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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 8, 2024 |

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| **Submitter’s Information** | |
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| **Market Segment** | Not Applicable |

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| **Comments** |

The lack of ride-through capability of existing Inverter-Based Resources (IBRs) represents a threat to the reliable operation of the entire Texas interconnection, putting the citizens of Texas at the risk of widespread outages or an extended blackout from even common disturbances. As the magnitude of this risk became apparent during North American Electric Reliability Corporation (NERC) event analyses, ERCOT filed Nodal Operating Guide Revision Request (NOGRR) 245, Inverter-Based Resource Ride-Through Requirements, to implement requirements to correct performance deficiencies of existing and new IBRs as quickly and completely as technically feasible. Additionally, the Federal Energy Regulatory Commission (FERC) issued its Order 901 in October 2023 requiring NERC to create additional requirements for IBRs closely aligned with the requirements ERCOT sought in its original and revised versions of NOGRR245. The ROS-endorsed version of this NOGRR nullifies the requirements ERCOT proposed for existing IBRs and even for many planned IBRs. It is vital that sufficient requirements be established to mitigate this risk to the greatest extent possible for the 160,000 MW of existing and planned IBRs the ROS-recommended version would exempt, as well as new units.

At the same time, ERCOT does not want to implement technically infeasible requirements or ones that would cause retirement of significant IBR capacity (although retirement of some existing capacity might be warranted given the significant risk of implementing lenient requirements). As such, ERCOT has worked with equipment manufacturers and owner/operators to understand current capabilities and technically feasible improvements to maximize the IBRs’ ability to ride-through events while appropriately balancing the cost of meeting the requirements.

ERCOT files these comments to restore key elements of the NOGRR to implement requirements mitigating the reliability risk, while appropriately balancing the need for those requirements to be technically feasible based on updated information obtained through the requests for information (“RFIs”) sent to original equipment manufacturers (“OEMs”) and Resource Entities in September 2023.

In summary:

* The mandatory ride-through requirements proposed in these comments are necessary to address current reliability risk on the ERCOT System.
* Deadlines for complying with the new requirements should be based on when the improvements to a particular category of Resources can reasonably be implemented rather than the latest date on which the last unit of any category could be modified.
* These requirements must address existing IBRs and new IBRs due to the volume of existing Resources contributing to the current and growing risk to the ERCOT System.
* The voluntary compliance regime for implementing ride-through capabilities proposed in the ROS-recommended language will not solve the problem because it effectively continues the current approach under which most Resource Entities have not maximized their actual, current ride-through capabilities.
* ERCOT, as the Reliability Coordinator for the ERCOT Region, has authority to give operating instructions to specific Resources, including ordering Resources offline if they cause reliability risk to the ERCOT System. The ROS-recommended version inappropriately attempts to limit this FERC-mandated authority.
* The project to add six synchronous condensers across West Texas is not a substitute for the proposed improvements in IBR ride-through requirements. While the synchronous condensers will improve overall system strength in West Texas to limit overall size of a disturbance, IBRs in a particular area will still experience voltage excursions that they must be able to ride-through. Both are needed to meet the overall reliability requirements.

In general, the ROS-recommended version of NOGRR245 does not sufficiently address the significant reliability risk from the lack of ride-through capability of existing and future IBRs. In the language changes below, ERCOT proposes revised requirements that will actually mitigate reliability risk, and considers new information received since the ROS discussion. Since ROS recommended language in September, ERCOT received responses to RFIs it issued in September. Thus, ERCOT proposes additional changes reflecting key takeaways from the RFI responses and FERC Order 901.

ERCOT provides the following additional explanation on each of these items:

***Current reliability risk***

Failure to ride-through normal system disturbances is *unreliable performance* that, if left unaddressed, threatens to cause uncontrolled loss of firm Load, instability, or cascading outages up to a complete ERCOT System blackout. The reliability risk is not localized but could affect the *entire ERCOT System* and, if coupled with insufficient generation, could trigger the first stage of Under-Frequency Load Shed (UFLS) that could trigger additional generation and Load loss resulting in a system-wide event. Such an event would be catastrophic with impact and costs far outweighing any commercial impacts to Resource Entities. NOGRR245 arose from the inability of IBRs and Type 1/Type 2 Wind-powered Generation Resources (WGRs) to ride-through normal system disturbances. As such, the Operating Guides must be revised to mitigate unreliable performance as soon as possible.

ERCOT has observed IBR, Type 1/Type 2 WGR ride-through failures *since 2013*. Those failures have increased in magnitude and frequency in recent years. ERCOT’s proposal seeks to prevent a catastrophic event and encourages entities to implement the important system changes as quickly as possible. ERCOT proposes retroactive application of certain requirements to ensure owners: (i) address *known failure causes*, (ii) coordinate inverter and turbine controls with protection and controls for the balance of the plant, and (iii) configure and modify turbines and inverters to ensure they ride through normal system disturbances. ERCOT does not seek retroactive application of higher voltage ride-through curves for legacy IBRs or IBRs with interconnection agreements before 6/1/23 and does not seek to apply the IEEE-2800-2022 requirements to existing IBRs if they implement changes prior to 1/1/28 to demonstrate good faith to maximize ride-through capability and address known failure modes.

***Extended implementation timelines do not address current risk***

Some stakeholders propose extending timelines for compliance but ERCOT finds this proposal untenable. The ERCOT System has experienced 23 disturbances related to IBR performance failures since *December 26, 2018* (*i.e.*, an average of nearly five events per year). The frequency and severity of events make it clear immediate action is needed to address the reliability risk. The critical and urgent reliability risks presented by poor ride-through performance have caused ERCOT to consistently take the position Resource Entities should implement mitigation activities as soon as possible. The ERCOT System cannot withstand continued extensions considering the significant penetration of IBRs.

In fact, as far back as September 2021, NERC stated:

ERCOT should ensure that the recommendations contained within the NERC reliability guidelines are comprehensively reviewed and adopted to ensure mitigating actions are put in place to prevent these types of issues in the future. May [sic] of the performance issues in this event could have been mitigated if appropriate performance requirements were established for these resources….[[1]](#footnote-2)

Accordingly, ERCOT included short deadlines for complying with the new voltage ride-through criteria in its original proposal.

ERCOT has revised the compliance deadlines in response to stakeholder concerns, but only so far as to make the deadlines technically feasible for a significant number of Resources:

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| Original Deadline | Revised Deadline |
| December 31, 2024(potentially extended to December 31, 2025) | December 31, 2025 (potentially extended to December 31, 2027 for complex mitigation activities) and  December 31, 2028 for Type 3 WGRs needing additional time to meet certain requirements |

While meeting the current voltage ride-through requirements may challenge a small subset of older WGRs, continuing to extend timelines for *all* IBRs increases risk to an unacceptable level and continues to encourage delay implementing mitigation activities. Those delays do not foster reliability and ignore the urgency ERCOT has highlighted throughout this revision request process. ERCOT proposes to allow extensions only for documented and valid changes and upgrade kits, especially in light of allowing a level of targeted exceptions and reducing several requirements as compared to what ERCOT initially proposed in NOGRR245.

After the Odessa 2 disturbance in 2022 and as the IEEE 2800-2022 standard was being approved, ERCOT alerted developers to build IBR plants capable of meeting the IEEE-2800-2022 standard. ERCOT continued reiterating that message in stakeholder meetings. ERCOT believes, concurrent with EPRI’s gap analysis presented to the IBR Task Force (IBRTF), adoption of the IEEE-2800-2022 standard will assist with preventing or minimizing future events as this robust set of capability requirements will help ensure system stability. ERCOT already deferred the compliance date from 1/1/23 to 6/1/23 and does not support further delays. While some OEMs have only recently developed new models capable of meeting the IEEE 2800-2022 standard, several models that can meet the IEEE 2800-2022 standard have already been shipped. Input from OEMs clearly indicates adopting the IEEE 2800-2022 standard is technically feasible and developers can retrofit IBRs if Resource Entities purchased older or currently limited models.

Extending the IEEE 2800-2022 compliance date to 2026 accommodates IBR OEMs by providing a long lead time to meet the new standard when, in fact, some OEMs can *currently* deliver equipment meeting the IEEE 2800-2022 specifications (to the best of their knowledge as modeling and testing evolve). ERCOT would prefer Resource Entities use the most capable equipment for new construction to ensure the most capable and resilient equipment. Some stakeholders oppose the date ERCOT initially proposed for compliance (1/1/23). Their primary concern is they may have entered into equipment contracts for older, less capable turbines or inverters before signing a Standard Generation Interconnection Agreement (SGIA). In its 6/22/23 comments, ERCOT agreed to revise the SGIA date from 1/1/23 to 6/1/23, with possible extensions for new units that can upgrade to meet IEEE 2800-2022 within 24 months of energization. ERCOT’s proposal offers a solution allowing timely capacity additions without sacrificing available technical capabilities to avert major system disturbances. Otherwise, ERCOT believes developers should consider alternative, more capable equipment that can meet IEEE 2800-2022. Some commenters propose waiting to adopt IEEE 2800-2022 until IEEE-P2800-2 and associated testing requirements are promulgated (scheduled for Q1 2025). ERCOT disagrees because the IEEE P2800-2 chair Andy Hoke made a presentation at the 4/14/23 Inverter-Based Resource Task Force (IBRTF) meeting in which he unequivocally stated, “Adoption of IEEE 2800 is ***not*** contingent upon publication/adoption of IEEE P2800.2.”[[2]](#footnote-3) (emphasis added) Finally, extending the IEEE-2800 compliance date would give developers an incentive to rush to sign a SGIA to circumvent more stringent ride-through requirements (that, presumably, may cost more to install). That practice would undermine system reliability.[[3]](#footnote-4)

***NOGRR245 should address existing and new IBRs***

Some stakeholders advocate “bifurcating” NOGRR245 to have requirements applicable to new Resources move forward while allowing additional time for further discussions regarding requirements for existing facilities to include in a future set of rules. However, ERCOT’s proposal clearly separates requirements and applicability into different sections, where appropriate (such as voltage ride-through requirements). ERCOT does not support separating the rules changes into two NOGRRs because:

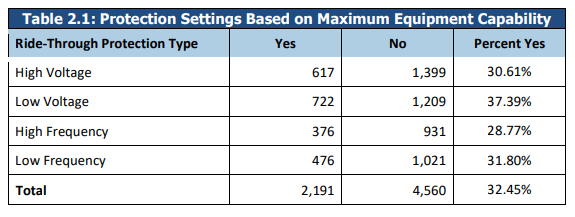
1. Rule changes applying to only new IBRs would take affect when new IBRs interconnect to the ERCOT System (not immediately). While such changes should provide additional ride-through capabilities and resiliency, their impact would not begin until late 2024 (the earliest) and beyond. Most importantly, **rule changes applying to only new IBRs would not remove the current, unacceptable reliability risk from existing IBRs**. Creating clarity and specificity of IBR performance requirements is critical and the highest priority to prevent instability and cascading outages on the ERCOT System. Resource Entities had more than three years of reliability guidelines,[[4]](#footnote-5) continued disturbances,[[5]](#footnote-6) and NERC alerts. These voluntary guidelines, without mandatory requirements, have not resulted, by and large, in improvements being implemented.[[6]](#footnote-7)
2. FERC Order 901 clearly ordered NERC to draft reliability standard requirements applying to new and existing IBRs.
3. Several OEMs have indicated available software or parameter settings changes or upgrade kits are available and are simply waiting on customers to purchase and implement them.
4. NERC Alert RFI responses clearly indicate a large amount of unused capability or incorrect settings on IBRs needing correction without delay.[[7]](#footnote-8)
5. The risk of Load loss due to instability, uncontrolled separation and cascading outages presented by existing IBRs and non-IBR WGRs is the highest form of risk on the ERCOT System and should be addressed with a commensurate level of urgency and oversight.

***The ROS-recommended language extends the current voluntary compliance regime that led to the current reliability problems by granting broad exemptions determined by generator owners with no oversight by ERCOT or the Public Utility Commission of Texas (PUCT)***

While ERCOT, FERC and NERC have continued to recommend that IBR and non-IBR WGR owners implement available improvements without delay, very few Resource Entities have proactively mitigated risks by implementing readily available improvements.[[8]](#footnote-9) This continues to highlight the need for NOGRR245 and enforcing existing rules to proceed as quickly as possible to mitigate the current and growing risk of ride-through failures on the ERCOT System.

Recent responses to the NERC Alert Level 2 highlighted the issue of how Resource Entities have not implemented recommended guidelines. NERC stated:[[9]](#footnote-10)

Results show that less than one-third of the inverter settings reported are set based on equipment capability, showing that there is significant underused ride-through capability across the BPS and reinforcing the conclusions drawn in the preceding section. This finding raises concerns regarding ride through performance, the provision of essential reliability services, and BPS reliability, especially at a time when the grid transformation is resulting retirements of substantial amounts of synchronous machines. This finding provides additional evidence that the ***voluntary recommendations set forth in NERC guidelines and other publications are not being implemented***.



ERCOT strongly objects to generator owners having the power to self-determine exceptions to ride-through requirements because they have no visibility of the impact on ERCOT System reliability nor the obligation to ensure that reliability.[[10]](#footnote-11) It is highly inappropriate to give IBR owners the power to self-determine exemptions that prioritize commercial impact over reliability. In fact, the ROS-recommended version of NOGRR245 gives Resource Entities the sole discretion to apply an exemption with no regard to the impact on reliability.

ERCOT proposes language supporting limited, documented technical exceptions for older IBRs consistent with FERC Order 901. ERCOT proposes that, as the Independent Organization obligated to ensure reliability with the visibility and information to assess the impact on ERCOT System reliability, it should have the authority to determine whether to allow an exception. This is consistent with ERCOT’s role as defined in subsections (b) and (f) of P.U.C Subst. R. 25.361.

***Feasibility of ERCOT’s proposal***

Some stakeholder comments call ERCOT’s proposal “infeasible” because OEMs have not yet fully engineered solutions or bringing units into compliance would be costly. However, GE Vernova stated, at the 9/14/23 ROS meeting, it cannot commit to having solutions *for the oldest Type 3 (1.x model) WGRs* (approximately 4,800 turbines) within the ERCOT-proposed timelines and submitted comments on 7/31/23 stating:

* GE Vernova can make legacy 1.x and 2.x ESS units compatible with the single dip current voltage ride through capabilities and the preferred frequency ride through capabilities, with limited modifications. Developing an upgrade solution for compatibility with the NOGRR245 specificity requirements for all configurations will not be completed until after the 2027 requirement deadline due to software and hardware upgrades.
* Legacy non-ESS units cannot be made compatible with the current ride-through curves and the NOGRR245 specificity without major retrofits not available until after the 2027 requirement deadline.

The public comments made at the 9/14/23 ROS meeting did not align with the previously-filed comments. Additionally, the RFI response and subsequent GE Vernova comments submitted on 11/7/23 indicate it has no plans to develop solutions for the 1.x units which could be up to 8,200 MW of installed nameplate capacity. While ERCOT respects OEMs’ ability to update their assessments, this level of exception may pose too much residual risk on the ERCOT System. Additional details may reveal some of the GE WGR 1.x models may be able to substantially meet the requirements with parameterization or software changes (lessening the residual risk) but ERCOT recommends owners work with GE Vernova to reassess if a subset of the 1.x models can implement solutions to lessen the number or magnitude of exceptions. ERCOT appreciates GE Vernova’s transparency, involvement and commitment to improve capabilities of other models but ERCOT must highlight this significant level of potential exceptions and the impact on reliability associated with leaving a large amount of IBRs with residual ride-through performance failure risk on the ERCOT System.

ERCOT believes that, when considering all technically feasible options to meet the performance requirements (including adding supplemental equipment[[11]](#footnote-12)), no reason exists to create or extend permanent and broad exemptions to ride-through performance requirements that undermine grid reliability. The ERCOT System cannot endure *unplanned* performance failures together with *planned* failures due to exempted equipment. Thus, ERCOT stakeholders should proactively and urgently prevent planned failures resulting from exempted equipment. ERCOT can support *targeted* exemptions (*e.g.*, inability to meet a particular time portion or level of a ride-through curve with a lower probability of occurring) where it can assess the reliability impact as minimal and modifications difficult for the owner to implement.

***Operational restrictions***

Additionally, as described in multiple stakeholder meetings, ERCOT agreed to extend compliance deadlines *only if coupled with clear language giving ERCOT authority to impose operational restrictions on Resources failing to meet legacy voltage ride-through requirements*. ERCOT’s August proposal allowed it to remove unacceptable reliability risk by imposing operational restrictions on units until IBR owners implement needed changes.[[12]](#footnote-13) ERCOT believes operational restrictions are needed to encourage generators to develop and implement *timely* strategies to mitigate performance failures.[[13]](#footnote-14) Mitigation time must include modeling and subsequent evaluation aligning with Planning Guide Revision Request (PGRR) 109, Dynamic Model Review Process Improvement for Inverter-Based Resource (IBR) Modification.

As the Reliability Coordinator for the ERCOT Region, ERCOT must reliably operate the ERCOT System. ERCOT has the wide-area view of that system, the operating tools, processes and procedures, and the authority to prevent or mitigate emergency operating situations. ERCOT has a purview broad enough to monitor and address the operating parameters of the ERCOT System beyond any Transmission and/or Distribution Service Provider (TDSP), Qualified Scheduling Entity (QSE) or Resource Entity. As such, 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.[[14]](#footnote-15)

The ROS-recommended version of NOGRR245 removes ERCOT’s discretion to impose operational restrictions on IBRs with performance failures or that fail to comply with the voltage ride-through requirements. ERCOT cannot support extending compliance timelines without having the ability to remove reliability risk due to ride-through performance failures or non-compliance. Any TAC language recommended for approval must allow ERCOT to exercise reasonable discretion to ensure ERCOT System reliability.[[15]](#footnote-16)

***NOGRR245 and the addition of six synchronous condensers currently proposed as part of the West Texas Synchronous Condenser Project are both needed to preserve different aspects of system reliability***

To minimize potential reliability risks driven by the high penetration of IBRs, in addition to this NOGRR, ERCOT proposed adding six synchronous condensers as part of the West Texas Synchronous Condenser Project (the “Project”). To ensure reliability, NOGRR245 *and* transmission upgrades (such as the Project) are needed.

High levels of (grid following) IBR penetration degrade system strength due to the characteristics of the power electronics interface and lack of rotating mass. Under very low system strength conditions, even well-tuned IBR controls will not function properly. The Project increases system strength and will reduce the magnitude of a disturbance (*i.e.*, the extent to which large voltage excursions perturbate a wide area of the system). This reduction in the extent of the voltage dip area will reduce the number of IBRs entering voltage ride-through mode which will, in turn, reduce the likelihood of ride-through performance failures. Finally, the Project will improve the voltage overshoot characteristically observed in weak systems, which may minimize over-voltage IBR performance failures as well as large load losses in West Texas (an emerging reliability issue).

While the Project may reduce the extent of voltage excursions IBRs experience during system disturbances, it does not eliminate voltage excursions entirely. Thus, the requirements proposed by ERCOT in NOGRR245 are still needed to improve IBR capability to ride through system disturbances.

More details of the Project and associated key findings can be found at the following links:

* “[Item 14.2 West Texas Synchronous Condenser RPG Project](https://www.ercot.com/files/docs/2023/12/11/14.2%20West%20Texas%20Synchronous%20Condenser%20RPG%20Project.pdf)” at the December 2023 ERCOT Board meeting. It also contains the ERCOT Independent Review Report.
* “[Assessment of Synchronous Condensers to Strengthen the West Texas System](https://www.ercot.com/files/docs/2023/06/27/Assessment-of-Synchronous-Condensers-to-Strengthen-West-Texas-System.pdf)” posted in the ERCOT public website. This is Appendix A of the ERCOT Independent Review Report.
* [Final Regional Planning Group (RPG) presentation](https://www.ercot.com/files/docs/2023/06/09/Assessment%20of%20Synchronous%20Condensers%20to%20Strengthen%20West%20Texas%20System_RPG_20230613.pdf) of the Project which provide a summary of the analysis conducted by ERCOT.

***ERCOT proposed changes***

ERCOT proposes several changes in response to stakeholder comments, technical discussions at the IBRWG and other technical forums, and the RFI responses from OEMs and Resource Entities as summarized below:

* Allow exceptions for documented *technical* limitations meeting frequency ride-through and voltage ride-through curves for IBRs and Type 1/Type 2 WGRs with SGIAs before 1/16/14
  + Exceptions given based on ERCOT sole discretion
  + Must meet existing requirements and substantially meet new requirements, with each plant's documented technical limitation becoming the requirement for that plant
  + Must maximize frequency and voltage ride-through capability through parameterization, software upgrades and technically feasible upgrade kits (no retrofits required)
  + Resource Entities must accurately represent all technical limitations in modeling data provided to ERCOT[[16]](#footnote-17)
  + ERCOT may apply operational restrictions for performance failures posing significant reliability risk and not mitigated in a reasonable time (*e*.*g*., 90 days)
  + Must meet current requirements upon reinvestment (*e.g*., retrofit requiring Generator Interconnection or Modification (GIM) process)
* Removes specificity requirements for legacy IBRs for rate-of-change of frequency and phase angle jump
  + Return expectations around rate-of-change of frequency and phase angle jump requirements to status quo
    - The IBR must ride through if voltage and frequency are within “no trip” zones
* Modify multiple excursion requirements for legacy IBRs to maximize capability if they use a counter or can adjust parameters to ensure riding through normal Transmission Service Provider (TSP) reclose schemes versus current alignment with IEEE 2800-2022
* Allow documented technical limitations to IEEE 2800-2022 for units synchronized before 1/1/26
  + Exceptions given based on ERCOT’s sole discretion
  + Must fully meet legacy requirements
  + Must substantially meet preferred requirements with each plant’s documented technical limitations becoming the new specificity requirements for that plant
  + Must maximize capability through the use of parameterization, software upgrades and technically feasible upgrade kits (with allowed implementation timeframes)
  + Technical limitation must be accurately represented in all provided models
  + ERCOT may apply operational restrictions for performance failures to the documented limitation that pose significant reliability risk that cannot be mitigated within a reasonable timeframe (*e.g*., 90 days)
  + Must meet latest requirements upon reinvestment (*e.g*., retrofit requiring GIM process)
* Revise operational restrictions expectations for performance failures that pose significant reliability risk and cannot be implemented within a reasonable timeframe
* Other minor clarifications/exceptions
  + Handling of active current reductions during a fault
  + SGIA modifications for Load-only additions would not trigger requirement to meet IEEE 2800-2022 requirements if IBR does not need physical modifications to meet other requirements
  + Clarify rate-of-change of frequency and phase angle jump requirements to address differences between fault and non-fault timeframes

ERCOT *strongly* urges TAC to recommend approval of these comments that prioritize reliability over commercial discretion and exemptions that circumvent reliability performance requirements. ERCOT also *strongly* urges all Resource Entities to implement available improvements without delay.

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| **Revised Cover Page Language** | |
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| 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)  2.6.2.1.1, Temporary Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs) (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, Preferred Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) (new)  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) (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 Type 1 and Type 2 Wind-powered Generation Resources (WGRs)and provides new frequency ride-through requirements for IBRs and Type 1 and 2 WGRs 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”). |
| Business Case | ERCOT submits this NOGRR based on reliability issues associated with the inability of some IBRs to ride-through system disturbances, and in light of the IEEE 2800-2022 standard. In its recently issued guidance document *Inverter-Based Resource Strategy*, theNorth American Reliability Corporation (NERC) noted it has supported the development of the IEEE 2800-2022 standard (and continues to support the IEEE P2800.2, Recommended Practice for Test and Verification Procedures for Inverter-based Resources (IBRs) Interconnecting with Bulk Power Systems, standards development efforts). Among other things, the document also highlights that:   * New technology can introduce significant risks if not integrated properlywhich 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 ride-through requirements for IBRs and Type 1 and Type 2 WGRs 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 some ESRs may not be IBRs and the IBR attributes create unique ride-through requirements. Additionally, due to Type 1 and 2 WGRs failing to ride through normal system disturbances, ERCOT proposes to apply several of the new requirements to these Resources. 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 which would result in the uncontrolled loss of firm Load. As such, ERCOT does not propose to grandfather existing IBRs and Type 1 and Type 2 WGRs indefinitely. Rather, ERCOT proposes that all IBRs and Type 1 and Type 2 WGRs with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2023 (“existing IBRs”), 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 but no later than December 31, 2025. IBRs and Type 1 and Type 2 WGRs that cannot meet the new ride-through requirements will need to submit a report by December 31, 2024 documenting such and provide a mitigation plan to give ERCOT an accurate understanding of the physical limitations and maximum ride-through capability. To minimize the reliability risk on the ERCOT System, this proposal stipulates existing IBRs and Type 1 and Type 2 WGRs that experience a ride-through failure may be restricted or not permitted to operate on the ERCOT System. An IBR or Type 1 WGR or Type 2 WGR that will be replaced or retrofitted and has documented technical exceptions granted, must meet the latest IEEE 2800 and preferred voltage ride-through requirements and will no longer be granted exceptions..  ERCOT believes 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. 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. |

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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:

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

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

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

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

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

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

(4) An IBR or Type 1 WGR or Type 2 WGR shall inject electric current during all periods requiring ride-through.

(5) An 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 its output during frequency conditions where ride-through is required unless necessary for providing appropriate frequency response or preventing equipment damage. If an IBR or Type 1 WGR or Type 2 WGR requires any setting that would prevent it from riding through the frequency conditions required in paragraph (1) above, ERCOT may restrict its operations unless a documented technical exception provides the basis for such setting as set forth in paragraph (8) below.

(6) The Resource Entity or IE for each IBR or Type 1 WGR or Type 2 WGR with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2023, shall ensure its frequency ride-through capability is set to the maximum level the equipment allows to meet or exceed the requirements of paragraphs (1) through (5) above as soon as practicable but no later than December 31, 2025. Such IBRs or Type 1 WGR or Type 2 WGR shall comply with the frequency ride-through requirements specified 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), until the IBR or Type 1 WGR or Type 2 WGR implements changes to comply with paragraphs (1) through (5) above.

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| ***[NOGRR245: Replace paragraph (6) above with the following on January 1, 2026.]***  (6) The Resource Entity or IE for each IBR or Type 1 WGR or Type 2 WGR with a Standard Generation Interconnection Agreement (SGIA) executed prior to June 1, 2023, shall ensure its frequency ride-through capability is set to the maximum level the equipment allows to meet or exceed the requirements of paragraphs (1) through (5) above as soon as practicable but no later than December 31, 2025. |

(7) If an IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023 cannot comply with paragraphs (1) through (5) above by December 31, 2025, the Resource Entity or IE shall, by December 31, 2024, submit to ERCOT a report and supporting documentation containing the following:

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

(b) The proposed modifications that maximize the IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability in paragraphs (1) through (5) above;

(c) A schedule for implementing those modifications as soon as practicable but no later than December 31, 2027 with documentation supporting the need for the extension;

(d) Any documented technical limitations for the IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability making it technically infeasible to meet any requirement in paragraphs (1) through (5) above with documentation from the IBR or Type 1 WGR or Type 2 WGR original equipment manufacturer (or subsequent inverter/turbine vendor support company if the original equipment manufacturer is no longer in business) attesting there are no technically feasible solutions that do not require replacement or major retrofits to achieve, if applicable. Major retrofits include any hardware and labor that costs more than 20% of the cost of installing new, comparable replacement equipment on a per turbine or per inverter basis; and

(e) Evidence that all models provided to ERCOT represent any documented technical limitation.

(8) In its sole and reasonable discretion, ERCOT may allow a documented technical exception to an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023, that provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) of a technical limitation identified in paragraph (7)(d) above. Evidence from paragraph (7) above must sufficiently demonstrate that the ride-through capability has been maximized, can meet the ride-through curves specified 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), does not create any risk of instability, uncontrolled separation or cascading outages for the ERCOT System, and the limitation is accurately represented in models provided to ERCOT. Any exceptions will expire when the IBR implements a modification as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a Generator Interconnection or Modification (GIM) was initiated or when ERCOT is notified that the technical limitation no longer exists. Software and parameterization changes needed to achieve the required performance are required and not allowed for an exception. Exceptions are not allowed that would effectively be lower than the current frequency ride-through requirements in effect as of December 1, 2023. For any IBR or Type 1 WGR or Type 2 WGR that receives a documented technical exception, the documented maximum capabilities that do not meet the capabilities in paragraphs (1) through (5) above will become the new performance requirements until the exception is removed.

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| ***[NOGRR245: Replace paragraph (8) above with the following on January 1, 2026.]***  (8) In its sole and reasonable discretion, ERCOT may allow a documented technical exception to an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023, that provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) of a technical limitation identified in paragraph (7)(d) above. Evidence from paragraph (7) above must sufficiently demonstrate that the ride-through capability has been maximized and does not create any risk of instability, uncontrolled separation or cascading outages for the ERCOT System, and the limitation is accurately represented in models provided to ERCOT. Any exceptions will expire when the IBR implements a modification as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a Generator Interconnection or Modification (GIM) was initiated or when ERCOT is notified that the technical limitation no longer exists. Software and parameterization changes needed to achieve the required performance are required and not allowed for an exception. Exceptions are not allowed that would effectively be lower than the current frequency ride-through requirements in effect as of December 1, 2023. For any IBR or Type 1 WGR or Type 2 WGR that receives a documented technical exception, the documented maximum capabilities that do not meet the capabilities in paragraphs (1) through (5) above will become the new performance requirements until the exception is removed. |

(9) If an IBR or Type 1 WGR or Type 2 WGR fails to perform in accordance with the applicable frequency ride-through requirements, ERCOT may restrict the IBR or Type 1 WGR or Type 2 WGR operation as set forth in paragraph (10) below. Additionally, 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. All impacted TSPs shall provide available information to ERCOT to assist with event analysis.

(10) In its sole and reasonable discretion, ERCOT may restrict, or not permit to operate, any IBR or Type 1 WGR or Type 2 WGR that has one or more performance failures to the applicable frequency ride-through requirements. ERCOT shall assess the risk of the performance failure in determining whether to implement any restriction. If the assessment determines that any one of the below criteria is met, ERCOT may impose such restrictions on the Resource or portions of the Resource that experienced the performance failure:

(a) The actual or potential severity of the event on the ERCOT System is greater than the most severe single contingency. To determine potential severity, ERCOT will utilize: (i) nameplate capacity for PhotoVoltaic Generation Resources (PVGRs) and ESRs; and (ii) the greater of the pre-disturbance output of the WGR or 50% of its nameplate capacity;

(b) The cause of the performance failure cannot be mitigated (i.e., fully implemented corrective actions) within 90 calendar days;

(c) The location of the performance failure did affect or has the potential to materially affect known stability limitations on the ERCOT System;

(d) The IBR or Type 1 WGR or Type 2 WGR experienced one or more previous failures in the prior 36 calendar months; or

(e) The performance failure presents an imminent safety or equipment risk on the ERCOT System.

(11) Each Qualified Scheduling Entity (QSE) shall, for each IBR or Type 1 WGR or Type 2 WGR not permitted to operate, reflect in its Current Operating Plan (COP) and Real-Time telemetry a Resource Status of OFF, OUT, or EMR in accordance with Protocol Sections 3.9.1, Current Operating Plan (COP) Criteria, and 6.5.5.1, Changes in Resource Status, as appropriate. If the Resource Entity can implement IBR or Type 1 WGR or Type 2 WGR modifications to resolve the technical limitations or performance failures, it shall submit to ERCOT a report and supporting documentation containing the following:

(a) The current technical limitations and 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 or Type 1 WGR or Type 2 WGR to comply with the applicable frequency ride-through requirements in a format similar to the table in paragraph (1) above; and

(c) A schedule for implementing those modifications.

(12) In its sole and reasonable discretion, ERCOT may accept the proposed modification plan submitted in paragraph (11) above. Upon completion of the accepted modification plan, ERCOT will remove the restrictions on the IBR or Type 1 WGR or Type 2 WGR unless it experiences additional unresolved technical limitations or performance failures. ERCOT may allow the IBR or Type 1 WGR or Type 2 WGR to operate at reduced output prior to the implementation of an accepted modification plan if the reduced output allows the IBR or Type 1 WGR or Type 2 WGR to comply with the applicable ride-through requirements. ERCOT may also temporarily lift operational restrictions for any IBR or Type 1 WGR or Type 2 WGR to prevent or mitigate an actual or anticipated emergency condition. During such instances, ERCOT shall inform each affected QSE that the restrictions have been temporarily lifted as well as the start time and proposed end time. Each QSE shall update the COP, Outage Scheduler, and Real-time telemetry to appropriately reflect the IBR’s or Type 1 WGR’s or Type 2 WGR’s availability and capability during the timeframe for which the restriction was lifted.

***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)***

(1) This Section applies to only certain IBRs and Type 1 and Type 2 WGRs with an SGIA executed prior to June 1, 2023 in accordance with paragraph (6) 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).

(2) IBRs and Type 1 WGRs and Type 2 WGRs shall ride through the frequency conditions at the POIB specified in the following table:

|  |  |
| --- | --- |
| **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 |

(3) IBRs and Type 1 WGRs and Type 2 WGRs shall ride through the frequency conditions at the POIB specified in the following table:

|  |  |
| --- | --- |
| **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 |

(4) This Section shall not affect the Resource Entity’s responsibility to protect equipment from damaging operating conditions. The Resource Entity for an IBR or Type 1 WGR or Type 2 WGR subject to paragraphs (2) and (3) above that is unable to remain reliably connected to the ERCOT System as set forth in paragraphs (2) and (3), shall provide to ERCOT the reason(s) for that inability, including study results or manufacturer advice. The limitation description shall include the IBR or Type 1 WGR or Type 2 WGR frequency ride-through capability in the format shown in the tables in paragraphs (2) and (3) above. The limitation description is independent of any obligations required in paragraph (6) of Section 2.6.2.1.

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| ***[NOGRR245: Delete Section 2.6.2.1.1 above on January 1, 2026.]*** |











***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) 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 owner of 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, 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 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 owner of each Generation Resource or ESR shall provide to ERCOT technical documentation of voltage ride-through capability upon request. |

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

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

(i) IBRs with a Standard Generation Interconnection Agreement (SGIA) executed on or after June 1, 2023.

(ii) IBRs that implement any modification, as described in paragraph (1)(c) of Planning Guide Section 5.2.1, Applicability, for which a GIM was initiated on or after June 1, 2023 unless the modification was fully implemented prior to January 1, 2028.

(b) 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), shall apply to IBRs not subject to Section 2.9.1.1, and Type 1 WGRs and Type 2 WGRs.

(2) An IBR with an SGIA executed on or after June 1, 2023 or that implements 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, 2023, shall meet or exceed the capability and performance requirements in the following sections of Institute of Electric Engineers (IEEE) 2800-2022, Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems “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 ERCOT Protocols, these Operating Guides, or Planning Guide:

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

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

(c) Section 9, Protection.

(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 resource unit terminal, respectively, unless otherwise clarified, modified, or exempted in the Protocols.

(4) IBRs and Type 1 WGR and Type 2 WGRs with an original SGIA executed before June 1, 2023, that implement modifications complying with Section 2.9.1.2 prior to January 1, 2028, are not required to meet or exceed the capability and performance requirements in sections 5, 7 and 9 of the IEEE 2800-2022 standard or any successor IEEE standard that are not required in the Protocols, these Operating Guides, or Planning Guide. Any IBR modifications implemented on after January 1, 2028 do not qualify for this exception.

(5) In its sole and reasonable discretion, ERCOT may allow limited exceptions to the voltage ride-through requirements in Table 11 of the IEEE 2800-2022 standard or successor IEEE standard for Type 3 WGRs that have an original SGIA executed before June 1, 2023 and implement a modification as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a GIM was initiated. The Resource Entity or Interconnecting Entity (IE) must provide 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) that it maximized its voltage ride-through capability with the best converter upgrade available along with any modification and demonstrates it meets most of the low voltage ride-through curve portions in Table 11 of the IEEE 2800-2022 standard or successor IEEE standard as part of the modification.

(6) In its sole and reasonable discretion, ERCOT may allow a temporary extension for IBRs with an SGIA executed on or after June 1, 2023, to meet or exceed the capability and performance requirements in sections 5, 7 and 9 of the IEEE 2800-2022 standard or any successor IEEE standard 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 original equipment manufacturer is no longer in business) along with the modifications and the schedule for implementing those modifications. During any temporary extension, the Resource Entity or IE shall maximize its ride-through capability within its known equipment limitations as soon as practicable. Any temporary extensions shall be minimized and not extend beyond December 31, 2028 or 24 months after the Commercial Operations Date, whichever is earlier.

(7) In its sole and reasonable discretion, ERCOT may allow a limited exception for new IBRs with an SGIA executed after June 1, 2023 with a Commercial Operations Date prior to January 1, 2026 that provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) of a technical limitation in meeting the capability and performance requirements in sections 5, 7 and 9 of the IEEE 2800-2022 standard or any successor IEEE standard. Evidence must sufficiently demonstrate that the ride-through capability has been maximized, that the limitation is accurately represented in all models provided to ERCOT, that the limitation does not create any risk of instability, uncontrolled separation or cascading outages for the ERCOT System, and an attestation that there are no technically feasible solutions that do not require replacement or major retrofits to achieve the required performance and capabilities. Major retrofits include any hardware and labor that costs more than 20% of the cost of installing new, comparable replacement equipment on a per turbine or per inverter basis. Any exceptions will expire when the IBR implements a modification as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a GIM was initiated or when ERCOT is notified that the technical limitation no longer exists. Software and parameterization changes needed to achieve the required performance are required and not allowed for an exception. Exceptions are not allowed that would effectively be lower than the current voltage ride-through requirements in effect as of December 1, 2023. For any IBR that receives a documented technical exception, the documented maximum capabilities that do not meet the required capabilities will become the new performance requirements until the exception is removed.

(8) Existing Type 1 and Type 2 WGRs are not required to meet or exceed the capability and performance requirements in sections 5, 7 and 9 of the IEEE 2800-2022 standard or any successor IEEE standard but must meet or exceed the capability and performance requirements in Section 2.9.1.2 unless exceptions are allowed for documented technical limitations as identified in paragraph (9) of Section 2.9.1.2.

(9) ERCOT and the interconnecting TSP may allow a documented technical exception for an IBR from section 7.2.2.3.5, including Table 13, of the IEEE 2800-2022 standard when studies indicate a slower response time is required, 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. ERCOT may not grant this exception when the IBR must meet both Table 13 performance and other performance requirements such as Subsynchronous Resonance (SSR) Mitigation plans.

(10) The addition of co-located Load as a modification, as described in paragraph (1)(c) of Planning Guide Section 5.2.1, for which a GIM was initiated, shall not trigger a change in voltage ride-through requirements so long as the IBR or Type 1 WGR or Type 2 WGR with an original SGIA executed prior to June 1, 2023 does not have to be modified or replaced to accommodate the Load, in which case, the Resource Entity shall continue to be subject to Section 2.9.1.2.

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

(1) All IBRs subject to this Section in accordance with paragraph (1) of Section 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) 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. ERCOT, at its sole discretion, may allow slower real power injection recovery rates if necessary for reliability as determined by the impacted TSP or ERCOT. Subsynchronous Resonance (SSR) Mitigation shall not depend on slower real power injection recovery rates.

(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. If an IBR requires any setting that would prevent it from riding through the voltage conditions required in paragraph (1) above, ERCOT may restrict its operations.

(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 fault disturbance where the POIB voltage remains within the ride-through profiles specified in paragraph (1) above. Measurements of quantities such as phase angle jump and rate-of-change-of-frequency during fault conditions are not meaningful and shall not be used to trip or reduce the output of the IBR during fault conditions.

(9) In its sole and reasonable discretion, ERCOT may allow a temporary extension for upgrades or retrofits to confirm capability specified in paragraph (7) 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) In its sole and reasonable discretion, ERCOT may allow temporary extensions to meet the voltage ride-through performance Tables A and C in paragraph (1) above for Type 3 WGRs 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. During any temporary extension, the Resource Entity or IE shall ensure its voltage ride-through capability is set to the maximum level the equipment allows as soon as practicable. Any temporary extensions shall be minimized and not extend beyond December 31, 2028. Temporary extensions for performance that do not meet the voltage ride-through performance in Table A in paragraph (1) of 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), are not allowed.

(11) If an IBR fails to perform in accordance with the voltage ride-through requirements of paragraphs (1) through (8) above, ERCOT may restrict the IBR operation as set forth in paragraph (12) below. Additionally, 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.

(12) In its sole and reasonable discretion, ERCOT may restrict, or not permit to operate, any IBR that has one or more performance failures to the applicable voltage ride-through requirements. ERCOT shall assess the risk of the performance failure in determining if such restrictions are implemented. If the assessment determines that any one of the below criteria is met, it may impose such restrictions on the IBR, or portions thereof, that experienced the performance failure:

(a) The actual or potential severity of the event on the ERCOT System is greater than the most severe single contingency. To determine potential severity, ERCOT will utilize: (i) nameplate capacity for PVGRs and ESRs; and (ii) the greater of the pre-disturbance output of the WGR or 50% of its nameplate capacity;

(b) The cause of the performance failure cannot be mitigated (i.e., fully implemented corrective actions) within 90 calendar days;

(c) The location of the performance failure did affect or has the potential to materially affect known stability limitations on the ERCOT System;

(d) The IBR experienced one or more previous failures in the prior 36 calendar months; or

(e) The performance failure presents an imminent safety or equipment risk on the ERCOT System.

(13) Each Qualified Scheduling Entity (QSE) shall, for each IBR not permitted to operate, reflect in its Current Operating Plan (COP) and Real-Time telemetry a Resource Status of OFF, OUT, or EMR in accordance with Protocol Sections 3.9.1, Current Operating Plan (COP) Criteria and 6.5.5.1, Changes in Resource Status, as appropriate. If the Resource Entity can implement IBR modifications to resolve the technical limitations or performance failures, it shall submit to ERCOT a report and supporting documentation containing the following:

(a) The current technical limitations and 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.

(14) In its sole and reasonable discretion, ERCOT may accept the proposed modification plan submitted in paragraph (13) above. Upon completion of the accepted modification plan, ERCOT will remove the restrictions unless the IBR experiences additional unresolved technical limitations or performance failures. ERCOT may allow the IBR to operate at reduced output prior to implementation of an accepted modification plan if the reduced output allows the IBR to comply with the applicable ride-through requirements. ERCOT may also temporarily lift operational restrictions for any IBR to prevent or mitigate an actual or anticipated emergency condition. During such instances, ERCOT shall inform each affected QSE that the restrictions have been temporarily lifted as well as the start time and proposed end time. Each QSE shall update the COP, Outage Scheduler, and Real-Time telemetry to appropriately reflect the availability and capability of the IBR during the timeframe for which the restriction was lifted.

***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) All IBRs and Type 1 and Type 2 WGRs subject to this Section in accordance with paragraph (1) of Section 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-powered Generation Resources (WGRs), shall ride through the root-mean-square voltage conditions in Table A below as measured at the IBR’s POIB:

**Table A**

|  |  |
| --- | --- |
| Root-Mean-Square Voltage  (p.u. of nominal) | Minimum Ride-Through Time  (seconds) |
| V > 1.20 | May ride-through or may trip |
| 1.175 < V ≤ 1.2 | 0.2 |
| 1.15 < V ≤ 1.175 | 0.5 |
| 1.10 < V ≤ 1.15 | 1.0 |
| 0.90 ≤ V ≤ 1.10 | continuous |
| 0.0 < V < 0.90 | (V+0.084375)/0.5625 |
| V = 0.0 | 0.15 |

For voltage between zero and 0.9 p.u. the minimum ride-through time in Table A above is defined by a straight line mathematical function where the duration is 0.15 seconds at zero voltage and 1.75 seconds at 0.9 p.u. voltage.

(2) Nothing in paragraph (1) above shall be interpreted to require an IBR or Type 1 WGR or Type 2 WGR to trip for voltage 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-voltage, 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 voltage conditions beyond those defined in paragraph (1) above to the maximum extent possible.

(4) An IBR or Type 1 WGR or Type 2 WGR 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 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 shall be based on the local needs of the area of the ERCOT System to which the IBR interconnects and ensure sufficient active current is available for protection system sensing. An IBR or Type 1 WGR or Type 2 WGR 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. Slower real power injection recovery rates may be allowed if necessary for reliability as documented by the impacted TSP or ERCOT. Subsynchronous Resonance (SSR) Mitigation shall not depend on slower real power injection recovery rates.

(5) An IBR or Type 1 WGR or Type 2 WGR plant controls, turbine 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 voltage conditions where ride-through is required unless necessary for providing appropriate frequency response or to prevent equipment damage. If an IBR or Type 1 WGR or Type 2 WGR requires any setting that would prevent it from riding through the voltage conditions required in paragraph (1) above, ERCOT may restrict its operations unless a documented technical exception provides the basis for such setting as set forth in paragraph (11) below.

(6) If installed and activated to trip the IBR or Type 1 WGR or Type 2 WGR, instantaneous over-current or over-voltage protection systems shall use filtered quantities or sufficient time delays to prevent misoperation while providing the desired equipment protection. Any instantaneous over-voltage protection that could disrupt power output shall use a measurement period of at least one cycle (of fundamental frequency).

(7) The IBR or Type 1 WGR or Type 2 WGR shall coordinate with its interconnection TSP to ensure it can 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, it may trip to protect equipment from the cumulative effect of successive voltage deviations:

(a) More deviations than would occur based on the documented level of automatic reclose actions utilized by its interconnecting TSP.

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

Any IBR or Type 1 WGR or Type 2 WGR that monitors and actively protects against multiple excursions shall ensure its parameters to ride-through multiple voltage excursions are set to the maximum level the equipment allows to meet or exceed the requirements in paragraph (7) of Section 2.9.1.1, Preferred Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs). 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 range.

(8) An IBR or Type 1 WGR or Type 2 WGR shall ride through any fault disturbance where the POIB voltage remains within the ride-through profiles specified in paragraph (1) above. Measurements of quantities such as phase angle jump and rate-of-change-of-frequency during fault conditions are not meaningful and shall not be used to trip or reduce the output of the IBR or Type 1 WGR or Type 2 WGR during fault conditions.

(9) The Resource Entity or IE for each IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023, shall ensure its voltage ride-through capability is set to the maximum level the equipment allows to meet or exceed the requirements of paragraphs (1) through (8) above as soon as practicable but no later than December 31, 2025.

(10) If an IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023 cannot comply with paragraphs (1) through (8) above by December 31, 2025, the Resource Entity or Interconnecting Entity (IE) shall, by December 31, 2024, submit to ERCOT a report and supporting documentation containing the following:

(a) The current and potential future voltage ride-through capability (including any associated adjustments to improve voltage ride-through capability) in a format similar to Table A in paragraph (1) above;

(b) The proposed modifications to maximize voltage ride-through capability and allow compliance with the applicable voltage ride-through requirements in paragraphs (1) through (8) above;

(c) A schedule for implementing those modifications as soon as practicable but no later than December 31, 2027 with documentation supporting the need for the extension;

(d) Any documented technical limitations for the IBR or Type 1 WGR or Type 2 WGR voltage ride-through capability making it technically infeasible to meet any requirement in paragraphs (1) through (8) above with documentation from the IBR or Type 1 WGR or Type 2 WGR original equipment manufacturer (or subsequent inverter/turbine vendor support company if the original equipment manufacturer is no longer in business) attesting there are no technically feasible solutions that do not require replacement or major retrofits to achieve, if applicable. 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; and

(e) Evidence that all models provided to ERCOT represent any documented technical limitation.

(11) In its sole and reasonable discretion, ERCOT may allow a documented technical exception to an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to January 16, 2014, that provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) of a technical limitation identified in paragraph (10)(d) above. Evidence from paragraphs (10)(a) through (e) above must sufficiently demonstrate that the ride-through capability has been maximized and does not create any risk of instability, uncontrolled separation or cascading outages for the ERCOT System and the limitation is accurately represented in models provided to ERCOT. Any exceptions will expire when the IBR implements a 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 or when ERCOT is notified that the technical limitation no longer exists. Software and parameterization changes needed to achieve the required performance are required and not allowed for an exception. Exceptions are not allowed that would effectively be lower than the current voltage ride-through requirements in effect as of December 1, 2023. For any IBR or Type 1 WGR or Type 2 WGR that receives a documented technical exception, the documented maximum capabilities that do not meet the capabilities in paragraphs (1) through (8) above will become the new performance requirements until the exception is removed Mitigation plans where a Resource Entity or IE for an IBR, Type 1 WGR, or Type 2 WGR installs supplemental dynamic reactive devices or batteries that can provide sufficient leading and lagging dynamic Reactive Power to meet all Reactive Power requirements and the applicable ride-through requirements are allowed.

(12) If an IBR or Type 1 WGR or Type 2 WGR fails to perform in accordance with the voltage ride-through requirements, ERCOT may restrict its operation as set forth in paragraph (13) below. Additionally, the Resource Entity shall investigate the event and report to ERCOT the cause of the failure. All impacted TSPs shall provide available information to ERCOT to assist with event analysis.

(13) In its sole and reasonable discretion, ERCOT may restrict, or not permit to operate, any IBR or Type 1 WGR or Type 2 WGR that has one or more performance failures to the applicable voltage ride-through requirements. ERCOT shall assess the risk of the performance failure in determining if such restrictions are implemented. If the assessment determines that any one of the below criteria is met, it may impose such restrictions on the IBR or Type 1 WGR or Type 2 WGR, or portions thereof, that experienced the performance failure:

(a) The actual or potential severity of the event on the ERCOT System is greater than the most severe single contingency. To determine potential severity, ERCOT will utilize: (i) nameplate capacity for PVGR and ESR resources; and (ii) the greater of the pre-disturbance output of the WGR or 50% of its nameplate capacity;

(b) The cause of the performance failure cannot be mitigated (i.e., fully implemented corrective actions) within 90 calendar days;

(c) The location of the performance failure did affect or has the potential to materially affect known stability limitations on the ERCOT system;

(d) The IBR or Type 1 WGR or Type 2 WGR experienced more than one failure in the prior 36 calendar months; or

(e) If the performance failure presents an imminent safety or equipment risk on the ERCOT System.

(14) Each QSE shall, for each IBR or Type 1 WGR or Type 2 WGR not permitted to operate, reflect in its COP and Real-Time telemetry a Resource Status of OFF, OUT, or EMR in accordance with Protocol Sections 3.9.1, Current Operating Plan (COP) Criteria and 6.5.5.1, Changes in Resource Status, as appropriate. If the Resource Entity can implement modifications to resolve the technical limitations or performance failures, it shall submit to ERCOT a report and supporting documentation containing the following:

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

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

(c) A schedule for implementing those modifications.

(14) In its sole and reasonable discretion, ERCOT may accept the proposed modification plan. Upon completion of the accepted modification plan, ERCOT will remove the restrictions unless the IBR or Type 1 WGR or Type 2 WGR experiences additional unresolved technical limitations or performance failures. ERCOT may allow the IBR or Type 1 WGR or Type 2 WGR to operate at reduced output prior to the implementation of an accepted modification plan if the reduced output allows the IBR or Type 1 WGR or Type 2 WGR to comply with the applicable ride-through requirements. ERCOT may also temporarily lift operational restrictions for any IBR or Type 1 WGR or Type 2 WGR to prevent or mitigate an actual or anticipated emergency condition. During such instances, ERCOT shall inform each affected QSE that the restrictions have been temporarily lifted as well as the start time and proposed end time. Each QSE shall update the COP, Outage Scheduler, and Real-Time telemetry to appropriately reflect the availability and capability of the IBR or Type 1 WGR or Type 2 WGR during the timeframe for which the restriction was lifted.







1. *See*,NERC Odessa Disturbance Report (<https://www.nerc.com/pa/rrm/ea/Documents/Odessa_Disturbance_Report.pdf>) [↑](#footnote-ref-2)
2. *See*, *The IEEE 2800 Conformity Assessment Paradigm,* (Slide 15)*.* [*https://www.ercot.com/files/docs/2023/04/17/IEEE-P2800-2-and-IEEE-2800-adoption---ERCOT--IBR-TF.pptx*](https://www.ercot.com/files/docs/2023/04/17/IEEE-P2800-2-and-IEEE-2800-adoption---ERCOT--IBR-TF.pptx) [↑](#footnote-ref-3)
3. Virtually all Market Participants who filed comments stated they support more stringent ride-through requirements if implemented *prospectively*. Nonetheless, they want to extend the deadline as far as possible. As the saying goes, “actions speak louder than words.” [↑](#footnote-ref-4)
4. NERC has issued IBR configuration recommendations since as early as 2017. *See*, *1,200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report* – *Southern California 8/16/2016 Event* (June 2017)

   (<https://www.nerc.com/pa/rrm/ea/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_Interruption_Final.pdf>). [↑](#footnote-ref-5)
5. *See*, <https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx>. [↑](#footnote-ref-6)
6. *See*, NERC Alert Report. [↑](#footnote-ref-7)
7. *See,* NERC Alert Report. [↑](#footnote-ref-8)
8. *See*, *NERC Inverter-Based Resource Performance Issues Report* - Findings from the Level 2 Alert (November 2023) at pp. iv, 4 (<https://www.nerc.com/comm/RSTC_Reliability_Guidelines/NERC_Inverter-Based_Resource_Performance_Issues_Public_Report_2023.pdf>) (hereafter “NERC Alert Report”). [↑](#footnote-ref-9)
9. *Id*. [↑](#footnote-ref-10)
10. *See*, NERC Reliability Standards BAL-001-TRE-2; BAL-003-2; TOP-001-5; and VAR-001-5. [↑](#footnote-ref-11)
11. ERCOT has made it clear throughout the process that Resource Entities can install supplemental equipment such as additional dynamic reactive devices or batteries to meet the requirements without having to perform significant retrofits or equipment replacement. [↑](#footnote-ref-12)
12. On Slide #9 of ERCOT’s presentation on NOGRR245 to the IBRTF on May 12, 2023, ERCOT stated, “[a]lternative framework *hinges on performance failure restrictions* *and removal of exemptions* to allow additional time frames and reduction of requirements for the majority of existing IBRs.” (emphasis added) (<https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ercot.com%2Ffiles%2Fdocs%2F2023%2F05%2F12%2FNOGRR%2520245%2520Alternative%2520framework%2520proposal_IBRTF(051223).pptx&wdOrigin=BROWSELINK>) [↑](#footnote-ref-13)
13. Specifically, ERCOT has seen very slow implementation of mitigation activities in response to the Odessa and subsequent disturbances . [↑](#footnote-ref-14)
14. *See*, Nodal Protocols § 6.5.1.1; Public Utility Commission of Texas (PUCT) Elec. Subst. Rule § 25.361(b)(1), (b)(4), (f). [↑](#footnote-ref-15)
15. ERCOT’s language also provides that, if an entity cannot meet the established deadline, the owner must submit a mitigation plan to address the non-compliance even if ERCOT does not impose operational restrictions. [↑](#footnote-ref-16)
16. NERC specifically identified, “deficiencies in modeling and study accuracy of IBR integration and performance” in the NERC Alert Report. [↑](#footnote-ref-17)