide for all applicable elements in column "steady-state" [GO, TO] **Transmission Line** **Transformer to include winding connection type**	R1 + jX1 in P.U. ____ MVA Base	
c. Zero Sequence Data – provide for all applicable elements in column "steady-state" [GO,TO] **Transmission Line** **Transformer to include winding connection type**	R0 + jX0 in P.U. ____ MVA Base	
2. Mutual Line Impedance Data [TO] . This data shall be provided for each line to which the subject line is coupled. The impedance is also polarity sensitive.	R + jX in P.U. ____ MVA Base	
5. Generator Saturated Synchronous, Transient, Subtransient and Negative-sequence reactances		
a. xd (saturated synchronous reactance, direct axis)	P.U.	1.67
b. x'd (saturated transient synchronous reactance, direct axis)	P.U.	0.265
c. x"d (saturated subtransient synchronous reactance, direct axis)	P.U.	0.205

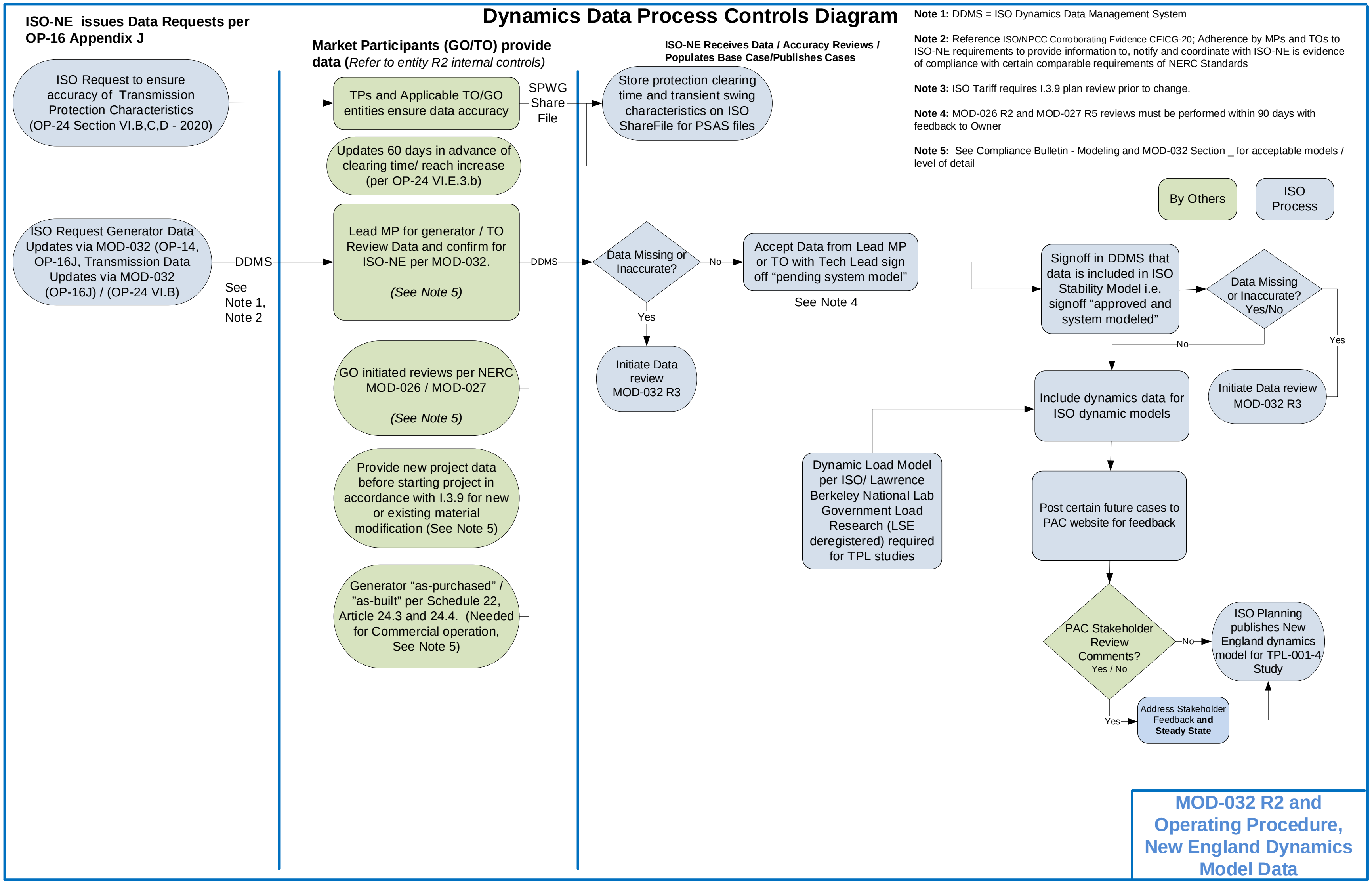
d. X2 (negative sequence reactance)	P.U.	0.205
Short-circuit	**Units**	**Example**
6. Generator and Transformer Grounding Impedance		
a. Zero Sequence Grounding Resistance for an Impedance Grounded Generator/Transformer	ohms	0.635
b. Zero Sequence Grounding Reactance for an Impedance Grounded Generator/Transformer	ohms	0.635
c. Nominal Voltage level of grounding impedance	kV	12
d. Vh (kV)	kV	14.4
e. Vl (kV)	kV	0.24
f. MVA base	MVA	506

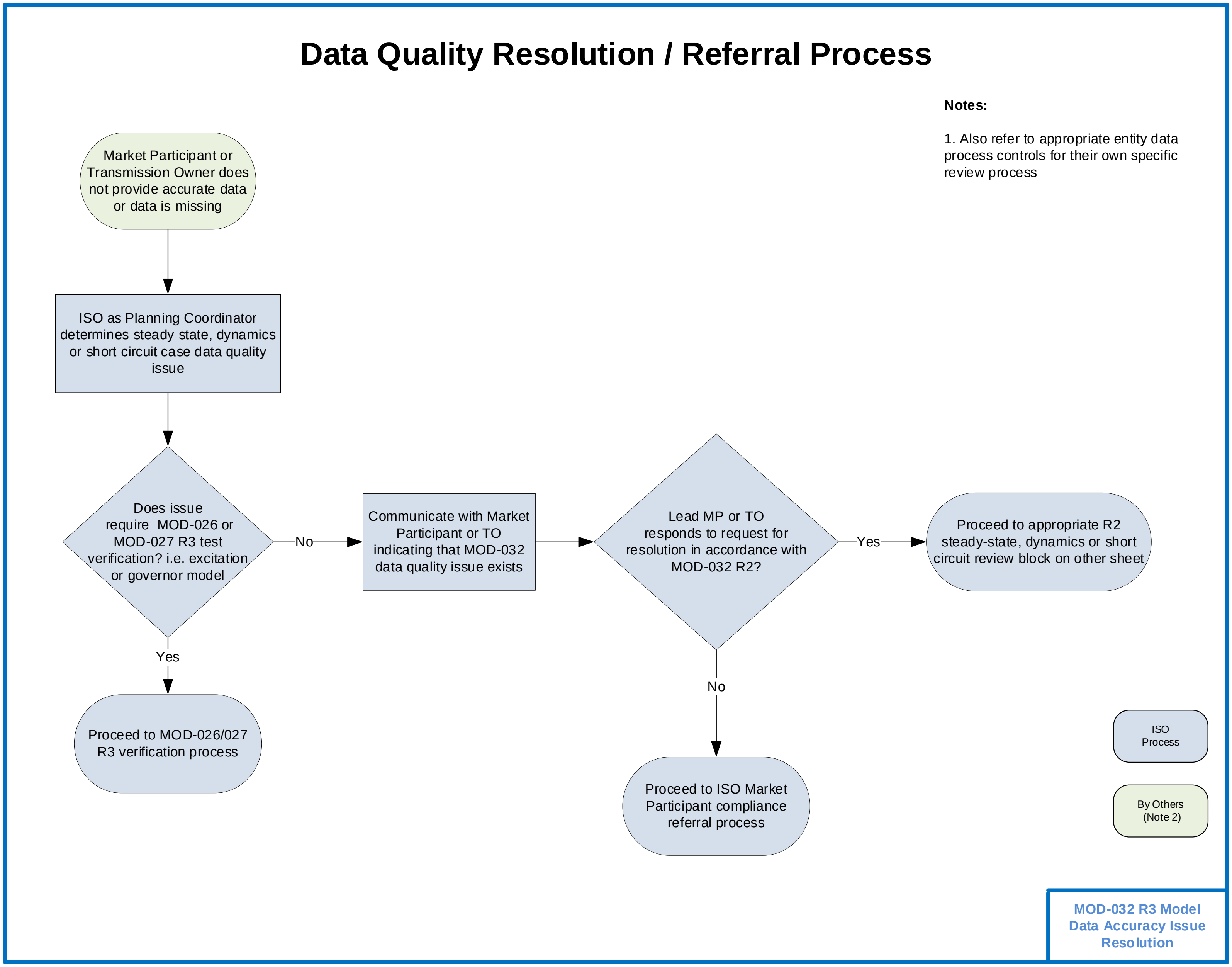
Appendix E – Process Flow Diagrams

Appendix E – Process Flow Diagrams



Appendix E – Process Flow Diagrams




Data Quality Resolution / Referral Process
Notes:
1. Also refer to appropriate entity data process controls for their own specific review process
Market Participant or Transmission Owner does not provide accurate data or data is missing
ISO as Planning Coordinator determines steady state, dynamics or short circuit case data quality issue
Does issue require MOD-026 or MOD-027 R3 test verification? i.e. excitation or governor model
No
Yes
Proceed to MOD-026/027 R3 verification process
Communicate with Market Participant or TO indicating that MOD-032 data quality issue exists
Lead MP or TO responds to request for resolution in accordance with MOD-032 R2?
Yes
No
Proceed to appropriate R2 steady-state, dynamics or short circuit review block on other sheet
Proceed to ISO Market Participant compliance referral process
ISO Process
By Others (Note 2)
MOD-032 R3 Model Data Accuracy Issue Resolution

ISO New England Compliance Bulletin MOD-032 Document History

Rev. No.	Date	Reason
Rev 0	July 1, 2015	Initial Issue
Rev 1	June 16, 2016	Remove short circuit and transmission dynamics equipment appendices that became OP-16 Appendix J and K, remove NX screenshots, remove generator dynamics appendix that was supersceded by new wording in OP-14. Modify DDMS description as system is in-service. Reflect developer entry of DDMS data. Correct SS HVDC review. Include DYR and RAW file illustrated descriptions. Add PSSe Version 33 required for models. ISO/TP Base Case Working Group review pending.
Rev 2	April 26, 2017	7/19/2016 Review with ISO/TP BCWG. Minor modification to section 2.5, 4/26/2017 Reference to Geomagnetic Data per TPL-007, minor updates
Rev 3	July 31, 2017	Review with ISO/TP BCWG. Clarify dedicated load and reactive device language
Rev 4	January 2018	Add Obsolete Models listing per OP-14 Approval with NERC Modeling Notifications as basis for change. Issue initial dynamics data requests in January. Issue initial short circuit requests in September.
Rev 4.1	March 2018	Clarify language regarding GENROU model and add gas turbine governor model information.
Rev 5	August 7, 2018	Add process flow diagrams and data transfer tables as Appendix E to illustrate data provision and review progression. Review with ISO/TO-TP Base Case Working Group.
Rev 6	March 15, 2019	Retitle to indicate ISO requirements for lower MVA generators than NERC BES, Add precedence label, revise process flow diagrams and update to current version of NERC acceptable models, indicate data submissions by ISO request, add specific language for IBR, reviewed with Base Case Working Group
Rev 6.1	February 7, 2020	Change to latest NERC List of Acceptable Models