**Voltage Workshop List of Issues/Recommendations**

1. **Planning and Operations (for both ERCOT and ERCOT TOs) need to enhance coordination on voltage support activities. *PLWG, SSWG, DWG, OWG, NDSWG***
   1. Reactive device sizing should have operations input to allow for operational flexibility after the necessary additional reactive support amount has been determined. Examples should be provided. Potential solution could be for ERCOT, in coordination with market participants, to consider drafting guidelines regarding reactive device sizing, availability (i.e. if device tapped on line ensure that line contingency does not require the device to be in service for voltage control) and acceptable voltage rise/dip during energization for peak and off-peak seasons to ensure that the Planning-proposed reactive device sizes are appropriate for Operations. **Not Started.**
   2. Voltage limits should be reviewed for more consistent methodology across the ERCOT system for when planning voltage limits differ from operational voltage limits. More restrictive planning limits should not cause an issue with operational limits in Real-time. If this is not the case, discuss the reasoning for the discrepancy in limits **Not Started**
   3. Voltage limits should be reviewed and coordinated for more consistent methodology across the ERCOT system when voltage limits vary significantly between neighboring ERCOT Transmission Operators as to not burden any one Transmission Operator. Clarification should be made as to the term “voltage limit” and the rationale for neighboring TOs to have consistent criteria. **Not Started**
   4. A formalized process and criteria is needed for identifying reactive support needs that show up in operations due to system conditions (generation dispatch, outages, and load patterns) that differ from traditional peak/off-peak planning study cases. Discussion should also include issues related to PUN dispatch assumptions and availability when ERCOT is unable to actually dispatch them in a real time situation, whether Planning Criteria must be changed to provide the TO with more static devices to compensate for PUN unavailability, and discuss where this new criteria should be located in the Planning and/or Operating Guides. **Not Started**
   5. Voltage Schedules should be reviewed for more consistent methodology across the ERCOT system when planning voltage schedules differ from operations schedules (some schedules may simply be generic in nature). This should include variations between the Network Model and SSWG cases. Network Model should be reviewed (with NDSWG) to ensure that the appropriate fields are available to accommodate the necessary inputs relative to voltage schedules and reactive device operating guidelines. **Not Started**
   6. A criteria to maintain adequate dynamic reactive reserves should be identified for both operations and planning. If operations is tasked with monitoring and maintaining dynamic reactive reserves, then planning should have a process to plan for that capability. Also, the planning process should include the operational criteria of monitoring generator power factor at POI and maintaining dynamic/balancing reactive use proportionally (while clarifying in the ERCOT Protocols and Operating Guides language what this means – i.e. unity power factor at all times?). **Not Started – Target 2017**
   7. Voltage stability screening processes should be reviewed for the studied areas and cases utilize so that they can consider additional stressed conditions that Operations may see. (Currently there are peak and some off peak scenarios).

Voltage stability may be more of an issue in off peak cases (i.e. shoulder months) when generation may be offline in voltage sensitive areas. **Started – Target 2017 – Reactive zones (VSAT Monitoring)**

* 1. Planning and Operational assessments that identify steady state voltage instability (Jacobean matrix) should consider a methodology when there should be an additional investigation into angular/transient instability as the former may indicate the presence of the latter. **Started – Target 2017 – Reactive Zones (TSAT Monitoring)**
  2. Motor load modeling requirements should be reviewed to ensure the VARs are where they need to be (sending VARs long distance in a study assessment would be inefficient and may not be indicative of real time operations.) Motor load may vary seasonally as well. **Not Started**
  3. Potential solution could be for ERCOT, in coordination with market participants, to draft guidelines regarding motor starting such as acceptable voltage dip, source outage considerations (i.e. motor starting with single line outage at the POI or at nearest major breakered station). A forecast margin of error should be established to allow for that error to be accounted for in planning and operational assessments if not already. **Not Started**

1. **A new Voltage Profile Working Group should be created that reports to ROS. *(\*new\* VPWG)***
   1. All ERCOT Transmission Operators that have generation interconnected to their system(s) should have mandatory participation. **In Progress- Increased Participation with VPWG, but not 100%.**
   2. Resource Entities should have mandatory participation and provide input earlier in the current process. – **In Progress - No mandatory participation, but VPWG outreach to QMWG part of profile creation process.**
   3. Current process of TOs proposing profiles to ERCOT, then allow ERCOT to study and accept should be maintained. The cases used for setting the Profiles should be validated against real time conditions to ensure the developed Profiles are realistic. If necessary, provide feedback to SSWG of the results of the validation. **In Progress, VPWG is evaluating performance and considering any necessary adjustments. VPWG also evaluating if case SSWG cases should be modified to reflect different conditions.**
   4. Definitions related to voltage profiles, voltage set points, ranges, thresholds, schedules/limits, peak/off peak set points, and seasons should be clarified in the ERCOT Protocols/Operating Guides. Consider using diagrams or visuals depiction of these defined terms to show how they relate to one another and how they relate to NERC terminology. Consider using NERC terminology whenever possible. **In Progress – NPRR 747/NOGRR 150 modified definitions to voltage profiles and voltage set-points, NERC OC/PC committees have produced a reactive planning and operations guideline document, FAC SDT is considering voltage limits definition change, and VAR EPRT is considering recommending voltage schedules definition.**
   5. A method of updating generator reactive capabilities should be implemented to ensure the SSWG cases have the latest reactive capabilities (there may be a few months lag from the SSWG Case to the voltage profile assessment). **Started - Developed RARF vs NDCRC verification tool.  EMS and SSWG receive reactive capability data from RARF.  Found multiple instances where NDCRC curves where not updated in RARF.  Developing internal procedure to find discrepancies and notify Resource to update RARF.**
   6. The current +/- 2% range should be reviewed to determine if this is an appropriate performance range for generators to be within for operating to their published or instructed voltage profile set point. The 2% language needs to be expanded upon in the ERCOT Protocols and Operating Guides. Currently the language is only referenced as a compliance measure for reporting to the TRE. However, the Steady State Voltage Control Procedure shows this to be a requirement of the unit during the voltage set point process. Discuss how the 2% range is applied when set points have been temporarily changed by the TSP and clarify the actual range when the new range goes beyond the voltage limits (SOL) coordinated with ERCOT. **Started – New NPRR 776 and associated NOGRR introduce issue.**
   7. The studied voltage profile range should be reviewed to study larger ranges in areas that typically have to have large voltage profile set point modifications due to changing system conditions (load variability, wind generation variability, PUN loading). When voltages in an area swing considerably, which were previously unplanned for, a process should exist in which Planning recreates the extreme voltage swings and proposes future projects to mitigate the large swings as long as the swings are recurrent and not special/abnormal/unusual configurations. **Not Started**
   8. The voltage profile location should be reviewed to accommodate a requirement that helps to alleviate confusion and unnecessary work (currently ERCOT protocols require at POI and NERC standards at the high or low side of the GSU). Verify the NERC intent and ERCOT implementation of the voltage profile at the POI. The Resource entity should have telemetry/SCADA available to allow them to monitor their performance to the published/instructed voltage profile set point. This would be at the final determined voltage profile location after review of item 2.i. **Started – NPRR 776 and associated NOGRR introduce voltage set point telemetry. ERCOT conducting a POI survey to identify POI as RARF POI locations did not appear to be correct.**
   9. The expected dates/seasons for implementation of new published voltage profile set points should be clarified. **In Progress - NPRR 747/NOGRR 150 identify seasons and clarifications offered in Market Notice.**
   10. Study process should be monitoring Q output of generators to help assess that the generators have the capability to support the studied conditions when in real time operations. **In Progress – VPWG assessing in next study process and will be incorporating into future studies.**
   11. Study process should also come up with a strategy for PUNs that cannot be dispatched by ERCOT and how to determine a set point for units that are not being dispatched in the off peak cases. Perhaps include the G-1 N-1 contingency as part of voltage profile study. **Started - VPWG discussing treatment of PUN’s in study as part of VPWG procedure development.  Initial discussions only.**
   12. Propose an education effort to ensure Resource Entities are aware of their obligations related to voltage profile set points and instructions. **In Progress – VPWG has tried to have outreach to QMWG. NPRR 747 and 776 will further advance expectations.**
2. **General Voltage Coordination - *OWG***
   1. Roles and Responsibilities between ERCOT and ERCOT TOs, related to 69kV voltage limit monitoring, should be reviewed relative to current ERCOT Protocols and PUCT substantive rules.
      1. Currently between 60 to 70% of the voltage limit exceedances in ERCOT are on the 69kV system. This takes away focus from more critical voltages.
      2. ERCOT TOs may have telemetry not available to ERCOT or be able to take manual readings that ERCOT does not have visibility of. The 69kV system has the least available amount of SCADA information at ERCOT.
      3. Some reactive support devices for the 69kV system are on the distribution system for which ERCOT does not have visibility of.
      4. Most if not all the 69kV system is not within the NERC BES.
      5. A potential line of demarcation may be the step up transformers from the 69kV system, but not all the 69kV buses or limited 69kV buses.

**In Progress - NOGRR 150 has provided some flexibility for 69kV voltage limit exceedances to allow time for corrective action by the TO to take place prior to ERCOT’s involvement.**

* 1. Private Use Network (PUN) coordination should be improved to allow for more advanced and better preparation when PUN flows (into/out) of the ERCOT system varies greatly due to outages within the PUN. Study assumptions for the loading impacts of PUNs being online or offline need to be defined (ERCOT currently assumes that when the PUN is offline so is the load when, in some instances, when the PUN is offline the TSP needs to supply the entirety of their load). **Not Started**
  2. Additional telemetry needs should be evaluated to help improve state estimator performance. The need appears to be greater on the 69kV system. **Not Started – Target 2017**
  3. A process should be formalized to report to ERCOT instances where an ERCOT TO is instructing a Generation Resource to a set point outside of the +/- 2% range of the published voltage profile set point. (Ideally, this is a telemetered value from the ERCOT TO or QSE).

A feedback process needs to be given to Planning/Voltage Profile group on generators required to be outside the 2% range to determine if it was a special/abnormal configuration or a recurring issue that needs to be addressed. **Started - NPRR 776 and associated NOGRR will allow for telemetered voltage profiles set-point. VPWG is considering performance now, and would have better and additional performance data once set-point is telemetered and historized.**

* 1. Significant load additions (MW and MVAR) should be closely coordinated and accurately reported to allow for operational assessments to identify issues prior to adding the new load. **Not Started – Target 2017**
  2. ERCOT TOs should review the Current Operating Plan (COP) information to determine if the short term future COP (~ next 4 hours) provides reliability benefit in anticipating and potentially enhancing voltage coordination. **Not started.**
  3. Telemetry inaccuracies should be monitored closely and addressed in a timely fashion to minimize the effects. **In progress - NOGRR 162 addresses expectations.**
  4. Roles and Responsibilities for operating to the voltage profiles, should be clarified. Specifically, a clear understanding that ERCOT Transmission Operators have the authority to direct a generator to adjust its voltage set point up to its maximum reactive capability should be clarified. **In Progress – NPRR 747/NOGRR 150 clarified.**
  5. Roles and Responsibilities related to ownership and operatorship of Resource Entity owned static Reactive support resources should be reviewed and clarified. **Not Started.**

1. **Modeling/New or Existing Equipment *NDSWG/RDWG***
   1. A process should be created to identify and communicate when Resource entities increase their real or reactive capability based on historical/actual data. **Not started.**
   2. There are multiple D curves for a generator based on different operational conditions, but the model only has place for one of those D curves. ERCOT should also consider looking into how to model air cooled generators which can produce more output based on ambient temperature.

One alternative may be where max/min possible output is submitted based on the max/min temperatures expected or max/min operating conditions (when changes in output depends on plant processes), rather than accommodating all D curves. **Not Started**

* 1. Process for ERCOT transmission system additions or modifications should be reviewed to help minimize issues where the Network Model database load timeframes do not align to the actual field work and energization timeframe. **In Progress – Discussions held at NDSWG and some individual market participants some improvement has been realized. Workshop scheduled had been cancelled.**
  2. Generator’s RARF data assumes 1.0 P/U. If after the Voltage Profile process their set point is 1.03 (example) is this data (Qmax, Qmin) correctly set. **Not Started**
  3. Discuss whether testing processes are enough to ensure valid RARF data is modeled for the upcoming season rather than canned manufacturer D curve data which may not be applicable based on interconnecting conditions (set point/temperature). Discuss whether the requested RARF should be submitted based on maximum/minimum expected temperatures for that season and describe how RARF data is updated based on ERCOT required testing. Consider screening RARF data against historical seasonal PI data. **Not Started.**

**Additional notes:**

* Load Rollover schemes need to be shared with ERCOT to enhance outage coordination. *OWG?* **Not Started**
* Voltage/Regulation Schedules need some effort to clarify language to distinguish between NERC VAR standard terminology and ERCOT terminology if needed. Confusion remained on what the schedule represented, how it was used, and how best to maintain due to varying operational practices. This item may need more significant effort. *SSWG/OWG/NRWG* **In Progress – NPRR 747/NOGRR 150 and NERC VAR EPRT.**
* Question was raised if there is a better way to use the outage scheduler in the future? Short term vs a long term solution. *OWG?* **Uncertain**
* General Objective was expressed that any changes should also be to provide additional flexibility for Real Time operations relative to steady state voltage control and voltage stability while not removing any flexibility currently in the ERCOT Protocols/Operation Guides. **In Progress – Considered in NPRR 747/NOGRR 150 and NPRR 776 and associated NOGRR.**
* Allowed levels of aggregation and process for approval of aggregation of distribution load for performance relative to .97 pf requirement needs to be clarified. Moreover, tariff agreements between DSPs and Industrial Customers should probably be reviewed *OWG* **Not Started – Target 2017**
* Is there value in having the Generation Resources telemeter real time reactive capability (remaining Q?). *OWG* **Consider closing *-* Initial discussions have yielded that this would be very difficult to implement.**