|  |  |  |  |
| --- | --- | --- | --- |
| NOGRR Number | [245](https://www.ercot.com/mktrules/issues/NOGRR245) | NOGRR Title | Inverter-Based Resource (IBR) Ride-Through Requirements |
| Date of Decision | | February 8, 2023 | |
| Action | | Tabled | |
| Timeline | | Normal | |
| Proposed Effective Date | | To be determined | |
| Priority and Rank Assigned | | To be determined | |
| Nodal Operating Guide Sections Requiring Revision | | 2.6.2, Generators and Energy Storage Resources  2.6.2.1, Frequency Ride-Through Requirements for Transmission-Connected inverter-Based Resources (IBRs) (new)  2.6.2.1, Frequency Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs)  2.9, Voltage Ride-Through Requirements for Generation Resources  2.9.1, Voltage Ride-Through Requirements for Intermittent Renewable Resources Connected to the ERCOT Transmission Grid | |
| Related Documents Requiring Revision/Related Revision Requests | | None | |
| Revision Description | | This Nodal Operating Guide Revision Request (NOGRR) replaces the current voltage ride-through requirements for Intermittent Renewable Resources (IRRs) with voltage ride-through requirements for Inverter-Based Resources (IBRs) and provides new frequency ride-through requirements for IBRs consistent with or beyond requirements identified in the new 2800-2022 - Institute of Electrical and Electronics Engineers (IEEE) Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems (“IEEE 2800-2022 standard”). | |
| Reason for Revision | | Addresses current operational issues.  Meets Strategic goals (tied to the [ERCOT Strategic Plan](http://www.ercot.com/content/wcm/lists/144926/ERCOT_Strategic_Plan_2019-2023.pdf) or directed by the ERCOT Board).  Market efficiencies or enhancements  Administrative  Regulatory requirements  Other: Addresses future potential operational issues associated with IBR voltage ride-through capability.  *(please select all that apply)* | |
| Business Case | | 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 additional frequency ride-through requirements for IBRs consistent with the IEEE 2800-2022 standard. It also clarifies IBR voltage ride-through requirements so they are consistent with or beyond the IEEE 2800-2022 standard where appropriate (e.g., applying to the Point of Interconnection Bus (POIB) instead of the “Resource Point of Applicability”). The revisions specify the ride-through requirements for IBRs rather than IRRs or Energy Storage Resources (ESRs) because they are not necessarily IBRs and their attributes create unique ride-through requirements. Some clarifications included from the IEEE 2800-2022 standard may not require additional “capability” but provide additional specificity for settings that can prevent failures rather than adjustments being made after a failure occurs.  Failure of IBRs to ride through normal frequency and voltage deviations on the ERCOT System today can lead to severe consequences such as instability, cascading Outages, or triggering of the first stage of an Under-Frequency Load Shed (UFLS) event. As such, ERCOT does not propose to grandfather existing IBRs indefinitely. Rather, ERCOT proposes that all IBRs meet the new requirements as soon as practicable but not to exceed 12 months, unless granted a temporary exemption for up to an additional 12 months to implement new equipment and/or changes. IBRs that cannot meet the new ride-through requirements will need to submit a report within six months documenting such and provide a mitigation plan to give ERCOT an accurate understanding of the physical limitations to meeting the requirements. To minimize the risk on the present ERCOT System, IBRs that cannot meet the new requirements within 24 months will not be allowed to operate on the ERCOT System unless ERCOT issues a Reliability Unit Commitment (RUC) or Verbal Dispatch Instruction (VDI).  Finally, 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 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. | |
| ROS Decision | | On 2/8/23, ROS voted unanimously to table NOGRR245 and refer the issue to the Operations Working Group (OWG), Dynamics Working Group (DWG) and Inverter-Based Resource Task Force (IBRTF). All Market Segments participated in the vote. | |
| Summary of ROS Discussion | | On 2/8/23, ERCOT Staff reviewed NOGRR245. Market Participants discussed whether it was appropriate to apply the new frequency ride-through requirements to certain existing IBRs, noting technical limitations of equipment and financial implications as concerns, and requested that ERCOT explore incorporating provisions that would allow for exemptions under some circumstances. ERCOT Staff requested that Market Participants provide, for consideration, detailed information supporting their concerns, including specifics from original equipment manufacturers identifying technical limitations. | |
|  | |  | |
| Opinions | | | |
| Credit Review | | To be determined | |
| Independent Market Monitor Opinion | | To be determined | |
| ERCOT Opinion | | To be determined | |
| ERCOT Market Impact Statement | | To be determined | |

|  |  |
| --- | --- |
| Sponsor | |
| Name | John Schmall |
| E-mail Address | [John.Schmall@ercot.com](mailto:John.Schmall@ercot.com) |
| Company | ERCOT |
| Phone Number | 512-248-4243 |
| Cell Number |  |
| Market Segment | Not Applicable |

|  |  |
| --- | --- |
| **Market Rules Staff Contact** | |
| **Name** | ERCOT |
| **E-Mail Address** | [Erin.Wasik-Gutierrez@ercot.com](mailto:Erin.Wasik-Gutierrez@ercot.com) |
| **Phone Number** | 413-886-2474 |
|  |  |
| **Comments Received** | |
| **Comment Author** | **Comment Summary** |
| None |  |
|  |  |
| **Market Rules Notes** | |

Administrative changes to the language were made and authored as “ERCOT Market Rules.”

Please note the baseline Nodal Operating Guide language in the following section has been updated to reflect the incorporation of the following NOGRR into the Nodal Operating Guide:

* NOGRR196, Related to NPRR973, Add Definitions for Generator Step-Up and Main Power Transformer (unboxed 2/1/23)
  + Section 2.9

|  |
| --- |
| Proposed Guide Language Revision |

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

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

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

(3) All instantaneous frequency protections shall use filtered quantities or add sufficient time delays to prevent misoperations while providing the desired equipment protection.

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

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

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

|  |  |
| --- | --- |
| Frequency (f) in (Hz) | Minimum Ride-Through Time  (seconds) |
| f > 61.8 | No ride-through requirement |
| 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 | No ride-through requirement |

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

(3) The Resource Entity for an IBR shall set protective over-/under-frequency relays to enable the IBR to ride through frequency conditions beyond those defined in paragraph (1) above to the maximum extent possible consistent with IBR capability.

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

(5) An IBR’s Resource Entity shall not enable any protections, plant controls, or inverter controls (including, but not limited to protection for rate-of-change of frequency (ROCOF), anti-islanding, and phase angle jump) that disconnect the IBR from the ERCOT System or reduce IBR output during frequency conditions where ride-through is required unless necessary for proper operation of the IBR or to prevent equipment damage. If an IBR requires ROCOF protection to prevent equipment damage, it shall not disconnect the IBR for frequency excursions having an absolute ROCOF magnitude less than or equal to 5.0 Hz/second. The ROCOF shall be the average rate of change of frequency over a period of at least 0.1 seconds unless ERCOT or the interconnecting Transmission Service Provider (TSP) specifies otherwise.

(6) An IBR with a Standard Generation Interconnection Agreement (SGIA) executed prior to January 1, 2023, must comply with the frequency ride-through requirements in effect immediately prior to the effective date of this paragraph until December 31, 2023, at which time the IBR must comply with this Section.

The Resource Entity or Interconnecting Entity (IE) for an IBR that cannot comply with the requirements of this Section by December 31, 2023 shall, by June 1, 2023, provide to ERCOT a schedule for modifying the IBR to comply with this Section’s requirements or a written explanation of the IBR’s inability to comply with the requirements, with supporting documentation containing the following:

(a) The IBR’s frequency ride-through capability as of January 1, 2023 in a format similar to the table in paragraph (1) above;

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

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

Based on the information provided by the Resource Entity or Interconnecting Entity, if ERCOT determines in its sole and reasonable discretion that an IBR cannot comply with one or more of the frequency ride-through requirements of this Section, ERCOT shall grant a temporary exemption from such requirements until December 31, 2024, or an earlier date, if ERCOT determines that earlier compliance is possible, provided that such an exemption will not affect any Resource Entity’s duty to comply with frequency ride-through requirements in effect before the effective date of this paragraph. During any temporary exemption period, the Resource Entity for the IBR shall implement any technically feasible modifications to achieve the IBR’s maximum frequency ride-through capability as soon as practicable but no later than December 31, 2024. All temporary exemptions from this requirement to allow for IBR modifications shall terminate no later than December 31, 2024.

(7) If an IBR fails to comply with the frequency ride-through requirements of this Section, the Resource Entity for the IBR and the interconnecting TSP shall investigate the event and report to ERCOT the cause of the IBR failure. The Resource Entity for each IBR not meeting the frequency ride-through requirements shall install, if not already installed, phasor measurement units or digital fault recorders at locations identified by ERCOT.

(8) Any IBR that cannot comply with the frequency ride-through requirements after December 31, 2024 shall not be permitted to operate on the ERCOT System unless ERCOT issues the IBR a Reliability Unit Commitment (RUC) or Verbal Dispatch Instruction (VDI). Each QSE shall, for each applicable IBR, 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 preventing compliance with these frequency ride-through requirements, the Resource Entity shall submit to ERCOT a report and supporting documentation containing the following:

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

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

(c) A schedule for implementing those modifications.

In its sole reasonable discretion, ERCOT may accept the proposed modification plan. Upon completion of the accepted modification plan, ERCOT will remove the restrictions placed on the IBR unless the IBR experiences additional unresolved technical limitations or performance failures.

***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 subject to Sections 2.9.1, Voltage Ride-Through Requirements for Transmission-Connected Inverter-Based Resources (IBRs), or 2.9.2, Voltage Ride-Through Requirements for Distribution Generation Resources (DGRs) and Distribution Energy Storage Resources (DESRs), each Generation Resource must be designed, and its generation voltage relays must be set, to remain connected to the transmission system during the following:

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

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

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

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

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

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

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

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

Time (seconds) 10 30 60 120

Field Voltage % 208 146 125 112

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

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

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

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

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

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

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

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

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

**Table A**

|  |  |
| --- | --- |
| Root-Mean-Square Voltage  (p.u. of nominal) | Minimum Ride-Through Time  (seconds) |
| V > 1.20 | No ride-through requirement |
| 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**

|  |  |
| --- | --- |
| Instantaneous Phase Voltage  (p.u. of nominal) | Minimum Ride-Through Time  (milliseconds) |
| V > 1.80 | No ride-through requirement |
| 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 |

During the conditions identified in Table B above, an IBR should continue injecting current, but need not respond to the sub-cycle transient overvoltage. If required by equipment limitations, the IBR may operate in current blocking mode when instantaneous voltage exceeds 1.20 p.u. at the POIB. If the IBR operates in current blocking mode, it shall restart current exchange in less than or equal to five cycles following instantaneous voltage falling below, and remaining below, 1.2 p.u. at the POIB.

(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) The Resource Entity for an IBR shall set protective over-/under-voltage relays to enable the IBR to ride through voltage conditions beyond those defined in paragraph (1) above to the maximum extent possible consistent with IBR capability.

(4) An IBR shall inject electric current during all periods requiring ride-through pursuant to paragraphs (1) and (3) above. An IBR shall continue to deliver pre-disturbance active power current unless otherwise limited due to its current limit or Reactive Power priority mode. Unless otherwise specified by ERCOT or the interconnecting TSP, Reactive Power priority mode shall be set to minimize reductions in real power while maintaining robust Reactive Power response. When operating in Reactive Power priority mode, any reductions in active power current to prioritize Reactive Power current shall be proportional to the voltage change at the POIB. An IBR shall return to its pre-disturbance level of real power injection as soon as possible but no more than one second after POIB voltage recovering to normal operating range.

(5) An IBR shall not enable any protections, plant controls, or inverter controls (including, but not limited to protection for rate-of-change of frequency (ROCOF), anti-islanding, and phase angle jump) that disconnect the IBR from the ERCOT System or reduce IBR output during voltage conditions where ride-through is required unless necessary for proper operation of the IBR or to prevent equipment damage. If phase angle jump protection is required to prevent equipment damage, it shall allow the IBR to ride through positive-sequence phase angle changes within a sub-cycle-to-cycle time frame of the applicable voltage of less than or equal to 45 electrical degrees. If the positive-sequence angle change does not exceed 45 electrical degrees, the IBR shall remain in operation for any change in the phase angle of individual phases caused by occurrence and clearance of unbalanced faults.

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

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

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

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

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

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

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

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

(g) For wind turbine IBRs, individual wind turbines may trip for consecutive voltage deviations resulting in stimulation of mechanical resonances exceeding equipment limits.

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

(8) An IBR with a Standard Generation Interconnection Agreement (SGIA) executed prior to January 1, 2023, must comply with the voltage ride-through requirements in effect immediately prior to the effective date of this paragraph until December 31, 2023, at which time the IBR must comply with all parts of this Section except the instantaneous phase voltage conditions in Table B in paragraph (1) above. IBRs with an SGIA executed on or after January 1, 2023 must comply with all parts of this Section.

The Resource Entity or Interconnecting Entity for an IBR that cannot comply with the requirements of this Section by December 31, 2023 shall, by June 1, 2023, provide to ERCOT a schedule for modifying the IBR to comply with this Section’s requirements or a written explanation of the IBR’s inability to comply with the requirements, with supporting documentation containing the following:

(a) The IBR’s voltage ride-through capability as of January 1, 2023 in a format similar to the tables in paragraph (1) above;

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

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

Based on the information provided by the Resource Entity or Interconnecting Entity, if ERCOT determines in its sole and reasonable discretion that an IBR cannot comply with one or more of the voltage ride-through requirements of this Section, ERCOT shall grant a temporary exemption from such requirements until December 31, 2024, or an earlier date, if ERCOT determines that earlier compliance is possible, provided, that such an exemption will not affect any Resource Entity’s duty to comply with voltage ride-through requirements in effect before the effective date of this paragraph. During any temporary exemption period, the Resource Entity for the IBR shall implement any technically feasible modifications to achieve the IBR’s maximum voltage ride-through capability as soon as practicable but no later than December 31, 2024. All temporary exemptions from this requirement to allow for IBR modifications shall terminate no later than December 31, 2024.

(9) If an IBR fails to comply with the voltage ride through requirements of this Section, the Resource Entity for the IBR and the interconnecting TSP shall investigate the event and report to ERCOT the cause of the IBR failure. The Resource Entity for each IBR not meeting the voltage ride-through requirements shall install, if not already installed, phasor measurement units or digital fault recorders at locations identified by ERCOT.

(10) Any IBR that cannot comply with the voltage ride-through requirements after December 31, 2024, shall not be permitted to operate on the ERCOT System unless ERCOT issues the IBR a Reliability Unit Commitment (RUC) or Verbal Dispatch Instruction (VDI). Each QSE shall, for each applicable IBR, reflect in its Current Operating Plan (COP) and Real-Time telemetry a Resource Status of OFF, OUT, or EMR in accordance with Protocol Section 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 preventing compliance with these voltage ride-through requirements, the Resource Entity shall submit to ERCOT a report and supporting documentation containing the following:

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

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

(c) A schedule for implementing those modifications.



In its sole reasonable discretion, ERCOT may accept the proposed modification plan. Upon completion of the accepted modification plan, ERCOT will remove the restrictions placed on the IBR unless the IBR experiences additional unresolved technical limitations or performance failures.