ERCOT User Defined Model Submittal Guideline

# Introduction

To adequately simulate dynamic and transient events in the ERCOT System, it is necessary to establish and maintain dynamics data and simulation-ready study cases representing the dynamic capability and frequency characteristics of machines and equipment connected to the ERCOT System. ERCOT Dynamics Working Group (DWG) uses the PSS/E software package. Standard PSS/E library dynamics models are preferred where possible, as these models typically provide good compatibility with PSSE and are automatically made forward compatible with the next version of PSS/E. If a standard PSS/E library model cannot be used to represent the dynamics of a device, user defined models (also referred to as UDM) can be used, if accepted by ERCOT and the DWG after being tested for compatibility.

# Observed Issues and Examples

UDM have several limitations and deficiencies, listed below, that have been observed to create challenges in preparing DWG simulation-ready study cases and performing system studies.

* **Black-box model with limited control and model information**:

Most UDM user manuals focus on how to incorporate model properly in the simulation tool. Many features are described very briefly without detailed control block diagrams and design logic included in the document. This basic information may allow a user to include the model in the study tool but is not sufficient to fully understand the response and perform further investigation for observed responses.

* **Unclear set up procedures**:

Some UDM documentation is incomplete or unclear regarding basic steady state modeling such as settings for Xsource, Qmin, Qmax, time step, etc. or how to represent aggregated resources.

* **Multiple library files and specific set up**:

UDMs are typically provided with associated .obj, .lib, or .dll files. Some UDMs require more than one library file and some even require a specific sequence or directory structure when compiling these files. These additional restrictions create difficulty and extra burden to incorporate the model in the study case and often are not compatible with the case building practices of the ERCOT DWG.

* **Inconsistent simulation time step requirements**:

It is not possible to run simulations incorporating all UDMs when they have conflicting time step requirements. For example, some UDMs have a maximum simulation time step restriction (e.g. not greater than 1 ms) while other UDMs have a minimum simulation time step restriction (e.g. not less than a quarter-cycle).

* **Multiple versions/formats/library files for the same type of machines**:

Where different models are provided for the same facilities at different locations, it is often not clear that the different model reflects actual differences in the facilities or improved/corrected modeling that should be applied to all such facilities. File naming practices are often confusing and inconsistent.

* **Settings and parameters**:

UDMs can include hundreds of parameters to represent a device. Although it may be necessary to have access to all of the parameters in the design and development phase, only critical parameters (that are adjustable and can significantly affect the system response) should be available to the study user. A model with hundreds of parameters that are not adjustable by the user create an unnecessary data maintenance burden and make data and simulation errors more likely.

* **UDM robustness**:

Some UDMs perform well within a simple test case, but appear to cause issues (simulation crashes, suspect response, etc.) when incorporated into a full ERCOT/DWG flat start case.

* **Crash without message**:

It is impossible to effectively troubleshoot a case when the addition of a UDM causes a simulation crash without any messages about what conditions are incompatible with the model.

* **Models with protection settings sensitive to numerical noise**:

During/after faults, bus frequency, which is a calculated value in PSSE, may be subject to numerical deviations. Protection models should avoid using instantaneous protection (zero pickup time) and consider whether additional filtering and associated time delay is necessary.

* **Models crashing when Point of Interconnection is islanded**:

This has been observed to occur for certain models when branch contingencies are applied resulting in an island.

* **Modes crashing when GNETing or out-of-service**:

The GNET function in PSSE is a useful debugging tool to discount certain plant dynamics. Some UDMs also require removal of the dynamic model itself in order to GNET properly, which makes the debugging process cumbersome.

* **Models with poor memory management**:

UDMs require designated memory location to write the response. Poor memory management can write to the memory address that is out of the bound of the allocated space by PSS/E and affect other models in the system.

* **Protocol-Required Capability**:

Except where otherwise allowed, all generating plants must have dynamic reactive power and automatic voltage regulation capability (NP 3.15 and NOG 2.2.5), Voltage Ride Through capability (NOG 2.9), and Frequency Response (NOG 2.2.7), among others. This required capability should be reflected in provided models.

* + In addition, control strategies should consider the need to provide system support while coordinating with nearby resources. Voltage regulation with droop capability and dynamic reactive capability during voltage ride through are examples of such response.
* **Model may not adhere to PSS/E UDM requirements:**

Some cases where PSS/E reserved keywords have been used in UDMs. Should there be some process for ensuring that PSS/E UDM protocols are being followed?

* Others?

# UDM Submittal Requirements

* Model is submitted by completing the ERCOT-provided Dynamic Model Templates and attaching it to the Stability Model Page of your RARF. There is a location to attach model files and manuals for PSSE modeling.
* UDM models should be provided in .dll file format for PSSE version 33. .
* One UDM should have only one associated library file.
* New UDMs should be designed and written to eliminate issues identified in section 2 above. A UDM should not restrict the selection of the simulation time step.
* Manufacturers should clearly indicate what model files correspond to what product families and utilize consistent naming strategies for associated model files to ensure that the appropriate model for a particular installation is being used.
* Others?

# Implementation

ERCOT will work with DWG and DMTF to develop a guideline for UDMs. Once the guideline is approved/accepted by DWG and DMTF, ERCOT should work with MPs to develop a process to improve the UDM model quality.