There are three requirements placed on wind generators in ERCOT above and beyond their general responsibilities as interconnected generators. These are: voltage ride through, reactive support, and frequency response.

Voltage ride through:

Wind generators are required to set their relays to remain interconnected through low-voltage fault conditions of at least 9 cycles at zero volts (as shown in the boundaries of the graph in the attached VRT document). This document is an extract from the current ERCOT Operating Guides. There are grandfather provisions that restrict application of this requirement to units that were in operation when the requirement was enacted.

Reactive Requirements:

Wind generators are required to provide .95 leading/lagging reactive power (compared to their maximum output, rather than compared to their instantaneous output) at their point of interconnection. This requirement was recently clarified, and the approved, clarified version has been appealed to the Public Utility Commission of Texas. Wind generators are not required to provide reactive power when their output is below 10% of nameplate. Again, there are grandfather provisions for existing units. See the reactive power document attached.

Frequency response:

Wind units are required to provide primary frequency response in response to high system frequency similar to a thermal unit with a droop of 5%. Again, there are grandfather provisions, and the relevant protocol revision is attached.

Dispatch Control of Wind Plants:

One grid requirement that we take for granted but others do not have is the ability to instruct wind units to ramp down. This is currently done in ERCOT either through economic means (through the purchase of a wind units balancing down energy offers) or through control - through machine or verbal instructions. When we go to a nodal market in December, the SCED engine will control wind generation levels and reduce output to cost-effectively control congestion.

Excerpts from relevant ERCOT documents are on the following pages.
3.1.4.6.1 Protective Relaying Requirement and Voltage Ride-Through Requirement for Wind-powered Generation Resources

- Wind-powered Generation Resources (WGRs) specified below are required to set generator voltage relays to remain in-service during all transmission faults (no more than nine (9) cycles) in accordance with Figure 1, Voltage Ride-Through Boundaries For Wind-powered Generation Resources, below. Faults on individual phases with delayed clearing (zone 2) may result in phase voltages outside this boundary but if the phase voltages remain inside this boundary then generator voltage relays are required to be set to remain connected and recover within the voltage recovery boundary of Figure 1.

- WGR voltage relays shall be set to remain interconnected during three-phase faults on the transmission system for a voltage level as low as zero (0) volts with a duration of nine (9) cycles as measured at the point of interconnection as shown in Figure 1 unless a shorter clearing time requirement for a three-phase fault specific to the generating plant point of interconnection is determined by and documented by the transmission provider in conjunction with the Standard Generation Interconnection Agreement (SGIA). This requirement does not apply to faults that would occur between the generator terminals and the transmission voltage side of the generation step-up transformer or when clearing the fault effectively disconnects the generator from the system.

- WGRs may be tripped after the fault period if this action is intended as part of a Special Protection System (SPS).

- WGRs may meet the VRT requirements of Figure 1 by the performance of the generators or by installing additional equipment (e.g., Static VAR Compensator) within the generating plant or by a combination of generator performance and additional equipment.

- WGRs that have had over fifty (50) seconds cumulative operation over the life of the WGR below ten percent (10%) of nominal voltage at the point of interconnection shall be allowed, with ERCOT’s approval, to set generator voltage relays to provide sufficient protection to the WGR to comply with warranty requirements and to retain the expected life of the resource.

- Existing individual WGRs that are replaced are required to meet the requirements of Figure 1.

- WGRs that are part of a Generation Interconnect Agreement signed after November 1, 2008 shall meet the requirements of this Section. All such WGRs shall provide a status of compliance to ERCOT System Planning by July 1, 2009.

- WGRs that are part of a Generation Interconnect Agreement signed prior to November 1, 2008 shall provide information requested by ERCOT, including existing WGR VRT capabilities, for a study to evaluate the need for additional
protective relaying and VRT requirements applicable to some or all such WGRs. The study will be conducted using the 2009-2010 transmission system as determined by ERCOT. The study shall be conducted by a qualified organization having no real or apparent bias and with no financial interest in the outcome of the study. ERCOT shall publish study results and provide recommendations to ROS no later than the scheduled ROS meeting of June 2010. If the results of the study demonstrate the need, this Operating Guide shall be revised on an expedited basis to establish those requirements. Those WGRs requiring retrofit to meet a revised Operating Guide shall install the required retrofits within eighteen (18) months after the effective date of the revised Operating Guide.

- Notwithstanding any of the foregoing provisions, existing individual WGRs that meet the requirements of Figure 1 on November 1, 2008 shall continue to meet the requirements of Figure 1.

- If, due to a system disturbance, a WGR comes Off-line within the boundaries of the VRT requirement of Figure 1, then the WGR owner and the TSP shall be required to investigate and report to ERCOT on the cause of the WGR trip identifying a reasonable mitigation plan and timeline.

- ERCOT and the TSP shall be notified of any equipment changes that affect the reactive capability of an operating WGR no less than sixty (60) days prior to implementation of the changes, and any such changes that decrease the reactive capability of the WGR below the required level and changes that decrease the VRT capability of the plant must be approved by ERCOT prior to implementation.
6.5.7.1 **Installed Reactive Power Capability Requirement for Generation Resources Required to Provide VSS**

(1) Generation Resources required to provide VSS must be capable of producing a defined quantity of Reactive Power to maintain a Voltage Profile established by ERCOT. Generation Resources shall comply with the following Reactive Power requirements: an over-excited (lagging) power factor capability of ninety-five hundredths (0.95) or less and an under-excited (leading) power factor capability of ninety-five hundredths (0.95) or less, both determined at the generating unit's maximum net power to be supplied to the ERCOT Transmission Grid and at the transmission system Voltage Profile established by ERCOT, and both measured at the POI. The Reactive Power requirements shall be available at all MW output levels and may be met through a combination of the Generation Resource’s Unit Reactive Limit (URL), which is the generating unit’s dynamic leading and lagging operating capability, and/or dynamic VAR capable devices. For WGRs, the Reactive Power requirements shall be available at all MW output levels at or above ten percent (10%) of the WGR’s nameplate capacity. When a WGR is operating below ten percent (10%) of its nameplate capacity and is unable to support voltage at the POI, ERCOT may require a WGR to disconnect from the
ERCOT System. The Reactive Power requirements of this paragraph shall apply to all Generation Resources except as otherwise provided in paragraphs (2) through (4) below.

(2) 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, must be capable of producing a defined quantity of Reactive Power to maintain a Voltage Profile established by ERCOT in accordance with the Reactive Power requirements established in paragraph (1) above. However, the Reactive Power requirements may be met through a combination of the WGR’s URL and/or automatically switchable static VAR capable devices and/or dynamic VAR capable devices. WGRs shall comply with the Reactive Power requirements of this paragraph by no later than December 31, 2010, unless it is known by July 31, 2010, that related retrofits are required by the Voltage Ride-Through study conducted in accordance with Operating Guide Section 3.1.4.6.1, Protective Relaying Requirement and Voltage Ride-Through Requirement for Wind-powered Generation Resources, in which event ERCOT may in its discretion modify the deadline for an affected WGR. ERCOT, in its sole discretion, also may grant an extension of time for other reasons.

5.9.1.3 Wind-powered Generation Resource (WGR) Primary Frequency Response

Wind-powered Generation Resources (WGRs) with Standard Generation Interconnection Agreements (SGIAs) signed after January 1, 2010 shall provide Primary Frequency Response to frequency deviations from 60.000 Hz. The WGR automatic control system design shall have an adjustable dead band that can be set as specified in the ERCOT Operating Guides. The Primary Frequency Response shall be similar to the droop characteristic of five-percent (5%) used by conventional steam generators. For WGRs with SGIAs executed on or prior to January 1, 2010, those not already equipped with Primary Frequency Response shall by December 1, 2011 acquire that capability. Those WGRs that cannot technically be retrofitted with Primary Frequency Response capability shall submit an attestation to ERCOT by June 1, 2010 explaining the technical infeasibility. At ERCOT’s sole discretion, those WGRs for which Primary Frequency Response is technically infeasible may be granted a permanent exemption from the requirement. ERCOT shall make a determination within one hundred eighty (180) days of receipt of the attestation. If ERCOT does not grant an exemption, the WGR shall acquire the capability to provide Primary Frequency Response within twenty-four (24) months of being notified of that determination. If ERCOT grants the exemption, then ERCOT may require the WGR to install alternate measures, such as over-frequency relays, that are technically feasible and would approximate Primary Frequency Response to Measurable Events.