DWG Procedure Manual Updates for NOGRR-245

Jonathan Rose
ERCOT Transmission Planning

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Objective

- NOGRR-245 introduces new requirements. This draft DWG Procedure Manual update, posted in this July IBRWG meeting page for review, aligns the model quality process, particularly the low voltage ride through (LVRT) and high voltage ride through (HVRT) evaluation.

- ERCOT presented model testing for NOGRR24, soliciting feedback.
  - https://www.ercot.com/calendar/03082024-IBRWG-Meeting-_-Webex : March IBRWG
  - https://www.ercot.com/calendar/04122024-IBRWG-Meeting-_-Webex : April DWG and IBRWG Joint Workshop
  - https://www.ercot.com/calendar/04242024-DWG-Meeting-_-Webex : April DWG Meeting
  - https://www.ercot.com/calendar/06142024-IBRWG-Meeting-_-Webex : June DWG and IBRWG Joint Workshop
  - https://www.ercot.com/calendar/06202024-DWG-Meeting-_-Webex : June DWG Meeting

- Targeting August ROS meeting approval. Language to be effective once NOGRR-245 is approved.

- Please provide comments / questions by July 19, 2024.
  - Email: Jonathan.Rose@ercot.com; John.Schmall@ercot.com; Sunwook.Kang@ercot.com

Summary of DWG Procedure Manual Edits

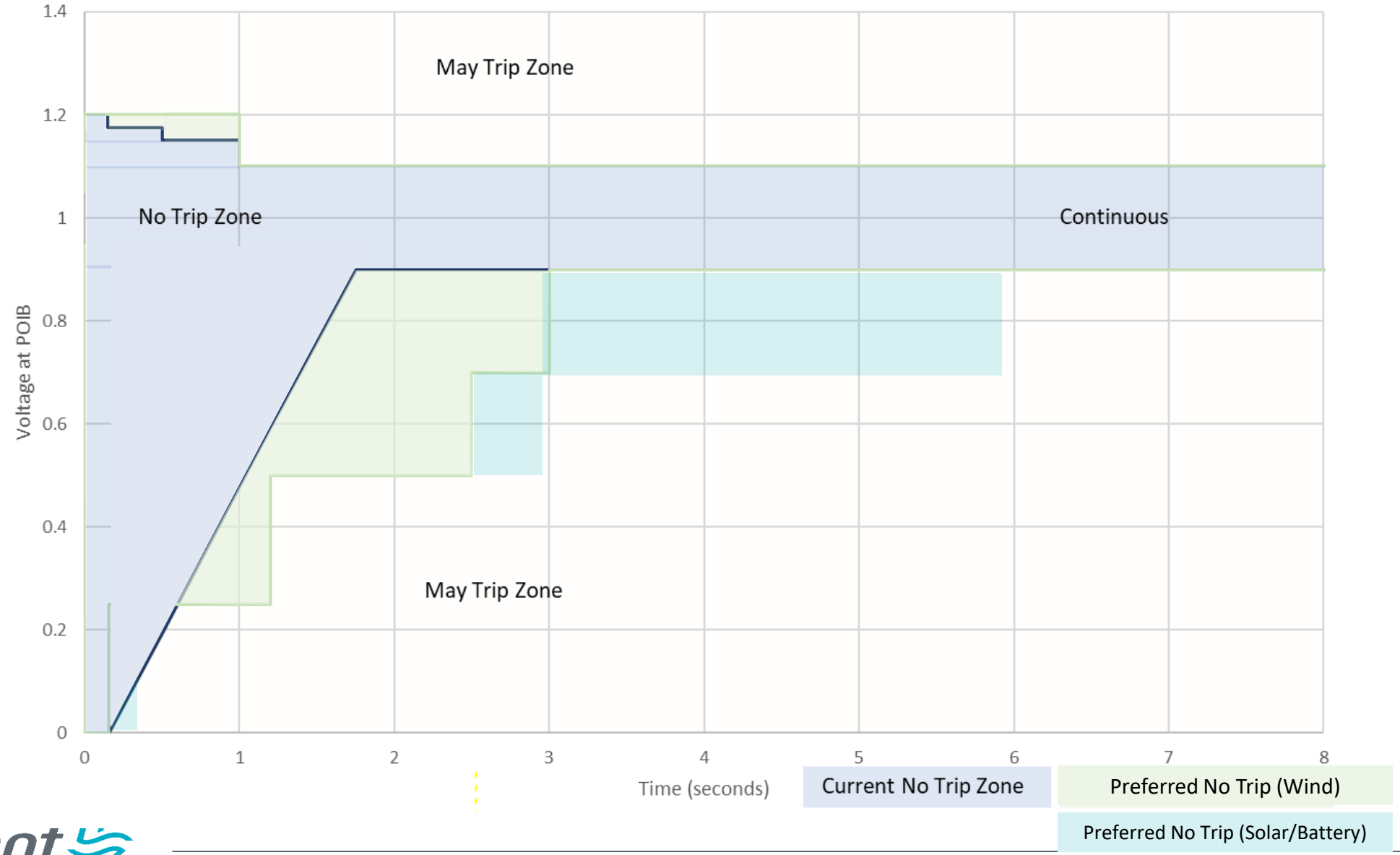
1. Edit LVRT testing to include new NOGRR-245 “Preferred” curve.
   - ERCOT is asking everyone to run both the “Preferred” new curve and the “Legacy” curve. (Informative even if an old plant is not required to meet the Preferred curve.)
   - Performance requirement criteria updated slightly for the new curve.

2. Edit HVRT to include new NOGRR-245 “Preferred” curve.
   - Run the new curve first. If plant cannot pass, run the existing curve.
   - No change to performance criteria.

3. Miscellaneous Edits:
   - Now requesting modeling of switched shunt and transformer tap controls
   - Resources should maximize their capability beyond requirements and document their capability.
   - Transient over-voltage test has been removed. After direction from IEEE-2800.2, we may reconsider.

NOGRR245

Current vs New IBR Voltage Ride through Curves (Table A)



Section 3.1.5.4, LVRT setup

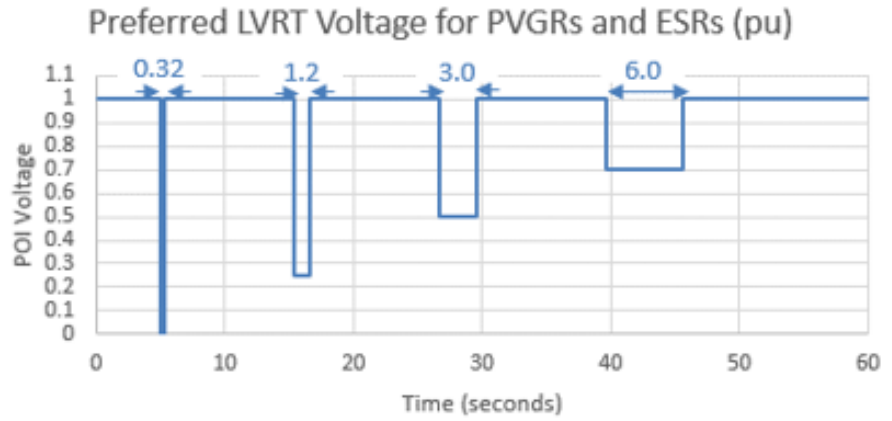
3.1.5.4 Large Voltage Disturbance Test: (Low Voltage Ride-Through (LVRT) for IBRs, WGRs, and IBTEs)

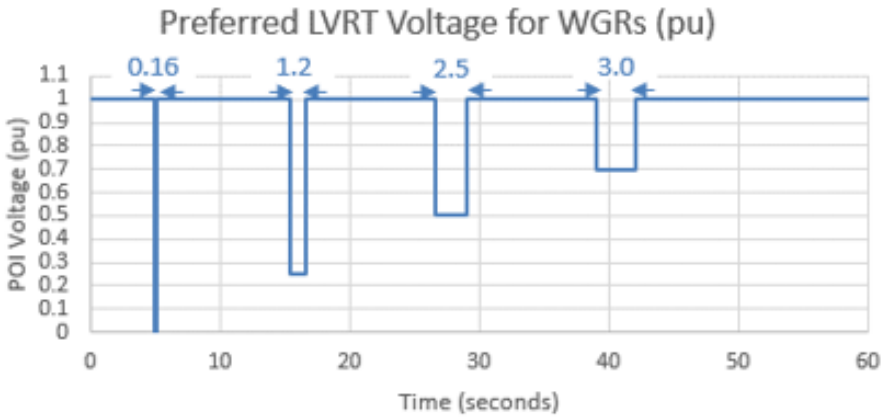
All IBRs, WGRs, and IBTEs ~~and WGR plants~~ should test two curves, both a "legacy" curve and a "preferred" curve as described in NOG 2.9.1. Testing both curves helps provide important model performance information. In situations where passing the "preferred" curve is not mandated by NOG 2.9.1, the "preferred" curve test must be run but will be considered for informational purposes regarding owner efforts to maximize capability.

- The "legacy" Low Voltage Ride Through curve per NOG 2.9.1.2.
- The "preferred" Low Voltage Ride Through curve per NOG 2.9.1.1. The curve shall be run as a series of separate piece-wise disturbances with the voltage returning to 1.0 per-unit (pu) voltage after each disturbance (see below examples). The spacing between each disturbance may be greater than 10 seconds to allow for recovery as necessary.

NOGRR-245 Edits:

- Requires testing of both Legacy and Preferred curves.
- Preferred curve run piece-wise.





Section 3.1.5.4, LVRT Criteria

When testing the "legacy" curve, the following performance criteria apply:

- For the low voltage transient, the model should inject reactive current throughout the voltage recovery period. At the POI, both P and Q are necessarily zero during zero voltage. Q injection at the POI should be observable immediately or very shortly after voltage begins ramp up from zero.
- For 0.9 pu sustained POI voltage, the AVR should provide voltage support that moves the resource towards nearly full reactive production (significantly lagging).
- Real power recovery should start prior to the POI voltage recovering to 0.9 pu.
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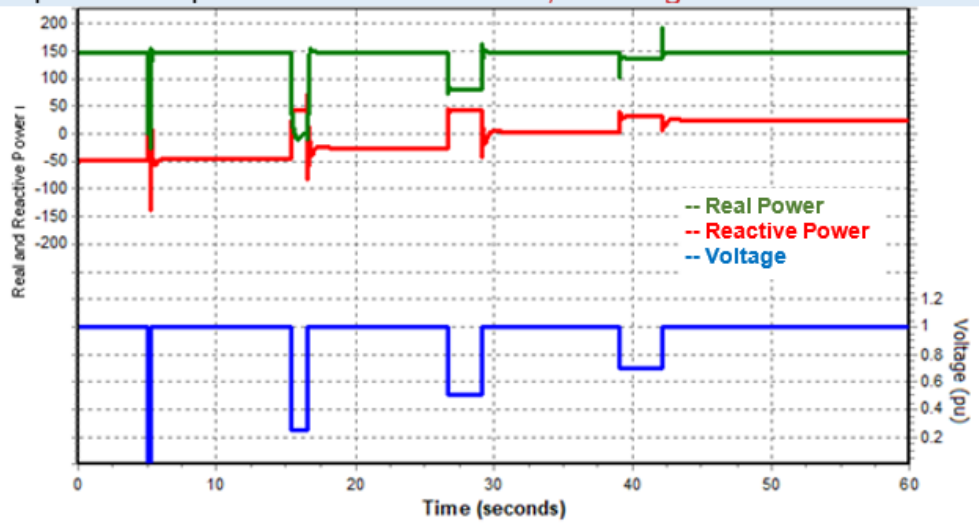
When testing the "preferred" curves, the following criteria applies:

- During the voltage dips:
  - The model shall inject active current for POI voltage dips of 0.5 and higher.
    - Injections of significantly reduced active current for voltage dips 0.5 pu and 0.7 pu should be accompanied by increased reactive current.
  - Reactive current injection at the POI shall be observable immediately or very shortly after a non-zero voltage dip is applied.
- After the voltage dips:
  - Real power should recover to full output within 1.0 seconds of POI voltage recovery to 1.0 pu.
- An explanation, including a reference to any exempt status per ERCOT Nodal Operating Guide Section 2.9.1, shall be provided for models which indicate that the unit trips or fails to meet any of the above performance criteria .

- Legacy curve performance criteria unchanged
- New performance criteria for preferred curve.
  - Note that these borrow heavily from the existing requirements and are mostly updated because the piece-wise nature of the test is different from the Legacy curve.

Acceptable Response: Preferred: LVRT, Leading Initial Power Factor

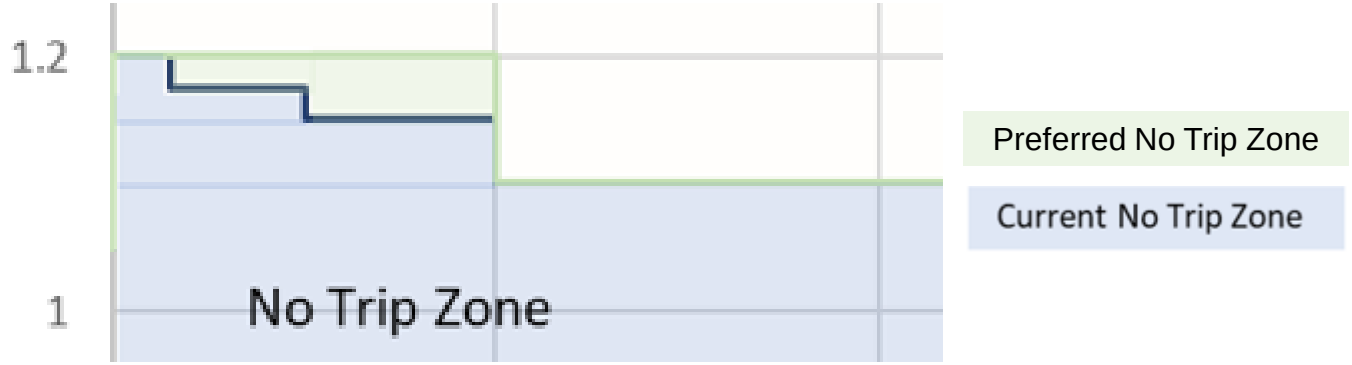


Section 3.1.5.5, HVRT setup

3.1.5.5 Large Voltage Disturbance Test (High Voltage Ride-Through for IBRs, WGRs, and IBTEs)

First, apply the "preferred" HVRT curve to the POI per NOG 2.9.1. If the facility cannot meet the "preferred" ride through requirements, then additionally test the "legacy" HVRT curve and report both results. The "preferred" curve has more stringent requirements, so it is not necessary to test the "legacy" curve for devices passing the "preferred" curve, and such testing would generally not provide additional revelations regarding model behavior.

- Run the new preferred curve. If unacceptable, then run the Legacy curve.
- HVRT model performance criteria unchanged



Section 3.1.5.5 HVRT Criteria

The HVRT profiles start at 1.0 pu voltage and ends at 1.1 ~~per unit~~pu. ~~This~~ The tests ~~shall~~ should be performed for two initial conditions: with the facility operating at ~~a~~ 0.95 lagging power factor (at the POI) and with the facility operating at 0.95 leading power factor (at the POI). The model shall exhibit appropriate dynamic reactive response, active current injection, AVR response, and the model shall not exhibit momentary cessation.

The following criteria apply to both the "preferred" and "legacy" HVRT tests:

- During the high voltage transient, the model should provide a fast dynamic response to absorb reactive power. The resource should be absorbing a significant amount of reactive power at the POI during the high voltage transient, and ideally within 0.5 seconds of the transient inception.
- For 1.1 pu sustained POI voltage, the AVR should move the resource towards nearly full reactive absorbing (significantly leading).
- Real power should be sustained during high voltage condition. A modest real power reduction (typically 5% of Pmax or less) may be acceptable to accommodate greater reactive power absorbed for sustained POI voltages in the range of 1.05 pu to 1.10 pu provided real power fully recovers when POI voltage returns to normal operating range (0.95-1.05 pu).
- An explanation, including a reference to any exempt status per ERCOT Operating Guide Section 2.9.1, shall be provided for models which indicate that the unit trips or fails to meet any of the above performance criteria.

- Performance criteria unchanged.
- "Active current injection" added for symmetry with LVRT; we already had a requirement for sustained real power so this adds nothing new.

Requirement to Document Maximized Performance

- NOGRR-245 requests sites to maximize to equipment capability, not just meet requirements.
- NOGRR-245 provides timeframes for this work
- The DWG Procedure Manual has added a small paragraph:

  Additionally, the maximized LVRT capability as required in NOG 2.9.1.1(9) or 2.9.1.2(8) shall be demonstrated and documented in a format similar to the tables in NOG 2.9.1.1(1) or NOG 2.9.1.2(1).

- Information gathered can be used to benchmark model updates. If a later update appears to decrease capability, an explanation should be provided for review.
  - Goal is for everyone to work together to improve riding through system events.
  - The current process for evaluating MQT results will continue (will continue to test prescribed curves, not the maximized capability reported by Resources).

2.9.1.1 Preferred Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs)

(1) All IBRs subject to this Section shall ride through the root-mean-square voltage conditions in Tables A or B below, as applicable, and the instantaneous phase voltage conditions in Table C below, as measured at the IBR's POIB:

Table A: Applicable to WGR IBRs

Root-Mean-Square Voltage (p.u. of nominal)	Minimum Ride-Through Time (seconds)
V > 1.20	May ride-through or trip
1.10 < V ≤ 1.20	1.0
0.90 ≤ V ≤ 1.10	continuous
0.70 ≤ V < 0.90	3.0
0.50 ≤ V < 0.70	2.5
0.25 ≤ V < 0.50	1.2
0.005625 ≤ V < 0.25	(V+0.084375)/0.5625
V < 0.005625	0.16

Table B: Applicable to PhotoVoltaic Generation Resources (PVGRs) and ESR IBRs

Root-Mean-Square Voltage (p.u. of nominal)	Minimum Ride-Through Time (seconds)
V > 1.20	May ride-through or trip
1.10 < V ≤ 1.20	1.0
0.90 ≤ V ≤ 1.10	continuous
0.70 ≤ V < 0.90	6.0
0.50 ≤ V < 0.70	3.0
0.25 ≤ V < 0.50	1.2
0.095625 ≤ V < 0.25	(V+0.084375)/0.5625
V < 0.095625	0.32

Changes to Section 3.1.2

3.1.2 Dynamic Models – General

Dynamic models compatible with the software(s) and version(s) listed in Section 3.1.1 shall be submitted to both ERCOT and the interconnecting TSP. In addition to the requirements described in the Planning Guide Section 6.2, Dynamics Model Development, providers of dynamic models shall also adhere to the following requirements:

- Each dynamic device requires a model with model parameters that accurately represent the dynamics of the device over the entire range of operating conditions.
- Static switchable devices part of Inverter-Based Resource (IBR) facilities (such as on-load tap changing transformers (OLTC) and switchable reactive shunts) should include an initialization script or logic to correctly initialize for the POI initial conditions of the power flow case the model is integrated in (for example, a Python file for PSS/e and initialization logic for PSCAD), and should include switching control logic if the device is expected to switch within 45 seconds of a disturbance.
- PSCAD models shall be submitted to ERCOT for all IBRs, Wind-powered Generation Resources (WGRs), and inverter-based transmission elements (IBTEs) installed on or after January 2015; for equipment installed before 2015 PSCAD models shall be submitted to ERCOT upon request. For purposes of this manual, IBTEs includes STATCOMs, static VAR compensators (SVCs), and other transmission devices with power electronic grid interfaces.

Switched Shunt and Transformer Tap Controllers

ERCOT is requesting all IBR facilities to start modeling these controllers to improve model consistency and accuracy. Modeling has the additional benefit of enabling facilities to check their automatic voltage regulation (AVR) and primary frequency (PFR) response prior to the commissioning tests.

- ERCOT has had difficulty replicating the MQT report behavior, often due to vague shunt / tap control objectives.
- Provide switching models going forward for future model submissions. In case of difficulties, ERCOT will consider extensions on a case-by-case basis.

Clarified requirements for TSP-owned dynamic equipment. This was previously approved at DWG.

Overview Table Added

Test		Applicable Models	Applicable Technologies
Flat Start		PSCAD PSS/E TSAT	ALL
Small Voltage Disturbance			
Small Frequency Disturbance			
Large voltage disturbance tests	Low Voltage Ride Through (LVRT)		IBRs* and WGRs and IBTEs
	High Voltage Ride Through (HVRT)		
Large voltage disturbance via a fault test		PSS/E, TSAT	Synchronous machines (including synchronous condensers)
System Strength		PSCAD, PSS/E, TSAT	IBRs*, WGRs and IBTEs
Phase Angle Jump		PSCAD	IBRs*

No changes here, but adding the table provides clarity when a test is required.

Definitions in Nodal Protocol Section 2:

- **IBR** = “Inverter Based Resource” and includes Solar, Battery, and Type 3 and Type 4 Wind
- **WGR** = “Wind Generation Resource” and includes all types of wind.
- **IBTE** = “Inverter-Based Transmission Element”. This applies to TSP-owned dynamic devices and is the responsibility of the TSP.

Next Steps

- Please provide comments / questions by July 19, 2024.
  - Email: Jonathan.Rose@ercot.com; John.Schmall@ercot.com; Sunwook.Kang@ercot.com

- ERCOT will request DWG to consider moving forward with the changes at August ROS meeting.

- (While NOGRR-245 is not yet approved, the parts still under discussion seem unlikely to impact the DWG Procedure Manual edits, since the DWG Procedure Manual captures the VRT curves and references applicability back to the Nodal Operating Guide Language which NOGRR-245 is updating.)