

ERCOT VOLTAGE PROFILE WORKING GROUP
PROCEDURE MANUAL

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1 INTRODUCTION

1.1 **Background**

ERCOT Nodal Protocols, Section 3.15 (1) dictates that ERCOT in coordination with the TSPs shall establish, update as necessary and post on the Market Information System (MIS) Secure Area the ERCOT System Voltage Profiles for all Electrical Buses used for Voltage Support in the ERCOT System.

ERCOT staff in coordination with the TSPs establishes the ERCOT System Voltage Profiles at the Point of Interconnection (POI) of Generation Resources biannually. These voltage profiles, calculated twice a year, are posted on the MIS Secure Area by June 1st for Summer and Fall voltage profiles and by December 1st for Winter and Spring voltage profiles.

1.2 **Purpose & Scope**

The purpose of the Voltage Profile Working Group (VPWG) is to formalize a framework of requirements and criteria associated with the coordination necessary to produce Voltage Profiles for the ERCOT System. This coordination may include appropriate Protocol and Guide changes necessary to support development and implementation of the Voltage Profiles. The VPWG's scope of work should include consideration of the following issues:

- Improving the Voltage Profile Study process
- Develop and update the VPWG procedural manual to reflect current practices
- Establishing the system voltage profiles and tolerance for Generator Buses and Generator POI's used for voltage support in the ERCOT system
- Establishing a preferred voltage profile and tolerance at the POI of future generating units for the Summer and Fall voltage profiles and the Winter and Spring voltage profiles.
- Establishing the basis of the need for constraint management plans to mitigate post contingency voltage violations
- Providing feedback to OWG for operational concerns identified in the Voltage Profile Study process
- Providing feedback to the Planning Working Group (PLWG) for planning needs identified in the Voltage Profile Study process
- Recommend Protocol and Guide changes to clarify definitions, provide guidelines, address conflicts with NERC Reliability Standards, and modify rules to account for emerging reliability needs as necessary relative to the ERCOT system Voltage Profiles
- Hold bi-annual open meetings to include QSEs and REs to consider ways to improve process.
- Support technical workshops and training efforts related to the obligations of entities in the development and implementation of the Voltage Profiles

2 VOLTAGE PROFILE STUDY PROCEDURE

2.1 Study Setup

- a. **Study Cases:** Steady State Working Group (SSWG) cases are used as a starting point for the voltage profile study.
 - i. The summer study cases are SUM1, FAL2 year+1. The winter study cases are WIN1, SPG2 year+1.
 - ii. TSPs will check control bus numbers for each of the generators and verify that the correct transmission POIs are modelled in all study cases. All generator control bus numbers should be TSP-assigned bus numbers and not ERCOT generator bus numbers (should not be in the 11000-range).
 - iii. TSPs will submit updates (in IDEV format) which will add the appropriate voltage profile for the upcoming study season, the generation plant controlled bus (which shall be the same as the transmission POI), update reactive device status for equipment under their control, update any operational bus voltage limits (normal and emergency) which may differ from the limits modeled in the Network Operations Model, and add any transmission configuration changes that may not be represented in the case.
 - iv. ERCOT, in conjunction with the TSPs, shall review typical Private User Network (PUN) load/generation injection for the season to be studied and determine the appropriate load/generation ratio to be modeled for each PUN.
- b. **Study Case Conditioning:**
 - i. Off-line or New Generation Resources: The treatment of off-line (and/or mothballed) units and new generators is coordinated with the TSP for the area where the generators are located.
 - ii. Generator Reactive Capabilities: TSPs will check generator reactive capabilities in the case and submit IDEVs for any necessary corrections.
 - iii. Incorporate any long term transmission and generation outages expected to last a significant portion of the study period. Check the study case for any lines incorrectly modeled out of service.
 - iv. Incorporate any known operational issues or limitations into the case. Documentation of these operational issues to be provided as feedback to the SSWG.
 - v. VPWG will consider input provided by the QSEs and REs regarding their current voltage profiles.
- c. **Contingency List**

A contingency list for the planning horizon topology representation is created & maintained by the SSWG and posted on the MIS Secure Area. The following contingencies are selected from the latest contingency set that matches the selected study cases used in the voltage profile study:

 - i. NERC P1 Contingencies: Single Contingency (includes loss of a generator, breaker-to-breaker transmission circuit, transformer, and shunt device)
 - ii. NERC P7 Contingencies: Loss of a double-circuit on a common tower sharing more than half a mile.
 - iii. Automatically generated single element contingencies (includes loss of individual segments within a breaker-to-breaker line segment)

2.2 Study Process

1. **Study Pass 0 (Study Kickoff):**

The study is kicked off via an e-mail to the Voltage Profile Group using the e-mail address: voltageprofilegroup@lists.ercot.com.

This email must include the base cases and contingency files that will be used as a starting point for the study. ERCOT and the TSPs must perform the checks listed under Study Case Conditioning, Section 2.1 b. TSPs must review the information in the modified SSWG cases for accuracy and to correct any base case or contingency voltage abnormalities:

- Check base case system voltages
- Adjust Capacitors and Reactors (including wind farm devices)
- Check SVC voltage control settings
- Check Autotransformer LTCs. If changes are needed, the TSPs are requested to submit corrections in an acceptable format (such as an IDEV or CON file).

This email may also include a proposed calendar of activities to be performed during the review & the expected start/stop dates.

2. **Study Pass 1:**

- a. Upon completion of the initial case review, ERCOT will incorporate the suggested updates and revisions into the base cases & contingency definitions as needed.
- b. ERCOT staff will then run Contingency Analysis using the updated base cases and contingency definitions and identify voltage violations based on the below voltage criteria. Contingency analysis will be run assuming a Full Newton-Raphson solution method with tap adjustments locked, switched shunt adjustments locked, phase shift and DC taps locked.
- c. ERCOT will check for conflicting setpoints at a common control bus and will report back to the TSPs.
- d. TSPs shall use their procedures for the operation of transmission-controlled reactive Resources in order to minimize the dependence on generation-supplied reactive Resources.

Voltage Criteria

The following ranges are considered to be the default steady-state system voltage limits in ERCOT for Operations purposes:

- i. 0.95 per unit to 1.05 per unit in the pre-contingency state
- ii. 0.90 per unit to 1.10 per unit in the post-contingency state.

As per the ERCOT SOL Methodology for the Planning and Operations Horizon, Section 3.3.2, if a Facility owner communicates alternate voltage limits that are more restrictive than the default, these limits shall be considered the steady-state voltage limit for their Facilities. TSPs shall review the voltage limits modeled in the Network Operations Model and use as a limit for any PSS/E bus when these are seen to be more restrictive than the above listed values.

- e. The list of voltage violations resulting from the Contingency Analysis study is sent out to the VPWG. Each TSP is requested to review the violations for their system/area and provide suggestions to resolve the voltage violation.

3. **Review Pass 1:** Each TSP provides solutions to resolve the voltage violations sent by ERCOT at the end of Study Pass 1.
4. **Study Pass 2:**
 - a. ERCOT staff will verify the suggested resolutions.
 - b. ERCOT staff will create a preliminary voltage profile report for all units in the case. The voltage profile will be based on the scheduled voltage in the case. For all online units, the resulting POI voltage is expected to be within +/-2% of the voltage setpoint assigned to that unit. Any deviations from the +/-2% shall be identified. If a unit is out-of-service in the study case, then its scheduled voltage shall be used as its voltage profile.
 - c. Documentation will be requested for any deviations greater than the +/- 2% or for any online unit that shows its reactive power output to have reached a Qmin/Qmax limit.
 - d. The voltage profile shall be rounded to the nearest 0.5 kV.
 - e. The updated voltage violation list and preliminary voltage profile spreadsheet is sent to the VPWG during Pass 2. Each TSP is requested to review these for their system/area and provide documented suggestions to resolve any voltage violations as specified in c. above.
5. **Review Pass 2:** Each TSP provides solutions to resolve voltage violations and/or changes to the draft voltage profile spreadsheet sent by ERCOT.
6. Steps subsequent to Pass 2 are iterative in nature, and are repeated until all voltage violations have been resolved and all applicable voltage set points have been established.

2.3 **Finalizing the Study Results**

- a. Before finalizing the voltage profile, the VPWG shall meet in person or via WebEx to discuss voltage violations, suggested solutions, the voltage profile, and any deviations from the +/- 2% check.
 - i. ERCOT staff will document the suggested solutions and/or any exemptions (granted in the Nodal Protocols) that allow a unit's voltage profile to deviate from the +/- 2% requirement and then implement these in the base case of the study. If necessary, contingency analysis shall then be re-run, and the results evaluated.
 - ii. The contingency analysis results will be sent out to the VPWG. If any of the suggested solutions do not resolve the intended violations, these results will be communicated to the specific TSPs.
 - iii. If a TSP is unable to resolve any of the voltage violations, the TSP is requested to develop an Operational solution, Remedial Action Scheme (RAS) or Congestion Management Plan (CMP) for the associated contingency or contingencies. Any new RAS or CMPs shall be coordinated with ERCOT.
- b. The finalized Voltage Profile is posted on the MIS Secure Area. A Market Notice will be issued informing the ERCOT Market Participants (QSEs and TSPs) of the study completion and new voltage profile postings.
 - i. To be compliant with NERC Reliability Standard VAR-001-4.1, ERCOT Staff shall ensure a column is provided that will note an equivalent Voltage Profile at the bus

representing the high-side of the Generator Step Up (GSU) transformer for every Generator. In most instances this is the same bus as the transmission POI. If the low-side of the GSU must be used for some reason, identify it as such.

- ii. When the POI is electrically separated from the high-side of the GSU, the following formula shall be used to estimate the equivalent Voltage Profile at the high side of the GSU:

$$HS\ GSU\ V_s = \frac{HS\ GSU\ V_A \times POI\ V_s}{POI\ V_A}$$

- iii. The Market Notice shall include a presentation explaining the Voltage Support Service (VSS) responsibilities and the format of the Voltage Profile spreadsheet.

2.4 **Study Feedback to other Working Groups**

1. At the end of each study period, VPWG shall provide the following feedback to other ERCOT Working Groups:
 - a. Any modeling or contingency issues discovered while reviewing the SSWG cases will be documented and provided as feedback to the SSWG.
 - b. Any operational issues or limitations discovered in the course of the voltage profile study shall be documented and provided as feedback to the SSWG, including suggested solutions.
 - c. Any generating plant which reaches its maximum reactive capability during the course of the study, shall be documented and provided as feedback to the SSWG. This list may indicate the need for additional study to determine if reactive devices under TSP control (Capacitor banks, SVCs, STATCOMs, Auto Transformer LTCs and Reactors) are required in order to maintain adequate dynamic reserve.
 - d. ERCOT shall attend the QMWG meeting at least once a year to present the Voltage Support Service responsibilities and Voltage Profile information, mentioned in item 2.3 b. iv. above, to the QSEs.
 - e. VPWG shall report its progress to ROS.