



ERCOT Dynamic Model Submittal Guideline

Version 1.9

Document Revisions

Date	Version	Description	Author(s)
May 2020	1.0	Initial Draft	Jonathan Rose
			Reviewed by: John Schmall
September 2020	1.1	Add leading / lagging power factor scenarios for VRT	Jonathan Rose
January 2021	1.2	Updates associated with PGRR 085	Jonathan Rose
			Reviewed by: John Schmall
April 2021	1.3	Update link to Acceptable Model List, elaborate TSAT data submission requirements, add Table 1, and miscellaneous edits for clarity	Jonathan Rose
			Mehdi Daryabak Reviewed by: John Schmall
August 2022	1.4	Update various out-of-date links and Planning Guide references. Added clarifications to Table 1.	John Schmall
January 2023	1.5	Clarifications, request overlaid PSS/E, TSAT, PSCAD MQT plots, updated DMVIEW instructions, add PCAR	Jonathan Rose
			Reviewed by: John Schmall
March 2023	1.6	Update TSAT data submission and TSAT MQT requirement. Add PMVIEW.	ERCOT Operation Stability Analysis Group, Dynamic Studies
December 2023	1.7	Clarifications	
June 2024	1.8	Clarifications, "combined MQT" requirement, NOGRR245.	Dynamic Studies Department
March 2025	1.9	Reference to operational voltage tolerance requirements on pgs. 4 and 8 and updated Planning Guide 5.5 section numbers, misc. updates.	Dynamic Studies Department

Table of Contents

Executive Summary	3
Where to Find Help	3
ERCOT Dynamic Model Requirements	4
AVR and PFR Testing and Modeling Switched Shunt and Transformer Tap Controllers.....	7
About Dynamic Models	10
A Caution about Generic Models and MOD 026/027 Studies	11
Dynamic Model Templates	11
The Model Quality Test.....	12
Using DMVIEW	13
Using PMVIEW	14
Unacceptable Test Results per the DWG Procedure Manual	15
A special note on the frequency tests.....	15
Deliverables	15
Enclosures	18
References	18

Executive Summary

This guideline facilitates a Resource or Interconnecting Entity fulfill ERCOT Dynamic and Transient model requirements outlined in the [ERCOT Planning Guide \(PG\)](#) Sections 5.5 and 6.2 and [Dynamics Working Group](#) Procedure Manual Section 3. This guide applies to all modeled Resources.

Where to Find Help

- Questions regarding this guide..... dynamicmodels@ercot.com
- Interconnection and QSA issues..... Contact your Resource Integration (RI) engineer.
- General Interconnection questions..... ResourceIntegrationDepartment@ercot.com
- RIOO issues: Refer to the RIOO Documentation at <https://www.ercot.com/services/rq/re>
 - These helpful guides cover everything from setting up an account to using RIOO.
 - Additional help:
 - RIOO-IS issues (for interconnection projects) Contact your RI engineer.
 - RIOO-RS issues (for online projects) Rioo-help@ercot.com
- Dynamic model questions: Email dynamicmodels@ercot.com (please include your registered site-code¹ in the email subject line if available).
- This Guide is posted at <https://www.ercot.com/services/rq/re> , search Model Quality Guide
- [DWG Procedure Manual](#) Section 3.1 describes model requirements and model testing.
- Template issues or requesting a model Template: Email dynamicmodels@ercot.com with “*Template Issue*” in the email subject line.
- TSAT model questions: Email dynamicmodels@ercot.com with “TSAT Question” in the subject line.
- PSS/e and PSCAD model questions..... dynamicmodels@ercot.com

¹ Site-code: Visible in RIOO under Substation → Code.

ERCOT Dynamic Model Requirements

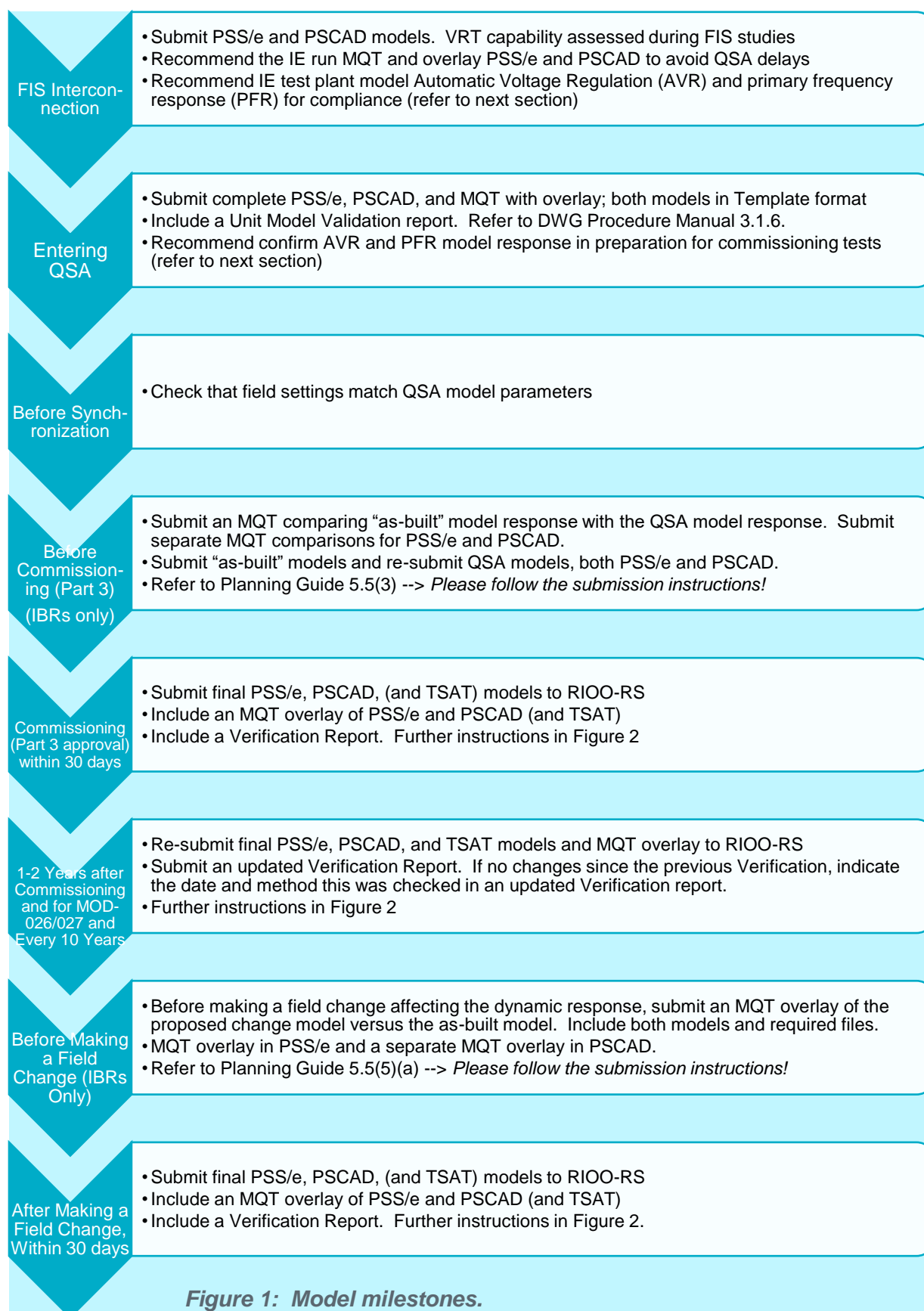


Before uploading a model to RIOO-RS, please ensure everything is included:

Check	Model Requirement [PG Section 6.2(5)(a) and Section 5.5]
	Consulted the Deliverables section at the end of this document for additional details?
	A PSS/e version 35 model (.raw, .dyr files and .dll file if a user-defined model)
	The model should not have been identified as unacceptable by NERC ²
	The model should include switched shunt and on-load transformer tap initialization scripts (PSS/e Python format) and include dynamic control models
	The number, size, and name of units in PSS/e and TSAT should match registration and should not be aggregated differently. Unit definitions can be found in RIOO-RS under “Unit Attributes”.
	IRR (wind and solar) models should be provided set up for “no-headroom” meaning that a dispatch less than Pmax does not result in a power increase to a frequency drop. The model manual should describe steps to place the model in a “headroom” (curtailed) state.
	PSS/e model in Excel Template format. Blank Templates are downloadable from: https://www.ercot.com/services/rq/re . For User-Defined Models (UDMs), the new “Universal” model Template included in this package should be capable of importing any type of PSS/e model. Problems?: Email dynamicmodels@ercot.com with “Template Issue” in the subject line.
	A TSAT model if submitting a user-defined PSS/E model (.raw, .dyr, .dll, and .tudm files)
	Two TSAT example cases, one set up using bus numbers matching the PSS/e case and the other set up using equipment names. Include a space in the generator node name(s) to confirm that the model is compatible with space characters. (include .pfb plus above files)
	The TSAT .dyr file should interoperate with the PSS/e .dyr file.
	The TSAT .tudm file should only define the structure of the model and shall not include any project-specific information
	Model manuals (okay to reference PSS/e manuals if using standard library models). PSCAD models must include manuals.
	PSCAD for Inverter-Based Resources (IBRs), embedded in the PSCAD Template downloadable from Dynamic Templates at https://www.ercot.com/services/rq/re
	Completed PSCAD Guideline checksheet. Available in the Model Quality Guide package.
	Model Quality Test report per DWG Procedure Manual. Plots should overlay PSS/e, PSCAD, and TSAT models as required. [PG Section 6.2 (5)(c), PG Section 5.5(4)]
	Model matches field equipment and appears to meet the performance requirements in the DWG Procedure Manual section 3.1.5. If not, please explain limitations.
	Plant should regulate POIB voltages within the tolerance specified in NOG 2.7.3.5(4). This generally means that plant should provide full reactive capability of at least 0.95 pf or better at POIB, in response to a voltage step of 4 kV for a 345 kV POIB, a step of 2 kV for a 138 kV

² <https://www.nerc.com/pa/RAPA/ModelAssessment/Pages/default.aspx>. Click on “Dynamic Modeling Recommendations.” See Appendix A. If unacceptable, must be corrected at the next MOD-026/027 review.

	POIB, and a step of 1 kV for a 69 kV POIB. It is recommended that REs test such a voltage step and model switched shunt controls to identify issues where their proposed model and settings may not meet operational requirements. Refer to Page 7.
	Plant Verification Report if updating field settings or any time per PG 5.5(6)(c). Details on this report can be found in the About Verification Report included in this package.
	A Unit Model Validation (“Hardware Benchmark”) report is required to enter the QSA. [PG Section 6.2(5)(d), DWG Procedure Manual Section 3.1.6]



AVR and PFR Testing and Modeling Switched Shunt and Transformer Tap Controllers

Automatic Voltage Regulation (AVR) and Primary Frequency Response (PFR) are required for all resource facilities according to Section 2 of the Nodal Operating Guides. During Part 2 of the commissioning process, ERCOT will require operational testing of both.

ERCOT has observed many plants needing to making field adjustments during commissioning. These adjustments sometimes conflict with performance objectives in the Model Quality Testing, resulting in additional model updates, and ultimately, a second round of field adjustments and testing. Interconnecting Entities can usually avoid these complications by ensuring that the models are accurate representations of the future facility and subjecting the models to AVR and PFR tests during the planning stage. This requires precise modeling of any switched shunt and transformer tap controllers and ensuring they are well coordinated with protection settings and the generator reactive controller. **To facilitate this effort, ERCOT is strongly encouraging all resources to model such controllers and provide initialization scripts in PSS/e (Python format) to ensure that the taps and switched shunts are initialized in the correct position for power flow initial conditions (real and reactive dispatch, POI voltage, etc.).** When reviewing submitted models, ERCOT has often needed to reach out regarding an MQT test reflecting poor performance. The Resource Entities (REs) reaches out to their consultant, who investigates and finds that the switched shunts were not initialized in the proper position. ERCOT must then re-review the model. This inefficient back-and-forth can again be avoided by REs who provide accurate models of their shunt / tap controllers.

- Nodal Operating Guide 2.7.3.5(4) requires plants to regulate their POIB voltage within a tight tolerance. For example, externally applying a 4 kV voltage step at a 345 kV POIB should result in the model's voltage regulator transitioning the model to maximum reactive power exchange (generally better than 0.95 power factor). Thus, it is recommended to model test applying the following voltage steps to the POIB: ± 4 kV step for a 345 kV POIB, ± 2 kV for a 138 kV POIB, and a ± 1 kV for a 69 kV POIB.
 - Refer [here](#) for a sample IRR AVR test. For more information on the PFR and AVR testing, contact Resource Integration. ResourceIntegrationDepartment@ercot.com
- ➔ Please provide accurate dynamic models for all switched shunt and transformer tap controllers and provide Python file initialization scripts for PSS/e so that the correct initial shunt / transformer tap position is selected for the initial POI conditions.

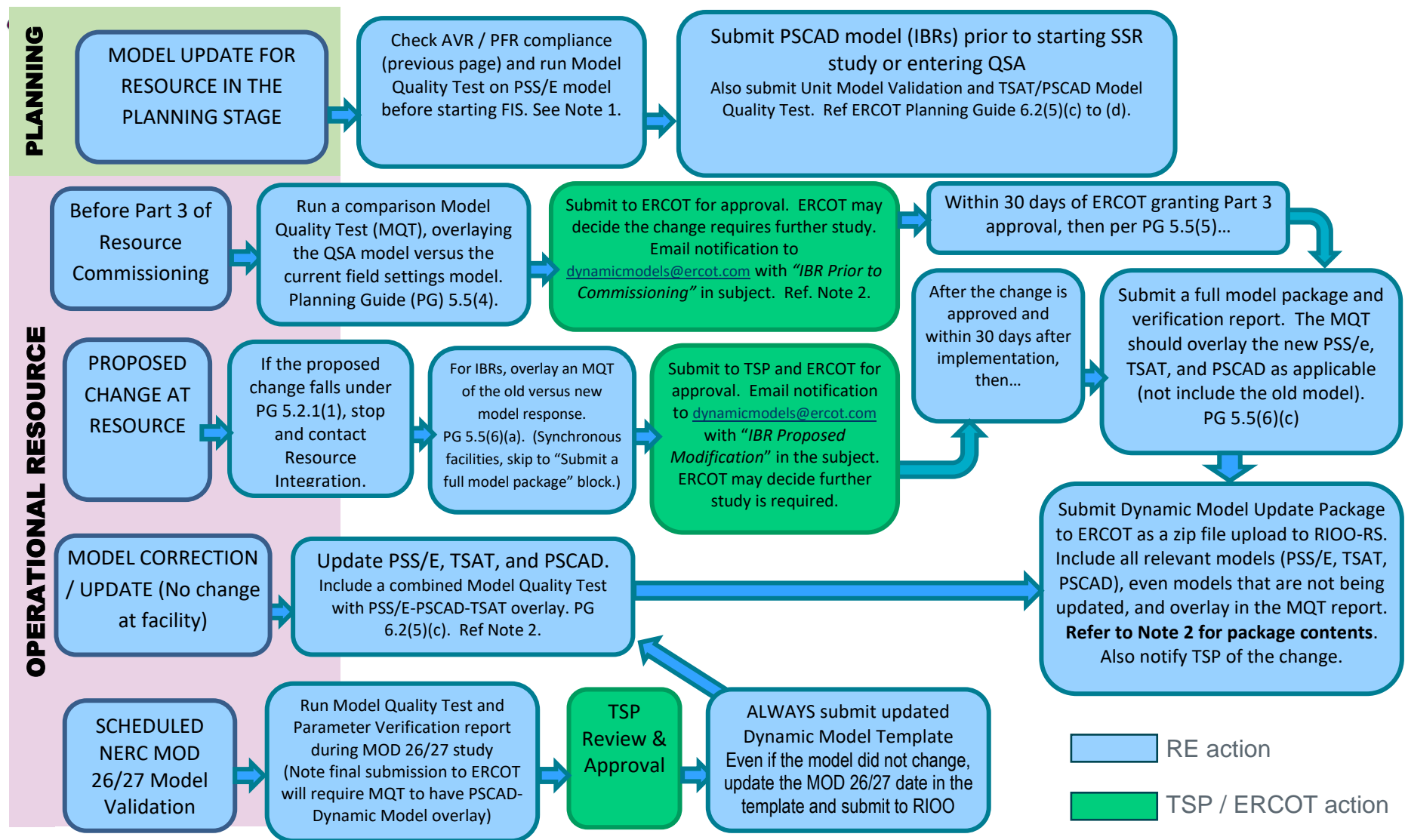


Figure 2: Model update process flow for Resource Entities (REs) and Interconnecting Entities (IEs).

(Note 2 appears on the next page.)

Note 1: IBRs, a joint Model Quality Test report (showing the PSS/E and PSCAD models overlaid) is required to enter the QSA and may be advisable to enter the FIS.

Note 2 from previous page: Follow instructions in this document for submission of models. Per the DWG Procedure Manual, PSCAD models are generally required for all inverter-based resources (certain IBRs constructed prior to 2015 may only require a PSCAD model if requested by ERCOT). TSAT models are required if utilizing a PSS/E model that is user-defined. Resource Owners must notify the interconnecting TSP of any model updates.

Requirement	Applicable Facilities	Required Tests ⁽¹⁾	When to Update	Responsible Entity	Planning Guide Language
<p>Model Quality Test for PSS/E, TSAT, and PSCAD Models</p> <p>(A single report should show the PSS/E, TSAT, and PSCAD model responses overlaid on the same plot axes.)</p>	<p>All Resources and Inverter-Based Transmission Elements</p> <ul style="list-style-type: none"> TSAT required if utilizing a user-defined model (UDM) PSCAD generally required for Inverter-based Resources (IBRs) and Inverter-based Dynamic Transmission Elements 	<p>Flat start, small and large voltage disturbance, small frequency disturbance, and system strength tests (system strength test is only required for inverter-based devices)</p> <p>When running PSCAD MQT, also include:</p> <ul style="list-style-type: none"> Phase angle jump test 	<p>A new or updated PSS/E, TSAT, or PSCAD model. Model updates are required:</p> <ol style="list-style-type: none"> When there is a change at the facility (refer to flow chart on previous page). To enter QSA. Before requesting Part 3 approval. Within 30 days of Part 3 approval. Completing MOD-026/027 studies. 	<p>Facility owner (RE, IE, or TSP)</p>	<p>PG 6.2(5)(c), PG 6.2.1, PG 5.5(6)(b) PG 5.5(4), DWG Procedure Manual 3.1.5</p>
<p>Unit Model Validation for PSCAD Model⁽²⁾</p>	<p>Inverter-based Resources (IBRs)</p>	<p>Step change in voltage, large voltage disturbance, system strength, phase angle jump, and subsynchronous tests</p>	<p>A new PSCAD model provided after 3/1/21. (UMV reports should not need updating for model parameter updates.)</p>	<p>Facility owner (RE or IE)</p>	<p>PG 6.2(5)(d), DWG Procedure Manual 3.1.6</p>
<p>Model Parameter Verification ("Verification Report")</p>	<p>All Resources and Inverter-Based Transmission Elements</p>	<p>Provide evidence that tunable model parameters match what is implemented in the field. Evidence can take the form of screenshots, nameplate photographs, signed manufacturer commissioning reports, etc.</p>	<p>A report is required:</p> <ol style="list-style-type: none"> Within 30 days of Part 3 approval, Within 12 to 24 months after Part 3 approval. (Projects built before March 1, 2021, required by March 1, 2023), A minimum of every ten years, and Within 30 days of implementing a change at the facility. 	<p>Facility owner (RE, IE, or TSP)</p>	<p>PG 5.5(5) PG 5.5(6)(c), PG 6.2(5)(b)</p>

(1). Detailed test information is available in the DWG Procedural Manual 3.1.5.

(2). Benchmark the PSCAD model against actual hardware measurements. This is not a site-specific test; the same report can be submitted for different projects whenever the same inverter is used.

About Dynamic Models

Dynamic models are utilized to simulate time-domain phenomena on the ERCOT system. These models use mathematical state equations to represent generating plant behavior to disturbances. A summary of the types of models is listed below.

DYNAMIC STABILITY MODELS (PSS/E and TSAT)

- Used for general dynamic simulations
- Required for all modeled generators
- Submitted using Dynamic Model Templates
- Manual should illustrate control logic
- Must undergo model quality testing
- Either Standard Library or UDM (User-Defined)

TRANSIENT (EMT) MODELS (PSCAD)

- Used for specialized studies
- Required for all inverter-based equipment including wind, solar, batteries
- Must complete PSCAD Model Guideline check sheet
- Manual should describe model set up
- Must undergo model quality testing

DYNAMIC STABILITY MODELS CAN BE STANDARD LIBRARY OR UDM

- Standard Library models come included in the software. This includes WECC “Generic” models and most synchronous power plant models
- User-Defined Models (UDM) models may provide a more accurate response
- UDM require .DLL files from the OEM for PSS/E and .DLL and .TUDM files for TSAT
- UDM typically require update with each new version of software*
- UDM models should adhere to the enclosed ERCOT UDM Guideline
- Either UDM or Std. Library/Generic are acceptable for ERCOT and for MOD 26/27 studies
- Generic WECC models should be confirmed by the manufacturer

* In many cases, this update effort is minimal. Manufacturers compile an updated version of their .DLL file. The parameters representing site-specific settings may remain the same in which case the MQT report would not require updating.

Figure 3: Model Types

ERCOT requires models to be provided supporting PSS/E and TSAT software and also requires PSCAD models for IBRs (e.g., wind / solar / battery resources). These models are typically furnished by the device manufacturer and should reflect the site-specific settings and layout of the plant all the way up to the Point of Interconnection (POI). The stability models for can be of either UDM or Standard Library/Generic type. Both types are acceptable for use in MOD 26/27 studies. See discussion on the next page.

A Caution about Generic Models and MOD 026/027 Studies

Many REs appear to be using generic models for their MOD 26/27 studies. While not prohibited, ERCOT has observed a high proportion of these models not yielding acceptable response, are no longer passing Voltage Ride Through, or have a response that is markedly different than the original UDM model without providing technical rationale. Per the rules in Planning Guide Section 6, ERCOT will reject such models. Please refer to the enclosed presentation.

The cause of this problem is perhaps rooted in the fact that generic models are lower fidelity models and necessitate great care in choosing appropriate parameters. The expertise necessary to convert from a UDM model to a generic model usually requires involvement of the manufacturer and is sometimes not within the expertise of 3rd party consultants advertising MOD 26/27 services.

In the ERCOT region, UDM models are allowed for MOD 26/27 studies and there is no requirement that generic models must be used. ERCOT DWG has adopted the “unacceptable” portion of the [NERC Acceptable Models List](#)^{3, 4}. Thus REs may use any model that NERC has *not* classified as *unacceptable* including models not appearing on the NERC list.

ERCOT recommends Resource or Interconnecting Entities providing a generic model to obtain confirmation from their equipment manufacturer to ensure that the generic model is appropriate.

Dynamic Model Templates

Dynamic stability (PSSE/TSAT) and transient (PSCAD) models are submitted to ERCOT using model templates. The templates are downloadable from the ERCOT Resource Entity webpage:

→ <https://www.ercot.com/services/rq/re>

The posted templates support a wide range of manufacturers and technologies. If you find that your dynamic model is not supported by the posted templates, contact dynamicmodels@ercot.com and put the phrase “Template Request” in the email subject. ERCOT will create/update a template for you.

NEW! -- Any updated PSCAD models should be submitted in PSCAD Template format. The PSCAD Template is stored in the same zip file as the dynamic model Templates. There is an included video tutorial.

³ NERC Acceptable Models List, <https://www.nerc.com/pa/RAPA/ModelAssessment/Pages/default.aspx>

⁴ ERCOT rule regarding acceptable models: Refer to Section 3.1.9 of the DWG Procedure Manual, posted at <https://www.ercot.com/committees/ros/dwg>

The Model Quality Test

The model quality test is designed to help a Resource or Interconnecting Entity test their model before submitting to ERCOT. This helps ensure the model meets requirements and reduces arduous back and forth communication and corrections. Two optional tools are provided to facilitate testing: DMVIEW for PSS/E and PMVIEW for PSCAD. (No tool is currently provided for TSAT however it is straightforward to set up using the TSAT injection function. Search for “Voltage and Frequency/Angle Injection Data” in the TSAT Model Manual.) At the conclusion of the test, the Resource or Interconnecting Entity provides a test report and testing files to ERCOT via RIOO.

- **Model quality tests must be performed using the current version of the Planning Software** (ref. DWG Manual 3.1.5.1) which is **PSS/E version 35** and **PSCAD version 4.5 or higher** (ref. DWG Manual 3.1.1).
- Model quality tests must be provided whenever providing a new or updated PSS/E, TSAT, or PSCAD model.
 - Standard library/generic models are not required to provide an MQT report testing the model in TSAT. User-defined models (UDM) are required to provide an MQT report testing the model in TSAT as well as PSS/E.
- In most situations, the PSS/E, TSAT and PSCAD models should be updated at the same time. Please overlay the PSS/E-TSAT-PSCAD MQT plots to facilitate comparison.
- For synchronous plants, a MOD 26/27 test report plus TSP usability report of the same model may fulfill ERCOT’s model quality test requirements. However, for inverter-based resources, MOD 26/27 reports do not fulfill the MQT requirements.
- Resources should perform model quality testing at the same time as conducting MOD 26/27.
- Self-Limiting Facilities (SLFs) and Hybrid plants, e.g., solar + energy storage system (ESS), should submit a combined model and perform at least 4 test scenarios to ensure comprehensive model testing. The required test scenarios are as follows:
 - Non-ESS Off, ESS On (Charging)
 - Non-ESS Off, ESS On (Discharging)
 - Non-ESS On, ESS Off
 - Non-ESS On (Generally 50% of Max Capacity), ESS On (Generally 50% of Max Capacity)
- Additionally, a combined model quality test report is necessary for multiple sites sharing any control systems, such as a Power Plant Controller (PPC), and is recommended when sites share a main power transformer (MPT).

A sample testing report is enclosed with this document. Details on the model quality test can be found in the most recent DWG Procedure Manual, Section 3.1.5 posted at:

→ <https://www.ercot.com/committees/ros/dwg>

The DWG Procedure Manual Section 3.1.5 contains information:

- How to set up the simulation
- Types of tests to perform

- Test criteria
- Example plots

Using DMVIEW

Dynamic Model reView (DMVIEW) is an optional external tool that can be used to perform model testing in PSS/E. Download the tool from:

→ <https://sites.google.com/view/dmview/home>

Before using DMVIEW, you must have a working dynamic case with your plant modeled up to the Point of Interconnection (POI). Please refer to the DMVIEW manual for complete instructions as well as the DWG Procedure Manual Section 3.1.5 for how to set up the case. Some helpful tips are provided here.

1. Copy your model files to a new folder under the CASEs folder. Follow the DMVIEW Program Manual instructions to place a slack generator connected to the POI bus by a zero-impedance line. Tip: ERCOT has found that adding a very small amount of impedance to the zero-impedance line will facilitate setting an initial reactive flow. For example, use a value of 0.001 reactance.
 - a. The generator is connected to the medium voltage bus by the appropriate transformers and collector system equivalent. Note: You must use an aggregate model (i.e. do not model individual wind turbines or solar inverters). Several methods exist for calculating the equivalent collector impedance; see for instance the NREL/WECC method⁵.
 - b. Refer to the DWG Procedure Manual Section 3.1.5 for information on setting up the initial voltage schedule and dispatch.
 - i. For most of the tests, you can set up an initial 0 MVar reactive exchange at the POI. A convenient way to achieve this is to set the voltage schedules of the slack generator and test generator to 1.0 per-unit and set the test generator to regulate the POI bus. For the lead and lag Voltage Ride Through tests (LVRT/HVRT), you can modify the voltage schedule of the test generator slightly to achieve a desired reactive dispatch at the POI or the latest version of DMVIEW accepts POI_PF = 0.95 command in the INI file for lagging and -0.95 for leading. Tip: Assign the “zero impedance” branch a slight non-zero impedance, say 0.001 reactance, to facilitate voltage control initialization.
 - c. Ensure that the powerflow solves.
 - d. For Inverter-Based Resources (including Wind, Solar, and Batteries), you will generally need to set up four powerflow cases and run DMVIEW four times:
 - i. Case with 100% real power and minimal reactive power exchange
 - ii. Case with 80% real power and minimal reactive power exchange for the frequency step tests
 - iii. Case with 100% real power and 0.95 power factor leading at the POI for the voltage ride through tests (also called the Large Voltage Disturbance tests)

⁵ E. Muldadi, “Method of Equivalencing for a Large Wind Power Plant with Multiple Turbine Representation.” NREL Conference paper, July 2008. <https://www.nrel.gov/docs/fy08osti/42886.pdf>

- iv. Case with 100% real power and 0.95 power factor lagging at the POI for the voltage ride through tests (also called the Large Voltage Disturbance tests)
2. Copy one of the example INI files (either Wind.ini or Solar.ini) and edit the path names to correctly point to your project files.
3. Change the tests specified in the INI file: (for synchronous plants, see footnote⁶)

```
Test1_FS = ['FS', '10']
Test2_VDWN = ['VOLT', 'DATAS\\ERCOT_VOLT-STEP-DOWN.xlsx']
Test3_VUP = ['VOLT', 'DATAS\\ERCOT_VOLT-STEP-UP.xlsx']
Test4_HVRT = ['VOLT', 'DATAS\\ERCOT_HVRT.xlsx']
Test5_LVRT = ['VOLT', 'DATAS\\ERCOT_LVRT.xlsx']
Test6_FRQDWN = ['FREQ', 'DATAS\\ERCOT_FRQ-STEP-DOWN.xlsx']
Test7_FRQDWN = ['FREQ', 'DATAS\\ERCOT_FRQ-STEP-UP.xlsx']
Test8_SCR2 = ['SCR2', '10->5->3->1.5->1.2, 5, 1'] /SCR is changed from 10 to 1.2 in 5 second intervals, with fault.
```

These settings will run the following tests:

- No disturbance 10-second Flat Start
 - POI Voltage Step Down 3%
 - POI Voltage Step Up 3%
 - HVRT
 - LVRT
 - Frequency Step Down 0.3 Hz, assuming no headroom
 - Frequency Step Down 0.3 Hz, assuming headroom⁷
 - Frequency Step Up 0.3 Hz
 - Short Circuit Ratio Test
4. Follow the program instructions to run the tool.
 5. Compare your result plots to the examples illustrated in the DWG Procedural Manual. From these, you should get a good idea whether your model will be acceptable.
 6. Prepare a test report similar to the enclosed example. Submit to ERCOT.

Using PMVIEW

PSCAD Model reView (PMVIEW) is an optional external tool that can be used to perform model tested in PSCAD. One benefit over other tools is that it will perform most tests in one button click using the PSCAD multi-run block. Download the tool from:

➔ <https://sites.google.com/view/pmview>

Before using PMVIEW, you must have a working PSCAD case with your plant modeled up to the Point of Interconnection (POI). A brief manual is included in the download. More help is available

⁶ For synchronous plants such as fossil, delete the HVRT, LVRT, and SCR2 tests and add **Test8_FAULT = ['FAULT', '-2e10']** at the end. Note that you will need version 2.5.1 or higher of DMVIEW.

⁷ "Headroom / no headroom": Refer to discussion under the heading "A special note on the frequency tests."

once the tool is opened in PSCAD; the tool has numerous comment boxes to guide you through usage.

Unacceptable Test Results per the DWG Procedure Manual

If you find that your model is unacceptable and it is for an existing resource, provide a description of the issue, including whether the shortcoming is limited to the model or whether the shortcoming really exists in the field. Your priority is to first provide an accurate model of your resource as it exists in the field. Then afterwards, develop a plan to correct the shortcoming. Provide a proposed model illustrating the corrected response to ERCOT for review along with an estimated timeline. After adjustments are made, a new PSS/E / TSAT / PSCAD model, model quality test reports, and verification report should be submitted.

A special note on the frequency tests

Renewable generators typically operate in a “power availability” state without headroom. Thus, there will be no response to a low frequency event unless the plant is curtailed (i.e., has headroom). By default, the model should be set up to interpret $P_{GEN} < P_{MAX}$ to mean that power availability is less than capability (e.g., wind speed or solar insolation is lower than maximum) so the model should not respond to a low frequency event. There should be some means to enable headroom (such as a switch or flag in the dynamic model) to tell the model to instead interpret $P_{GEN} < P_{MAX}$ to mean that the facility is curtailed. The dynamic model should not require adjusting P_{MAX} to indicate whether headroom is available. A flag in the dynamic model would be the preferred means to indicate headroom availability. (This discussion only applies to renewable units; for conventional units the difference between P_{GEN} and the temperature-compensated P_{MAX} is typically available to the governor for frequency response.)

ERCOT requires that all intermittent renewable (IRR) models be able to operate in the “no headroom” state and this be the default setting when the model is received. If the model is not currently capable of being switched for headroom / no headroom, then this limitation should be explained in the quality report with a note when the feature will be added.

Deliverables

Models and Verification reports should be submitted to ERCOT’s R100-RS portal:

- Select your plant or station and begin a New Change Request. The type of Change Request should be an “Attachment Only” change request.
- Upload all files as attachments. Compressed .zip file format works best. The maximum size per file is approximately 60 MB so it may be necessary to split large files into smaller files by un-zipping them first and re-zipping them.

- Be sure to upload all plant models, manuals, and reports to the change request, even models that are not being changed (Refer to Section 1 of this document, ERCOT Dynamic Model Requirements). Thus, for example, if you are updating the PSS/E model, then please attach your latest PSCAD model as well for IBR plants. To indicate whether a model is being updated, please indicate the model update date in the filename. For example, a PSCAD model which was last updated December 27th 2018 for Sitecode Turtle should be named “TURTLE_PSCAD_2018-12-27.zip” Refer below for file naming instructions.
- If you have difficulties using RIOO-RS, first see the RIOO guides posted at <https://www.ercot.com/services/rq/re> and, if that does not resolve your issue, then email RIOO-help@ercot.com. If all else fails, reach out to your ERCOT client services account manager asking to submit files an MIS service request. You will need a digital certificate with role assigned called “MP Assets” in order to make the upload.

Submitting PSS/E and TSAT models:

- ✓ Model contained within an Excel model template⁸
- ✓ If the model is a user-defined model (UDM), then submit:
 - Models adhering to the requirements in the included “ERCOT UDM Guideline”
 - PSS/E model package (including .sav or .raw, .dyr, and .dll files) set up based on the bus numbers that aligns with the bus numbers in the TSAT model package
 - TSAT model package (.raw, .dyr, .dll, and .tudm files) set up based on the bus numbers that align with the bus numbers in the PSS/E model package
 - TSAT model package (.pfb, .dyr, .dll, and .tudm files) set up based on Equipment Names. The equipment names should include a space in the names to demonstrate that the UDM model is compatible with the space character (an ERCOT TSAT requirement)
 - A model manual describing simulation set-up, tunable parameters, and illustrating a functional control block diagram
 - Include switched shunt and transformer tap initialization scripts and controls as necessary
- ✓ Model Quality Test report (a sample report is included)
 - Include the test case consisting of .sav, .dyr, and any .dll files.
 - Overlay the PSCAD and TSAT model responses with the PSS/E model response. (TSAT is required for UDM models and PSCAD is required for most IBR models.)

Submitting PSCAD models:

- ✓ Model contained within a PSCAD template
- ✓ PSCAD model with model manual

⁸ Blank Templates for PSS/e and PSCAD can be downloaded from: <https://www.ercot.com/services/rq/re> User-defined model templates are available upon request by emailing dynamicmodels@ercot.com with “Template Request” in the email subject line.

- ✓ Completed PSCAD model guideline (a blank guideline checksheet is included)
- ✓ Model Quality Test report showing the PSS/E and TSAT model responses overlaid
- ✓ Unit model verification (“hardware benchmark”) (required for resources interconnected after 3/1/2021)

File Submission and Naming Guides:

- For the PSS/E / TSAT models, package all files into a single compressed zip file, name the file: **(SITECODE)_DYNAMIC_(date).zip** with the appropriate sitecode and date, and upload to ERCOT’s RIOO portal.
- For the PSCAD model, package all files into a single compressed zip file, name the file: **(SITECODE)_PSCAD_(date).zip**, and upload to ERCOT’s RIOO portal.
- The “date” in the filename should refer to the date that the model was last updated.
- RIOO has an upload file size limit of approximately 60 MB. If your file is too large, you may need to re-zip a file, splitting the contents into several smaller zip files for upload.
- Please submit all models, even models that you are not currently updating. For example, an IBR utilizing a UDM model should submit the PSS/E, TSAT, and PSCAD models. The date in the filename will indicate to ERCOT whether, for example, the PSCAD model was updated.

Operational resources must also submit a model parameter verification report as required by Planning Guide 5.5 (5) and Planning Guide 5.5 (6)(c). Refer to the “About Verification Reports” document for additional information about this report.

Questions:

- ➔ Regarding dynamic models? → dynamicmodels@ercot.com
- ➔ Regarding RIOO / RIOO-RS system? → RIOO-HELP@ercot.com
- ➔ Additional contacts found in the “Where to Find Help” section of this document.

Enclosures

- ERCOT PSCAD Model Guideline
- ERCOT UDM Model Guideline
- ERCOT presentation, Caution with Generic Models
- Memo on REGC Generic Models
- Sample model quality test report and files
- Sample verification (PVR) report
- About Verification Reports informational document

References

- Dynamic Model Templates, posted at <https://www.ercot.com/services/rq/re>
- DMView PSS/E model testing tool. Available at <https://sites.google.com/view/dmview/home>
- PMView PSCAD model testing tool. Available at <https://sites.google.com/view/pmview>
- NERC Unacceptable Model List
<https://www.nerc.com/pa/RAPA/ModelAssessment/Pages/default.aspx>
- DWG Procedure Manual Section 3.1.5 <https://www.ercot.com/committees/ros/dwg>
- ERCOT Planning Guide Section 5.5 and Section 6,
<http://www.ercot.com/mktrules/guides/planning/current>