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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 | January 23, 2024 |

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| Market Segment | Independent Generator |

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| Comments |

Invenergy, NextEra Energy Resources LLC, and Southern Power Company (“Joint Commenters”) appreciate the opportunity to comment on Nodal Operating Guide Revision Request (“NOGRR”) 245. Joint Commenters support the adoption of a more robust Inverter-Based Resource (“IBR”) performance standard to improve equipment technical capabilities and mitigate the reliability risk of grid disturbance events. However, Joint Commenters remain concerned that NOGRR245, as proposed by ERCOT’s comments filed on January 8, 2024, will cause IBR facility owners to incur significant and unprecedented capital investments to meet new technical requirements not contemplated at the time of facility design and development, will increase resource adequacy risk on the ERCOT system due to the premature retirement of IBR facilities, will create a chilling effect on generation investment in the state, and violates ERCOT’s statutory and constitutional authority. Joint Commenters continue to support the framework endorsed by the Reliability and Operations Subcommittee (“ROS”) on September 14, 2023, that allows for legacy IBRs to use commercially reasonable efforts to comply with the newly proposed frequency and voltage ride-through requirements. Joint Commenters believe that the combination of maximizing capabilities of legacy IBRs, establishing more robust ride-through requirements for new IBRs, requiring ongoing annual assessments of newly available capabilities, and strengthening the transmission system will substantially mitigate ride-through risk, while also properly avoiding increased resource adequacy risk associated with an unknown amount of IBR retirements if such resources’ technical and commercial limitations are ignored.

Joint Commenters remain deeply concerned that the net impact of ERCOT’s proposal will be to increase resource adequacy risk to the ERCOT System through the premature retirement of legacy solar, wind, and battery energy storage resources that are unable to meet the new requirements. Due to the uncertainty – or impossibility – of meeting the new requirements, legacy IBRs will be at risk of limited or completely restricted operations and may choose retirement instead of investing in potentially cost-prohibitive and/or commercially unproven technologies. Moreover, the ERCOT System continues to experience significant load growth and IBRs critically contribute to serving peak load demands while keeping costs reasonable for consumers. The contribution of these facilities to resource adequacy has been noted as recently as the January 18th Public Utility Commission of Texas (“PUCT”) Open Meeting where the recent cold weather event was discussed. Finally, the ERCOT System will potentially be exposed to additional resource adequacy risk through the introduction of proposed rulemakings at the Environmental Protection Agency that will likely put further financial and operational stress on thermal resources. The potential impact of NOGRR245 cannot be viewed in a vacuum but must be assessed in light of other regulatory changes that may increase system resource adequacy risk.[[1]](#footnote-1)

A holistic solution will improve IBR performance and transmission grid strength. The lack of transmission strength in far West Texas is exacerbating the impact of grid disturbances and creating larger and more frequent abnormal system conditions through which certain IBRs must ride through. Transmission solutions that mitigate the impact of grid disturbances and improve system resiliency already have been approved but not yet installed. Those transmission improvements and potentially others must be evaluated and their implementation expedited.[[2]](#footnote-2)

Joint Commenters submit these comments on top of the ROS Report recommended for approval on September 14, 2023, and propose the following changes:

* Modifying the date that defines a new IBR from June 1, 2026 to June 1, 2024 (or June 1, 2026 if the Interconnecting Entity provides an affidavit from the original equipment manufacturer (“OEM”) stating that the OEM intends to use Institute of Electrical and Electronics Engineers (IEEE) 2800.2, Recommended Practice for Test and Verification Procedures for Inverter-Based Resources (IBRs) Interconnecting with Bulk Power Systems “IEEE 2800.2 standard” finalization in order to support compliance with IEEE 2800-2022, Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems “IEEE 2800-2022 standard,” Nodal Operating Guide Section 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), and Nodal Operating Guide Section 2.9.1.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs).
  + Adding a new form for OEMs to indicate the above.
* A statement that software/firmware changes without physical modifications are presumed to be commercially reasonable if they are technically feasible.
* Changing the reporting timeline for existing IBRs to complete the initial capability and compliance report by December 1, 2024, and subsequent evaluations by the first of every December thereafter.

Retroactive application of new regulatory requirements, especially ones that impose the risk of substantial increased costs, unfettered restrictions up to disconnection, and premature retirements, does not encourage capital providers to make future investments. ERCOT and the stakeholder community have a long history of avoiding retroactive application of rules, including for IBRs.[[3]](#footnote-3) In brief, ERCOT initially asked for the very first OGRR on this topic – OGRR 208 – to be retroactive in 2008. ERCOT ultimately compromised on the matter before the Board meeting with many of the same joint commenters filing these comments sixteen years later. That precedent has continued. Any retroactive treatment, such as the proposed commercially reasonable standard, is a substantial compromise on our behalf.

1. **The ROS-Approved Version of NOGRR245 is Intended to Achieve ERCOT’s Stated Goals and Account for the Commercial Reasonableness of Technically Feasible Options on a Recurring Basis.**

ERCOT repeatedly mischaracterizes the ROS-approved version of NOGRR245 as a “voluntary compliance regime,” incorrectly equates it with today’s combination of requirements and recommended improvements, and wrongly claims it will “nullify the requirements ERCOT proposed” in NOGRR245. This is simply incorrect as illustrated by the ROS action itself. A “voluntary compliance regime” exists today, and many IBR have been working collaboratively with ERCOT to help grid stability and to address the ride-through issue without NOGRR245. If ROS intended to maintain the current “voluntary compliance regime,” then it would not have passed any version of NOGRR245, be it ERCOT’s or any other. While the stakeholder process at ROS (including votes from a diverse set of segments) approved a different version of NOGRR245 from that proposed by ERCOT, the stakeholder representatives at ROS neither “nullified” the NOGRR nor made compliance “voluntary.” In fact, the proposal endorsed by ROS and supported by Joint Commenters uses most of ERCOT’s same performance requirements, as summarized in Table 1, below.

ERCOT’s assertion that ROS’s commercial reasonability standard is a “voluntary compliance regime” is wrong. The standard requires investment and upgrades with an ongoing annual review and attestation process, and we expect it will result in both near-term and ongoing improvements. If a Resource Entity does not make commercially reasonable upgrades, it is a violation of the Nodal Operating Guides and subject to enforcement. For that reason, characterizing ROS’s approach as an exemption, as ERCOT does, is misleading. ERCOT’s assertion that the ROS-approved version has “no oversight by ERCOT or the Public Utility Commission” is incorrect for the same reason. The commercial reasonability standard **is a retroactive requirement.** It does not “prioritize commercial impact over reliability” with “self-determined exemptions.” Forcing the early retirement of thousands of megawatts of facilities is certainly not helpful for reliability.

*Improvements to the ROS-Approved Version: Commercial Reasonability for Existing Generators*

Joint Commenters have modified the ROS-approved version to specify that technically feasible software, firmware, parameter, or setting changes without physical modifications are presumed to be commercially reasonable unless the Resource Entity demonstrates otherwise. This change is consistent with the Federal Energy Regulatory Commission (“FERC”) Order 901’s distinction between changes requiring “physical modification” and those that do not and gets closer to ERCOT’s own proposal requiring “software and parameterization changes” without abandoning the concept of commercial reasonability.

It is reasonable to expect software and settings changes that do not require physical modifications to play an important role in improving ride-through capability, particularly for solar inverters. For example, consider ERCOT’s market notice communicated on September 8, 2023, about a specific inverter involved in the 2022 Odessa Disturbance and present elsewhere in ERCOT:

“During the 2022 Odessa Disturbance event in the ERCOT Region, multiple solar facilities with TMEIC Ninja inverters had them trip during the system disturbance due to instantaneous AC overcurrent. **TMEIC identified the problem and developed a solution** that reduces the current spike during a voltage disturbance and improves the ride-through capabilities of the inverters during system disturbances. In addition, **TMEIC has been working with ERCOT and affected Resource Entities (REs) to implement additional inverter settings changes to improve ride-through performance.** ERCOT is requiring all REs owning solar facilities with TMEIC Ninja inverters to consult with TMEIC to determine if the overcurrent mitigation and other ride-through setting changes need to be implemented at their facilities and notify ERCOT of: (i) the results of their findings and (ii) a timeline in which any needed updates will be completed.”[[4]](#footnote-4) (emphasis added)

For changes requiring physical modifications, Joint Commenter’s commercial reasonability framework remains superior to ERCOT’s. ERCOT’s January 8th proposal includes a cost-based threshold for whether existing generators are required to make physical modifications to their equipment:

“Major retrofits include any hardware and labor that costs more than 20% of the cost of installing a new, comparable replacement equipment on a per turbine or per inverter basis....”.[[5]](#footnote-5)

While this is an improvement from ERCOT’s previous proposals, which ignored commercial considerations entirely, this approach suffers from significant flaws that render it inferior to the commercial reasonableness approach included in the ROS-approved proposal as further modified by the Joint Commenters. ERCOT’s proposal is inconsistent with FERC Order 901, which contemplates exemptions for existing IBRs requiring physical modifications to meet voltage ride-through requirements, regardless of cost. In contrast, ERCOT’s threshold of 20% of the cost of new replacement equipment – per turbine or inverter – is both high and arbitrary. Why 20% and not 10%, for example? Why define the threshold as a fraction of the cost of new equipment rather than, say, the remaining book value of the existing equipment? ERCOT’s approach also lacks the flexibility required to account for differences among generators when assessing commercial reasonability. In contrast, the ROS-approved version allows Resource Entities to evaluate commercial reasonableness on a project-specific basis, considering the full range of relevant inputs rather than a single arbitrary cost threshold.

*Supporting Commercial Reasonability is Good Policy*

As recognized by FERC in its directives to the North American Electric Reliability Council (“NERC”) on voltage and frequency ride-through requirements, the set of existing resources requiring ride-through exceptions is finite and will decrease over time as generator owners either invest to replace existing equipment with more capable equipment or retire existing equipment at the end of its life. Such retirements at the end of the original project life may be followed by re-investment; many of the oldest wind facilities in ERCOT were sited at some of the most productive wind resource locations in Texas. Additionally, Texas has historically fostered a regulatory and market environment that encouraged ongoing investment in electric generation that uses the abundant wind and solar resources in the region. Together, these systematic factors support ongoing improvements to IBR ride-through capability in ERCOT as commercially reasonable investments are made. However, ERCOT’s proposal to require compliance for existing facilities outside of commercially reasonable investment is counterproductive. Forcing investors to make arbitrarily high levels of new investment upon the threat of restrictions, disconnection or early retirement – and the economic harm each entails - would have a chilling effect on the investment Texas will need at a time that the PUCT has undertaken extraordinary efforts to encourage new investment.

*Improvements to the ROS-Approved Version: Dates for Existing vs. New Generators*

While some OEMs have plans to develop and self-certify inverters compliant with IEEE 2800-2022 over the next few years, a recent NERC survey of OEMs identified the lack of a clear and accepted testing and verification standard as a primary hurdle to self-certification and product development.[[6]](#footnote-6) OEMs cited that it was not clear what criteria, data, and modeling should be used to self-certify equipment, and preferred to wait until the IEEE P2800.2 procedure was finalized. Additionally, recent NOGRR245 comments filed by OEMs highlight the importance of a generally accepted testing and verification procedure.[[7]](#footnote-7) Testing ride-through capabilities will produce different results under different conditions and guidance must be provided to ensure OEMs can design a universal standard that is being defined by IEEE P2800.2.[[8]](#footnote-8) OEMs also do not want to design a testing protocol for one part of the country only to discover a different protocol will be used everywhere else.

In the spirit of compromise, Joint Commenters propose updating the date that defines a new IBR from June 1, 2026, to June 1, 2024 (or June 1, 2026, if the Interconnecting Entity provides an affidavit from the OEM in the form of ERCOT Nodal Operating Guides, Section 8, Attachment N, Original Equipment Manufacturer Compliance Form). This proposal would create a higher ride-through standard for equipment designed by OEMs ready to self-certify and provide IEEE 2800-2022 compliant equipment on a quicker timeline, while at the same time providing other OEMs additional time to incorporate published testing and verification procedures into their design and development process. It is also consistent with implementation plans put forward by RTOs and ISOs across the country in response to FERC Order 2023[[9]](#footnote-9) updating voltage and frequency ride-through requirements for IBRs.[[10]](#footnote-10)

**Table 1. A Simplified Comparison of the Proposals to the Current Nodal Operating Guide**

| **Proposal Element** | **Current**  **Nodal Operating Guide** | **NOGRR245 Proposals** | |
| --- | --- | --- | --- |
| **ROS-Approved Proposal**  **(Sept 13, 2023)**  **As Modified by Joint Commenters** | **ERCOT Revised**  **(Jan 8, 2024)** |
| **Ride-through requirement:** Existing vs. new projects | * Different VRT requirements depending on SGIA date. | * Existing is SGIA < 6/1/24 or 6/1/26 (with an affidavit executed by the OEM in the form of ERCOT Nodal Operating Guides, Section 8, Attachment N, Original Equipment Manufacturer Compliance Form). * New is all other SGIA. | * Existing is SGIA < 6/1/23. * New is all other SGIA. |
| **Ride-through requirement:** Requirement level | * Less stringent VRT requirements for older SGIAs. * Single FRT requirement. * No reference to ROCOF, multiple excursions, or phase angle jumps. | * VRT   + Existing must meet “preferred” standard, except for IEEE 2800-2022 Sections 5, 7, and 9.   + New must meet all. * FRT – Existing and new must meet “preferred” standard by 12/31/2025. * Includes maximum requirement thresholds for ROCOF, multiple excursions, and phase angle jumps. | * VRT   + Existing must meet “legacy” standard.   + New must meet a higher “preferred” standard, including IEEE 2800-2022 Sections 5, 7, and 9. * FRT – Existing and new must meet “preferred” standard by 12/31/2025. * Requires existing to ride through all ROCOF and phase angle jumps and some multiple excursions. * Requires new to ride-through certain ROCOF, phase angle jumps, and certain multiple excursions. |
| **Ride-through requirement:**  Settings vs. performance | * FRT requirements are for relay settings. * VRT requirements are for design and relay settings. | Performance requirement for VRT and FRT. | Performance requirement for VRT and FRT. |
| **Commercial reasonableness for retroactive application of new requirements to existing resources** | Not applicable, as requirements were not applied retroactively. | Existing must meet or exceed “preferred” FRT and VRT requirements to the extent it is technically feasible and commercially reasonable.    Parameter, settings, firmware, or software changes that do not require physical modifications to the Resource Entity’s equipment are presumed to be commercially reasonable unless the resource owner demonstrates otherwise. | Existing resources must meet or exceed preferred FRT requirements and “legacy” VRT requirements using:     1. Parameterization and software changes, irrespective of cost 2. Hardware replacements and retrofits no more than 20% of the cost of replacing the entire turbine or inverter.     Subject to the potential exceptions and extensions below. |
| **Restrictions and disconnection** | No reference in Section 2 of the Nodal Operating Guide.  See Section 2 of Joint Commenter’s Comments for further details. | No reference in Section 2 of the Nodal Operating Guide.  See Section 2 of Joint Commenter’s Comments for further details. | New references in Section 2 of the Nodal Operating Guide about restricting operations (including not permitting to operate) after a performance failure if certaincriteria are met.  See Section 2 of Joint Commenter’s Comments for further details. |
| **Exceptions and extensions** | Pre-11/1/08 SGIA – Resources provided exemption from VRT requirements.  Post-11/1/08 SGIA and Pre-11/16/14 SGIA – Resources provided exception to high VRT requirements. | For existing resources, “preferred” requirements are subject to technical and commercial feasibility.  Exceptions require information in an initial report, including technical limitations, and subsequent annual updates or attestations. | ERCOT “may allow” certain exceptions and extensions at their sole discretion, with limits.  Exceptions require documentation of technical limitations that cannot be overcome without major retrofits.  There are also a few formulaic exceptions to requirements otherwise triggered by modifications to existing resources on or after 6/1/23.  For existing resources, there are no exceptions for items requiring only software or parameterization changes, and no exceptions for performance below protection settings requirements in effect as of 12/1/23.  Existing resources unable to comply with applicable FRT and VRT requirements by 12/31/25 must submit report by 12/31/24. No subsequent reporting requirements. |

It is difficult to predict the scale of ride-through improvements that will occur under these competing proposals. ERCOT’s summary of OEM and Resource Entity request for information (“RFI”) responses presented at the Technical Advisory Committee (“TAC”) meeting on December 4, 2023, provides a starting point for understanding potential adoption, but it also has significant limitations that bias that summary against the ROS-approved version.[[11]](#footnote-11) Any difference in the scale of expected ride-through improvements between ERCOT’s proposal as amended by it comments filed on January 8, 2024, and the ROS-approved version as modified by the Joint Commenters is likely to be narrower than ERCOT’s summary presented at the TAC meeting on December 4, 2023.

1. **Joint Commenters Oppose ERCOT’s Proposal to Add Language to Restrict or not Permit Operations.**

Under the ROS-approved version, ERCOT will have the same authority to impose operational restrictions as it has today, to the extent such authority exists. Similarly, any existing method it has for ensuring compliance remains unchanged, including referrals to the Reliability Monitor, Texas Reliability Entity (“TRE”), and the PUCT for enforcement, as applicable. Joint Commenters do not support ERCOT’s January 8th proposal language on restrictions, such as “...ERCOT may restrict, or not permit to operate...”.[[12]](#footnote-12)

ERCOT states on page nine of its January 8th comments: “As such [the Reliability Coordinator for the ERCOT Region], ERCOT has the authority to take actions necessary to preserve the reliability and integrity of its system, up to and including Load shedding or the disconnection of Resources presenting an unacceptable reliability risk to the ERCOT System.” Joint Commenters acknowledge ERCOT’s role as Reliability Coordinator and do not attempt to comprehensively catalogue ERCOT’s authority or the limitations to it in these comments.

To the extent ERCOT has the authority it claims, the limited instances elsewhere in the Protocols alluding to similar disconnection remedies shows that ERCOT has historically claimed the right to exercise this type of authority only to address transitory emergency conditions. Consider Load shedding, for example. Similarly, for Resource disconnection, consider this existing protocol passage contemplating a temporary disconnection to maintain reliability: “When an IRR is operating below 10% of its nameplate capacity and is unable to support voltage at the POIB, ERCOT, the interconnecting TSP, or that TSP’s agent may require an IRR to disconnect from the ERCOT System for purposes of maintaining reliability”.[[13]](#footnote-13) In contrast, the language ERCOT seeks to include in its January 8th comments contemplates scenarios that may not be transitory and could entail severe long-term restrictions (months rather than hours or days) despite the best efforts of a Resource Entity, particularly when they rely on the OEM for a technical solution. Moreover, these restrictions could potentially be applied to gigawatts of generation.

Exercising claimed disconnection authority is an ultimate exercise of power and should only be taken as a last resortand done in the most balanced, restrained, nondiscriminatory manner possible.

The combination of ERCOT’s January 8th proposed language relating to indefinitely restricting operations, the uncertainty relating to availability of technically feasible and commercially reasonable solutions to meet the new ride-through requirements, and the lack of generally accepted testing standards cumulatively present untenable risk for IBR owners and will create a chilling effect for all generation investment. For these reasons, Joint Commenters recommend striking such operational restriction authority language. Instead, non-compliance with NOGRR245 can be managed like other non-compliance with ERCOT Protocols and Guides, via a referral to the Reliability Monitor, TRE, and PUCT for review and enforcement, as applicable.

1. **IBRs will Face Significant Challenges and Uncertainty Meeting the Full-Suite of NOGRR245’s Proposed Requirements.**

Through Joint Commenters’ operational experience and extensive discussions with OEMs, we have identified various design limitations that will cause existing IBRs to face significant challenges in meeting NOGRR245’s proposed requirements, if possible at all. NOGRR245 comments filed by OEMs voice concern with the ability to meet the proposed compliance timelines, question if retrofits will even be possible for certain existing IBRs, and support the need for a good cause exemption process. Comments filed by Siemens Gamesa Renewable Energy (“SGRE”) on October 30, 2023, by Vestas on November 1, 2023, and by General Electric Vernova (“GE”) on November 7, 2023, all indicate that a portion of the legacy IBR fleet is expected to have technical solutions available to comply with NOGRR245 requirements, although such analysis is preliminary and subject to change. However, another portion of the legacy fleet is expected to face significant challenges meeting all of the proposed requirements.

ERCOT says it modified its proposal based on the responses it received to its RFI but then acknowledges that its requirements are not technically feasible for many generators. For example, ERCOT says 8,200 MW of GE wind turbine generators cannot comply with ERCOT’s proposed FRT requirements. It is unclear how ERCOT arrived at the count, but it appears from GE’s public RFI response[[14]](#footnote-14) that the figure is likely lower (2,115 Legacy 1.X non-ESS turbines plus a subset of the 2,707 Legacy 1.x ESS), though still substantial.

Joint Commenters are concerned that ERCOT’s proposed revisions to remove rate-of-change-of-frequency (“ROCOF”) and phase angle jump specificity requirements for existing IBRs do not in fact relax those requirements, but rather raise them. For example, under ERCOT’s proposed framework in its comments filed on August 18, 2023, existing IBRs would be required to ride through frequency excursions during which the absolute ROCOF magnitude does not exceed 5 Hz/second, but ERCOT’s most recent comments require existing IBRs to ride through frequency excursions during all possible ROCOF values, including values above 5 Hz/second, as long as the voltage and frequency measured at the Point of Interconnection are within no-trip zones.[[15]](#footnote-15) Similarly, rather than requiring IBRs to ride through phase angle jumps not exceeding 25 electrical degrees, ERCOT’s comments filed on January 8, 2024, would require existing IBRs to ride through infinite phase angle jumps, including values above 25 electrical degrees, as long as voltage and frequency measured at the Point of Interconnection are within the no-trip zones. This approach is contrary to current knowledge of what is technically feasible[[16]](#footnote-16) and to the IEEE 2800-2022 standard.[[17]](#footnote-17) ERCOT could have dealt with these facts by adding exceptions or tailoring its proposal where needed. Instead, ERCOT unreasonably claims that this is the same requirement that exists today though the current Protocols and Nodal Operating Guide are silent on phase angle and ROCOF. Joint Commenters disagree with the interpretation that the absence of language in ERCOT’s Protocols and Guides creates binding requirements on Market Participants. Furthermore, the conclusion that the current Nodal Operating Guide requires IBRs to ride through all possible ROCOF and phase angle jump values if frequency and voltage are within no-trip zones is incorrect because the current Nodal Operating Guide only establishes frequency and voltage protective relay requirements and does not require the entire IBR facility to ride through the frequency and voltage ride-through curves.[[18]](#footnote-18) It is important context that legacy IBRs that have appropriately set their relay settings to not trip according to the currently effective Nodal Operating Guide are compliant with ERCOT’s existing requirements and that NOGRR245 establishes new requirements even for the existing curves proposed in Section 2.6.2.1.1, Temporary Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), and Section 2.9.1.2, Legacy Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs).

1. **The ROS-Approved Version of NOGRR245 is Aligned with FERC Order 901, which Directs NERC to Determine if a Limited Exemption should be Provided to Legacy IBRs unable to Meet New Voltage Ride-Through Requirements without Physical Modification.**

On October 19, 2023, FERC issued Order 901 directing NERC to develop new or modified Reliability Standards to address concerns pertaining to the impacts of IBRs on the reliable operation of the Bulk-Power System, including establishing IBR performance requirements for both new and existing registered IBRs.[[19]](#footnote-19) The ROS-approved version of NOGRR245 is aligned with FERC Order 901, in which FERC acknowledged the technical limitations of certain legacy IBRs and directed NERC to determine whether such IBRs should be provided a limited and documented exemption from voltage ride-through requirements:

“We agree that a subset of existing registered IBRs – typically older IBR technology with hardware that needs to be physically replaced and whose settings and configurations cannot be modified using software updates – may be unable to implement the voltage ride through performance requirements directed herein. Therefore, we direct NERC through its standard development process to determine whether the new or modified Reliability Standards should provide for a limited and documented exemption for certain registered IBRs from voltage performance requirements. Any such exemption should be only for voltage ride-through performance for those existing IBRs that are unable to modify their coordination protection and control settings to meet the requirements without physical modification of the IBRs’ equipment. Further, we direct NERC to ensure that any such exemption would be applicable for only existing equipment that is unable to meet voltage ride-through performance. When such existing equipment is replaced, the exemption would no longer apply, and the new equipment must comply with the appropriate IBR performance requirements. The concern that there are existing registered IBRs unable to meet voltage ride through requirements should diminish over time as legacy IBRs are replaced with or upgraded to newer IBR technology that does not require such accommodation.[[20]](#footnote-20)

The new or modified Reliability Standards must also mitigate the reliability impacts of such an exemption.[[21]](#footnote-21) FERC encouraged NERC to consider the currently effective Reliability Standard PRC-024-3, Requirement R3 as an appropriate example of how such exemptions could be established and documented,[[22]](#footnote-22) and unlike the ERCOT proposal did not place an end date or further limitation on granting this exemption for existing IBRs, aside from when the existing equipment is replaced.

Notably, in contrast to ERCOT’s proposal, Order 901 does not contemplate the application of a hard and fast cost threshold when defining the “physical modification” exemption. This proposed limited exemption, which would be provided to all legacy IBRs unable to comply with voltage ride-through requirements without physical modification of the IBR facility’s equipment, would achieve a similar result as the commercially reasonable framework supported by Joint Commenters. Software and setting changes are more likely to be commercially reasonable to implement than hardware retrofits and repowers, because such retrofits and repowers would require physical modification of equipment and be more extensive and costly. Hardware changes may be commercially reasonable, depending on the scope of work, cost, and demonstrated viability of such change. Ultimately, a commercial reasonableness determination would depend on the actual facts of the applicable solution. Joint Commenters support legacy IBRs taking actions that are both technically feasible and commercially reasonable to improve ride-through performance, but it is unjust and unreasonable to substantially change regulatory requirements that impose extensive physical facility changes that are cost prohibitive and/or commercially unproven. NOGRR245 should accommodate legacy IBRs in a similar fashion as proposed in FERC Order 901. Joint Commenters note that the Order-901 proposed ride-through requirements are subject to change, as NERC must still go through its Reliability Standard development process before such requirements become actionable for applicable entities.

**Conclusion**

Joint Commenters appreciate the opportunity to comment on NOGRR245 and urge TAC to recommend approval of NOGRR245 as amended by these comments.

These comments are submitted on top of the ROS Report recommended for approval on September 14, 2023.

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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) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs) (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) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs) (new)  8, Attachment N, Original Equipment Manufacturer Compliance Form (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. |
| Justification of Reason for Revision and Market Impacts | This NOGRR is 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, the North American Reliability Corporation (NERC) noted it has supported the development of the IEEE 2800-2022 standard (and continues to support development efforts for IEEE P2800.2, Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems “IEEE P2800.2 standard” or “IEEE 2800.2 standard” upon finalization). Among other things, the document also highlights that:   * New technology can introduce significant risks if not integrated properly which 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.   The IEEE 2800-2022 standard 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, 2024 (or June 1, 2026 if the Interconnecting Entity (IE) provides an affidavit executed by an original equipment manufacturer (“OEM”)in the form of Section 8, Attachment N), maximize ride-through capability to meet or exceed the new voltage ride-through profile and the new frequency ride-through profile as soon as practicable if it is commercially reasonable to do so. IBRs that cannot meet the new ride-through requirements will need to submit a report by December 1, 2024 documenting such to give ERCOT an accurate understanding of the physical limitations and maximum ride-through capability. No later than December 1st of each subsequent year, such IBRs must update this evaluation if there have been any material changes, or alternatively submit an attestation signed by an officer or Principal with authority to bind the IBR that there have been no material changes since the prior submission. 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 OEMs 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 finalization of the IEEE 2800.2 standard 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 (IBRTF) 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) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs) 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:

|  |  |
| --- | --- |
| **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:

|  |  |
| --- | --- |
| **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) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs)***

(1) All IBRs and Type 1 and Type 2 Wind-powered Generation Resources (WGRs) 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:

|  |  |
| --- | --- |
| 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 or Type 1 WGR or Type 2 WGR to trip for frequency conditions beyond those for which ride-through is required.

(3) If installed and activated to trip the IBR or Type 1 WGR or Type 2 WGR, 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 or Type 1 WGR or Type 2 WGR to ride through frequency conditions beyond those defined in paragraph (1) above to the maximum extent possible. An IBR or Type 1 WGR or Type 2 WGR 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 or Type 1 WGR or Type 2 WGR shall inject electric current during all periods requiring ride-through.

(5) IBR or Type 1 WGR or Type 2 WGR plant controls or inverter controls shall not disconnect the IBR or Type 1 WGR or Type 2 WGR from the ERCOT System or reduce IBR output during frequency conditions where ride-through is required unless necessary for providing appropriate frequency response or preventing equipment damage.

(6) An IBR or Type 1 WGR or Type 2 WGR with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2024 (or June 1, 2026 if the Interconnecting Entity (IE) provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N, Original Equipment Manufacturer Compliance Form), must make commercially reasonable efforts to comply with paragraphs (1) through (5) above as soon as practicable.

(7) The Resource Entity or IE for an IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of ERCOT Nodal Operating Guides, Section 8, Attachment N) that cannot comply with paragraphs (1) through (5) above shall, by December 1, 2024 (or as part of the interconnection process), submit to ERCOT a report and supporting documentation containing the following and in each case, only to the extent such information is reasonably available from the original equipment manufacturers and other parties:

(a) The current IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability in a format similar to the table in paragraph (1) above;

(b) Any known technical limitations on the IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability, to the extent the Resource Entity can reasonably identity them. Such limitations may include general limitations from the manufacturers or other parties;

(c) The proposed commercially reasonable modifications to maximize the IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability and allow the IBR or Type 1 WGR or Type 2 WGR to increase the level of compliance or to comply with the frequency ride-through requirements in paragraphs (1) through (5) above. ERCOT may allow an exception to the highest and lowest frequency ride-through bands where an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N), provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) stating no engineering, replacement, or retrofit solutions exist to fully meet the required duration of the lowest and highest frequency ride-through bands in paragraph (1) above if, after maximizing its frequency ride-through capabilities, it can ride through the frequency ride-through band between 57.0 Hz and 58.4 Hz for at least ten seconds and the frequency ride-through band between 61.6 Hz and 61.8 Hz for at least 30 seconds;

(d) A schedule for implementing those modifications as soon as commercially reasonable; and

(e) As contemplated in paragraph (2) of Section 2.6.4, Commercially Reasonable Efforts, the Resource Entity shall update this evaluation by December 1 of each year if there have been any material changes, or alternatively submit an attestation signed by an officer or Principal with authority to bind the Resource Entity.



(8) If an IBR or Type 1 WGR or Type 2 WGR fails to perform in accordance with the applicable frequency ride-through requirements, the Resource Entity for the IBR or Type 1 WGR or Type 2 WGR shall investigate the event and report to ERCOT the cause of the 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) This Section shall not affect the Resource Entity’s responsibility to protect IBRs or Type 1 WGRs or Type 2 WGRs from damaging operating conditions. The Resource Entity for an IBR or Type 1 WGR or Type 2 WGR 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 or Type 1 WGR or Type 2 WGR 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.

(10) An IBR or Type 1 WGR or Type 2 WGR 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.

(11) The addition of a co-located Load that results in the initiation of a Generator Interconnection or Modification (GIM) on or after the applicable date from paragraph (6) above or an amendment to an SGIA on or after the applicable date from paragraph (6) shall not trigger a change in frequency ride-through requirements. In those cases, the Resource Entity shall continue to be subject to paragraph (6) above using the SGIA date applicable before the amendment.











**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 December 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, must submit a detailed report as described in paragraph (6) of Section 2.9.1, Applicability of Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), and paragraph (7) of Section 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), regarding its evaluation of its facilities and what modifications, if any, can be made to its equipment. No later than December 1 of each subsequent year, such Resource Entities must update this evaluation if there have been any material changes, or alternatively submit an attestation signed by an officer or Principal with authority to bind the Resource Entity 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. If software, firmware, parameter, or settings changes are available to increase compliance without physical modifications to the Resource Entity’s equipment and they are technically feasible, then they are presumed to be commercially reasonable unless the Resource Entity can reasonably demonstrate otherwise.

(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, Applicability of Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), 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) The Resource Entity for each Generation Resource or ESR shall provide to ERCOT technical documentation of voltage ride-through capability upon request.

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| ***[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, Applicability of Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), 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) The Resource Entity for each Generation Resource or ESR shall provide to ERCOT technical documentation of voltage ride-through capability upon request. |

***2.9.1 Applicability of Voltage Ride-Through Requirements for Transmission-Connected*** ***Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs)***

(1) Except as specified below, all Inverter-Based Resources (IBRs) and Type 1 Wind-powered Generation Resources (WGRs) and Type 2 WGRs interconnected to the ERCOT Transmission Grid shall comply with voltage ride-through requirements as follows:

(a) Section 2.9.1.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), shall apply to:

(i) IBRs with a Standard Generation Interconnection Agreement (SGIA) executed on or after June 1, 2024 (or June 1, 2026 if the Interconnecting Entity (IE) provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N, Original Equipment Manufacturer Compliance Form).

(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, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N).

(iii) Any other IBR or Type 1 WGR or Type 2 WGR, subject to paragraph (3) below.

(2) IBRs: (i) with an SGIA executed on or after June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N) or (ii) that implement any modification, as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a GIM was initiated on or after June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N), shall meet or exceed the capability and performance requirements in the following sections of Institute of Electrical and Electronics Engineers (IEEE) 2800-2022, Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems “IEEE 2800-2022 standard” or any successor IEEE standard, including any intra-standard cross references or definitions, unless otherwise clarified, modified, or exempted in the Protocols, these Operating Guides, or the 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.

(3) All IBR plant requirements and all IBR unit requirements described in the IEEE 2800-2022 standard apply at the Point of Interconnection Bus (POIB) and the individual inverter based unit terminal, respectively, unless otherwise clarified, modified, or exempted in the Protocols.

(4) ERCOT and the interconnecting TSP may exempt an IBR from Section 7.2.2.3.5, Performance Specifications, including Table 13, of the IEEE 2800-2022 standard when studies indicate a slower response time may be required or if the IBR may not be able to meet response times noted in Table 13 for certain system conditions, or when meeting the requirements in Table 13 would negatively impact other performance requirements of greater importance. If so, greater response time and settling time are allowed with mutual agreement among an IBR owner, ERCOT and the interconnecting TSP.

(5) An IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N) must make commercially reasonable efforts to comply with paragraphs (1) through (8) of Section 2.9.1.1, as soon as practicable.

(6) The Resource Entity or IE for an IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8 Attachment N) that cannot comply with the voltage ride-through requirements in paragraphs (1) through (8) of Section 2.9.1.1 shall, by December 1, 2024 (or as part of the interconnection process), submit to ERCOT a report and supporting documentation containing the following, and in each case, only to the extent such information is reasonably available from the manufacturers or other parties:

(a) The current IBR or Type 1 WGR or Type 2 WGR voltage ride-through capability in a format specified by ERCOT;

(b) Any known technical limitations on the IBR or Type 1 WGR or Type 2 WGR’s voltage ride-through capability, to the extent the Resource Entity can reasonably identify them. Such limitations may include general limitations from the manufacturer and other parties;

(c) The proposed commercially reasonable modifications, if any, to maximize the IBR or Type 1 WGR or Type 2 WGR voltage ride-through capability and allow the IBR or Type 1 WGR or Type 2 WGR to increase the level of compliance or to comply with the voltage ride-through requirements in Section 2.9.1.1;

(d) A schedule for implementing those modifications as soon as commercially reasonable; and

(e) As contemplated in paragraph (2) of Section 2.6.4, Commercially Reasonable Efforts, the Resource Entity shall update this evaluation by December 1 of each subsequent year if there have been any material changes, or alternatively submit an attestation signed by an officer or Principal with authority to bind the Resource Entity that there have been no material changes since the prior submission.

(7) An Intermittent Renewable Resource (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.

(8) 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 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.

(9) This Section shall not affect the Resource Entity’s responsibility to protect IBRs or Type 1 WGRs or Type 2 WGRs from damaging operating conditions. The Resource Entity for an IBR or Type 1 WGR or Type 2 WGR unable to remain reliably connected to the ERCOT System as set forth in Section 2.9.1.1, including those subject to paragraphs (4) and (5) 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 or Type 1 WGR or Type 2 WGR 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.

(10) An IBR or Type 1 WGR or Type 2 WGR 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.

(11) The addition of co-located Load that results in the initiation of a GIM on or after June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N) or an amendment to a SGIA on or after June 1, 2024 (or June 1, 2026 if the IE provides an affidavit from the original equipment manufacturer in the form of Section 8, Attachment N) shall not trigger a change in voltage ride-through requirements. In those cases, the Resource Entity shall continue to be subject to paragraph (5) of above, using the SGIA date applicable before the amendment.

***2.9.1.1 Voltage Ride-Through Requirements for Transmission-Connected*** ***Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs)***

(1) All IBRs subject to this Section in accordance with paragraph (1) of Section 2.9.1, Applicability of Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), 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 POIB:

**Table A: Applicable to 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: Applicable to all IBRs**

|  |  |
| --- | --- |
| Instantaneous Peak Phase-to-Phase or Phase-to-Ground Voltage  (p.u. of nominal instantaneous peak voltage) | 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.

(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 reduction is needed to allow for voltage support or otherwise specified by ERCOT or the interconnecting TSP. Any necessary reductions in active current to prioritize reactive current shall be relative to the voltage change at the POIB. Typically, more aggressive reductions in active current to allow for additional reactive current (if needed to stay within its current limitations) will occur at lower voltages (e.g., 0.4 p.u. or lower) but settings should be made based on the local needs of the ERCOT System where the IBR interconnects and ensures sufficient active current is available for protection system sensing. 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 or time delays 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 range within any ten second period.

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

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

(d) Voltage deviations outside of continuous operation range following the end of a previous deviation outside of continuous operation range by less than 20 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) 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.

(9) In its sole and reasonable discretion, ERCOT may allow a temporary extension to allow for upgrades or retrofits to confirm capability specified in paragraphs (7) and (8) above if the Resource Entity or IE provides documented evidence of technical infeasibility from its original equipment manufacturer (or subsequent inverter/turbine vendor support company if the original equipment manufacturer is no longer in business) along with the modifications and the schedule for implementing those modifications. The Resource Entity or IE shall maximize the rate-of-change of frequency, phase angle jump and multiple excursion ride-through capability within known equipment limitations as soon as practicable. Any temporary extensions shall be minimized and not extend beyond December 31, 2028.

(10) If an IBR fails to perform in accordance with the voltage ride-through requirements of paragraphs (1) through (8) 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.

(11) 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.



(12) 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.



**ERCOT Nodal Operating Guides**

**Section 8**

**Attachment N**

**Original Equipment Manufacturer Compliance Form**

**[insert date]**

**Original Equipment Manufacturer Compliance Form**

For manufacturers that intend to use Institute of Electrical and Electronics Engineers (IEEE) 2800.2, Recommended Practice for Test and Verification Procedures for Inverter-Based Resources (IBRs) Interconnecting with Bulk Power Systems “IEEE 2800.2 standard” finalization in order to support compliance with IEEE 2800-2022, Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems “IEEE 2800-2022 standard”, Section 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs), and Section 2.9.1.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs).

Name of manufacturer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of product(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The product(s) listed above will not be designed to comply with the frequency and voltage ride-through requirements in Section 2.6.2.1 and Section 2.9.1.1, until the IEEE 2800.2 standard is finalized due to the following reasons: \_\_\_\_\_\_\_\_\_.

I understand and agree that this form is not confidential and does not constitute Protected Information under the Protocols.

STATE OF \_\_\_\_\_\_\_\_\_\_\_\_

COUNTY OF \_\_\_\_\_\_\_\_\_\_\_\_\_

Before me, the undersigned authority, this day appeared \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, known by me to be the person whose name is subscribed to the foregoing instrument, who, after being sworn by me and deposed and said:

“I am an officer of \_\_\_\_\_\_\_\_\_\_\_\_, I am authorized to execute and submit the forgoing form on behalf of \_\_\_\_\_\_\_\_\_\_\_\_, and the statements contained in such form are true and correct.”

SWORN TO AND SUBSCRIBED TO BEFORE ME, the undersigned authority on this the \_\_\_\_\_ day of \_\_\_\_\_\_\_\_\_\_\_\_\_, 20\_\_.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notary Public, State of \_\_\_\_\_\_\_\_\_\_

My Commission expires \_\_\_\_\_\_\_\_\_

1. See section three of the Southern Power Company comments filed on September 5, 2023, for more details. [↑](#footnote-ref-1)
2. For example, the ERCOT Board of Directors approved the West Texas Synchronous Condenser Regional Planning Group project on December 19, 2023. ERCOT’s assessment showed an average of 21% reduction in numbers of 345 and 138 kV buses that experienced severe voltage dips (less than 0.85 per unit) for major West Texas transmission faults, an average of 22% reduction in IBR capacity that experiences severe voltage dip at generator terminals (less than 0.85 per unit) for major West Texas faults, and a 11% increase in system strength compared to the study base case without new synchronous condensers. [↑](#footnote-ref-2)
3. For a thorough review, see NextEra’s NOGRR245 comments filed on September 5, 2023. [↑](#footnote-ref-3)
4. NOTICE TYPE: M-C090823-01 Operations. SHORT DESCRIPTION: Identified solar facilities must consult with their OEM about AC overcurrent mitigation and ride-through capabilities. [↑](#footnote-ref-4)
5. See Nodal Operating Guide Section 2.9.1.2(10)(d) of ERCOT’s NOGRR245 comments filed on January 8, 2024. [↑](#footnote-ref-5)
6. See slides 10 and 11 of “IEEE 2800 OEM Readiness” presentation discussed at the Energy Systems Integration Group 2022 Fall Technical Workshop, available at https://www.esig.energy/event/2022-fall-technical-workshop/. [↑](#footnote-ref-6)
7. See GE comments filed on January 19, 2024 ("Also, readiness of IEEE P2800.2 is of high importance in assessing compatibility to IEEE 2800 – 2022 and avoiding re-work iterations due to differences it may have to how OEMs determine compatibility. Discussions on IEEE P2800.2 are still evolving, and the verification process itself may raise difficulties in demonstrating compatibility to certain requirements, which may drive further changes to both requirements and product design”), Vestas comments filed on November 1, 2023 (“Vestas kindly requests ERCOT to collaborate with OEMs to fortify simulation requirements and test procedures, ultimately ensuring the proper performance and modeling capabilities”), and SGRE comments filed on October 30, 2023 (“Given that there is a large amount of work that has not yet happened, and that both NOGRR245 and IEEE P2800.2 are still evolving, the responses to the present RFI are only indicative and cannot be considered absolute”). [↑](#footnote-ref-7)
8. For example, if the IBR needs to test at 25% power, a resource where all individual IBR units are operating at 25% power level will produce different results than a resource where 25% of the individual IBR units are operating at full power while the remaining 75% are at no power. [↑](#footnote-ref-8)
9. FERC Order 2023, Improvements to Generator Interconnection Procedures and Agreements, RM22-14 [↑](#footnote-ref-9)
10. ISO-NE PP5-6 Updates, Updates for the Clean Energy Transition, Adoption of IEEE 2800 and Improvements to Modeling of Inverter Based Resources, available at <https://www.iso-ne.com/static-assets/documents/2023/09/a09_2_pp_5_6.pdf>, New York State Reliability Council, PRR 151, Section 9, available at <https://www.nysrc.org/wp-content/uploads/2023/11/Revised-PRR-151-and-Procedures-11-10-2023.pdf>, MISO Inverter-Based Resource Performance Requirements, Planning Advisory Committee, available at <https://cdn.misoenergy.org/20231115%20PAC%20Item%2005a%20IBR%20Performance%20Requirements%20Presentation630868.pdf> (“Several stakeholder raised the issue of manufacturer readiness, which was discussed extensively in IPWG, and MISO reiterated that the approach is prospective and coordinated with understanding of manufacturers’ evolving equipment capabilities.”). [↑](#footnote-ref-10)
11. First, a solution that is technically feasible but commercially unreasonable is unlikely to be adopted. Consequently, the OEM or Resource Entity indicating a requirement is technically feasible under the ERCOT proposal does not mean it will be adopted if required. Second, responses to the ROS-approved version are at a single point in time, but the ROS-approved version requires an annual ongoing review and reporting to ERCOT of technical and commercial feasibility as upgrades continue to be developed. In other words, a “no” under the ROS-Approved version today could be a “yes” in the future. Third, the structure of the RFI forced respondents into the same response for very different scenarios. For example, for the ROS-approved version, “no” could mean an upgrade is available but not commercially reasonable (a true “no”) or could mean that the respondent does not know whether it is commercially reasonable because the product does not yet exist or the price is unknown (could ultimately be a “yes” instead). The second scenario is common. Fourth, the responses about technical feasibility are about ERCOT’s previous August 18th proposal, not the current January 8th version. [↑](#footnote-ref-11)
12. See proposed Nodal Operating Guide Section 2.9.1.2(12) of ERCOT’s NOGRR245 comments filed on January 8, 2024. [↑](#footnote-ref-12)
13. See Nodal Protocols Section 3.15(4)(e). [↑](#footnote-ref-13)
14. See GE’s NOGRR245 comments filed on November 7, 2023. [↑](#footnote-ref-14)
15. See proposed Nodal Operating Guide Section 2.6.2.1(5) of ERCOT’s NOGRR245 comments filed on January 8, 2024 (“An IBR or Type 1 or Type 2 WGR plant controls or inverter controls shall not disconnect the IBR or Type 1 WGR or Type 2 WGR from the ERCOT System or reduce its output during frequency conditions where ride-through is required unless necessary for providing appropriate frequency response or preventing equipment damage.”) Importantly, this paragraph does not establish a 5 Hz/second ROCOF threshold such as proposed in IEEE 2800-2022. [↑](#footnote-ref-15)
16. See slide four of ERCOT’s NOGRR245 presentation discussed at the TAC meeting on December 4, 2023, available at <https://www.ercot.com/calendar/12042023-TAC-Meeting>. This presentation indicates 40% of OEMs cannot comply with the previously proposed specific 5 Hz/second maximum ROCOF requirement and 41% of OEMs cannot comply with the previously proposed specific 25-degree phase angle jump requirement. [↑](#footnote-ref-16)
17. See Sections 7.3.2.3.5 (“Within the mandatory operation range and continuous operation region … the IBR plant shall ride through and shall not trip for frequency excursions having an absolute ROCOF magnitude that is less than or equal of 5 Hz/second”) and 7.3.2.4 (“The IBR plant shall ride through positive-sequence phase angle jumps within a sub-cycle-to-cycle time frame of the applicable voltage of less than or equal to 25 electrical degrees”) of IEEE 2800-2022. [↑](#footnote-ref-17)
18. See section six of the Southern Power Company comments filed on September 5, 2023, for more details explaining the historical changes made to NERC Reliability Standard Protection and Control 024 and a comparison to the current ERCOT Nodal Operating Guide and proposed revisions in NOGRR245. [↑](#footnote-ref-18)
19. Order 901, Reliability Standards to Address IBRs in Docket RM22-12-000. See paragraph 190 (“We adopt the NOPR proposal and direct NERC to develop new or modified Reliability Standards that require registered IBR generator owners and operators to use appropriate settings (i.e., inverter, plant controller, and protection) to ride through frequency and voltage system disturbances and that permit IBR tripping only to protect the IBR equipment in scenarios similar to when synchronous generation resources use tripping as protection from internal faults. The new or modified Reliability Standards must require registered IBRs to continue to inject current and perform frequency support during a Bulk-Power System disturbance. Any new or modified Reliability Standards must also require registered IBR generator owners and operators to prohibit momentary cessation in the no-trip zone during disturbances. NERC must submit new or modified Reliability Standards that establish IBR performance requirements, including requirements addressing frequency and voltage ride through, post-disturbance ramp rates, phase lock loop synchronization, and other known causes of IBR tripping or momentary cessation”). [↑](#footnote-ref-19)
20. Id., paragraph 193 (emphasis added). [↑](#footnote-ref-20)
21. Id., paragraph 199. [↑](#footnote-ref-21)
22. Id., paragraph 193. [↑](#footnote-ref-22)