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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 | May 1, 2023 |

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| Market Segment | Independent Generator |

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| Comments |

Southern Power Company (Southern Power) appreciates the opportunity to comment on NOGRR245 and to work constructively with ERCOT staff and stakeholders to identify and implement practical solutions for grid disturbance events and their undesirable effects. These comments provide recommended changes on top of the ERCOT comments filed on April 5, 2023. Southern Power recommends the following factors be considered in development of an Inverter-Based Resource (IBR) performance standard for the ERCOT region:

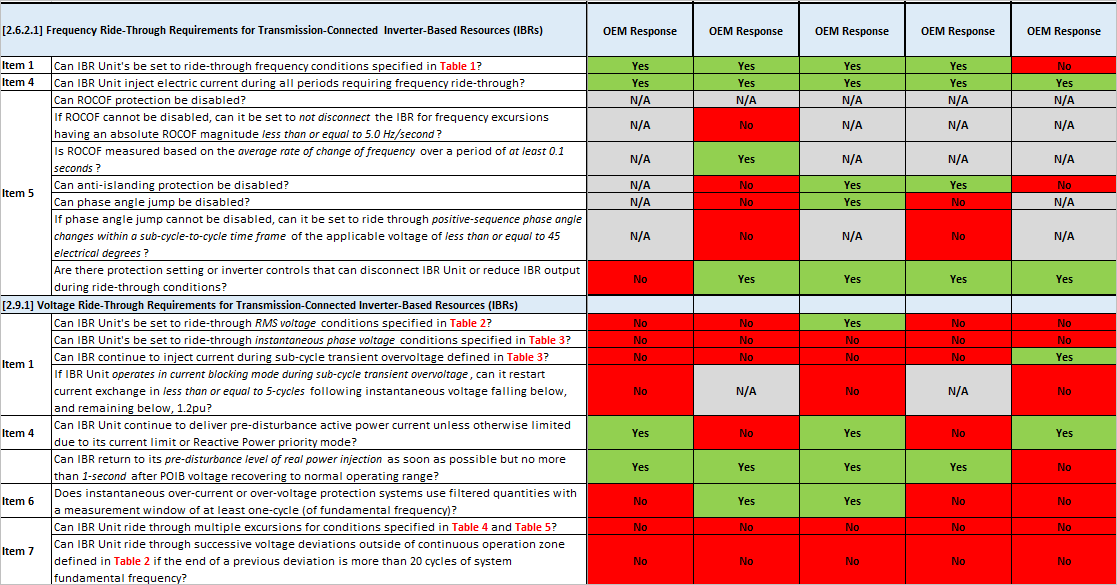
* The revision request process should move forward at a more reasonable pace that allows Original Equipment Manufacturers (OEMs) sufficient time to assess technical equipment capabilities/limitations and potential retrofit or other feasible solutions. Hurried votes in the stakeholder committee process would not achieve this goal, and the NOGRR should remain tabled so that OEMs can provide critical input. A rushed voting process would deny stakeholders and ERCOT Staff of vital information and an adequate opportunity for factfinding related to the NOGRR.
* Existing IBRs should be allowed to seek a narrowly tailored infeasibility exemption, provide supporting documentation showing relevant equipment limitations, and have more time to comply with requirements. All IBRs should be required to take actions to comply with the standard as quickly as practicable, to the extent such actions are technically feasible and commercially proven when applied to currently installed equipment.
* In support of the stated objective of this NOGRR to address and improve reliability issues and significant risks associated with “instability, cascading Outages, or triggering of the first stage of an Under-Frequency Load Shed event”, and in absence of proven technological and testing capabilities for both current or future resources, the revision request process should recognize that momentary cessation by some IBRs may be the best desired performance to prevent equipment tripping and to prioritize a return to pre-disturbance real power output as quickly as possible. Additionally, the added risk of implementing these changes too quickly may inadvertently create a resource adequacy problem by forcing a significant amount of IBRs offline, including on-peak resources like solar and resources that the Public Utility Commission of Texas (PUCT or Commission) has identified as necessary to address the duck curve like energy storage.
* Regulatory and financial certainty is critical for entities to make investment decisions and to deploy hundreds of millions to billions of dollars to develop, own, and operate generation resources. NOGRR245 may force existing IBRs to incur uneconomic and/or unproven retrofits or cease operations. Inserting new after-the-fact requirements would have a chilling effect on future generation investments, further driving a resource adequacy deficiency in an already strained environment.
* In addition to improving IBR performance, a holistic approach concurrently evaluating transmission solutions that improve system resiliency and mitigate the impact of grid disturbance events will produce more cost-effective and durable results.

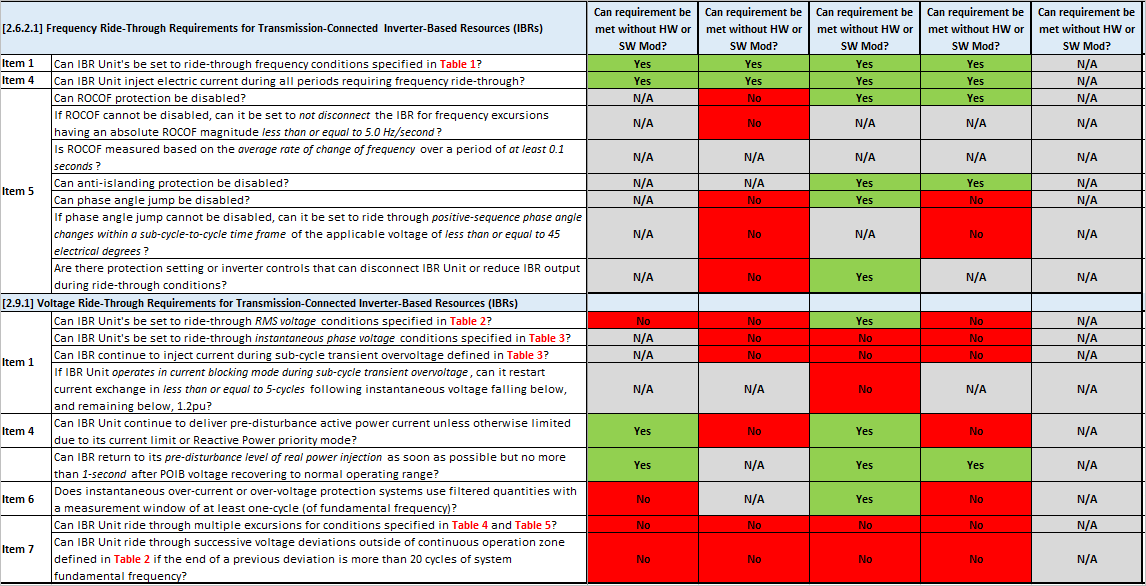
1. **NOGRR245 should Implement Technically Achievable Requirements, Considering Capabilities/Limitations of Existing Resources**

Southern Power acknowledges the need for a more robust IBR engineering and manufacturing performance standard, including adequate facility testing followed by modeling/studies efforts, to improve technical capabilities of IBR equipment and to mitigate the impact of grid disturbance events. Such an engineering standard should implement technically achievable requirements and consider the capabilities of existing IBRs. Southern Power supports the adoption of the Institute of Electrical and Electronics Engineers Standard for Interconnection and Interoperability of IBRs Interconnecting with Associated Transmission Electric Power Systems (IEEE 2800-2022), which was developed over two years by a diverse group of technical experts, to apply to new IBRs.[[1]](#footnote-1) It is important that a reasonable transition timeline is implemented to allow OEMs sufficient notice to test and design equipment accordingly. Currently, NOGRR245 proposes to apply immediately to IBRs with a signed Interconnection Agreement on or after January 1, 2023. Southern Power is concerned that some Interconnecting Entities with recently signed Interconnection Agreements may have been in development for years and already procured equipment that does not have full capabilities to meet all the proposed ride-through requirements. Southern Power recommends updating NOGRR245 to apply to IBRs with Interconnection Agreements signed on or after the effective date of the policy.

Over the past few years, Southern Power internally has developed significant knowledge about the frequency and voltage ride-through capabilities for its solar generation resources and has worked collaboratively with ERCOT to optimize facility performance. Through that process, Southern Power has identified various challenges to riding through these grid disturbances and the overall complexity of this topic. Importantly, existing IBR equipment may have technical design and operational limitations that render complete compliance with the proposed NOGRR245 impossible.[[2]](#footnote-2) Southern Power has collected feedback from solar and wind OEMs relating to its existing IBRs’ capabilities to meet NOGRR245 requirements.[[3]](#footnote-3) For many of the specific proposed requirements in the NOGRR, OEMs reported that additional time was needed to evaluate equipment capabilities and if software or hardware changes were needed for existing equipment to come into compliance.[[4]](#footnote-4) This need for additional time underpins Southern Power’s recommendation that the NOGRR be considered in a deliberate process rather than pushed in a hurried one. The below tables summarize Southern Power’s understanding of the feedback collected.[[5]](#footnote-5)

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| **NOGRR245 Requirement** | **Can legacy equipment (Photovoltaic Inverter & Wind Turbine Generator) meet NOGRR245 requirements today?** |
| **2.6.2.1**  **Frequency ride-through** | **All** legacy equipment should be able to comply with frequency ride-through requirement. |
| **All** legacy equipment should be able to inject current during all periods requiring frequency ride-through |
| **2.9.1**  **Voltage ride-through** | **None of the legacy equipment can fully comply with root-mean-square (RMS) voltage ride-through requirements.** |
| **None of the legacy equipment can comply and are not required to comply with instantaneous voltage ride-through requirements.** |
| **Most** legacy equipment should be able to inject current during RMS voltage ride-through and should be able to limit active power curtailment while in Q-priority mode. |
| **All** legacy equipment should be able to return to pre-disturbance real power injection within 1-sec after exiting momentary cessation. |
| **None of the legacy equipment are tested to comply with consecutive voltage ride-through requirements.** |
| **2.6.2.1 & 2.9.1 (5)**  **Protection settings** | **Most** legacy equipment does not have an explicit ROCOF protection that can be set. |
| **Most** legacy equipment does not have an explicit Phase-jump protection that can be set. For some PV inverters, it is part of anti-islanding protection. |
| **All** legacy PV inverters should be able to have anti-islanding protection disabled. |
| Some legacy equipment filters current and/or voltage measurements. |





Additionally, Southern Power has the following specific technical concerns:

* The complexity of demonstrating compliance. NOGRR 245 seeks to impose testing and operational requirements where the industry has not yet developed them.
  + There currently are no established testing requirements for IEEE 2800-2022. IEEE P2800.2 is developing new testing and verification procedures to demonstrate compliance with IEEE 2800-2022, but that process is still ongoing and currently the targeted publication of IEEE P2800.2 is Q1-Q2 of 2025.[[6]](#footnote-6)
  + Equipment may have difficultly riding through multiple abnormal system conditions occurring simultaneously or in succession.
  + There is a disconnect between the NOGRR standard’s applicability at the Point of Interconnection Bus (POIB) and the fact that inverters can react differently based on varying conditions experienced at inverter terminals across a facility.
  + As required by the existing standards and guidelines, current IBR modeling practices do not represent the facility at the individual inverter level but utilize industry accepted aggregated models feasible for transmission wide range analyses. Hence, capturing individual inverters response under various electrical conditions is currently not possible. Over time, the industry has developed greater understanding of IBR responses to various grid conditions and improved testing and modeling procedures. Thus, there is an ongoing industry and regulatory effort to create and publish adequate guidelines and study practices. In addition, North American Electric Reliability Corporation (NERC) standards are currently under review to establish uniform IBR modeling criteria. Southern Power supports all these efforts.
* Phase angle jump protection – Southern Power appreciates ERCOT’s comments submitted on April 5, 2023, that updated the phase angle jump ride-through requirement to 25 electrical degrees on a sub cycle-to-cycle basis, as recommended by IEEE 2800-2022.
* Instantaneous and root-mean-square voltage ride-through requirements – OEMS have provided preliminary feedback that some existing IBRs will have significant challenges meeting the root-mean-square voltage ride-through requirements.
* Injecting real or reactive current during voltage ride through
  + While most existing equipment should be able to satisfy this requirement, some will not. Southern Power’s experience includes an inability to fix this limitation without a significant and unproven hardware change to a facility, and that momentary cessation (e.g., temporary blocking of controlled exchange of current with the grid) is the best desired performance for such a facility to prevent equipment tripping and to prioritize return to pre-disturbance real power output as quickly as possible.
  + Southern Power has also experienced injecting reactive current immediately following a transmission fault, which then resulted in an alternating current overvoltage condition that faulted the inverter.
* Legacy inverter controls have limitations in processing power, speed of decision making, and control. Newer inverters can be designed to respond more quickly to system disturbances.
* It will be difficult, if not impossible, to evaluate and perform retrofits for some existing inverters where the inverter OEM is no longer in business.

As evidenced by the above information, some existing IBRs will have significant challenges meeting the proposed NOGRR245 requirements. Further, as evidenced by the above OEM responses and as stated directly by OEM representatives in recent ERCOT IBR Task Force meetings, additional time is needed for the industry to understand technical capabilities/limitations, possible retrofit or other feasible solutions, and what considerations for legacy equipment are appropriate.

1. **Additional Time Would Lead to a More Informed and Vetted IBR Performance Standard and Reduce Unintended Consequences**

NOGRR 245’s consideration in the stakeholder process must not be rushed. Additional time would lead to a more informed and vetted IBR performance standard. As previously mentioned, Southern Power has received feedback from its OEMs that significant testing must be performed to fully evaluate equipment capabilities relative to NOGRR245’s requirements. Approving a policy aimed at improving grid stability, without understanding technical capabilities, the number of impacted generation resources, and necessary actions to achieve desired capabilities would be counterproductive and imprudent. Non-compliance could lead to generation resource shutdowns, undermining the intended purpose of the policy. While a policy could be approved and then updated at a future time, such an approach would create significant risk for IBRs in the meantime. It also adds an unnecessary layer of regulatory risk for generators at the same time that the Texas Legislature and the PUCT are seeking to incentivize new investment by the same generation companies. Southern Power believes a better approach is to take additional time to evaluate the policy’s substance and understand the scope of impacted resources. Southern Power recommends that NOGRR245 remain tabled in the ERCOT review process until the consequences of the proposed standard are better understood. This could also include prioritizing approval of NOGRR245 to apply to new IBRs while continuing to evaluate the applicability of new ride-through requirements for existing IBRs.

Additionally, the (NERC) is working to develop an IBR performance standard on a longer timeline than NOGRR245, which ERCOT is seeking approval of without delay. In November 2022, the Federal Energy Regulatory Commission (FERC) issued a Notice of Proposed Rulemaking 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 the need for performance requirements.[[7]](#footnote-7) In recently submitted comments, NERC and the six Regional Entities[[8]](#footnote-8) proposed to submit proposed Reliability Standards addressing comprehensive ride-through requirements for registered IBRs within 12 months of FERC approval of the standard’s development and implementation plan.[[9]](#footnote-9) Southern Power is not aware of any coordination between ERCOT and Texas RE regarding NOGRR245 and its potential interplay with NERC standards on the same issues. In addition to the need for time to get information from OEMs, tabling NOGRR245 would give ERCOT time to coordinate with Texas RE on these issues.

A recent comparison of the system frequency characteristics during loss of generation events in 2018 to similarly sized loss of generation events in 2023 indicate that there has been improvement in the ability of the decreasing frequency to be arrested.[[10]](#footnote-10) The time to the nadir “C” point has been reduced from approximately seven to eight seconds to approximately four to five seconds in most cases, and the minimum frequency point reached at the “C” point is significantly higher. These comparisons reveal that frequency responsiveness has improved during that time frame. This improvement suggests that the NOGRR’s requirements may be relaxed without significantly increasing the risk to system reliability. Given this improvement, and consistent with OEM responses that more time is needed to determine if existing equipment can be modified to meet the new requirements, it is clearly premature to determine if existing facilities cannot be grandfathered within reason. In fact, the impact on overall resource adequacy is likely to be a greater reliability concern if the NOGRR proceeds as proposed.

Southern Power believes that one benefit of a good cause exemption process is that if ERCOT wants to move forward on a faster timeline than the NERC review process, a version of NOGRR245 could be approved that provides notice to OEMs and IBR owners to take actions necessary to satisfy the standard, while also giving ERCOT flexibility to apply reason as the industry learns more about equipment capabilities and retrofit options. Many of the same OEMs and IBR owners active in ERCOT will be engaged in and impacted by the NERC standard. This opportunity to participate in nation and industry-wide standards development will produce a consistent and improved final result for ERCOT’s standards.

1. **A Narrowly Tailored Infeasibility Exemption Process for Existing IBRs is Needed to Mitigate the Negative Effects of Reversing Established and Codified Ride-Through Requirements.**

Policy development must strike the right balance between updating performance criteria to obtain desired technical capabilities and forcing severe consequences onto assets that are technically incapable of performing to a standard that they were not designed to meet. Failure to do so introduces substantial regulatory and financial risk for asset owners that must deploy significant capital to develop, own, and operate generation resources that may become stranded assets due to changing regulatory requirements. Southern Power recommends updating NOGRR245 to allow existing IBRs to seek a narrowly tailored infeasibility exemption and provide supporting documentation showing relevant equipment limitations. All IBRs should be required to take actions to comply with the standard as quickly as practicable, to the extent such actions are technically feasible and commercially viable when applied to currently installed equipment.

NOGRR245 proposes to prevent IBRs that cannot implement timely retrofits to meet the requirements of NOGRR245 from operating on the ERCOT system unless ERCOT issues the IBR a Reliability Unit Commitment (RUC) or a Verbal Dispatch Instruction (VDI). IBRs generally are wind and solar facilities that do not receive RUCs or VDIs. In effect, NOGRR245 proposes a death penalty for IBRs that cannot meet the new standards, including those “beyond” the IEEE 2800-2022 standard. Such a decision should come from a PUCT docket with due process instead of pursuant to an Operating Guide. Its addition in an Operating Guide creates a new and unprecedented regulatory risk for existing generators that can disincentivize future investment in ERCOT.

NOGRR245 proposes to prevent these IBRs from operating on the ERCOT system without performing any estimation of how many units might become inoperable, where those units are located on the ERCOT system, or the reliability implications of preventing potentially material amounts of generating capacity from serving ERCOT loads. As discussed during the February 2023 ERCOT Board meeting, the ERCOT region is now relying on the contribution of IBRs to serve load and to prevent increased unserved load risk.[[11]](#footnote-11) Resource adequacy risk may further increase due to operational and financial impacts of the Environmental Protection Agency’s Cross-State Air Pollution Rule (EPA CSAPR) and other rules currently being considered and/or promulgated by the EPA on fossil-fuel resources.[[12]](#footnote-12) The below table puts operational wind and solar megawatts (MW) into different vintage buckets, with the expectation that older equipment will have more challenges meeting the standard. [[13]](#footnote-13) Southern Power recognizes that some existing IBRs will be able to identify and implement technically feasible actions to comply with the NOGRR’s requirements; however, the capacity value and location of such resources is currently unknown.

Total Installed Capacity in ERCOT Region According to In-Service Year

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Before 2015 | 2015 - 2020 | 2021 - 2023 | Total |
| Wind (MW) | 10,927 | 12,808 | 13,388 | 37,123 |
| Solar (MW) | 169 | 3,811 | 10,984 | 14,965 |
| Total (MW) | 11,096 | 16,620 | 24,372 | 52,088 |

For many IBRs, NOGRR245 comes years after the contractual agreement to interconnect the facility and ERCOT’s express finding that the interconnection comports with reliability requirements. NOGRR245 ignores that commitment and imposes the risk of potentially cost-prohibitive and/or unproven retrofits or, where there is no plausible retrofit, the premature retirement of generating capacity. In many cases, this generating capacity is subject to a Power Purchase Agreement (PPA) with Load Serving Entities or commercial and industrial customers. Ignoring the potential litigation among the parties to PPAs that NOGRR245 might cause, if new costs and/or premature retirement of generation result from NOGRR245, electricity costs for Texas consumers almost certainly will increase to account for the newly imposed costs and reduced dispatch of zero-dollar marginal cost generation. Before something as strict as refusing existing generation capacity on the ERCOT grid is codified in the Nodal Operating Guide, ERCOT, the PUCT, the Texas Legislature, and stakeholders should have a deliberate discussion about its implications.

The risk that ERCOT might impose costly or unproven retrofit mandates and/or the early retirement of a generation resource will discourage new investment in ERCOT. The decision to invest hundreds of millions, if not billions, in a new generation resource requires confidence in the predictability of revenue streams and expenses for the life of the plant and in the operational life of the plant. NOGRR245 would throw that predictability asunder, especially for IBRs; but also for thermal units because a future Binding Document might seek comparably costly or impossible retrofits for them.

ERCOT and PUCT precedent shows the problems that result when new, onerous mandates are placed on existing generation resources that invested millions of dollars with an expectation of reasonable regulatory certainty. In particular, PUCT Docket No. 37817[[14]](#footnote-14) and NPRR 389[[15]](#footnote-15) spotlight the need for exemptions and grandfathering for existing generation resources where compliance is either impossible or impracticable. In that instance, certain stakeholders contended that the changes in reactive power requirements on existing wind generators was essential for reliability. After years of litigation at the PUCT, ERCOT and the industry agreed that grandfathering is appropriate, leading to the passage of NPRR 389. NPRR 389 grandfathers wind generation resource that commenced operation on or after February 17, 2004, and had a signed Standard Generation Interconnection Agreement on or before December 1, 2009, from reactive power requirements that were imposed after the fact. We find ourselves in a remarkably similar situation today as certain advocates contend that grandfathering is unacceptable.

Finally, Southern Power believes that the industry does not currently have enough information to determine what a reasonable timeline is for existing IBRs to make retrofits to comply with the NOGRR – if such retrofits are possible at all. While Southern Power’s preference is to keep the NOGRR tabled to support a more informed decision-making process on how the standard applies to existing IBRs, the currently proposed timeline is unworkable and needs to be extended to reflect uncertainty relating to technical feasibility, scope of impacted resources, supply chain, OEM feedback, and limited engineering resources. A recent NERC survey shows that a significant number of OEMs are planning to develop inverters compliant with IEEE 2800-2022 by 2026 or later – in either case, sometime after IEEE P2800.2 has been implemented.[[16]](#footnote-16) The survey also shows that some major OEM implementation plans currently exclude incorporating IEEE 2800 into projects and equipment that are already sold and are currently in production, let alone for retrofitting existing IBRs. Southern Power expects OEMs will prioritize designing new equipment to comply with the IEEE 2800-2022 standard, and it will take additional time to address existing IBRs and study/verify how the overall plant complies with the requirements measured at the POIB. In absence of a clear industry feasibility timeline and agreement, Southern Power recommends at least updating the NOGRR so that existing IBRs must comply with the NOGRR’s requirements by December 31, 2026 (with the ability to seek an extension of up to an additional 12 months), but this date should ultimately be flexible and tied to proven industry capability and standards that have been incorporated into common practice and availability.

1. **IEEE2800-2022, ERCOT Precedent, PUCT Substantive Rules, and FERC/NERC’s Initial Approach All Suggest that an IBR Performance Standard Should Account for Existing IBRs’ Limitations**

Southern Power disagrees with the assumption that any version of grandfathering existing IBRs presents unacceptable reliability risk. Regulators have always had to weigh expected benefits and costs when making important electric system planning decisions. Improved reliability comes at a cost, and the reason that reliability standards accept some level of load shed risk is because striving for a system with no load shed would be cost prohibitive. ERCOT’s modern electric grid has evolved over decades - and will rightfully continue evolving in the future - to reliably and economically integrate a variety of resources with a wide range of performance capabilities. With additional time, ERCOT can better assess how many existing IBRs cannot meet the NOGRR requirements, how far out of compliance they are, if sufficient mitigation measures – including both IBR performance and strategic transmission improvements – have been implemented to address the most significant reliability risks, and how transmission solutions have reduced risk posed by grid faults.

The IEEE 2800-2022 standard, upon which NOGRR245 is based, recognizes that the standard may be limited to IBR facilities for which interconnection requests are submitted after the date by which IEEE 2800-2022 is enforced and that existing IBRs may have limitations in meeting the performance requirements.[[17]](#footnote-17) NOGRR245 ignores this reality identified by the technical experts who drafted IEEE 2800-2022 and instead proposes to force existing IBRs to make potentially infeasible and/or unproven facility changes or cease operations.

Historically, ERCOT has grandfathered similarly situated resources facing technical infeasibility challenges. As mentioned above, after long debate, ERCOT agreed to grandfather existing wind generation from newly created reactive power performance obligations.[[18]](#footnote-18) There is an obvious relationship between reactive power and the voltage at issue in NOGRR245 as voltage sags without adequate reactive power. However, NOGRR245 proposes a diametrically opposed path by mandating functionality without consideration for feasibility and calling for the potential prohibition of facilities operating on the ERCOT grid. As such, it deviates from ERCOT and PUCT precedent.

Further, NOGRR245 conflicts with the PUCT Substantive Rules by ignoring the capabilities of IBRs and imposing a bright-line prohibition on operations without regard for equipment capability. “A market participant may be excused from compliance with ERCOT instructions or Protocol requirements only if such non-compliance is due to communication or equipment failure beyond the reasonable control of the market participant; if compliance would jeopardize public health and safety or the reliability of the ERCOT transmission grid, or create risk of bodily harm or damage to the equipment; if compliance would be inconsistent with facility licensing, environmental, or legal requirements; if required by applicable law; or for other good cause.”[[19]](#footnote-19) Market participants do not have reasonable control over equipment’s technical capabilities, the inability to meet a standard not in effect at the time of development and construction, and the lack of a viable retrofit solution; so, 16 TAC § 25.503(f)(2)(C) should apply. Moreover, as crafted, NOGRR245’s denial of the ability for a resource to participate in the ERCOT markets would be without due process and effectively could rescind Power Generation Company (PGC) certification of affected IBRs without PUCT involvement. Procedurally, it is inappropriate for the Nodal Operating Guide to deviate from PUCT Rules and to interfere with the PUCT’s PGC certification processes.

While the NERC IBR Reliability Standard drafting process is still underway, in the IBR NOPR, FERC directed NERC to require mitigation activities for existing facilities unable to comply with new voltage ride-through requirements, and NERC has recognized equipment limitations in prior alerts and reports rather than mandate retrofits.[[20]](#footnote-20) In reference to voltage-ride through requirements, FERC noted in the IBR NOPR: “we are aware that certain registered IBRs currently in operation may not be able to meet the requirements proposed above. Therefore, we propose to direct NERC to require transmission planners and operators to implement mitigation activities that may be needed to address any reliability impact to the Bulk-Power System posed by these existing facilities. We believe that planners and operators should be able to accommodate this limited number of affected existing registered IBRs, and we expect that the technology of newer IBRs will not require such accommodation.”[[21]](#footnote-21) NOGRR245 should similarly accommodate affected existing IBRs. In addition, historically FERC and NERC have considered equipment limitations and the ability to recover newly imposed costs when setting just and reasonable rates and Reliability Standards.[[22]](#footnote-22)

1. **A Holistic Solution Must Improve IBR Performance and Transmission Grid Strength**

By its very nature, a frequency or voltage ride-through event requires that a transmission or distribution facility carry a frequency or voltage anomaly to a generation resource. It is not produced by the IBRs on which the NOGRR proposes to place a new burden. Consequently, addressing voltage ride-through issues should not focus solely on IBRs but should identify solutions on the transmission and distribution system as well. The lack of transmission strength in far West Texas is exacerbating the impact of faults and creating larger and more frequent abnormal system conditions through which certain IBRs must ride through.[[23]](#footnote-23) Transmission solutions should be considered that mitigate the impact of grid disturbances and improve system resiliency in such scenarios.

At the Regional Planning Group meeting on February 14, 2023, ERCOT discussed the results of an assessment performed to identify needs and options to improve West Texas grid reliability and resiliency, including a recommendation of adding six new synchronous condensers across West Texas that would reduce the widespread impacts of transmission faults.[[24]](#footnote-24) Similar to benefits provided by synchronous condensers in the Texas Panhandle region,[[25]](#footnote-25) these six synchronous condensers would provide voltage and system strength support in West Texas and mitigate the electrical distortions created by grid faults. Southern Power supports the approval of these six synchronous condensers and continued evaluation of solutions to improve the strength of the West Texas transmission system.

Pursuant to recent changes approved by the Commission updating 16 TAC §25.101, Certification Criteria, the Commission may approve a transmission project that is submitted as an economic or reliability project and does not demonstrate sufficient economic savings or reliability benefits to merit approval on those grounds if ERCOT determines the project would provide resiliency benefits by reducing the impact of potential outages caused by extreme weather scenarios. Southern Power believes it is appropriate to broaden the types of transmission projects that qualify to provide resiliency benefits to include those that reduce load shed risk posed by transmission faults. For example, the transmission system in far West Texas is more susceptible to the impact of transmission faults and would benefit from improvements that reduce the impact of and improve recovery time from such faults. Southern Power recognizes that this is an issue outside the purview of the ERCOT stakeholder process and must be considered by the Commission.

1. **Conclusion**

Southern Power appreciates the opportunity to comment on NOGRR245, and believes the development of an IBR performance standard would benefit by:

* Allowing additional time to determine IBR technical capabilities/limitations and retrofit (or other reasonably feasible) options.
* For existing IBRs, creating a narrowly tailored technical infeasibility exemption process and requiring actions to comply with ride-through requirements as quickly as practicable, to the extent such actions are technically feasible and commercially viable when applied to currently installed equipment.
* Pursuing transmission solutions to improve transmission system strength and mitigate the impacts of grid disturbance events.

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| Revised Cover Page Language | | | |
| NOGRR Number | [245](https://www.ercot.com/mktrules/issues/NOGRR245) | NOGRR Title | Inverter-Based Resource (IBR) Ride-Through Requirements |
| Date Posted | | January 11, 2023 | |
|  | |  | |
| Requested Resolution | | Normal | |
| Nodal Operating Guide Sections Requiring Revision | | 2.6.2, Generators and Energy Storage Resources  2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected inverter-Based Resources (IBRs) (new)  2.6.2.1, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs)  2.9, Voltage Ride-Through Requirements for Generation Resources  2.9.1, Voltage Ride-Through Requirements for Intermittent Renewable Resources Connected to the ERCOT Transmission Grid | |
| Related Documents Requiring Revision/Related Revision Requests | | None | |
| 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”). | |
| Reason for Revision | | Addresses current operational issues.  Meets Strategic goals (tied to the [ERCOT Strategic Plan](http://www.ercot.com/content/wcm/lists/144926/ERCOT_Strategic_Plan_2019-2023.pdf) or directed by the ERCOT Board).  Market efficiencies or enhancements  Administrative  Regulatory requirements  Other: Addresses future potential operational issues associated with IBR voltage ride-through capability.  *(please select all that apply)* | |
| Business Case | | This NOGRR is being submitted based on reliability issues associated with the inability of some IBRs to ride through system disturbances, and in light of the IEEE 2800-2022 standard. In its recently issued guidance document *Inverter-Based Resource Strategy*, theNorth American Reliability Corporation (NERC) noted it has supported the development of the IEEE 2800-2022 standard (and continues to support the IEEE P2800.2, Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems, standards development efforts). Among other things, the document also highlights that:   * New technology can introduce significant risks if not integrated properlywhich could result in high impact and high likelihood events that require substantive action; * 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 significant risk to bulk power system reliability; * Analyzed events identified new performance issues such as momentary cessation, unwarranted inverter or plant-level tripping issues, controller interactions and instabilities, and other critical 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.   Consequently, this NOGRR proposes additional frequency ride-through requirements for IBRs consistent with the IEEE 2800-2022 standard. It also clarifies IBR voltage ride-through requirements so they are 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 their 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 today can lead to severe consequences such as instability, cascading Outages, or triggering of the first stage of an Under-Frequency Load Shed (UFLS) event. This NOGRR proposes that all IBRs meet the new requirements as soon as practicable but not later than December 31, 2026, unless granted a temporary or permanent exemption. By March 1, 2026, IBRs that cannot meet the new ride-through requirements by the proposed deadline may seek a temporary exemption for up to an additional 12 months to implement new equipment and/or changes by submitting a report documenting a mitigation plan to give ERCOT an accurate understanding of the physical limitations to meeting the requirements. Existing IBRs may seek a permanent exemption for requirements of the standard that the IBRs are technically incapable of meeting and for which there are not commercially viable solutions that apply to currently installed equipment. Such permanent exemption requests must be submitted by March 1, 2026, and will include supporting documentation showing relevant equipment limitations.  The proposed requirements are intended to improve several of the major failure modes identified in the Odessa disturbances in 2021 and 2022. Market Participants in the Inverter Based Resource Task Force encouraged ERCOT to focus on enhancements adopting portions of the IEEE 2800-2022 standard or NERC Reliability Guidelines that would provide the most reliability benefit in the short-term rather than a holistic approach. As such, additional requirements on IBRs may be necessary based on additional event analyses, lessons learned, recommendations contained in the NERC Odessa 2022 report, IEEE requirements, and NERC Reliability Standard revisions. | |

|  |
| --- |
| Revised Proposed Guide Language |

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

(1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) or 2.6.2.2, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), if under-frequency relays are installed and activated to trip the Generation Resource or ESR, these relays shall be set 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 be set 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, all instantaneous frequency protections shall use filtered quantities or add sufficient time delays to prevent misoperations while providing the desired equipment protection.

(4) This Operating Guide 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 that is subject to paragraphs (1) and (2) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraphs (1) and (2), shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the Generation Resource’s or ESR’s frequency ride-through capability in the format shown in the tables in paragraphs (1) and (2) above.

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

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

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

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

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

(4) An IBR shall inject electric current during all periods requiring ride-through pursuant to paragraphs (1) and (3) above.

(5) An IBR’s Resource Entity shall not enable any plant controls or inverter controls that disconnect the IBR from the ERCOT System or reduce IBR output during frequency conditions where ride-through is required unless necessary for proper operation of the IBR, for providing frequency response, or to prevent equipment damage. If an IBR requires any setting that would prevent it from riding through a frequency event as required in paragraph (1) above, the IBR operation shall be restricted as set forth in paragraph (8) below.

(6) An IBR with a Standard Generation Interconnection Agreement (SGIA) executed prior to the effective date of this Section must comply with the frequency ride-through requirements in effect immediately prior to the effective date of this Section until December 31, 2026, at which time the IBR must comply with the requirements in this Section unless granted a temporary or permanent exemption by ERCOT as described in paragraph (c) below. IBRs with an SGIA executed on or after the effective date of this Section must comply with this Section.

The Resource Entity or Interconnecting Entity (IE) for an IBR with an SGIA executed prior to the effective date of this Section that cannot comply with the requirements of this Section by December 31, 2026 shall, by March 1, 2026, provide to ERCOT a schedule for modifying the IBR to comply with this Section’s requirements or a written explanation of the IBR’s inability to comply with the requirements, with supporting documentation containing the following:

(a) The IBR’s frequency ride-through capability as of the effective date of this Section in a format similar to the table in paragraph (1) above;

(b) The IBR’s maximum frequency ride-through capability and any associated settings to attempt to meet this Section’s requirements; and

(c) Any limitations on the IBR’s frequency ride-through capability making it technically infeasible to meet this Section’s requirements.

Based on the information provided by the Resource Entity or Interconnecting Entity, if ERCOT determines in its sole and reasonable discretion that an IBR cannot comply with one or more of the frequency ride-through requirements of this Section, ERCOT may grant a temporary or permanent exemption from such requirements. Temporary exemptions shall extend until December 31, 2027, or an earlier date, if ERCOT determines that earlier compliance is possible, provided that such an exemption will not affect any Resource Entity’s duty to comply with frequency ride-through requirements in effect before the effective date of this Section. During any temporary exemption period, the Resource Entity for the IBR shall implement any technically feasible modifications to achieve the IBR’s maximum frequency ride-through capability as soon as practicable but no later than December 31, 2027. All temporary exemptions from this requirement to allow for IBR modifications shall terminate no later than December 31, 2027. The Resource Entity or IE for an IBR unable to comply with the frequency ride-through requirements implemented as of the effective date of this Section may seek a permanent exemption for the specific requirements for which there are not technically feasible and commercially viable modifications available.

(7) If an IBR fails to perform in accordance with the frequency ride-through requirements of this Section, the Resource Entity for the IBR shall investigate the event and report to ERCOT the cause of the IBR failure. All impacted TSPs shall provide available information to ERCOT to assist with event analysis. The Resource Entity for each IBR not meeting the frequency ride-through requirements shall install, if not already installed, phasor measurement units and digital fault recorders at locations identified by ERCOT as soon as practicable but no later than 18 months after notification.

(8) If the Resource Entity can implement IBR modifications to resolve the technical limitations or performance failures preventing compliance with these frequency ride-through requirements, the Resource Entity shall submit to ERCOT a report and supporting documentation containing the following:

(a) The current technical limitations and IBR frequency ride-through capability in a format similar to the table in paragraph (1) above;

(b) The proposed modifications and frequency ride-through capability allowing the IBR to comply with the frequency ride-through requirements in a format similar to the table in paragraph (1) above; and

(c) A schedule for implementing those modifications.

In its sole and reasonable discretion, ERCOT may accept the proposed modification plan.

(9) A Resource Entity or IE that makes a material change to an IBR facility in accordance with paragraph (1)(c) of Planning Guide Section 5.2.1, Applicability, must comply with this Section.

***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.

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

(1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), or 2.9.2, Voltage Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), each Generation Resource or ESR must be designed, and its generation voltage relays must be set, to remain connected to the transmission system 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 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 that over-excitation protection only operates 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 its equipment from abnormal conditions as well as to 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 that occur 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 this action is part of an approved Remedial Action Scheme (RAS).

(7) Each Generation Resource and ESR shall provide technical documentation of voltage ride-through capability to ERCOT upon request.(8) These Operating Guides shall not affect the Resource Entity’s responsibility to protect Generation Resources from damaging operating conditions. The Resource Entity for a Generation Resource unable to remain reliably connected to the ERCOT System as set forth in paragraph (1) 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’s voltage ride-through capability.

|  |
| --- |
| ***[NOGRR204: Replace Section 2.9 above with the following upon system implementation of NPRR989:]***  **2.9 Voltage Ride-Through Requirements for Generation Resources and Energy Storage Resources**  (1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), or 2.9.2, Voltage Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), each Generation Resource and ESR must be designed, and its voltage relays must be set, to remain connected to the transmission system 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 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 that over-excitation protection only operates 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 their equipment from abnormal conditions as well as to 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 that occur 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 this action is part of an approved Remedial Action Scheme (RAS).  (8) Each Generation Resource and ESR shall provide technical documentation of voltage ride-through capability to ERCOT upon request.  (9) These Operating Guides shall not affect the Resource Entity’s responsibility to protect Generation Resources from damaging operating conditions. The Resource Entity for a Generation Resource unable to remain reliably connected to the ERCOT System as set forth in paragraph (1) 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’s voltage ride-through capability. |

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

(1) All IBRs interconnected to the ERCOT Transmission Grid shall ride through the root-mean-square voltage conditions in Table A and the instantaneous phase voltage conditions in Table B, as measured at the IBR’s Point of Interconnection Bus (POIB):

**Table A**

|  |  |
| --- | --- |
| 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 |

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

**Table B**

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

The instantaneous voltage in Table B are the residual voltages with surge arrestors, if applied. During the conditions identified in Table B above, 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 B 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 be set to enable the IBR to ride through voltage conditions beyond those defined in paragraph (1) above to the maximum extent possible. An IBR shall ride-through any grid disturbance during which ride-through is required and the positive-sequence angle change within a sub-cycle-to-cycle time frame does not exceed 25 electrical degrees. In addition, the IBR shall ride-through any change in the phase angle of individual phases caused by occurrence and clearance of unbalanced faults, provided that the positive-sequence angle change does not exceed the stated criterion. Positively damped active and reactive current oscillations in the post-disturbance period are acceptable in response to phase angle changes.

(4) An IBR shall inject electric current during all periods requiring ride-through pursuant to paragraphs (1) and (3) above, except for IBRs with Standard Generation Interconnection Agreements (SGIAs) executed prior to the effective date of this paragraph and for which there are not technically feasible and commercially viable modifications available to eliminate momentary cessation. When the POIB voltage is outside the continuous operating voltage range, an IBR shall continue to deliver pre-disturbance active current unless otherwise limited due to its current limit. Unless otherwise specified by ERCOT or the interconnecting TSP, an IBR shall minimize reductions in active current while maintaining robust reactive current response. Any necessary reductions in active current to prioritize reactive current shall be proportional to the voltage change at the POIB. An IBR shall return to its pre-disturbance level of real power injection as soon as possible but no more than one second after POIB voltage recovers to normal operating range. For IBRs with SGIAs executed prior to the effective date of this paragraph and for which momentary cessation cannot be eliminated entirely, the Resource Entity or Interconnecting Entity (IE) for the IBR shall prioritize a return to pre-disturbance real power output as quickly as possible and identify the changes that can be made to inverter settings to minimize the impact of momentary cessation to the greatest extent possible.

(5) An IBR shall not enable any plant controls or inverter controls that disconnect the IBR from the ERCOT System or reduce IBR output during voltage conditions where ride-through is required unless necessary for proper operation of the IBR, for providing frequency response, or to prevent equipment damage. If an IBR requires any setting that would prevent it from riding through a voltage event as required in paragraph (1) above, the IBR operation shall be restricted as set forth in paragraph (10) below..

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

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

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

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

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

(d) Voltage deviations outside of continuous operation zone in Table A in paragraph (1) above following the end of a previous deviation by less than twenty cycles of system fundamental frequency.

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

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

(g) For wind turbine IBRs, 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 with a Standard Generation Interconnection Agreement (SGIA) executed prior to the effective date of this paragraph must comply with the voltage ride-through requirements in effect immediately prior to the effective date of this paragraph until December 31, 2026, at which time the IBR must comply with all parts of this Section except the instantaneous phase voltage conditions in Table B in paragraph (1) above. IBRs with an SGIA executed on or after the effective date of this paragraph must comply with all parts of this Section.

The Resource Entity or IE for an IBR with an SGIA executed prior to the effective date of this paragraph that cannot comply with the requirements of this Section by December 31, 2026 shall, by March 1, 2026, provide to ERCOT a schedule for modifying the IBR to comply with this Section’s requirements or a written explanation of the IBR’s inability to comply with the requirements, with supporting documentation containing the following:

(a) The IBR’s voltage ride-through capability as of the effective date of this paragraph in a format similar to the tables in paragraph (1) above;

(b) The IBR’s maximum voltage ride-through capability and any associated settings to attempt to meet this Section’s requirements; and

(c) Any limitations on the IBR’s voltage ride-through capability making it technically infeasible to meet this Section’s requirements.

Based on the information provided by the Resource Entity or IE, if ERCOT determines in its sole and reasonable discretion that an IBR cannot comply with one or more of the voltage ride-through requirements of this Section, ERCOT may grant a temporary or permanent exemption from such requirements. Temporary exemptions shall extend until December 31, 2027, or an earlier date, if ERCOT determines that earlier compliance is possible, provided, that such an exemption will not affect any Resource Entity’s duty to comply with voltage ride-through requirements in effect before the effective date of this Section. During any temporary exemption period, the Resource Entity for the IBR shall implement any technically feasible modifications to achieve the IBR’s maximum voltage ride-through capability as soon as practicable but no later than December 31, 2027. All temporary exemptions from this requirement to allow for IBR modifications shall terminate no later than December 31, 2027. The Resource Entity or IE for an IBR unable to comply with the voltage ride-through requirements implemented as of the effective date of this paragraph may seek a permanent exemption for the specific requirements for which there are not technically feasible and commercially viable modifications available.

(9) If an IBR fails to perform in accordance with the voltage ride through requirements of this Section, the Resource Entity for the IBR shall investigate the event and report to ERCOT the cause of the IBR failure. All impacted TSPs shall provide available information to ERCOT to assist with event analysis. The Resource Entity for each IBR not meeting the voltage ride-through requirements shall install, if not already installed, phasor measurement units and digital fault recorders at locations identified by ERCOT as soon as practicable but no later than 18 months after notification.

(10) .If the Resource Entity can implement IBR modifications to resolve the technical limitations or performance failures preventing compliance with these voltage ride-through requirements, the Resource Entity shall submit to ERCOT a report and supporting documentation containing the following:

(a) The current technical limitations and IBR voltage ride-through capability in a format similar to the tables in paragraph (1) above;

(b) The proposed modifications and voltage ride-through capability allowing the IBR to comply with the voltage ride-through requirements in a format similar to the tables in paragraph (1) above; and

(c) A schedule for implementing those modifications.

(11) A Resource Entity or IE that makes a material change to an IBR facility in accordance with paragraph (1)(c) of Planning Guide Section 5.2.1, Applicability, must comply with this Section.



In its sole and reasonable discretion, ERCOT may accept the proposed modification plan.

1. IEEE 2800-2022 was developed by over 175 working group participants from Transmission Owners, OEMs, developers, and consultants. The standard successfully passed industry peer review by 466 IEEE balloters with greater than 94% approval and greater than 90% response rate. [↑](#footnote-ref-1)
2. While Southern Power’s experience relates to its own generation facilities, it expects that existing IBR facilities will generally have similar technical limitations and challenges meeting the proposed ride-through requirements. [↑](#footnote-ref-2)
3. This evaluation assumes the NOGRR245 requirements are applied at the IBR unit terminals; vendor modeling/studies are needed to fully assess if an IBR facility complies with the ride-through requirements. [↑](#footnote-ref-3)
4. Some of the “no” responses reflect the uncertainty of equipment capabilities. It is possible that some “no” responses turn to “yes” responses upon further study. “Not applicable (N/A)” indicates that equipment does not have explicit protection for a given item. For example, if an inverter has “N/A” for a Rate of Change of Frequency (ROCOF) protection setting, it does not mean that the inverter will not trip if there is high ROCOF; instead, it means that the inverter does not explicitly calculate ROCOF and trip if ROCOF exceeds a certain value. [↑](#footnote-ref-4)
5. This information is subject to change as Southern Power continues to review and engage with its OEMs. [↑](#footnote-ref-5)
6. See slide 17 of “The IEEE2800 Conformity Assessment Paradigm” presented at the Inverter-Based Resource Task Force meeting on April 14, 2023, available at https://www.ercot.com/calendar/04142023-IBRTF-Meeting-\_-Webex. [↑](#footnote-ref-6)
7. FERC Docket RM22-12-000. [↑](#footnote-ref-7)
8. The six Regional Entities include Midwest Reliability Organization, Northeast Power Coordinating Council, Inc., ReliabilityFirst Corporation, SERC Reliability Corporation, Texas Reliability Entity, Inc. (Texas RE), and Western Electricity Coordinating Council (WECC). [↑](#footnote-ref-8)
9. See NERC and Electric Reliability Organization Enterprise comments submitted in Docket RM22-12-000 on February 6, 2023. [↑](#footnote-ref-9)
10. See agenda item 4f presentation from the April 26 – 27, 2023, NERC Resources Subcommittee meeting. [↑](#footnote-ref-10)
11. See slide seven of the “Revised CEO Update” presented at the ERCOT Board of Directors meeting on February 28, 2023, available at https://www.ercot.com/calendar/02282023-Board-of-Directors-Meeting. [↑](#footnote-ref-11)
12. The EPA’s CSAPR would establish nitrogen oxide emission limits for fossil-fuel power plants in 22 states, including Texas. A preliminary ERCOT assessment identified approximately 11 GW of thermal generation that could potentially retire by 2026 and lead to increased load shed risk. See “ERCOT Analysis of EPA FIP Regional Ozone Transport Rule” presented at the ERCOT Board of Directors meeting on June 21, 2022, available at https://www.ercot.com/calendar/06212022-Board-of-Directors-Meeting. [↑](#footnote-ref-12)
13. See the 2023 Spring Seasonal Assessment of Resource Adequacy report located at https://www.ercot.com/gridinfo/resource. The MW values include resources that have received approval for commercial operations and resources that have synchronized to the ERCOT system but not yet received approval for commercial operations. [↑](#footnote-ref-13)
14. *Appeal and Complaint by Iberdrola Renewables, Inc. et al of ERCOT Decision to Approve PRR 830* [↑](#footnote-ref-14)
15. Modification of Voltage Support Requirements to Address Existing Non-Exempt WGRs. [↑](#footnote-ref-15)
16. See “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-16)
17. IEEE 2800-2022, Section 1.4: “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 requests; 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).” [↑](#footnote-ref-17)
18. Nodal Protocol §3.15(7)(a). See also, NPRR389, Modification of Voltage Support Requirements to Address Existing Non-Exempt WGRs; PUCT Docket No.37817, Appeal and Complaint by Iberdrola Renewables, Inc. et al of ERCOT Decision to Approve PRR830; PUCT Docket No. 38981, Joint Appellants’ Appeal and Complaint Concerning the ERCOT Board’s Adoption of NPRR269 and Request for Related Relief. [↑](#footnote-ref-18)
19. 16 Texas Administrative Code (TAC) §25.503(f)(2)(C) (emphasis added). [↑](#footnote-ref-19)
20. FERC’s NOPR on Reliability Standards to Address IBRs in Docket RM22-12-000. See paragraphs 62 (“NERC also recommended that solar photovoltaic IBR owners should ‘work with their inverter manufacturer(s) to identify the changes that can be made to eliminate momentary cessation of current injection to the greatest extent possible, consistent with equipment capability’”) and 63 (“For IBRs for which momentary cessation cannot be eliminated entirely, NERC recommended that generator owners should identify the changes that can be made to inverter settings to minimize the impact of momentary cessation on the Bulk-Power System”). [↑](#footnote-ref-20)
21. Id. at paragraph 95 (emphasis added). [↑](#footnote-ref-21)
22. *See, e.g.*, NERC’s Procedure for Requesting and Receiving Technical Feasibility Exception to NERC Critical Infrastructure Protection Standards, NERC Rules of Procedure App. 4D, available at https://www.nerc.com/AboutNERC/RulesOfProcedure/Appendix\_4D\_20160701.pdf. [↑](#footnote-ref-22)
23. Southern Power recently reviewed frequency data measured on a minute basis at power quality meters for two of its solar resources located in far West Texas for 14 operating days in April 2023. For these days, these two solar resources experienced approximately 250 – 450 frequency events per day that required response to frequency outside the deadband settings required by ERCOT. [↑](#footnote-ref-23)
24. See “Strengthening the West Texas Grid to Mitigate Widespread IBR Events – Operation Assessment Reuslts\_RPG\_02142023” presented at the Regional Planning Group meeting on February 14, 2023. ERCOT’s preliminary 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 16% 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 16% increase in system strength compared to the study base case without new synchronous condensers. [↑](#footnote-ref-24)
25. Two synchronous condensers were installed in 2018 in the ERCOT Panhandle to provide voltage and system strength support. [↑](#footnote-ref-25)