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| NPRR Number | [849](http://www.ercot.com/mktrules/issues/nprr849) | NPRR Title | Clarification of the Range of Voltage Set Points at a Generation Resource’s POI |
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| Date | October 25, 2018 |
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| Market Segment | Not applicable |

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| Comments |

ERCOT submits these further revisions based on discussions at the September 28, 2018 workshop on Nodal Protocol Revision Request (NPRR) 849 and additional internal discussion. These revisions propose that the maximum Reactive Power capability that may be called upon in Real-Time is established by the Corrected Unit Reactive Limit (CURL) and include a definition of CURL that is consistent with Nodal Operating Guide Section 3.3.2.1, Corrected Unit Reactive Limits (CURL).

These revisions also modify the 2% tolerance band to require adherence to the Voltage Set Point “as close as practicable.” ERCOT is concerned that some Generation Resources have relied on the broad tolerance band to ignore changes in their Voltage Set Points. ERCOT agrees that some deviation from the Voltage Set Point is unavoidable and intends to address the appropriate tolerance band more specifically in a later effort, but believes this change is appropriate and sufficient for now.

These revisions also re-order the sections under paragraph (3) of Section 3.15 to insert the study requirements before the operational requirements. These revisions also insert graphical representations to aid in understanding the requirements.

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| Revised Cover Page Language |

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| Nodal Protocol Sections Requiring Revision  | 2.1, Definitions2.2, Acronyms and Abbreviations3.15, Voltage Support |
| Revision Description | This Nodal Protocol Revision Request (NPRR) revises Section 3.15 to clarify the range of voltages at the Point of Interconnection (POI) and circumstances for which a Generation Resource’s reactive capability must be designed to meet. This NPRR also reorders the paragraphs of Section 3.15 to address the reactive study requirements first and operational requirements later. This NPRR does not modify any other provisions within Section 3.15 or its subsections and does not change the Generation Resource’s responsibility to adhere to Voltage Set Points. Rather, this NPRR simply aims to more clearly specify the reactive capability the Generation Resource must be designed to provide.With respect to the changes in paragraph (3)(a) of Section 3.15, ERCOT would not require Generation Resources that have already been commissioned prior to the effective date of this NPRR to comply with the new study requirements. |

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| Revised Proposed Protocol Language |

**2.1 DEFINITIONS**

**Corrected Unit Reactive Limit (CURL)**

The gross maximum physical capability of a Generation Resource to produce Reactive Power at each level of real power output, adjusted to reflect the effects of under-excitation limiters, over-excitation limiters, ambient temperature limitations, and any other physical characteristic of the Generation Resource that impacts the reactive output of the unit.

**2.2 ACRONYMS AND ABBREVIATIONS**

**CURL** Corrected Unit Reactive Limit

**3.15 Voltage Support**

(1) ERCOT, in coordination with the Transmission Service Providers (TSPs), shall establish and update, as necessary, the ERCOT System Voltage Profile and shall post it on the Market Information System (MIS) Secure Area. ERCOT, the interconnecting TSP, or that TSP’s agent, may modify the Voltage Set Point described in the Voltage Profile based on current system conditions.

(2) All Generation Resources (including self-serve generating units) that have a gross generating unit rating greater than 20 MVA or those units connected at the same Point of Interconnection (POI) that have gross generating unit ratings aggregating to greater than 20 MVA, that supply power to the ERCOT Transmission Grid, shall provide Voltage Support Service (VSS).

(3) Each Generation Resource required to provide VSS shall comply with the following Reactive Power Requirements:

(a) As a condition for proceeding to the quarterly stability assessment described in Planning Guide Section 5.9, Quarterly Stability Assessment, the Interconnecting Entity (IE) must provide an engineering study that demonstrates the capability of the Generation Resource, at all real power output levels, to produce or absorb at least the amount of Reactive Power corresponding to a 0.95 leading and lagging power factor at the Generation Resource’s maximum net real power to be supplied to the ERCOT Transmission Grid, and to produce that quantity of lagging Reactive Power at any Voltage Set Point from 0.95 to 1.04 per unit and to absorb that quantity of leading Reactive Power at any Voltage Set Point from 1.0 to 1.05 per unit, as shown in Figures A and C below. This capability shall be determined at the Generation Resource’s POI. For an Intermittent Renewable Resource (IRR), the Resource Entity’s study must demonstrate the above capability at all MW output levels at or above 10% of the IRR’s nameplate MW capacity, as shown in Figure B below. In all cases, the required Reactive Power may be provided only by the Generation Resource’s inherent capability, as established by its Corrected Unit Reactive Limit (CURL), and/or its dynamic VAr-capable devices; however, automatically switchable static VAr-capable devices may be used to compensate for Reactive Power losses that occur behind the POI. The Resource Entity must also satisfy the requirements specified in Nodal Operating Guide Section 3.3.2.2, Reactive Testing Requirements, prior to the Generation Resource’s Resource Commissioning Date;

Figure A: Non-IRR Reactive Capability Requirement (Q vs. P)



Figure B: IRR Reactive Capability Requirement (Q vs. P)



Figure C: IRR and Non-IRR Reactive Capability Requirement (Q vs. V)



(b) Subject to the reactive capabilities of the Generation Resource, as established by its CURL, and its associated VAr-capable devices, each Generation Resource shall produce lagging Reactive Power or absorb leading Reactive Power as necessary to achieve and maintain a POI voltage that is as close as practicable to its Voltage Set Point pursuant to paragraph (4) of Nodal Operating Guide Section 2.7.3.5. If achieving and maintaining that Voltage Set Point is beyond the capability of the Generation Resource and its VAr-capable devices, then the Generation Resource shall meet the following minimum reactive requirements:

(i) For any Voltage Set Point from 0.95 to 1.04 per unit, if lagging Reactive Power is needed, the Generation Resource shall produce the maximum lagging Reactive Power within its capability, provided that the quantity of Reactive Power produced is equal to or greater than the quantity of Reactive Power corresponding to a 0.95 lagging power factor at the Generation Resource’s maximum net real power to be supplied to the ERCOT Transmission Grid, as measured at the POI; and

(ii) For any Voltage Set Point from 1.0 to 1.05 per unit, if leading Reactive Power is required, the Generation Resource shall absorb the maximum leading Reactive Power within its capability, provided that the quantity of leading Reactive Power absorbed is equal to or greater than the quantity of Reactive Power corresponding to a 0.95 leading power factor at the Generation Resource’s maximum net real power to be supplied to the ERCOT Transmission Grid, as measured at the POI; and

(c) Notwithstanding paragraph (b) above, an IRR shall not be required to produce any Reactive Power when operating below 10% of its nameplate MW capacity, but if the IRR is unable to produce or absorb reactive power at the POI when it is operating below 10% of its nameplate MW capacity, ERCOT, the interconnecting TSP, or the TSP’s designated agent may, for purposes of maintaining reliability, instruct the IRR to operate any of its VAr-capable devices or to disconnect the IRR from the ERCOT System.

(4) Wind-powered Generation Resources (WGRs) that commenced operation on or after February 17, 2004, and have a signed Standard Generation Interconnection Agreement (SGIA) on or before December 1, 2009 (“Existing Non-Exempt WGRs”), must be capable of producing a defined quantity of Reactive Power to maintain a set point in the Voltage Profile established by ERCOT in accordance with the Reactive Power requirements established in paragraph (3) above, except in the circumstances described in paragraph (a) below.

(a) Existing Non-Exempt WGRs whose current design does not allow them to meet the Reactive Power requirements established in paragraph (3) above must conduct an engineering study using the Summer/Fall 2010 on-peak/off-peak Voltage Profiles, or conduct performance testing to determine their actual Reactive Power capability. Any study or testing results must be accepted by ERCOT. The Reactive Power requirements applicable to these Existing Non-Exempt WGRs will be the greater of: the leading and lagging Reactive Power capabilities established by the Existing Non-Exempt WGR’s engineering study or testing results; or Reactive Power proportional to the real power output of the Existing Non-Exempt WGR (this Reactive Power profile is depicted graphically as a triangle) sufficient to provide an over-excited (lagging) power factor capability of 0.95 or less and an under-excited (leading) power factor capability of 0.95 or less, both determined at the WGR’s set point in the Voltage Profile established by ERCOT, and both measured at the POI.

(i) Existing Non-Exempt WGRs shall submit the engineering study results or testing results to ERCOT no later than five Business Days after its completion.

(ii) Existing Non-Exempt WGRs shall update any and all Resource Registration data regarding their Reactive Power capability documented by the engineering study results or testing results.

(iii) If the Existing Non-Exempt WGR’s engineering study results or testing results indicate that the WGR is not able to provide Reactive Power capability that meets the triangle profile described in paragraph (4)(a) above, then the Existing Non-Exempt WGR will take steps necessary to meet that Reactive Power requirement depicted graphically as a triangle by a date mutually agreed upon by the Existing Non-Exempt WGR and ERCOT. The Existing Non-Exempt WGR may meet the Reactive Power requirement through a combination of the WGR’s URL and/or automatically switchable static VAr-capable devices and/or dynamic VAr-capable devices. No later than five Business Days after completion of the steps to meet that Reactive Power requirement, the Existing Non-Exempt WGR will update any and all Resource Registration data regarding its Reactive Power and provide written notice to ERCOT that it has completed the steps necessary to meet its Reactive Power requirement.

(iv) For purposes of measuring future compliance with Reactive Power requirements for Existing Non-Exempt WGRs, results from performance testing or the Summer/Fall 2010 on-peak/off-peak Voltage Profiles utilized in the Existing Non-Exempt WGR’s engineering study shall be the basis for measuring compliance, even if the Voltage Profiles provided to the Existing Non-Exempt WGR are revised for other purposes.

(b) Existing Non-Exempt WGRs whose current design allows them to meet the Reactive Power requirements established in paragraph (3) above (depicted graphically as a rectangle) shall continue to comply with that requirement. ERCOT, with cause, may request that these Existing Non-Exempt WGRs provide further evidence, including an engineering study, or performance testing, to confirm accuracy of Resource Registration data supporting their Reactive Power capability.

(5) Qualified Renewable Generation Resources (as described in Section 14, State of Texas Renewable Energy Credit Trading Program) in operation before February 17, 2004, required to provide VSS and all other Generation Resources required to provide VSS that were in operation prior to September 1, 1999, whose current design does not allow them to meet the Reactive Power requirements established in paragraph (3) above, will be required to maintain a Reactive Power requirement as defined by the Generation Resource’s URL that was submitted to ERCOT and established per the criteria in the ERCOT Operating Guides.

(6) New generating units connected before May 17, 2005, whose owners demonstrate to ERCOT’s satisfaction that design and/or equipment procurement decisions were made prior to February 17, 2004, based upon previous standards, whose design does not allow them to meet the Reactive Power requirements established in paragraph (3) above, will be required to maintain a Reactive Power requirement as defined by the Generation Resource’s URL that was submitted to ERCOT and established per the criteria in the Operating Guides.

(7) For purposes of meeting the Reactive Power requirements in paragraphs (3) through (6) above, multiple generation units including IRRs shall, at a Generation Entity’s option, be treated as a single Generation Resource if the units are connected to the same transmission bus.

(8) Generation Entities may submit to ERCOT specific proposals to meet the Reactive Power requirements established in paragraph (3) above by employing a combination of the URL and added VAr capability, provided that the added VAr capability shall be automatically switchable static and/or dynamic VAr devices. A Generation Resource and TSP may enter into an agreement in which the proposed static VAr devices can be switchable using Supervisory Control and Data Acquisition (SCADA). ERCOT may, at its sole discretion, either approve or deny a specific proposal, provided that in either case, ERCOT shall provide the submitter an explanation of its decision.

(9) A Generation Resource and TSP may enter into an agreement in which the Generation Resource compensates the TSP to provide VSS to meet the Reactive Power requirements of paragraph (3) above in part or in whole. The TSP shall certify to ERCOT that the agreement complies with the Reactive Power requirements of paragraph (3).

(10) Unless specifically approved by ERCOT, no unit equipment replacement or modification at a Generation Resource shall reduce the capability of the unit below the Reactive Power requirements that applied prior to the replacement or modification.

(11) Generation Resources shall not reduce high reactive loading on individual units during abnormal conditions without the consent of ERCOT unless equipment damage is imminent.

(12) All WGRs must provide a Real-Time SCADA point that communicates to ERCOT the number of wind turbines that are available for real power and/or Reactive Power injection into the ERCOT Transmission Grid. WGRs must also provide two other Real-Time SCADA points that communicate to ERCOT the following:

(a) The number of wind turbines that are not able to communicate and whose status is unknown; and

(b) The number of wind turbines out of service and not available for operation.

(13) All PhotoVoltaic Generation Resources (PVGRs) must provide a Real-Time SCADA point that communicates to ERCOT the capacity of PhotoVoltaic (PV) equipment that is available for real power and/or Reactive Power injection into the ERCOT Transmission Grid. PVGRs must also provide two other Real-Time SCADA points that communicate to ERCOT the following:

(a) The capacity of PV equipment that is not able to communicate and whose status is unknown; and

(b) The capacity of PV equipment that is out of service and not available for operation.