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| NOGRR Number | [245](https://www.ercot.com/mktrules/issues/NOGRR245) | NOGRR Title | Inverter-Based Resource (IBR) Ride-Through Requirements |

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| Date | September 5, 2023 |

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| Comments |

**Introduction:**

NOGRR 245 was filed by ERCOT on January 11, 2023 and has undergone debate and discussion by ERCOT and stakeholders as to the best way to implement IEEE 2800-2022 into ERCOT’s operating guides. NextEra Energy Resources, LLC (NEER) submits this amendment to the proposed terms for NOGRR 245 to ensure that the standards for voltage and frequency ride-through are implemented by ERCOT in a manner that encourages and facilitates the successful integration of these standards into the ERCOT grid. These comments do not propose amendments to the actual technical voltage ride-through (“VRT”) and frequency ride-through (“FRT”) curves proposed by ERCOT to implement IEEE 2800-2022. Instead, this proposed amendment is offered to ensure that the timing and means of establishing these standards for all resources does so in a way that enhances grid reliability without undermining investor confidence in the ERCOT market and discouraging investment required to meet the rapid load growth Texas is experiencing.

ERCOT’s approach to mitigating complex reliability issues via NOGRR 245 has the potential to set a gold standard for leading integration of IEEE 2800-2022 into market rules. However, based on information currently available from original equipment manufacturers (OEM), attempts to mandate that existing Inverter-Based Resources (IBR) implement the ride-through standards applicable to new resources under the IEEE standards would be technically and commercially infeasible. Accordingly, revoking legacy standards for existing resources and enforcing new IEEE 2800 standards would result in forced retirements of existing online resources. This unnecessary consequence would have widespread reliability implications for the entire grid that are disproportionate to the localized reliability risk of VRT trips associated with these same facilities.

ERCOT’s August 18, 2023 comments recognize that it is not feasible to implement the same ride-through standards on the same timeline for all resources. ERCOT’s new comments suggest that ERCOT recognizes the need for greater flexibility in implementing new ride-through standards. Unfortunately, the ERCOT comments also still leave many core issues previously raised by commenters unaddressed. To address those concerns, NEER’s comments are intended to ensure that reliability is not jeopardized by the unintended de-energization of existing resources and allow each resource to maximize protection as they become available. The approach recommended herein allows recognition of the ongoing work by the OEMs to design technologies that increase ride-through capabilities for existing and future resources.

**Proposal Summary:**

1. Requires IBRs to comply with ERCOT's new reliability requirements if it is commercially reasonable to do so.
2. Creates a compliance framework that encourages investment in these reliability requirements and creates an ongoing focus on improving ride-through capability, IBRs that do not meet the standards must evaluate investment in additional ride-through capability each year based on the latest information in the market and confidentially provide the evaluation to ERCOT.
3. Requires resources with an SGIA on or after 6/1/2026 to comply with the new requirements. This date is set based on reasonable expectations around the availability of commercially reasonable and technically feasible packages from manufacturers.
4. Avoids what would be an extensive legal dispute over whether ERCOT has the authority to take the actions it initially proposed in this NOGRR, and could ultimately lead to earlier investment in these resources, to the benefit of all parties and to the public at large.

**Benefits of the proposal:**

NEER’s alternative proposal is designed to strike a careful balance between measures that encourage all resources to meet the expanded ride-through capabilities of modern IBRs while recognizing the cost and technical complexity of doing so. Under NEER’s proposed amendment to NOGRR 245, any currently grandfathered resources would be subject to ongoing, annual review of whether there are commercially reasonable methods to increase ride-through capabilities to match the standards in IEEE 2800-2022. This language is similar to the language in the current proposal for the applicability of the new standards to existing thermal resources.

The commercial reasonableness test introduced herein ensures that each Resource Entity is able to incorporate the most complete and up-to-date resource-specific information into plans to implement the proposed ride-through standards for existing facilities because the Resource Entity has the best information to make the technical and financial decisions associated with implementation. All resources benefit from a reliable grid, and under this proposal, existing facilities must make an annual assessment of commercially reasonable implementation options. While all resources have incentives to implement technology improvements to minimize potential unexpected tripping of their units, NEER’s proposal would require regular reporting on the feasibility of expanding ride-through capability to meet the new IEEE 2800-2022 standards.

NEER presents this proposed amendment and urges ERCOT, and ultimately, the Public Utility Commission, to adopt some version of these comments that allow for commercial reasonability in implementing new ride-through standards. Alternatively, NEER suggests that ERCOT limit the application of NOGRR 245 to newly-proposed generator interconnections with interconnection agreements signed after June 1, 2026, until more information and research can be performed on retrofitting existing units to meet the newly-adopted IEEE 2800-2022 capabilities. This approach would avoid unlawful regulatory takings of extensive investments in existing resources that currently deliver reliable energy to the grid, often at peak hours.

As described below, there are four significant issues with the draft proposed NOGRR that are resolved with NEER’s alternative language presented in these comments.

Adoption of NEER’s proposal would:

1. Prevent de-energization of existing resources for failing to comply with a set of standards developed for prospective application to new IBR technologies.
2. Be consistent with the comments of OEMs that recognize the case-by-case nature of assuring design standards consistent with IEE 2800 for all resources.
3. Ensure that the total impact to grid reliability is considered when implementing the IEEE 2800 standards.
4. Ensure that the reliability standards remain based on calculated reliability risk and performance capability in a technology neutral way.

**First**, to comply with ERCOT’s draft rule, existing IBRs may be required to make resource modifications that would result in the resource being uneconomic. Alternatively, there may not even be feasible modifications to IBRs, making it impossible for existing resources to comply, in which case the IBR’s operations will be restricted. This approach proposed in the ERCOT draft not only contravenes the 15 year-long precedent for VRT in ERCOT, but could also result in unlawful regulatory takings, reducing current resource adequacy. This would also negatively affect future resource adequacy by eroding investor confidence in the ERCOT market and the regulatory certainty necessary to support long-term investments.

ERCOT has long recognized the need to consider different ride-through standards for new and existing resources. ERCOT’s first rule revision related to IBR ride-through capability was OGRR 208. OGRR 208 was filed on April 15, 2008, by the Wind Coalition (the predecessor to the Advanced Power Alliance). OGRR 208 in its final form allowed the wind industry to improve system conditions in partnership with ERCOT. OGRR 208 suggested setting-based ride-through requirements (instead of a performance standard) for new wind resources (post 2008) and exempted both existing generators and generators that would come online in the near-term.

In comments before the Operations Working Group (OWG), ERCOT proposed requiring existing facilities to come into compliance in five to seven years, but OWG disagreed (June 19, 2008 OWG Recommendation Report) and said, for example, “WPGRs that are part of a Generation Interconnect Agreement signed before October 1, 2008 are exempt from meeting this VRT requirement for the remaining life of the generation equipment”. On August 8, 2018, the Reliability and Operations Subcommittee (ROS) directed that grandfathering issues be addressed, and, based on ERCOT’s OWG comments, added the “five to seven year” compliance timeline, thereby requiring compliance for most existing facilities by Jan. 1, 2015.

In response to the proposal to require existing wind generation resources to comply with new ride-through standards, the Wind Coalition suggested that study results should determine the need for voltage ride-through at a site. However, TAC approved ROS’s recommendation instead of the Wind Coalition’s alternative.

Invenergy, E.ON, FPL Energy (now NEER), Horizon (now EDP), and other affected generators filed an appeal of the TAC decision to the ERCOT Board. Subsequently, ERCOT and some of the affected parties developed a consensus recommendation that did not impose VRT requirements on existing facilities, and instead agreed to study whether VRT requirements were necessary for existing facilities. Based on the consensus recommendation the ERCOT Board granted the appeal of TAC’s decision and instead implemented the compromise language. **This created an important precedent that carried forward for future VRT enhancements.** Further, this compromise allowed ERCOT to avoid litigation regarding potential regulatory takings of existing Resources.

NOGRR 124 extended this technology-driven approach by establishing forward-looking requirements and backward-looking grandfathering of existing Resources. ERCOT’s April 17, 2014, comments noted that IBRs that would not meet that 2014 VRT requirement could be grandfathered, because they were “just short” of the proposed standard.

NEER’s comments offer a means to implement the proposed ride-through standards for new resources, while allowing existing resources to implement the standards in a manner consistent with ERCOT’s prior data-driven approaches. Given ERCOT’s prior support for reasonable accommodations for wind generation resources that provided expanded ride-through capability but could not ride-through the entire desired capability range, ERCOT should retain this approach.

The IEEE 2800-2022 authors and NERC both support recognizing the feasibility of applying the new standards before applying them to existing resources. IEEE 2800-2022 states **“this standard may not apply to IBR plants that are either already interconnected or for which an interconnection request had been submitted prior to the standard’s enforcement date (grandfathering).”** Similarly, NERC’s presentation to the Energy Systems Integration Group (ESIG) Fall Technical Workshop in October 2022 listed IEEE 2800-2022 as an “interconnection process improvement”.[[1]](#footnote-2)

While ERCOT’s August 18, 2023 Comments begin to recognize the technical limitations in applying the new standards to existing Type I and Type II wind resources, they do not alleviate the concerns addressed in prior comments.[[2]](#footnote-3) At this point, it is uncertain whether or when technical solutions will exist in the future, in many cases they do not exist today.

IEEE 2800-2022 also makes clear that it specifically does not apply to older facilities without power electronic inverters/converters. NEER’s July 28 comments point out that Type I and Type II wind facilities should be specifically excluded based on IEEE-2800-2022, and quotes from the standard: “A wind turbine generator generally uses one of the following electric generator configurations: direct connected asynchronous generator (type I), asynchronous generator with external resistance control (type II), doubly-fed generator (DFG) (type III), full-rated power converter (type IV), or direct-connected synchronous generator with torque/speed converter (type V). **For the purposes of this standard, only WTGs that use power electronic inverters/converters for interconnection to the grid are considered (e.g., type III and type IV).**”[[3]](#footnote-4) In light of the fact that IEEE 2800-2022 expressly excludes type I and type II wind turbines from the ride-through standards, NEER believes it is inappropriate to subject them to NOGRR 245’s ride-through requirements.

**Second**, while every party that has filed comments supports implementing rules to address IEEE 2800-2022 implementation prospectively for new resources, and not retroactively for existing resources, the OEMs that make IBRs have said they are not ready to implement these new standards – and many are waiting for IEEE 2800.2 to be published so they can be certain their equipment is designed and manufactured to satisfy the testing requirements and they can provide assurances that the equipment is IEEE 2800-2022 compliant.

The NERC ESIG presentation referenced above provided a survey of OEMs regarding IEEE-2800-2022 readiness. Almost 30% of OEMs surveyed by NERC plan to wait for the testing and verification procedures provided by IEEE 2800.2 before self-certifying their equipment conforms with the requirements of IEEE-2800-2022.[[4]](#footnote-5) Without a defined testing requirement, resources will be unable to offer assurances of design compliance, much less have any reasonable assurance of new compliance with performance requirements.

ERCOT’s proposal has created confusion and uncertainty for OEMs. While many OEMs plan to develop new equipment to comply, some have indicated that compliance for some of their existing equipment is impossible. Specific comments from key OEMs support these concerns and are highlighted here.[[5]](#footnote-6)

**Siemens Gamesa**

Siemens Gamesa’s June 6 comments explain why 2800.2 is so critical to compliance:

“[A]s already expressed by the different manufacturers, functionalities like multiple ride-through events cannot be confirmed through analysis alone. Well-defined specifications are needed to avoid seemingly endless possible configurations during field testing (IEEE 2800-2 testing and verification pending to be released).”

Siemens Gamesa also stated in its June 6 comments that it “cordially object[s] to ERCOT’s proposal on retroactive implementation of a new performance standard that significantly affects both electrical and mechanical integrity of the Wind Turbines (enforced simultaneously without a prioritization schedule, on all configurations, active and non-active designs alike and regardless of age, with implementation schedules that do not adequately consider potential resources, workforce, logistical and/or supply chain timeframes and limitations).”

Siemens Gamesa further noted in its June 6 comments that: “Designing new solutions for relatively old populations could prove to be a significant challenge (if even possible) considering the degree of obsolescence of many individual components, software, and available tools or other required support or resources” and “Older Type III (DFIG machines), which have a rated output power of < 2.3 MW may have available “catalogue” upgrades but may not meet all NOGRR 245 items or to the required extent.”

**GE Vernova (formerly GE Renewable Energy)**

GE’s February 17 comments made specific recommendations for changes based on the text of IEEE 2800-2022, but those changes have yet to be incorporated into the NOGRR.[[6]](#footnote-7) GE’s May 3 comments said any new unit retrofits and repowers may need at least two years to meet IEEE 2800-2022 standards. GE also notes that complex issues like multiple fault ride-through will require months of lab and field testing.

On July 31, GE supplemented its earlier comments, stating:

“Compatibility to these performance standards requires design and validation of the power path, auxiliaries, mechanical structure, and drivetrain systems. Based on the significant analysis required to make final determination of compatibility, including electromechanical requirements, the March 2024 date is not achievable across the GE fleet” and “For legacy 1.x and 2.x ESS units, GE expects that these platforms can be made compatible with the single dip current voltage ride through capabilities of Table A in Section 2.9.1.2, Legacy Voltage Ride-Through Requirements for Transmission-Connected Inverted-Based Resources (IBRs), and the preferred frequency ride through capabilities of paragraph (1) of Section 2.6.2.1, with limited modifications, and earlier than the specificity requirements. Developing an upgrade solution for compatibility with the NOGRR245 specificity requirements for all configurations will not be completed until after the 2027 requirement deadline.”

**Vestas**

Vestas has noted the complexity of requiring ride-through at the POI as it relates to IEEE 2800.2 – “Prior to implementing Voltage Ride-Through requirements for transmission-connected Inverter-Based Resources (IBRs), various test scenarios, conditions, and loadings need to be considered. The evaluation is influenced by preconditions before the occurrence of a fault. The reactive current injection settings and the plant controller strategy will impact the Reactive Power injection at turbine terminals, thereby significantly modifying the voltage at turbine terminals compared to the Point of Interconnection (POI). Hence, the single line diagram of the plant and the plant configuration are critical for determining compliance. Additionally, clear specifications are needed to validate functionalities events, since testing and verification protocols are pending with the release of IEEE 2800-2.

Vestas’ June 22 comments state:

“The current fleet of installed Type 2 wind turbines is unable to comply with the new NOGRR245, Frequency and Voltage Ride-Through Requirements and cannot be economically retrofitted to meet them. Some Type 3 machines may also encounter difficulties in meeting the voltage ride-through requirement.”

With regard to the need to ride through multiple voltage deviations, Vestas described the challenge based on thermal design limits and the need for an equipment cooling period: “The energy absorption capability of the direct current (‘DC’) chopper is limited by its thermal design. Once activated to absorb energy, the DC chopper requires a cooling period before it can be reactivated to absorb energy again. Typically, the DC chopper is designed to absorb the IBR's continuous rating (‘ICR’) for a couple of seconds and needs sufficient time to cool down. More details are required to determine if the chopper's energy absorption can meet the multiple fault ride-through requirements, considering different fault combinations and durations. Multiple faults occurring within short time windows can be considered as an adiabatic process[[[7]](#footnote-8)]. Therefore, a more detailed energy requirement should be specified.”

Texas Solar Power Association’s May 17 comments note that other OEMs for solar equipment have similar concerns and report that: “For example, at the April 14, 2023, IBRTF meeting, Nordex stated that for instantaneous voltage ride through performance criteria, ‘it will not be possible to secure the capability for all components’” and that some requirements ‘are outside of current requirements and design and must be assessed anew.’”[[8]](#footnote-9) Texas Solar Power Association’s comments go on to state : “Similarly, Power Electronics noted that it is unknown at this time whether the proposed requirements are feasible for some existing units: “Until the Gen. 3 evaluation is complete, it is not known if P-E Gen. 2 inverters (i.e.FS3510M and FS3350M) will meet the new requirements” and the “cost impact is not yet determined.”[[9]](#footnote-10)

While ERCOT’s August 18 comments purport to address some of the applicability issues for Type I and II resources, they do not address the very real concerns of the OEMs that there are still significant studies required to determine the feasibility of designing to these standards for existing resources. The comments proposed herein would allow all resources to come forward with compliance measures to the greatest extent possible without the concern that those resources could be subject to restrictions from ERCOT that prevent them from operating.

**Third**, more information and study is required to determine if NOGRR 245 as proposed by ERCOT will actually improve reliability. Without the changes proposed here, NEER is concerned that imposition of this standard on existing resources would harm resource adequacy. Further, the reliability risk that NOGRR 245 purports to address has not been quantified. In addition, the proposed standard includes requirements that directly conflict with other existing reliability requirements, like protection requirements related to subsynchronous oscillation (“SSO”) phenomena that require IBRs to protect equipment from damage due to SSO events, including by tripping if necessary.

Many commenters and stakeholders have raised concerns about the trade-offs between resource adequacy and the loss of resources that will occur from NOGRR 245. NEER’s July 28 comments note that ERCOT has not yet analyzed these reliability trade-offs. NEER’s proposed amendment ensures that the overall impacts to reliability are considered within the implementation of the standard without waiting for a full study of the reliability risks.

As NEER has previously commented: “During the February ERCOT Board of Directors meeting, it was noted that IBRs are now necessary to meet demand in ERCOT.  Since then, the value of IBRs for system reliability has been especially evident during this summer’s heat waves.  As the reliability advisor to TAC, ROS needs data and reliability analysis to weigh these matters and reach a reasonable, fact-based policy decision.” NEER notes “NOGRR 245 trades a potential reduction in one reliability risk, IBR tripping risk, for an increase in another reliability risk, capacity insufficiency risk, without providing supporting analysis showing that this tradeoff improves reliability.  To date, only anecdotal information regarding isolated wind IBRs tripping over a five-year period has been provided in support of the position that eliminating grandfathering for approximately 12.7 GW of the wind IBR fleet is essential to improve grid reliability.  No data has been presented that quantifies the reliability benefits of applying NOGRR 245 retroactively to currently grandfathered wind IBRs and potentially forcing them out of the market. A full study of the expected reliability improvements from improved FRT and VRT, net of the adverse reliability impacts caused by enforcement of NOGRR 245’s non-compliance provisions, needs to be conducted to ensure NOGRR 245’s potential impacts on reliability are understood.”

The reliability risk that may arise from the ERCOT draft is not just from the potential loss of existing generators, but also from the chilling effect that NOGRR 245 may have on future investment in new generation resources, which is critically important to maintaining reliability during this period of exceptionally high load growth that ERCOT is currently experiencing. The risk that ERCOT might impose substantial cost increases and compliance risks in the future has the potential to make investors hesitate before committing additional capital to the ERCOT region.

As previously mentioned in NEER’s July 28, 2023 comments, NEER has made an initial attempt to evaluate the potential resource adequacy impacts of restricting the operation of IBRs due to ride-through capability concerns. To provide insight into how significantly NOGRR 245 could affect reliability, engaged Astrapé to model how the loss of pre-2008 grandfathered wind IBR capacity could impact reliability and consumer energy costs. The analysis used traditional Monte Carlo modeling of the ERCOT system that is used in resource adequacy modeling studies.

Preliminary results indicate loss of pre-2008 wind IBRs causes a significant increase in the number of Energy Emergency Alert (EEA) Level 1 events at the one day in ten-year interval, doubling the number of EEA Level 1 events from six to twelve events annually in 2026. In addition, expected total costs to serve the ERCOT System increases range from $1.2 billion annually in the loss of pre-2008 wind IBR case to over $3 billion in other cases that include higher levels of restricted wind IBRs.

This analysis clearly demonstrates the potential adverse impacts NOGRR 245’s enforcement mechanisms can have on reliability. Given the magnitude of the increase in EEA events and the impact to consumer costs, it is critical for ERCOT to conduct and present a thorough reliability analysis that quantifies the expected improvements in reliability from additional ride through capability, the risks of restricting IBR operations, and the overall impact on loss of Load risk.

ERCOT’s comments do not reflect consideration of the conflicts between this NOGRR and other ERCOT requirements. GE notes conflicts between different reliability requirements in its July 31 comments: “In the proposed NOGRR245 comments, section 7.2.2.3.5 including Table 13 of the IEEE 2800-2022 are now included as part of the voltage ride-through requirements for units with an SGIA executed or a Generator Interconnection or Modification (GIM) initiated after June 1, 2023. This table requires aggressive, 6-cycle responses with a very tight tolerance band, applied at the POC of each turbine. GE Wind Turbine Generators have long been supplied with advanced stabilizing features that help to provide stable operation, particularly in regions with high wind penetration, series capacitors that risk Subsynchronous Control Interactions (SSCIs), or weak grid regions. Application of this section will require disabling of these features, which will be detrimental to stability for weak grids. GE recommends that this section 7.2.2.3.5 be listed as an Exception in the NOGRR language that references section 7, which is in paragraph (2)(b) of Section 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs).”

**Fourth**, the NOGRR unduly discriminates between technology types. ERCOT’s comments in the stakeholder process regarding this NOGRR state that for non-IBR resources, “[t]his Section shall not affect the Resource Entity’s responsibility to protect Generation Resources or ESRs from damaging operating conditions. The Resource Entity for a Generation Resource or ESR subject to paragraphs (1) and (2) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraphs (1) and (2), shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice.”

The comments offered here, provide alternative language to ensure that this technology and resource specific approach apply to all resources, ensure continued viability and the ability to remain reliably connected to the ERCOT grid.

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| Revised Cover Page Language | | |
| Nodal Operating Guide Sections Requiring Revision | 2.6.2, Generators and Energy Storage Resources  2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) (new)  2.6.2.1, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs)  2.6.4, Commercially Reasonable Efforts (new)  2.9, Voltage Ride-Through Requirements for Generation Resources  2.9.1, Voltage Ride-Through Requirements for Intermittent Renewable Resources Connected to the ERCOT Transmission Grid  2.9.1.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) (new) | |
| Revision Description | This Nodal Operating Guide Revision Request (NOGRR) replaces the current voltage ride-through requirements for Intermittent Renewable Resources (IRRs) with voltage ride-through requirements for Inverter-Based Resources (IBRs) and provides new frequency ride-through requirements for IBRs consistent with or beyond requirements identified in the new 2800-2022 - Institute of Electrical and Electronics Engineers (IEEE) Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems (“IEEE 2800-2022 standard”). It also requires all IBRs to improve performance to meet these standards, and establishes compliance requirements for Resource Entities when it is commercially reasonable to do so. | |
| Business Case | ERCOT submits this NOGRR based on reliability issues associated with the inability of some IBRs to ride-through system disturbances, and in light of the IEEE 2800-2022 standard. In its recently issued guidance document *Inverter-Based Resource Strategy*, theNorth American Reliability Corporation (NERC) noted it has supported the development of the IEEE 2800-2022 standard (and continues to support the IEEE P2800.2, Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems, standards development efforts). Among other things, the document also highlights that:   * New technology can introduce significant risks if not integrated properlywhich requires ERCOT and market participants to cooperate on solutions; * Inverter and plant controls and protection systems must support the reliable operation of the bulk power system during system disturbances; * Disturbance reports, alerts, guidelines, and other deliverables have shown that abnormal IBR performance issues pose a risk to bulk power system reliability that needs to be addressed going forward; * Analyzed events identified new performance issues such as momentary cessation, inverter or plant-level tripping issues, controller interactions and instabilities, and other performance risks that must be mitigated; and * Generation ride-through and provision of essential reliability services is a core principle for reliable operation of the bulk power system.   IEEE 2800-2022 states that the entity to determine compliance with the standard is the entity that governs the interconnection process, strongly implying that these standards are intended to be implemented on a prospective basis for new interconnections. For example, Section 1.4 of the standard states:  “The application of this standard may be limited to IBR plants for which interconnection requests are submitted after the date by which this standard is enforced by the responsible authority governing interconnection requirements (AGIRs); this standard may not apply to IBR plants that are either already interconnected or for which interconnection requests had been submitted prior to the standard’s enforcement date (grandfathering). Any substantial changes in an existing IBR plant, e.g., the “repowering” of a wind power plant, may require retrofitting that IBR plant to meet all of the requirements of this standard.”  This NOGRR proposes ride-through requirements for IBRs with specificity consistent with or beyond the IEEE 2800-2022 standard where appropriate (e.g., applying to the Point of Interconnection Bus (POIB) instead of the “Resource Point of Applicability”). The revisions specify the ride-through requirements for IBRs rather than IRRs or Energy Storage Resources (ESRs) because they are not necessarily IBRs and the IBR attributes create unique ride-through requirements. Some clarifications included from the IEEE 2800-2022 standard may not require additional “capability” but provide additional specificity for settings that can prevent failures rather than adjustments being made after a failure occurs.  Failure of IBRs to ride-through normal frequency and voltage deviations on the ERCOT System can lead to severe consequences such as instability, cascading outages, or triggering an Under-Frequency Load Shed (UFLS) event. However, in many cases, ERCOT relies on IBRs to meet system demand. Because of these complex risks, and with the recognition that the IEEE 2800-2022 standard may be limited to new interconnections with some mechanism for grandfathering, this NOGRR requires all Resources, even grandfathered ones, to undergo an annual review of what commercially reasonable efforts can be taken to come into compliance, and proposes an accelerated interconnection process for Resources that choose to re-power. This NOGRR proposes that all IBRs with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2026 (“existing IBRs”), maximize ride-through capability to meet or exceed the current voltage ride-through profile and the new frequency ride-through profile if it is commercially reasonable to do so. IBRs that cannot meet the new ride-through requirements will need to submit a report by June 1, 2024 documenting such to give ERCOT an accurate understanding of the physical limitations and maximum ride-through capability. If ERCOT has evidence that a Resource Entity’s review of commercially reasonable efforts to comply is not in good faith, then it must report the entity to the Reliability Monitor.  This compliance date for existing IBRs is in the future, because many original equipment manufacturers (“OEM”) have stated that they are not yet capable of compliance with the IEEE 2800-2022 standard, and in some cases because they were waiting on the development of IEEE 2800.2 before being able to evaluate the ability to comply.  The proposed requirements will help improve several of the major failure modes identified in the Odessa disturbances in 2021 and 2022. Market Participants in the Inverter Based Resource Task Force encouraged ERCOT to focus on enhancements adopting portions of the IEEE 2800-2022 standard or NERC Reliability Guidelines that would provide the most reliability benefit in the short-term rather than a holistic approach. | |

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| Revised Proposed Guide Language |

***2.6.2 Frequency Ride-Through Requirements for Generation Resources and Energy Storage Resources***

(1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) or 2.6.2.2, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), if under-frequency relays are installed and activated to trip the Generation Resource or ESR, these relays shall perform such that the automatic removal of individual Generation Resources or ESRs from the ERCOT System meets or exceeds the following requirements:

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| **Frequency Range** | **Delay to Trip** |
| Above 59.4 Hz | No automatic tripping  (continuous operation) |
| Above 58.4 Hz up to  and including 59.4 Hz | Not less than 9 minutes |
| Above 58.0 Hz up to  and including 58.4 Hz | Not less than 30 seconds |
| Above 57.5 Hz up to  and including 58.0 Hz | Not less than 2 seconds |
| 57.5 Hz or below | No time delay required |

(2) Except for Generation Resources subject to Sections 2.6.2.1 or 2.6.2.2, if over-frequency relays are installed and activated to trip the Generation Resource or ESR, they shall perform such that the automatic removal of individual Generation Resources or ESRs from the ERCOT System meets or exceeds the following requirements:

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| **Frequency Range** | **Delay to Trip** |
| Below 60.6 Hz down to and including 60 Hz | No automatic tripping (continuous operation) |
| Below 61.6 Hz down to and including 60.6 Hz | Not less than 9 minutes |
| Below 61.8 Hz down to and including 61.6 Hz | Not less than 30 seconds |
| 61.8 Hz or above | No time delay required |

(3) If installed and activated to trip a Generation Resource or ESR, frequency protection schemes shall use filtered quantities or add sufficient time delays to prevent misoperations while providing the desired equipment protection. Protection schemes shall not trip a Generation Resource or ESR based on an instantaneous frequency measurement.

(4) This Section shall not affect the Resource Entity’s responsibility to protect Generation Resources or ESRs from damaging operating conditions. The Resource Entity for a Generation Resource or ESR subject to paragraphs (1) and (2) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraphs (1) and (2), shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the Generation Resource’s or ESR’s frequency ride-through capability in the format shown in the tables in paragraphs (1) and (2) above.

***2.6.2.1 Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs)***

(1) All IBRs interconnected to the ERCOT Transmission Grid shall ride through the frequency conditions at the IBR’s Point of Interconnection Bus (POIB) specified in the following table:

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| --- | --- |
| Frequency (f) in (Hz) | Minimum Ride-Through Time  (seconds) |
| f > 61.8 | May ride-through or trip |
| 61.6 < f ≤ 61.8 | 299 |
| 61.2 < f ≤ 61.6 | 540 |
| 58.8 ≤ f ≤ 61.2 | continuous |
| 58.4 ≤ f < 58.8 | 540 |
| 57.0 ≤ f < 58.4 | 299 |
| f < 57.0 | May ride-through or trip |

(2) Nothing in paragraph (1) above shall be interpreted to require an IBR to trip for frequency conditions beyond those for which ride-through is required.

(3) If installed and activated to trip the IBR, all protection systems (including, but not limited to protection for over-/under-frequency, rate-of-change of frequency, anti-islanding, and phase angle jump) shall enable the IBR to ride through frequency conditions beyond those defined in paragraph (1) above to the maximum extent possible. An IBR shall ride through frequency excursions during which ride-through is required and the absolute rate-of-change of frequency magnitude does not exceed 5.0 Hz/second. The rate-of-change of frequency shall be considered the average rate of change of frequency over a period of at least 0.1 seconds unless ERCOT or the interconnecting Transmission Service Provider (TSP) specifies otherwise.

(4) An IBR shall inject electric current during all periods requiring ride-through.

(5) IBR plant controls or inverter controls shall not disconnect the IBR from the ERCOT System or reduce IBR output during frequency conditions where ride-through is required unless necessary for providing appropriate frequency response or prevent equipment damage.

(6) An IBR with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2026, must make commercially reasonable efforts to comply with paragraphs (1) through (5) above as soon as practicable.

The Resource Entity or Interconnecting Entity (IE) for an IBR with an SGIA executed prior to June 1, 2026 that cannot comply with paragraphs (1) through (5) above shall, by June 1, 2024 (or as part of the interconnection process), submit to ERCOT a report and supporting documentation containing the following:

(a) The current and potential future IBR frequency ride-through capability (including any associated adjustments to improve frequency ride-through capability) in a format similar to the table in paragraph (1) above;

(b) The proposed commercially reasonable modifications to maximize the IBR frequency ride-through capability and allow the IBR to comply with the frequency ride-through requirements in paragraphs (1) through (5) above;

(c) A schedule for implementing those modifications no later than December 31, 2026; and

(d) Any known limitations on the IBR’s frequency ride-through capability making it technically infeasible to meet the requirements in paragraphs (1) through (5) above.



(7) If an IBR fails to perform in accordance with the applicable frequency ride-through requirements, the Resource Entity for the IBR shall investigate the event and report to ERCOT the cause of the IBR’s failure. The Resource Entity’s investigation must include a diligent review of commercially reasonable efforts to avoid future failures. All impacted TSPs shall provide available information to ERCOT to assist with event analysis.

(8) This Section shall not affect the Resource Entity’s responsibility to protect IBRs from damaging operating conditions. The Resource Entity for an IBR subject to paragraph (1) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraph (1), shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the Generation Resource’s or ESR’s frequency ride-through capability in the format shown in the table in paragraph (1) above. Any such IBR that cannot comply with the applicable frequency ride-through requirements must evaluate commercially reasonable efforts needed to comply with the requirements or increase the IBR’s frequency ride-through capabilities as described in Section 2.6.4, Commercially Reasonable Efforts.

(9) An IBR is not required to comply with these requirements if doing so would cause it to violate its Subsynchronous Resonance (SSR) Mitigation plan developed to comply with Protocol Section 3.22.1.2, Generation Resource or Energy Storage Resource Interconnection Assessment.











***2.6.2.2 Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs)***

(1) For any short-circuit fault or open-phase condition that occurs on the circuit to which the DGR or DESR is connected, the DGR or DESR will cease to energize and trip offline, and this will take priority over the frequency ride-through function.

(2) DGRs and DESRs must have over-/under-frequency relays set to ride through frequency conditions as specified in the following table:

|  |  |  |
| --- | --- | --- |
| Frequency (Hz) | Ride-Through Mode | Minimum Ride-through Time  (seconds) |
| *f > 61.8* | No ride-through requirements | |
| 61.2 < f ≤ 61.8 | Mandatory Operation | 299 |
| 58.8 ≤ f ≤ 61.2 | Continuous Operation | continuous |
| 57.0 ≤ f < 58.8 | Mandatory Operation | 299 |
| *f < 57.0* | No ride-through requirements | |

(3) Any Resource Entity with a DGR or DESR utilizing inverter-based generation that achieved Initial Synchronization before April 1, 2020 that is not capable of complying with the requirements of paragraph (2) above may request an exemption from those requirements. Such a request shall be submitted by November 2, 2020 and shall include documentation that demonstrates the DGR’s or DESR’s frequency ride-through capability to ERCOT’s satisfaction. If, after reviewing the request and documentation, ERCOT determines the DGR or DESR is not capable of complying with the requirements of paragraph (2), then the DGR or DESR shall be exempt from those requirements, but shall be required to comply with those requirements to the greatest degree possible within its capability, as determined in writing by ERCOT. Upon replacement or retirement of the inverter, the DGR or DESR shall no longer be exempt and shall at that time be required to comply with the requirements of paragraph (2) or other applicable requirement.

**2.6.4 Commercially Reasonable Efforts**

(1) Any references to commercially reasonable efforts in Section 2, System Operations and Control Requirements, is a reference to this Section 2.6.4, Commercially Reasonable Efforts.

(2) Beginning June 1, 2024, a Resource Entity that must consider commercially reasonable efforts to increase the level of compliance with the voltage and frequency ride-through requirements of Section 2, System Operations and Control Requirements, must submit a detailed report regarding its evaluation of its facilities and what modifications, if any, can be made to its equipment. No later than June 1 of each subsequent year, such Resource Entities must update this evaluation if there have been any material changes, or alternatively submit an attestation that there have been no material changes since the prior submission.

(3) When considering commercially reasonable efforts, the Resource Entity may consider factors such as the availability and/or cost of firmware or hardware, whether those improvements are technically feasible, the depreciated value of the facility, the cost of capital, the availability of capital, the expected profitability for the remainder of the facility’s expected lifespan, whether the modifications would cause the Resource to be out of compliance with other ERCOT requirements, or any other relevant factor.

(4) If commercially reasonable efforts to increase compliance involve repowering a facility, then ERCOT must make reasonable efforts to reduce the time required for interconnection of the new facility when it is possible to do so.

(5) If a Resource Entity upgrades a Resource to increase its level of compliance, but does not fully comply, those efforts may be considered when evaluating additional modifications. ERCOT, in its sole discretion, may determine that a particular Resource has achieved a sufficient level of compliance so that ongoing commercially reasonable efforts evaluation are no longer necessary.

(6) If ERCOT has evidence that a Resource Entity has not identified commercially reasonable compliance plans, it may refer the Resource Entity to the Reliability Monitor. Evidence may include the filings of other similarly situated Resource Entities, data provided by original equipment manufacturers, or other similar information. Nothing herein requires ERCOT to run its own financial analysis on what is considered a good investment or commercially reasonable. Prior to a referral to the Reliability Monitor, ERCOT shall offer the Resource Entity 45 days to provide any additional relevant information. When ERCOT provides any evidence it used to make a determination to the Reliability Monitor, it must also provide it to the Resource Entity.

(7) All information provided to ERCOT about commercially reasonable efforts or analysis shall be considered as Confidential Information.

**2.9 Voltage Ride-Through Requirements for Generation Resources**

(1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), or 2.9.2, Voltage Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), each Generation Resource or ESR must remain reliably connected to the ERCOT Transmission Grid during the following:

(a) Generator terminal voltages are within 5% of the rated design voltage and volts per hertz are less than 105% of generator rated design voltage and frequency;

(b) Generator terminal voltage deviations exceed 5% but are within 10% of the rated design voltage and persist for less than ten seconds;

(c) Generator volts per hertz conditions are less than 116% of generator rated design voltage and frequency and last for less than 1.5 seconds;

(d) A transmission system fault (three-phase, single-phase or phase-to-phase), but not a generator bus fault, is cleared by the protection scheme coordinated between the Generation Entity and the Transmission Service Provider (TSP) on any line connected to the generator’s transmission interconnect bus, provided such lines are not connected to induction generators described in paragraph (12) of Protocol Section 3.15, Voltage Support; and

(e) In the case of a generator bus fault or a primary transmission system relay failure, the generator protective relaying may clear the generator independent of the operation of any transmission protective relaying.

(2) During operating conditions listed in paragraph (1) above, each Generation Resource and ESR subject to paragraph (1) shall not, during and following a transient voltage disturbance, cease providing real or reactive current except to the extent needed to provide frequency support or aid in voltage recovery.

(3) Synchronous Generation Resources required to provide Voltage Support Service (VSS) shall have and maintain the following capability:

(a) Over-excitation limiters shall be provided and coordinated with the thermal capability of the generator field winding and protective relays in order to permit short-term reactive capability that allows at least 80% of the unit design standard (ANSI C50.13-1989), as follows:

Time (seconds) 10 30 60 120

Field Voltage % 208 146 125 112

After allowing temporary field current overload, the limiter shall operate through the automatic AC voltage regulator to reduce field current to the continuous rating. Return to normal AC voltage regulation after current reduction shall be automatic. The over-excitation limiter shall be coordinated with the over-excitation protection so over-excitation protection operates only for failure of the voltage regulator/limiter.

(b) Under-excitation limiters shall be provided and coordinated with loss-of-field protection to eliminate unnecessary generating unit disconnection as a result of operator error or equipment malfunction.

(4) Generation Resources and ESRs shall have protective relaying necessary to protect equipment from abnormal conditions and be consistent with protective relaying criteria described in Section 6.2.6.3.4, Generator Protection and Relay Requirements.

(5) The voltage ride-through requirements do not apply to faults between the generator terminals and the transmission voltage side of the Main Power Transformer (MPT), or when clearing the fault effectively disconnects the Generation Resource from the ERCOT System.

(6) A Generation Resource or ESR may be tripped Off-Line or curtailed after the fault clearing period if part of an approved Remedial Action Scheme (RAS).

(7) Each Generation Resource and ESR shall provide to ERCOT technical documentation of voltage ride-through capability upon request.

|  |
| --- |
| ***[NOGRR204: Replace Section 2.9 above with the following upon system implementation of NPRR989:]***  **2.9 Voltage Ride-Through Requirements for Generation Resources and Energy Storage Resources**  (1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), or 2.9.2, Voltage Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), each Generation Resource and ESR must remain reliably connected to the ERCOT Transmission Grid during the following:  (a) Generator or inverter terminal voltages are within 5% of the rated design voltage and volts per hertz are less than 105% of generator rated design voltage and frequency;  (b) Generator or inverter terminal voltage deviations exceed 5% but are within 10% of the rated design voltage and persist for less than ten seconds;  (c) Generator or inverter volts per hertz conditions are less than 116% of rated design voltage and frequency and last for less than 1.5 seconds; and  (d) A transmission system fault (three-phase, single-phase or phase-to-phase), but not a unit bus fault, is cleared by the protection scheme coordinated between the Resource Entity and the Transmission Service Provider (TSP) on any line connected to the Resource’s Point of Interconnection (POI), provided such lines are not connected to induction generators described in paragraph (12) of Protocol Section 3.15, Voltage Support.  (2) In the case of a unit bus fault or a primary transmission system relay failure, the unit protective relaying may clear the unit independent of the operation of any transmission protective relaying.  (3) During operating conditions listed in paragraph (1) above, each Generation Resource and ESR subject to paragraph (1) shall not, during and following a transient voltage disturbance, cease providing real or reactive current except to the extent needed to provide frequency support or aid in voltage recovery. Each ESR, if it is consuming active power from the ERCOT System when operating in the charging mode, shall reduce or cease power consumption as necessary to aid in voltage recovery during and following transient voltage disturbances.  (4) Synchronous Generation Resources required to provide Voltage Support Service (VSS) shall have and maintain the following capability:  (a) Over-excitation limiters shall be provided and coordinated with the thermal capability of the generator field winding and protective relays in order to permit short-term reactive capability that allows at least 80% of the unit design standard (ANSI C50.13-1989), as follows:  Time (seconds) 10 30 60 120  Field Voltage % 208 146 125 112  After allowing temporary field current overload, the limiter shall operate through the automatic AC voltage regulator to reduce field current to the continuous rating. Return to normal AC voltage regulation after current reduction shall be automatic. The over-excitation limiter shall be coordinated with the over-excitation protection so over-excitation protection operates only for failure of the voltage regulator/limiter.  (b) Under-excitation limiters shall be provided and coordinated with loss-of-field protection to eliminate unnecessary generating unit disconnection as a result of operator error or equipment malfunction.  (5) Generation Resources and ESRs shall have protective relaying necessary to protect equipment from abnormal conditions and be consistent with protective relaying criteria described in Section 6.2.6.3.4, Generation Resource and Energy Storage Resource Protection and Relay Requirements.  (6) The voltage ride-through requirements do not apply to faults at or behind the POI, when clearing the fault effectively disconnects the Resource from the ERCOT System.  (7) A Generation Resource or ESR may be tripped Off-Line or curtailed after the fault clearing period if part of an approved Remedial Action Scheme (RAS).  (8) Each Generation Resource and ESR shall provide to ERCOT technical documentation of voltage ride-through capability upon request. |

***2.9.1 Voltage Ride-Through Requirements for Transmission-Connected*** ***Inverter-Based Resources (IBRs)***

(1) Except as specified below, all Inverter-Based Resources (IBRs) interconnected to the ERCOT Transmission Grid shall comply with voltage ride-through requirements as follows:

(a) Section 2.9.1.1, Preferred Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) shall apply to:

(i) IBRs with a Standard Generation Interconnection Agreement (SGIA) executed on or after June 1, 2026.

(ii) IBRs that implement any modification, as described in paragraph (1)(c) of Planning Guide Section 5.2.1, Applicability, for which a Generator Interconnection or Modification (GIM) was initiated on or after June 1, 2026.

(iii) Certain IBRs after December 31, 2027 in accordance with paragraph (8) of Section 2.9.1.2, Legacy Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs).

(2) IBRs: (i) with an SGIA executed on or (ii) after June 1, 2026 or that implement any modification, as described in paragraph (1)(c) of Planning Guide Section 5.2.1, Applicability, for which a Generator Interconnection or Modification (GIM) was initiated on or after June 1, 2026, shall meet or exceed the capability and performance requirements in the following sections of Institute of Electric Engineers (IEEE) 2800-2022, Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems or any successor IEEE standard, including any intra-standard cross references or definitions, unless otherwise clarified, modified, or exempted in the ERCOT Protocols, these Operating Guides, or Planning Guide:

(a) Section 5, Reactive power-voltage control requirements within the continuous operation region;

(b) Section 7, Response to TS abnormal conditions; and

(c) Section 9, Protection.

All IBR plant requirements and all IBR unit requirements described in the standard are to be applied at the Point of Interconnection Bus (POIB) and the individual inverter based unit terminal respectively unless otherwise clarified, modified, or exempted in the ERCOT Protocols.

(3) The Resource Entity or Interconnecting Entity (IE) for an IBR with an SGIA executed prior to June 1, 2026 that cannot comply with the voltage ride-through requirements above shall, by June 1, 2024 (or as part of the interconnection process), submit to ERCOT a report and supporting documentation containing the following:

(a) The current and potential future IBR voltage ride-through capability (including any associated adjustments to improve voltage ride-through capability) in a format specified by ERCOT;

(b) The proposed commercially reasonable modifications to maximize the IBR voltage ride-through capability and allow the IBR to comply with the voltage ride-through requirements above;

(c) A schedule for implementing those modifications no later than December 31, 2026; and

(d) Any known limitations on the IBR’s voltage ride-through capability making it technically infeasible to meet the requirements above.

(4) An IRR that interconnects to the ERCOT Transmission Grid pursuant to a SGIA (i) executed on or before January 16, 2014 and (ii) under which the IRR provided all required financial security to the TSP on or before January 16, 2014, is not required to meet any high voltage ride-through requirement greater than 1.1 per unit voltage unless the interconnected IRR includes one or more turbines that differ from the turbine model(s) described in the SGIA (including any attachment thereto), as that agreement existed on January 16, 2014. Notwithstanding the foregoing, if the Resource Entity that owns or operates an IRR that was interconnected pursuant to an SGIA executed before January 16, 2014, under which the IRR provided all required financial security to the TSP on or before January 16, 2014, demonstrates to ERCOT’s satisfaction that the high voltage ride-through capability of the IRR is not lower than the capability of the turbine model(s) described in the SGIA (including any attachment thereto), as that agreement existed on January 16, 2014, that IRR is not required to meet the high voltage ride-through requirement in this Section.

(5) An IRR that interconnects to the ERCOT System pursuant to an SGIA executed prior to November 1, 2008 is not required to meet voltage ride-through requirements presented in this Section. However, any Wind-powered Generation Resource (WGR) that is installed on or after November 1, 2008 and that initially synchronizes with the ERCOT System, pursuant to an SGIA (i) executed on or before January 16, 2014, and (ii) under which the IRR provided all required financial security to the TSP on or before January 16, 2014 (except for an IRR installed pursuant to an SGIA executed before November 1, 2008) shall be voltage ride-through capable in accordance with the low voltage ride-through requirements in this Section and high-voltage requirements in this Section up to 1.1 per unit voltage unless the interconnected IRR includes one or more turbines that differ from the turbine model(s) described in the SGIA (including any attachment thereto), as that agreement existed on January 16, 2014 in which case the IRR shall also be required to comply with the high voltage ride-through requirements of this Section, subject to the exemption described in paragraph (a), above.

(6) This Section shall not affect the Resource Entity’s responsibility to protect IBRs from damaging operating conditions. The Resource Entity for an IBR unable to remain reliably connected to the ERCOT System as set forth in Section 2.9.1.1, including those subject to paragraphs (3) and (4) above, shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the Generation Resource or ESR voltage ride-through capability in the format specified by ERCOT. Any such IBR that cannot comply with the applicable voltage ride-through requirements must evaluate commercially reasonable efforts needed to comply with the requirements or increase voltage ride-through capabilities as described in Section 2.6.4, Commercially Reasonable Efforts.

(7) An IBR is not required to comply with the voltage-ride through requirements above if doing so would cause it to violate its Subsynchronous Resonance (SSR) Mitigation plan developed to comply with Protocol Section 3.22.1.2, Generation Resource or Energy Storage Resource Interconnection Assessment.

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

(1) All IBRs subject to this Section in accordance with paragraph (1) of Section 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), 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 Point of Interconnection Bus (POIB):

**Table A: Applicable to Wind-powered Generation Resource (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 |
| V < 0.25 | 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 |
| V < 0.25 | 0.32 |

In the event of multiple excursions, the minimum ride-through time in Tables A or B is a cumulative time over a ten second time window.

**Table C**

|  |  |
| --- | --- |
| Instantaneous Phase-to-Phase or Phase-to-Ground Voltage  (p.u. of nominal) | Minimum Ride-Through Time  (milliseconds) |
| V > 1.80 | May ride-through or trip |
| 1.70 < V ≤ 1.80 | 0.2 |
| 1.60 < V ≤ 1.70 | 1.0 |
| 1.40 < V ≤ 1.60 | 3.0 |
| 1.20 < V ≤ 1.40 | 15.0 |

The instantaneous voltages in Table C above are the residual voltages with surge arrestors, if applied. During the conditions identified in Table C, an IBR should continue injecting current, but need not respond to the sub-cycle transient overvoltage. If required by equipment limitations, the IBR may operate in current blocking mode when instantaneous voltage exceeds 1.20 p.u. at the POIB. If the IBR operates in current blocking mode, it shall restart current exchange in less than or equal to five cycles following instantaneous voltage falling below, and remaining below, 1.2 p.u. at the POIB. In the event of multiple excursions, the minimum ride through time in Table C is a cumulative time over a one minute time window.

(2) Nothing in paragraph (1) above shall be interpreted to require an IBR to trip for voltage conditions beyond those for which ride-through is required.

(3) If installed and activated to trip the IBR, all protection systems (including, but not limited to protection for over-/under-voltage, rate-of-change of frequency, anti-islanding, and phase angle jump) shall enable the IBR to ride through voltage conditions beyond those defined in paragraph (1) above to the maximum extent possible. An IBR shall ride-through any grid disturbance during which ride-through is required and the positive-sequence angle change within a sub-cycle-to-cycle time frame does not exceed 25 electrical degrees. In addition, the IBR shall ride-through any change in the phase angle of individual phases caused by occurrence and clearance of unbalanced faults, provided the positive-sequence angle change does not exceed the stated criterion. Positively damped active and reactive current oscillations in the post-disturbance period are acceptable in response to phase angle changes.

(4) An IBR shall inject electric current during all periods requiring ride-through. When the POIB voltage is outside the continuous operating voltage range, an IBR shall continue to deliver pre-disturbance active current unless otherwise limited due to its current limit. Unless otherwise specified by ERCOT or the interconnecting TSP, an IBR shall minimize reductions in active current while maintaining robust reactive current response. Any necessary reductions in active current to prioritize reactive current shall be proportional to the voltage change at the POIB. An IBR shall return to its pre-disturbance level of real power injection as soon as possible but no more than one second after POIB voltage recovers to normal operating range.

(5) IBR plant controls or inverter controls shall not disconnect the IBR from the ERCOT System or reduce IBR output during voltage conditions where ride-through is required unless necessary to provide appropriate frequency response or prevent equipment damage.

(6) If installed and activated to trip the IBR, instantaneous over-current or over-voltage protection systems shall use filtered quantities to prevent misoperation while providing the desired equipment protection. Any instantaneous over-voltage protection that could disrupt IBR power output shall use a measurement window of at least one cycle of fundamental frequency.

(7) The IBR shall ride through multiple excursions outside the continuous operation range in Tables A or B in paragraph (1) above as applicable, unless the conditions and situations specified below exist, in which case the IBR may trip to protect equipment from the cumulative effect of successive voltage deviations:

(a) More than four voltage deviations at the POIB outside the continuous operation zone within any ten second period.

(b) More than six voltage deviations at the POIB outside the continuous operation zone within any 120 second period.

(c) More than ten voltage deviations at the POIB outside the continuous operation zone within any 1,800 second period.

(d) Voltage deviations outside of continuous operation zone following the end of a previous deviation outside of continuous operation zone by less than twenty cycles of system fundamental frequency.

(e) More than two individual voltage deviations at the POIB below 50% of the nominal voltage (including zero voltage) within any ten second period.

(f) More than three individual voltage deviations at the POIB below 50% of the nominal voltage (including zero voltage) within any 120 second period.

(g) Individual wind turbines may trip for consecutive voltage deviations resulting in stimulation of mechanical resonances exceeding equipment limits.

Individual voltage deviations begin when the voltage at the POIB drops below the lower limit of the continuous operation range or exceeds the upper limit of the continuous operation range. Individual voltage deviations end when the root-mean-square voltage magnitude at the POIB, for the previous one-cycle period of fundamental frequency, returns to the continuous operation region.

(8) If an IBR fails to perform in accordance with the voltage ride-through requirements of paragraphs (1) through (7) above, the Resource Entity for the IBR shall investigate the event and report to ERCOT the cause of the IBR failure. The Resource Entity’s investigation must include a diligent review of commercially reasonable efforts to avoid future failures. All impacted TSPs shall provide available information to ERCOT to assist with event analysis.

(9) Section 2, System Operations and Control Requirements, shall not affect the Resource Entity’s responsibility to protect Generation Resources, IBRs, or ESRs from damaging operating conditions. The Resource Entity for a Generation Resource, an IBR, or ESR subject to paragraphs (1) and (2) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraphs (1) and (2), shall provide ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the Generation Resource’s or ESR’s voltage ride-through capability in the format specified by ERCOT. Any such Generation Resource, IBR, or ESR that cannot comply with the applicable voltage ride-through requirements must evaluate commercially reasonable efforts needed to comply or to increase the voltage ride-through capabilities as described in Section 2.6.4, Commercially Reasonable Efforts.



(10) An IBR is not required to comply with the requirements in Section 2 if doing so would cause it to violate its SSR Mitigation plan developed to comply with Protocol Section 3.22.1.2, Generation Resource or Energy Storage Resource Interconnection Assessment.



1. NERC IEEE 2800 Readiness, ESIG Fall Technical Workshop (Oct. 2022), *available at* <https://www.esig.energy/download/session-2-ieee-2800-oem-readiness-aung-thant/?wpdmdl=9565&refresh=636027209ecc91667245856> (last accessed Aug. 28, 2023) (referred to herein as “NERC ESIG Fall 2022 Presentation”). [↑](#footnote-ref-2)
2. See, for example, NEER June 28, 2023 comments and the comments of all other major wind developers. [↑](#footnote-ref-3)
3. EEE 2800-2022, IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems, 39. [↑](#footnote-ref-4)
4. NERC ESIG Fall 2022 Presentation at 10. [↑](#footnote-ref-5)
5. Also see summary of OEM capabilities in Southern Power’s May 1 comments. [↑](#footnote-ref-6)
6. GE Renewables is now GE Vernova. [↑](#footnote-ref-7)
7. An adiabatic process is defined as a process in which no heat transfer takes place. This does not mean that the temperature is constant, but rather that no heat is transferred into or out of the system. [↑](#footnote-ref-8)
8. *See*, April 14, 2023 IBRTF Task Force Meeting Materials, Nordex Group IBRTF Feedback NOGRR245 Rev.00, Malte Laubrock, Head of Grid Integration, Presentation (April 14, 2023) at page 17. [↑](#footnote-ref-9)
9. *See*, April 14, 2023 IBRT Task Force Meeting Materials, P-E ERCOT presentation, S. Giguere, Director of Energy Storage U.S. (March 10, 2023) at page 14. [↑](#footnote-ref-10)