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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 19, 2024 |

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| **Submitter’s Information** | |
| **Name** | Gary Chmiel |
| **E-mail Address** | Gary.chmiel@ge.com |
| **Company** | GE Vernova (Onshore Wind) |
| **Phone Number** | 518-852-1150 |
| **Cell Number** |  |
| **Market Segment** | Not Applicable |

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| **Comments** |

GE Vernova, Onshore Wind business, appreciates the opportunity to submit the following public comments to the ERCOT comments submitted on January 8, 2024. As the nation’s leading energy and technology innovation company, GE Vernova is committed to supporting ERCOT’s efforts on ensuring and maintaining grid reliability and enabling easy integration and higher penetration of renewable sources.

GE Vernova appreciates the changes in ERCOT’s proposal and proposes the following additional changes:

1. Re-addition of specific frequency ride-through exception, placed in Section 2.6.2.1 (8): *“…* *it can ride through the* *frequency ride through* *band between 57.0 Hz and 58.4 Hz for at least 10 seconds and the frequency ride-through band between 61.6 Hz and 61.8 Hz for at least thirty seconds.”*
2. Elimination of Section 2.9.1.2 (7) until specific criteria is provided by Transmission Service Providers (TSPs) and can be specifically stated in Section 2.9.1.2 (7).
3. Addition of wording *“or if required based on physical limitations of IBR unit.”* in Sections 2.9.1.1 (4) and 2.9.1.2 (4).

GE Vernova would also like to take this opportunity to address the “Feasibility of ERCOT’s proposal” section in the January 8, 2024 ERCOT comments. GE Vernova has been consistent and transparent throughout the regulatory process with ERCOT, asset owners, and relevant stakeholders. Our overall position remains consistent in our various engagements with ERCOT, including comments submitted and public statements. Furthermore, GE Vernova has cooperated and promptly responded to information requests via several means (requests for information (“RFIs”), working groups, public comments, e-mails, calls) and included comments, in written and verbal forms, based on initial product assessments. Finally, we respectfully disagree with the comment stating GE Vernova has no plans to develop solutions for the GE 1.X platform. To reiterate our position, at this time, there are no plans to develop specific solutions to GE 1.X platform, however, we will review potential solutions when regulations are finalized.

Assessing the need for modifications to its products, and subsequent solution development, requires significant due diligence by the GE Vernova product development team. GE Vernova will be able to evaluate product compatibility once requirements are established. Ambiguity and modifications to proposed requirements prevent GE Vernova from moving forward with final product assessment, investments, and subsequent solution development.

GE Vernova has a rigorous development cycle which includes electrical and mechanical simulations, testing in lab environments and in prototypes, and certification for each applicable turbine configuration, to deliver high quality products and enable reliable integration of renewable energy resources. Also, readiness of IEEE P2800.2 is of high importance in assessing compatibility to IEEE 2800 – 2022 and avoiding re-work iterations due to differences it may have to how original equipment manufacturers (“OEMs”) determine compatibility. Discussions on IEEE P2800.2 are still evolving, and the verification process itself may raise difficulties in demonstrating compatibility to certain requirements, which may drive further changes to both requirements and product design.

GE Vernova products are leading the global renewable energy transition. Within ERCOT System, there are 9000+ (~19 GW) of wind turbines operating with industry leading grid reliability and performance. GE Vernova welcomes the opportunity to submit these comments.

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| **Revised Cover Page Language** |
| **None** |

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| **Revised Proposed Guide Language** |

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

(1) Except for Generation Resources and Energy Storage Resources (ESRs) subject to Sections 2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs) and Type 1 and Type 2 Wind-Powered Generation Resources (WGRs) or 2.6.2.2, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), if under-frequency relays are installed and activated to trip the Generation Resource or ESR, these relays shall perform such that the automatic removal of individual Generation Resources or ESRs from the ERCOT System meets or exceeds the following requirements:

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

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

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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:

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

(2) Nothing in paragraph (1) above shall be interpreted to require an IBR 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. An exception shall be granted to the highest and lowest frequency ride-through bands where an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023, provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) stating no engineering, replacement, or retrofit solutions exist to fully meet the required duration of the lowest and highest frequency ride-through bands in paragraph (1) above if, after maximizing its frequency ride-through capabilities, it can ride through the frequency ride-through band between 57.0 Hz and 58.4 Hz for at least ten seconds and the frequency ride-through band between 61.6 Hz and 61.8 Hz for at least 30 seconds. 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. An exception shall be granted to the highest and lowest frequency ride-through bands where an existing IBR or Type 1 WGR or Type 2 WGR with an SGIA executed prior to June 1, 2023, provides documented evidence from the original equipment manufacturer (or subsequent inverter/turbine vendor support company if original equipment manufacturer is no longer in business) stating no engineering, replacement, or retrofit solutions exist to fully meet the required duration of the lowest and highest frequency ride-through bands in paragraph (1) above if, after maximizing its frequency ride-through capabilities, it can ride through the frequency ride-through band between 57.0 Hz and 58.4 Hz for at least ten seconds and the frequency ride-through band between 61.6 Hz and 61.8 Hz for at least 30 seconds. 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 (10) 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, or if required based on physical limitations of IBR unit. 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, or if required based on physical limitations of IBR unit. 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 (10) 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) 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.

(8) 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 (7) above as soon as practicable but no later than December 31, 2025.

(9) 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 (7) 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 (7) 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 (7) 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.

(10) 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 (9)(d) above. Evidence from paragraphs (9)(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 (7) 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.

(11) 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 (12) 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.

(12) 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.

(13) 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.