INTERCONNECTION
INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

Forum for the Implementation of Reliability Standards for Transmission (i2X FIRST) | 7/30/24

An initiative spearheaded by the Solar Energy Technologies Office and the Wind Energy Technologies Office

BERKELEY LAB

ESIG

EPRI

The first half of this meeting call is being recorded and may be posted on DOE's website or used internally. If you do not wish to have your voice recorded, please do not speak during the call. If you do not wish to have your image recorded, please turn off your camera or participate by phone. If you speak during the call or use a video connection, you are presumed consent to recording and use of your voice or image.

Polling Question 1

What industry sector are you representing?

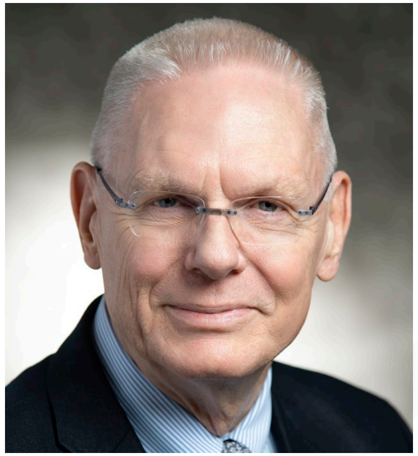
[Go to **slido.com** and enter event code **FIRST3**, then go to **Polls** tab]

Key Goals and Outcomes from i2X FIRST

- To facilitate understanding and adoption of new and recently updated standards relevant for existing and newly interconnecting wind, solar and battery storage plants
- The Forum will convene the industry stakeholders to enable practical and more harmonized implementation of these interconnection standards.
- The presentation portion of the meeting will be recorded and posted, and presentation slides will be shared.
- Additionally, the leadership team will produce **a summary of each meeting** capturing:
  - Recommended best practices
  - Challenges
  - Gaps that require future work

Leadership Team

Cynthia Bothwell, Boston Government Services, contractor to DOE's Wind Energy Technologies Office



Robert Reedy, Lindahl Reed, contractor to DOE's Solar Energy Technologies Office

Will Gorman, Lawrence Berkley National Laboratory

Jens Boemer, Electric Power Research Institute

Julia Matevosyan, Energy Systems Integration Group

Ryan Quint, Elevate Energy Consulting

Summary of the last meeting

- IEEE 2800-2022, Clause 7, Response to TS abnormal conditions – Wes Baker, Silicon Ranch
- NERC PRC-029 Draft, Comparison with IEEE 2800-2022 – Jens Boemer, EPRI
- MISO IEEE 2800-2022 Adoption Efforts, Phase 1 – Megan Pamperin, MISO
- Interactive Group Discussion
  - What are the BPS needs that drive Ride Through Requirements?
  - Adoption of IEEE 2800 Clause 7

- Meeting summary, recording & presentations are posted here (click on Past Events at the bottom of the page)

Key Themes from the Last Meeting

- Adoption of IEEE 2800-2022 is a critical step in ensuring reliability of the BPS with increasing levels of IBRs, and specifically Clause 7 is a high-priority set of requirements that should be implemented by industry at-large.
- A unified adoption at FERC/NERC level would provide uniformity across regions. However, FERC/NERC have generally avoided adoption of IEEE 2800-2022 in their standards development directives and activities.
- Therefore, TOs/ISO/RTOs should seek to adopt IEEE 2800-2022 in a uniform manner where possible.
- Industry is strongly encouraged to participate in the open NERC Standards development process by providing comments on the draft standards language, and open ballots to help refine the NERC Standards as they evolve.
- There are still inconsistencies between NERC PRC-029 draft and IEEE 2800-2022 requirements pertaining to IBR ride-through capability and performance. Aligning these standards as much as possible should be considered, especially since some regions have already adopted or are in the process of adopting IEEE2800-2022.
- There are still many technical questions pertaining to the IEEE 2800-2022 Clause 7 ride-through requirements, as illustrated in the meeting and the list of questions asked by stakeholders. Continued outreach, education, and training across industry stakeholders will help with effective adoption and implementation of the standard.
- Design evaluations and IEEE 2800-2022 conformity assessments during the interconnection process and during the lifetime of IBR plants will be an essential component of effective IEEE 2800-2022 requirements implementation.

Upcoming i2X FIRST Meetings

1. May 28th, 2024, 11 a.m.- 1 p.m. ET: Introduction of Evolving Standards Landscape
2. June 25th, 2024, 11 a.m.- 1 p.m. ET: IEEE2800 Ride Through Requirements
3. July 30th, 2024, 11 a.m.- 1 p.m. ET: IEEE2800 Ride Through Requirements, OEM Readiness
4. August 20th, 2024, 11 a.m.- 1 p.m. ET:
5. September 24th, 2024, 11 a.m.- 1 p.m. ET:
6. October 24th, 2024 hybrid, full day, during ESIG Fall Workshop, Providence, RI: Conformity Assessment
7. November 26th, 2024, 11 a.m.- 1 p.m. ET:
8. December 17th, 2024, 11 a.m.- 1 p.m. ET:
9. January 28th 2025, 11 a.m.- 1 p.m. ET:
10. February 25th 2025
11. March 20th, 2025 hybrid full day event during ESIG Spring Workshop, Austin, Texas

Sign up for all future i2X FIRST Meetings here: https://www.zoomgov.com/meeting/register/vJItceuorTsiErIC-HInpPbWuTUtrYQAuoM#/registration

Follow DOE i2X FIRST website: https://www.energy.gov/eere/i2x/i2x-forum-implementation-reliability-standards-transmission-first for meeting materials & recordings and for future meeting details & agendas

Ride-Through Requirements, OEM Readiness – Agenda

- Meeting Introduction (10 mins) – Julia Matevosyan, ESIG
- IEEE 2800-2022, Clause 7, TMEIC's Perspective (15 min) – Dinesh Pattabiraman, TMEIC
- IEEE 2800-2022, Clause 7, SMA's Perspective (15 min) – Ravi Dodballapur, SMA
- IEEE 2800-2022, Clause 7, Vestas's Perspective (15 min) – Miguel Angel Cova Acosta, Vestas
- IEEE 2800-2022, Clause 7, Summary of OEM Perspectives (10 min) – Jens Boemer, EPRI
- Q&A (10 min)
- Interactive Group Discussion (40 min)
  - Backward-Compatibility of IBR Plants with New Ride Through Requirements
  - Conformity of IBR plants with new Ride Through Requirements

Virtual Meetings Code of Conduct

1. *Assume good faith and respect differences*
2. *Listen actively and respectfully*
3. *Use "Yes and" to build on others' ideas*
4. *Please self-edit and encourage others to speak up*
5. *Seek to learn from others*

Mutual Respect . Collaboration . Openness

Stakeholder Presentations

Virtual Meetings Code of Conduct

1. *Assume good faith and respect differences*
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5. *Seek to learn from others*

Mutual Respect . Collaboration . Openness

Q & A Session

Interactive Group Discussion Topics

Topic #1: Backward-Compatibility of IBR Plants with New Ride Through Requirements

- Please go to slido to make comments and add questions of your own: **slido.com** and enter event code **FIRST3**
- For verbal commentary, please use the raise hand feature and we will call on you
- Additional related / associated questions:
  - Do you see the need for compatibility of existing / under construction plants with new ride through requirements (e.g., per IEEE 2800-2022 Clause 7)?
  - Should ride-through capability be configured to meet a set of performance requirements/curves or simply based on maximum equipment capability?
  - How should we be thinking about ride-through capability and performance for legacy (existing) resources? What are good practices being deployed to mitigate risks of ride-through risks for the existing fleet?

Topic #2: Conformity of IBR Plants with New Ride Through Requirements

- Please go to slido to make comments and add questions of your own: **slido.com** and enter event code **FIRST3**
- For verbal commentary, please use the raise hand feature and we will call on you
- Additional related / associated questions:
    - Do you see any barriers for future IBR plants (not yet in the interconnection queue) to comply with new ride through requirements (e.g., per IEEE 2800-2022 Clause 7)?
    - What is the current best practice to get assurance from OEMs and plant developers/owners that they can meet applicable ride through requirements (e.g. IEEE 2800 Clause 7): attestations, simulation results, physical etc.?
    - Are you planning to develop your own conformity assessment process for ride through requirements or wait until IEEE P2800.2 is completed?

Polling Question 2

Post any remaining questions related to Ride-Through Requirements that were not addressed so far?

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IEEE 2800-2022 Clause 7 Vestas's Perspective

Miguel A. Cova Acosta

July 2024

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OVERVIEW

IEEE 2800

IEEE 2800-2022 – Full Picture

Known

- Reactive power / voltage control requirements within the continuous operation region (Clause 5)
- Active power / frequency response requirements (Clause 6)
- **Response to TS abnormal conditions (Clause 7)**
- Power quality (Clause 8)
- Protection (Clause 9)
- Modelling (Clause 10)

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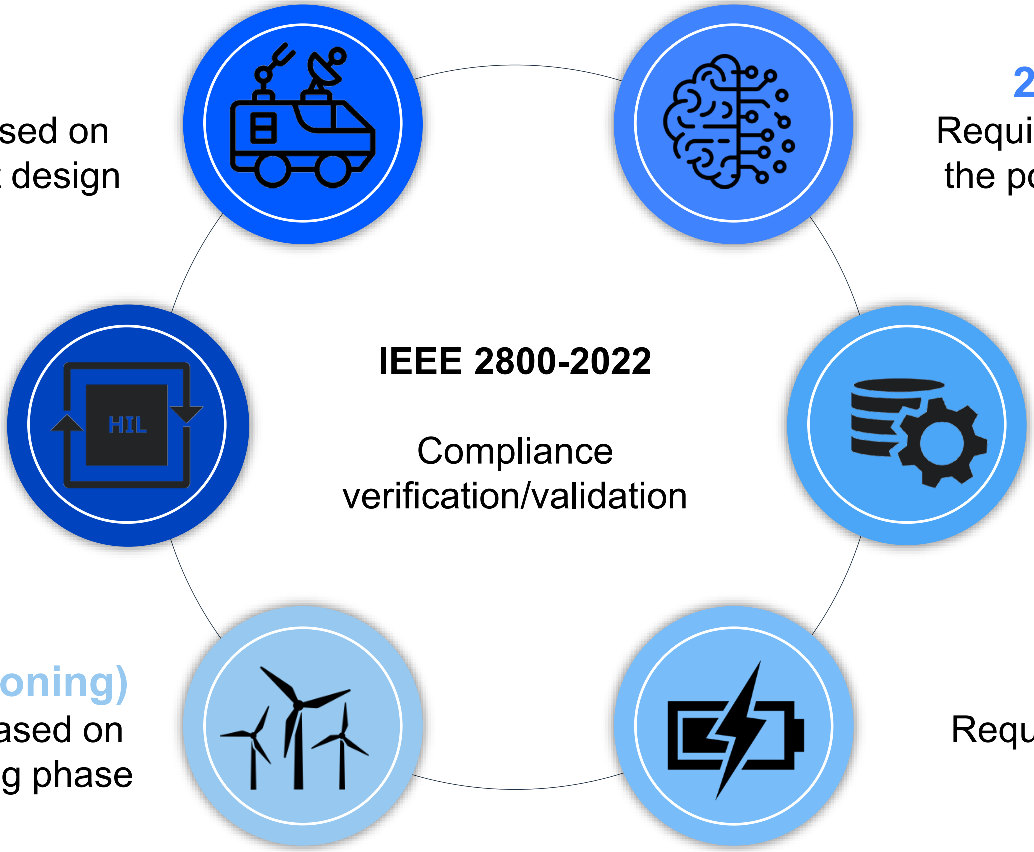
How to demonstrate IEEE 2800-2022 Compliance

Options

1. Field Test
Requirement compliance verification based on measurement campaigns during product design

2. EMT/RMS Model Simulation
Requirement compliance verification based on the power system tool simulation (RMS/EMT)



3. HiL Verification / Validation
Requirement compliance verification based on HiL Lab

4. OEM Confirmation/Attestation
Requirement compliance verification based on OEM model written confirmation

5. Park Performance (Commissioning)
Requirement compliance verification based on plant performance during commissioning phase

6. Exemption
Requirement Exemption based on Technology and/or Grid Stability

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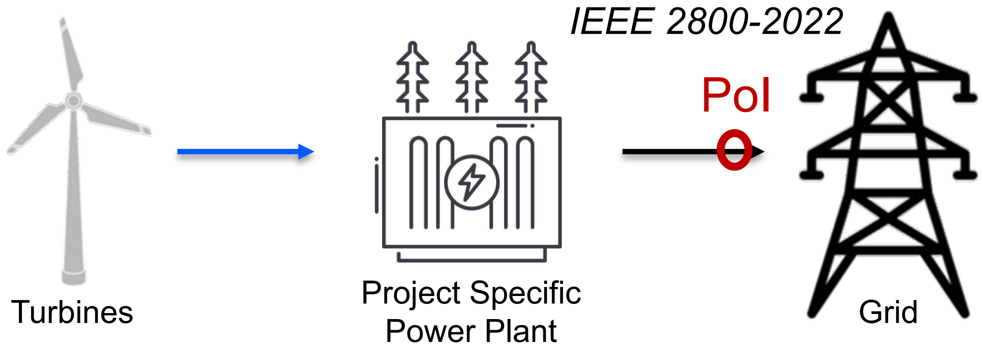
IEEE 2800-2022 Compliance

3 Way Catch-22 Paradox

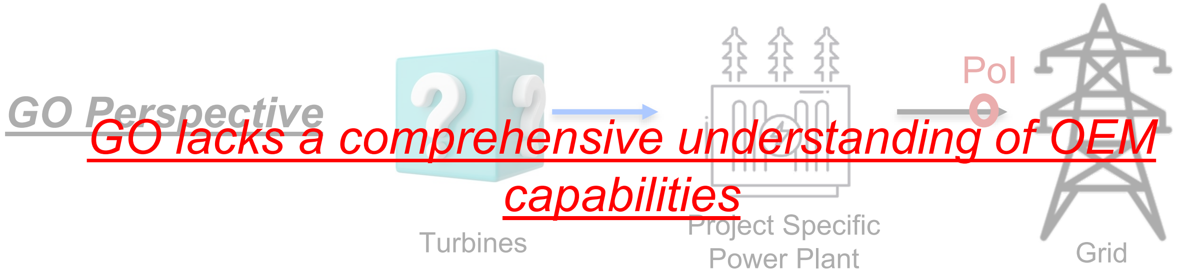


Evaluation Criteria

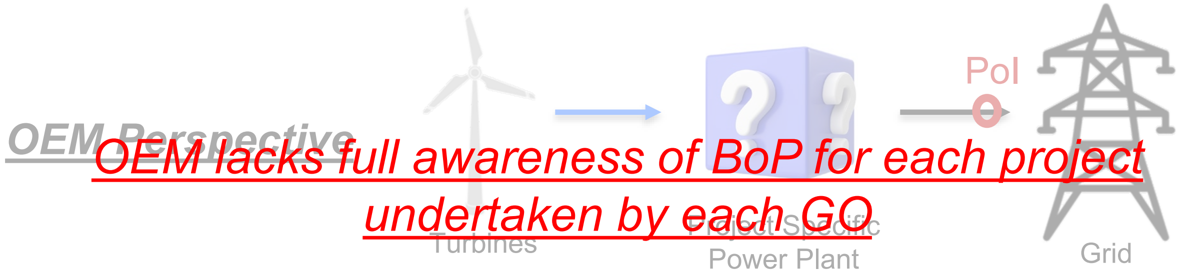
- Operational Points
- Loading Factor
- Project specific control tuning

Project Specific Conditions that will affect the compliance outcome:

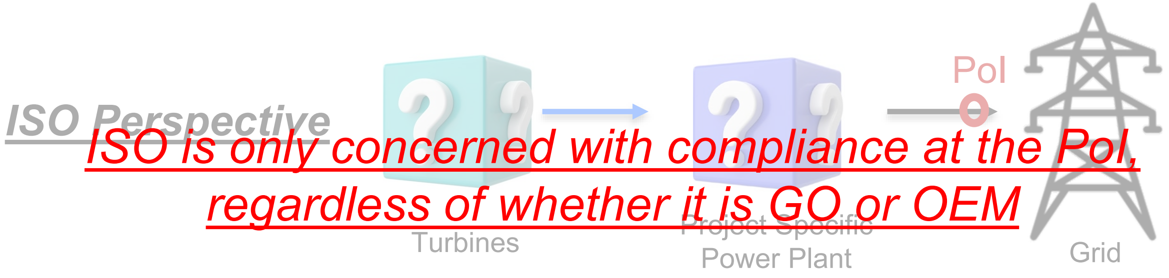
- Grid Stiffness
- Single Line Diagram/Reactive Compensation devices
- PPC Configuration (Control strategy)
- Nearby IBR plants
- Others



GO lacks a comprehensive understanding of OEM capabilities



OEM lacks full awareness of BoP for each project undertaken by each GO



ISO is only concerned with compliance at the PoI, regardless of whether it is GO or OEM

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Consecutive voltage deviations ride-through capability (7.2.2.4)

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Vestas IEEE 2800 Overview

Conformity Assessment – Type 4 WTG*

5. Reactive power-voltage control requirements within the continuous operation region

Section	Conformity	Clarity
5.1 Reactive power capability	High	High
5.2 Voltage and reactive power control modes	High	High
5.2.1 General	High	High
5.2.2 Voltage control	High	Low
5.2.3 Power factor control mode	High	High
5.2.4 Reactive power control mode	High	High

6. Active-power—frequency response requirements

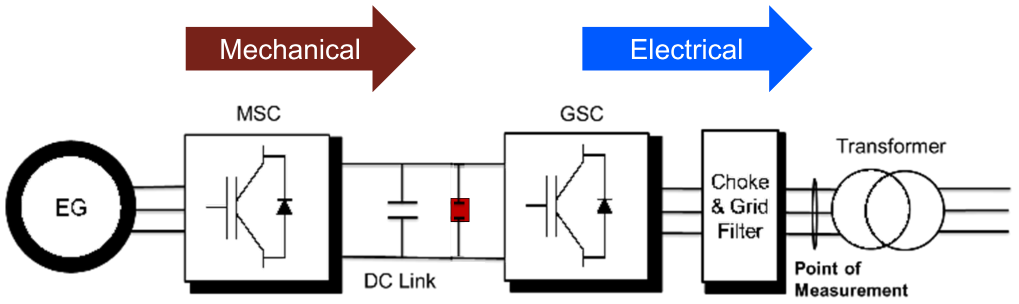
Section	Conformity	Clarity
6.1 Primary frequency response (PFR)	High	High
6.1.1 PFR capability	High	Low
6.1.2 PFR performance	High	Low
6.1.3 PFR utilization in operations	High	High
6.2 Fast frequency response (FFR)	High	Low
6.2.1 FFR capability	High	Low
6.2.2 FFR performance	High	Low
6.2.2.1 FFR1: FFR proportional to frequency deviation	High	High
6.2.2.2 Other variants of FFR	High	High
6.2.3 Fast frequency response from wind turbine generator	High	Low

7. Response to TS abnormal conditions

Section	Conformity	Clarity
7.2 Voltage	High	High
7.2.1 Voltage protection requirements	High	High
7.2.2 Voltage disturbance ride-through requirements	High	High
7.2.2.1 General requirements and exceptions	High	High
7.2.2.2 Voltage disturbances within continuous operation region	High	High
7.2.2.3 Low- and high-voltage ride-through within the mandatory operation	High	High
7.2.2.3.1 General	High	High
7.2.2.3.2 Low- and high-voltage ride-through capability	High	High
7.2.2.3.3 Low and high-voltage ride-through performance	Medium	Low
7.2.2.3.4 Current injection during ride-through mode	High	High
7.2.2.3.5 Performance specifications	High	High
7.2.2.4 Consecutive voltage deviations ride-through capability	Medium	High
7.2.2.5 Dynamic voltage support	High	High
7.2.2.6 Restore output after voltage ride-through	High	High
7.2.3 Transient overvoltage ride-through requirements	Medium	Low
7.3 Frequency	High	High
7.3.1 Mandatory frequency tripping requirements	High	High
7.3.2 Frequency disturbance ride-through requirements	High	High
7.3.2.1 General requirements and exceptions	High	High
7.3.2.2 Continuous operation region	High	High
7.3.2.3 Frequency disturbances within the mandatory operation region	High	High
7.3.2.3.1 Low-frequency ride-through capability	High	High
7.3.2.3.2 Low-frequency ride-through performance	High	High
7.3.2.3.3 High-frequency ride-through capability	High	High
7.3.2.3.4 High-frequency ride-through performance	High	High
7.3.2.3.5 Rate of change of frequency (ROCOF) ride-through	Medium	Low
7.3.2.4 Voltage phase angle changes ride-through	High	Low
7.4 Return to service after IBR plant trip	High	High

Consecutive voltage deviations ride-through capability (7.2.2.4)

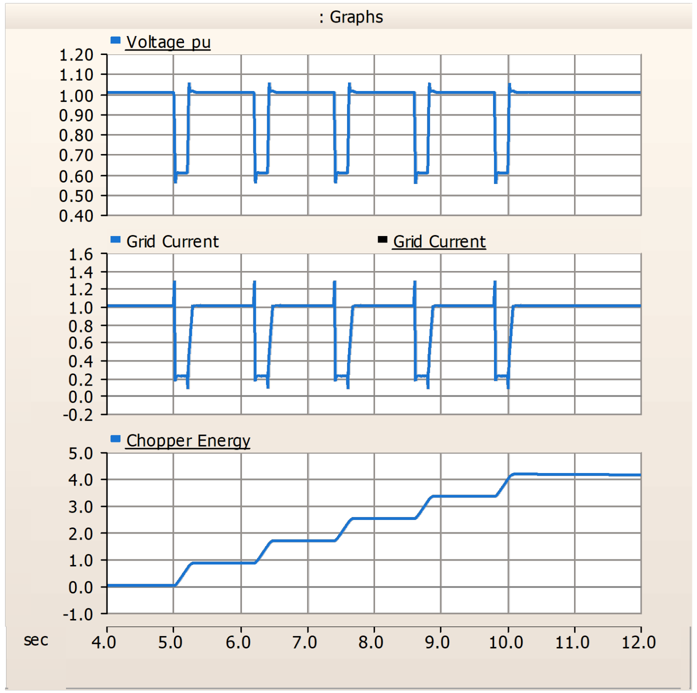
Challenges



$$Energy_{DC\ CHopper} = Energy_{Mechanical} - Energy_{Electrical}$$

Quasi Constant in the time frame of Voltage Disturbances

The cooling time constants for DC choppers used in wind Inverter-Based Resource (IBR) technologies are notably long, often spanning minutes. As a result, when evaluating Multiple FRT (MFRT) within 10-15 second intervals, such events can be viewed as adiabatic.



Type 4 turbines experience considerable thermal stress during multiple Fault Ride-Through (FRT) events. The thermal constraints are influenced not just by the frequency and duration of FRT occurrences, but also by the specific configuration of the site.

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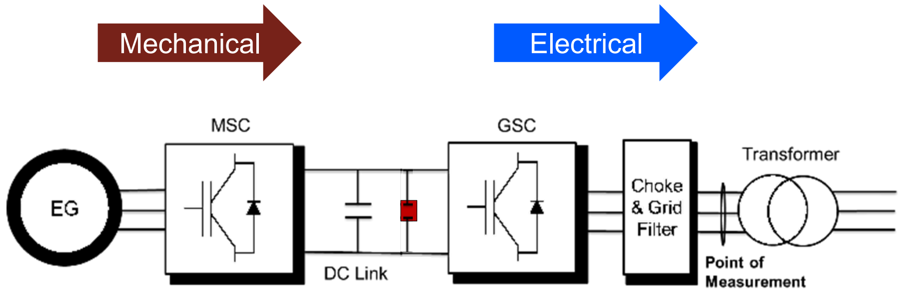
Consecutive voltage deviations ride-through capability (7.2.2.4)

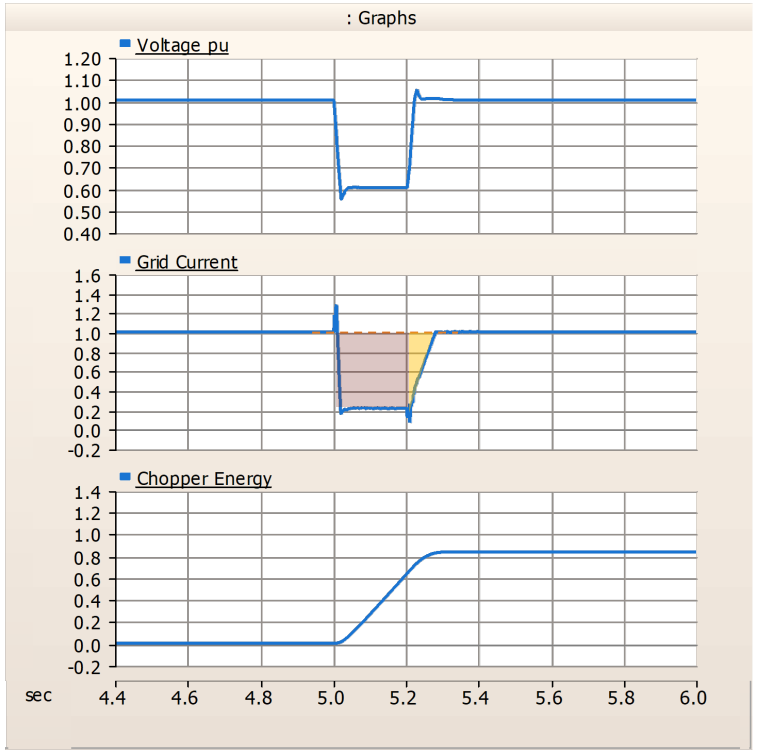
Project Specific



$$Energy_{DC\ CHopper} = Energy_{Mechanical} - Energy_{Electrical}$$

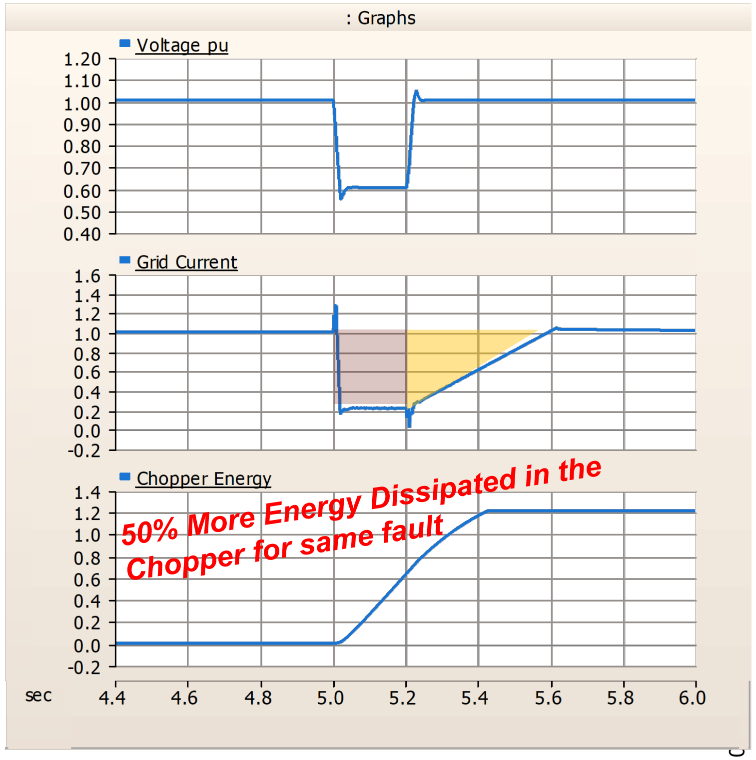
Quasi Constant in the time frame of Voltage Disturbances

Multiple Fault Ride-Through (FRT) is essential for maintaining grid stability. However, requirements should consider exemptions for energy dissipation, depending on the specific configuration of the project.



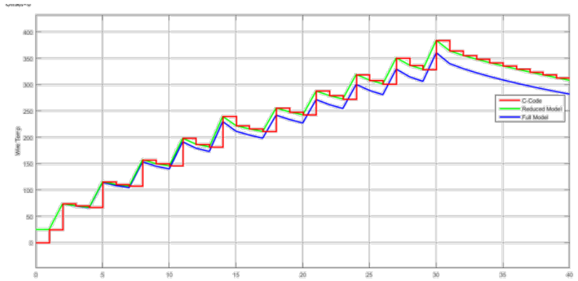
Strong Grid with 10pu/s recovery of Active Power

Weak Grid with 2pu/s recovery of Active Power



Accurate chopper thermal estimator models are needed!

Otherwise, false positive conclusions will be drawn



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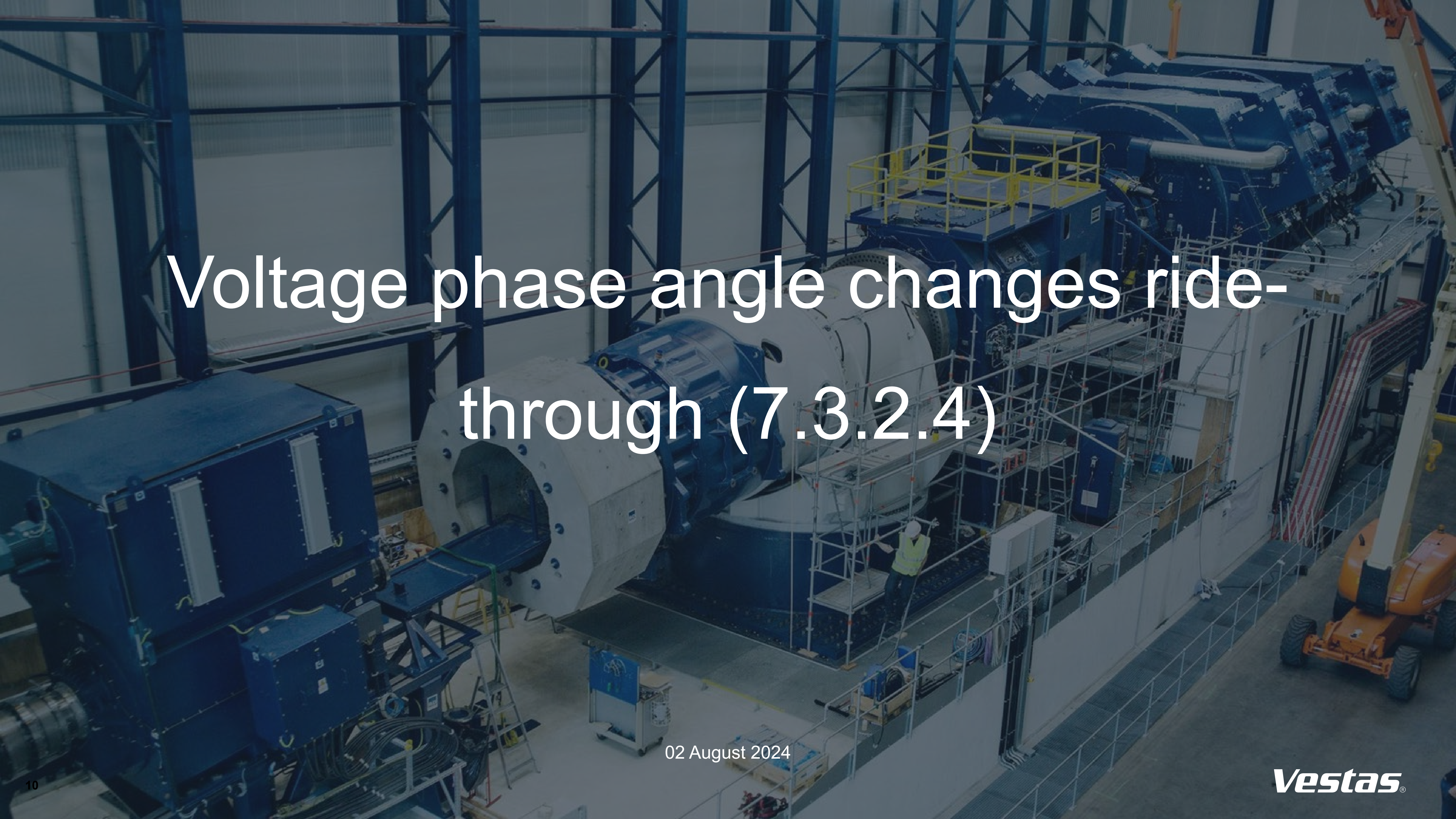

Voltage phase angle changes ride-through (7.3.2.4)

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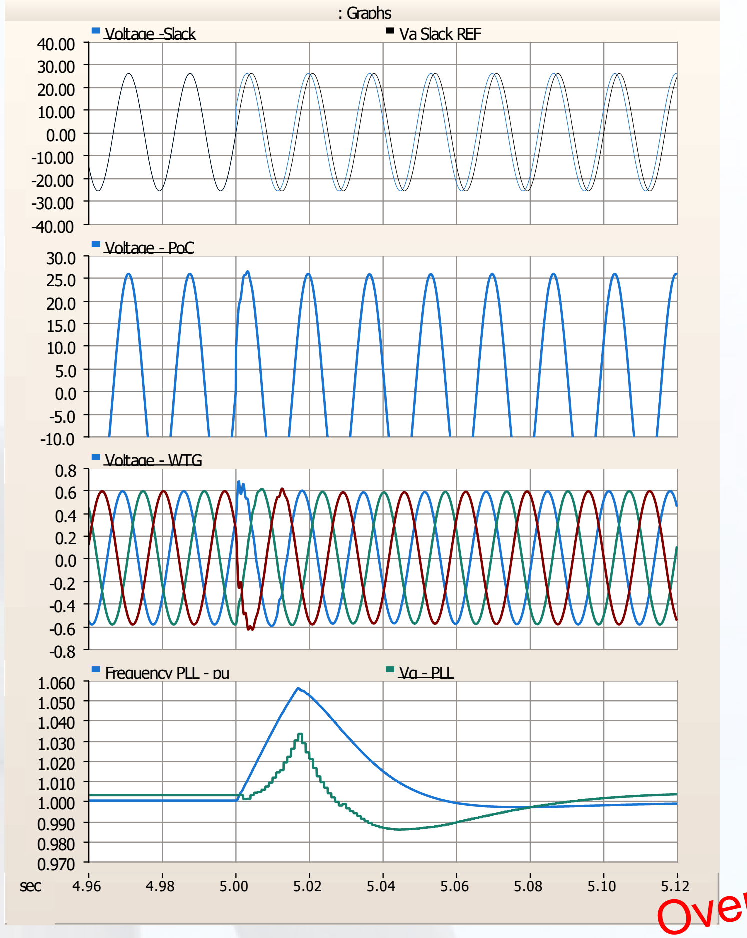
Voltage phase angle changes ride-through (7.3.2.4)

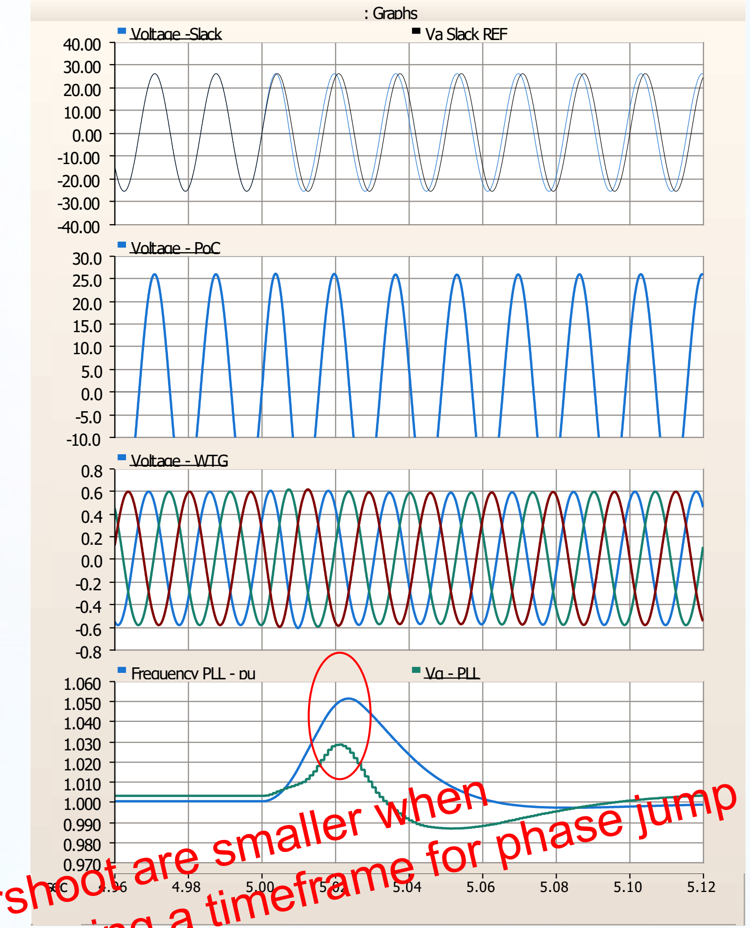
Requirement

An IBR shall ride-through any disturbance during which ride-through is required and the positive-sequence angle change within a **sub-cycle-to-cycle time frame** does not exceed 25 electrical degrees. In addition, the IBR shall ride-through any change in the phase angle of individual phases caused by unbalanced faults, provided the positive-sequence angle change does not exceed 25 electrical degrees. Positively damped active and reactive current oscillations in the post-disturbance period are acceptable in response to phase angle changes.

Phase Jump 25 Degrees applied in one time step



Phase Jump 25 Degrees applied in half cycle

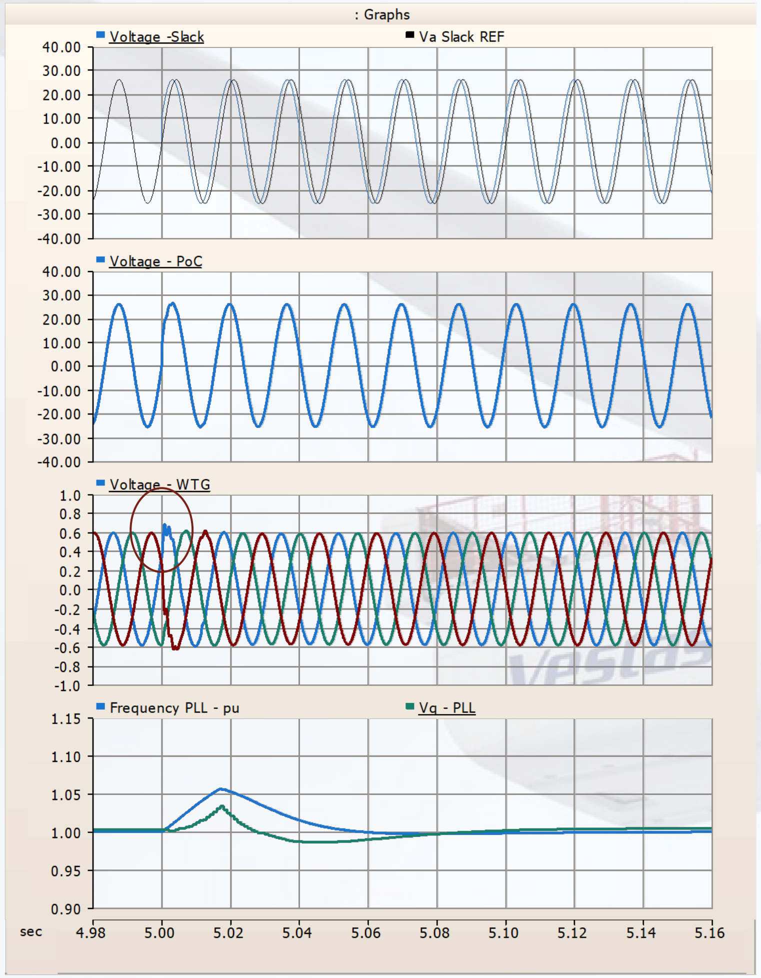


Overshoot are smaller when considering a timeframe for phase jump test

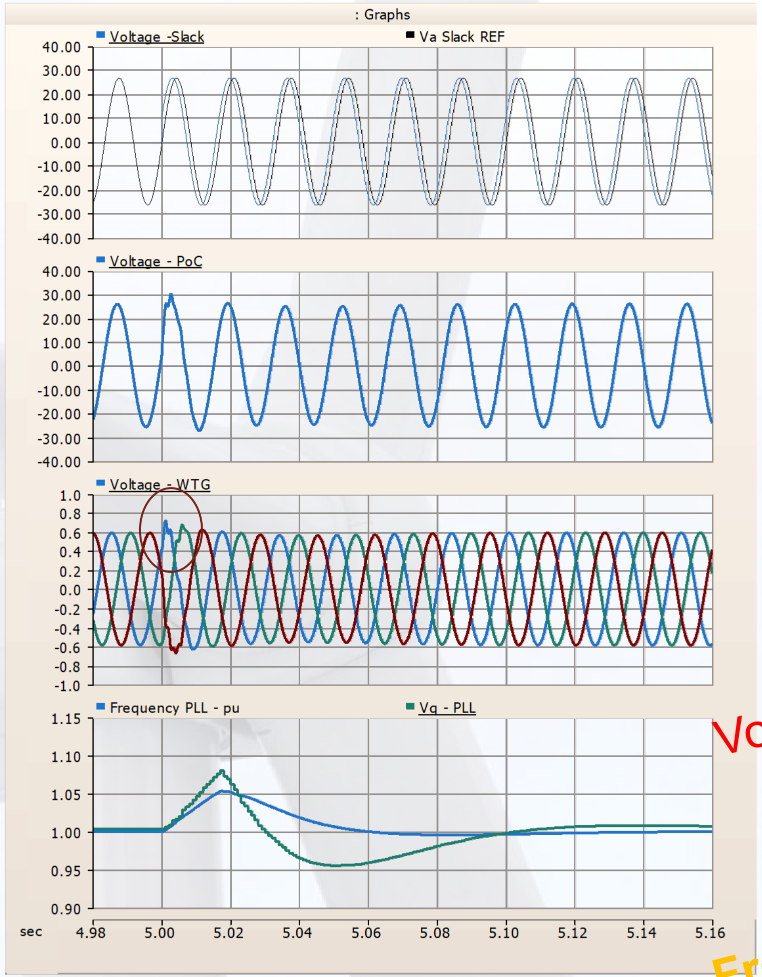
Voltage phase angle changes ride-through (7.3.2.4)

Grid strength dependency

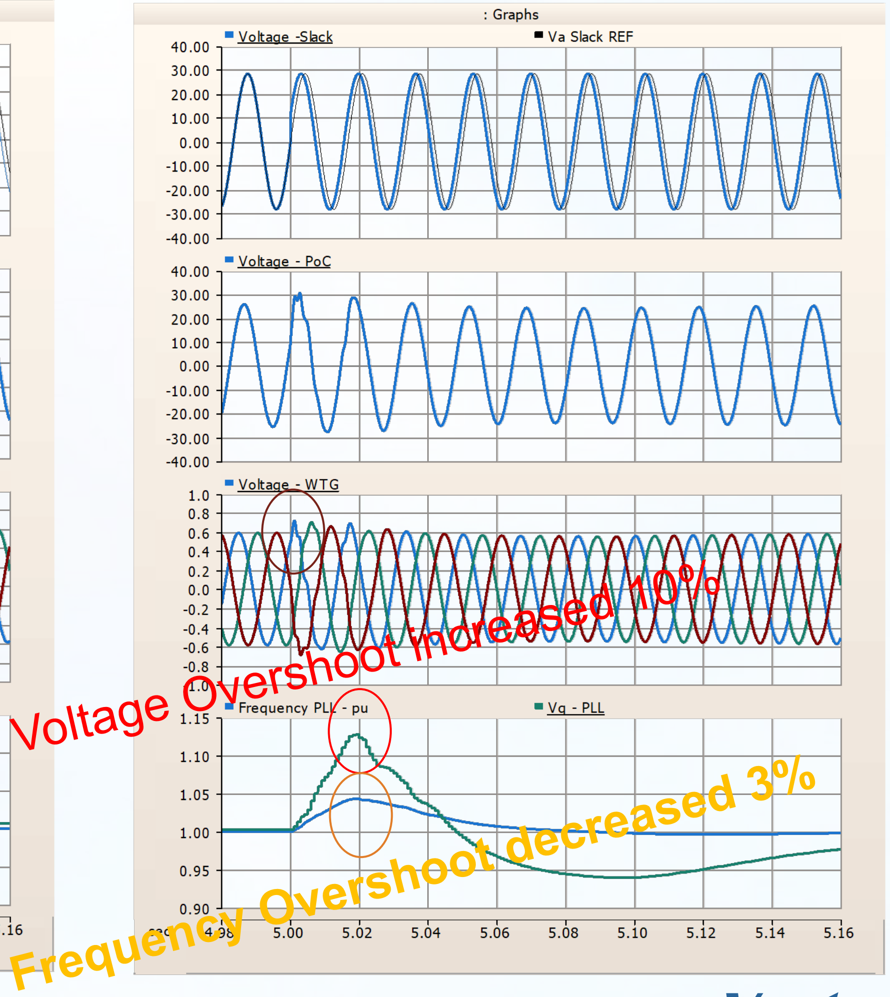
SCR = 50



SCR = 5



SCR = 2.5



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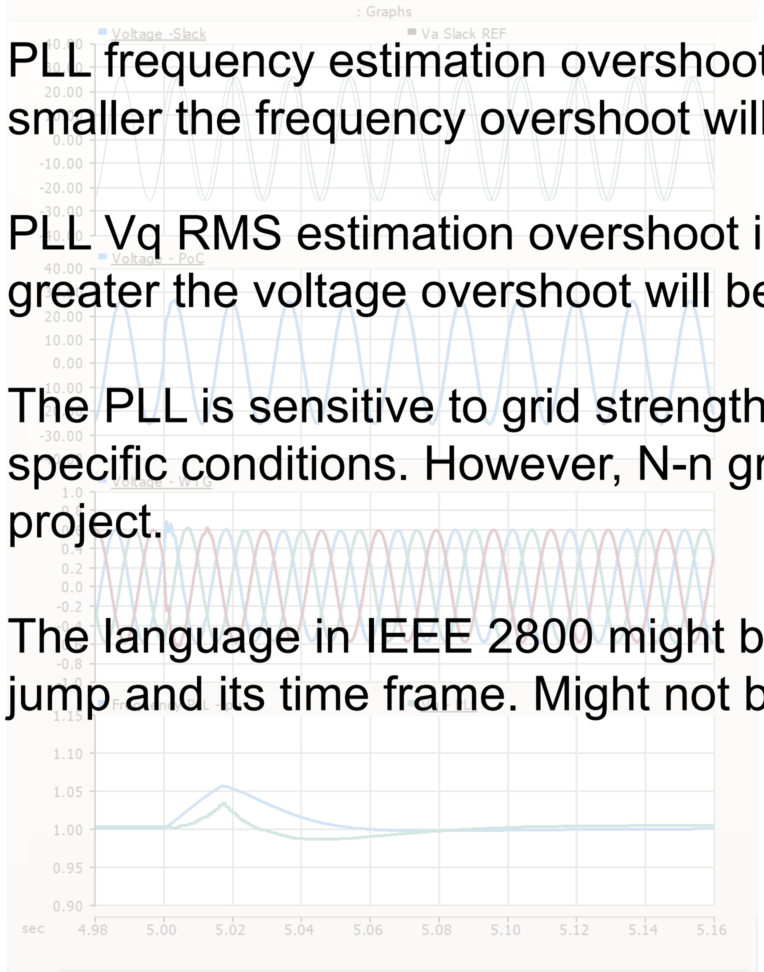
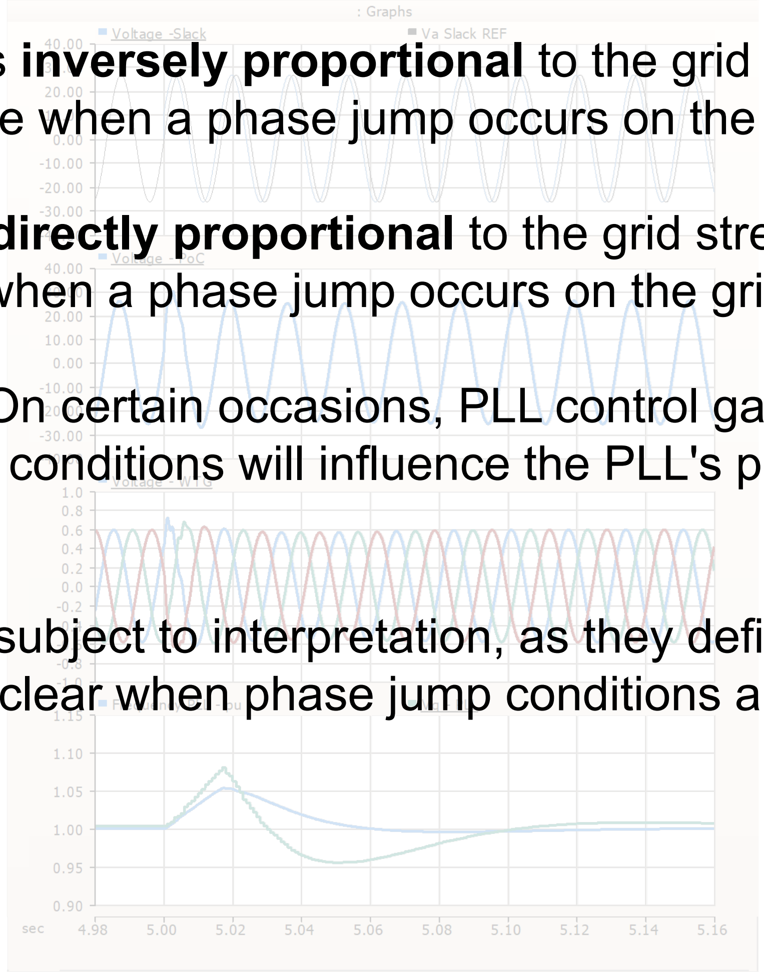
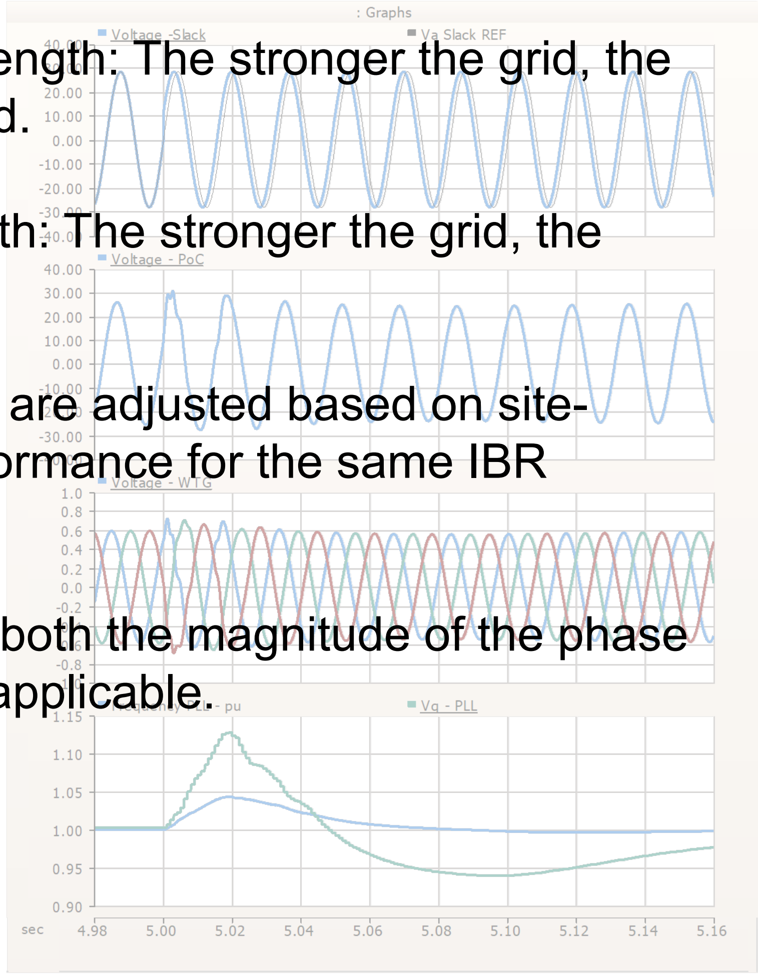
PLL Performance against Phase Jumps

Take Aways







PLL frequency estimation overshoot is **inversely proportional** to the grid strength: The stronger the grid, the smaller the frequency overshoot will be when a phase jump occurs on the grid.

PLL Vq RMS estimation overshoot is **directly proportional** to the grid strength: The stronger the grid, the greater the voltage overshoot will be when a phase jump occurs on the grid.

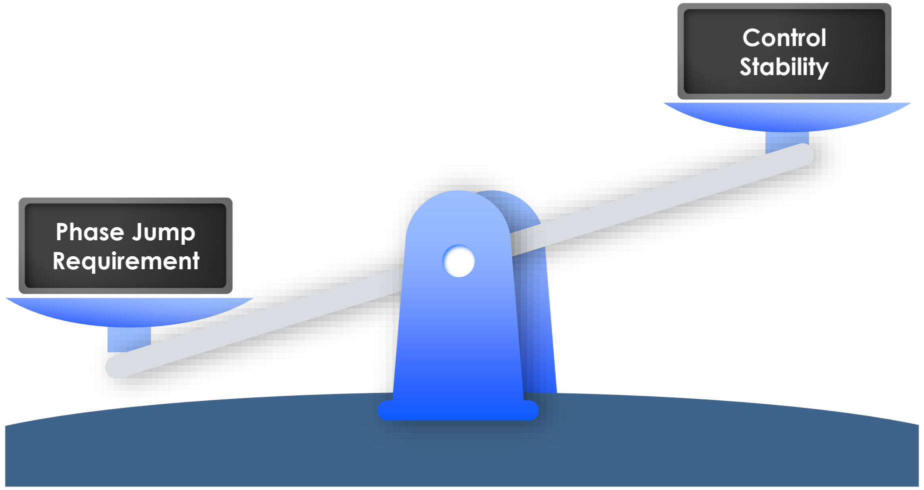
The PLL is sensitive to grid strength. On certain occasions, PLL control gains are adjusted based on site-specific conditions. However, N-n grid conditions will influence the PLL's performance for the same IBR project.

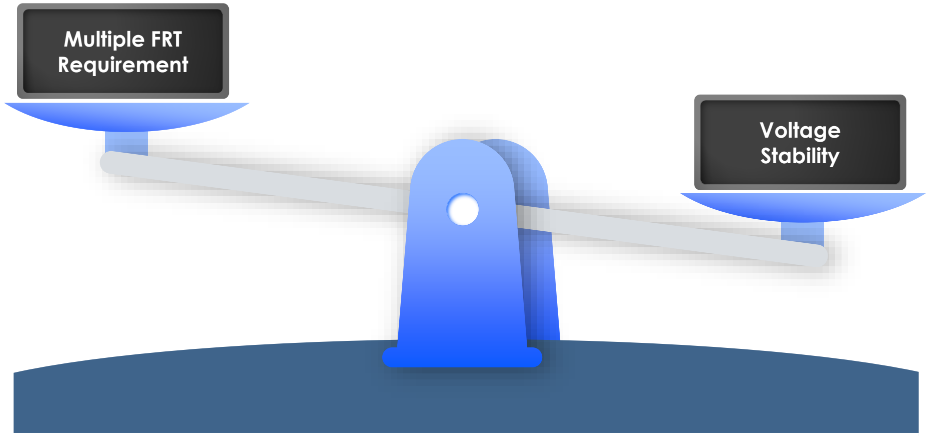
The language in IEEE 2800 might be subject to interpretation, as they define both the magnitude of the phase jump and its time frame. Might not be clear when phase jump conditions are applicable.

Learnings from NOGRR-245 applicable to IEEE 2800

Requirements exemption - Greater good: Examples

Multiple Fault Ride-Through (FRT) is essential for maintaining grid stability. However, requirements should consider exemptions for energy dissipation, depending on the specific configuration of the project.





Phase Jump Ride Through is beneficial for maintaining grid stability. However, requirements should consider exemptions for site specific PLL tuning to maintain control stability under very weak grid conditions.

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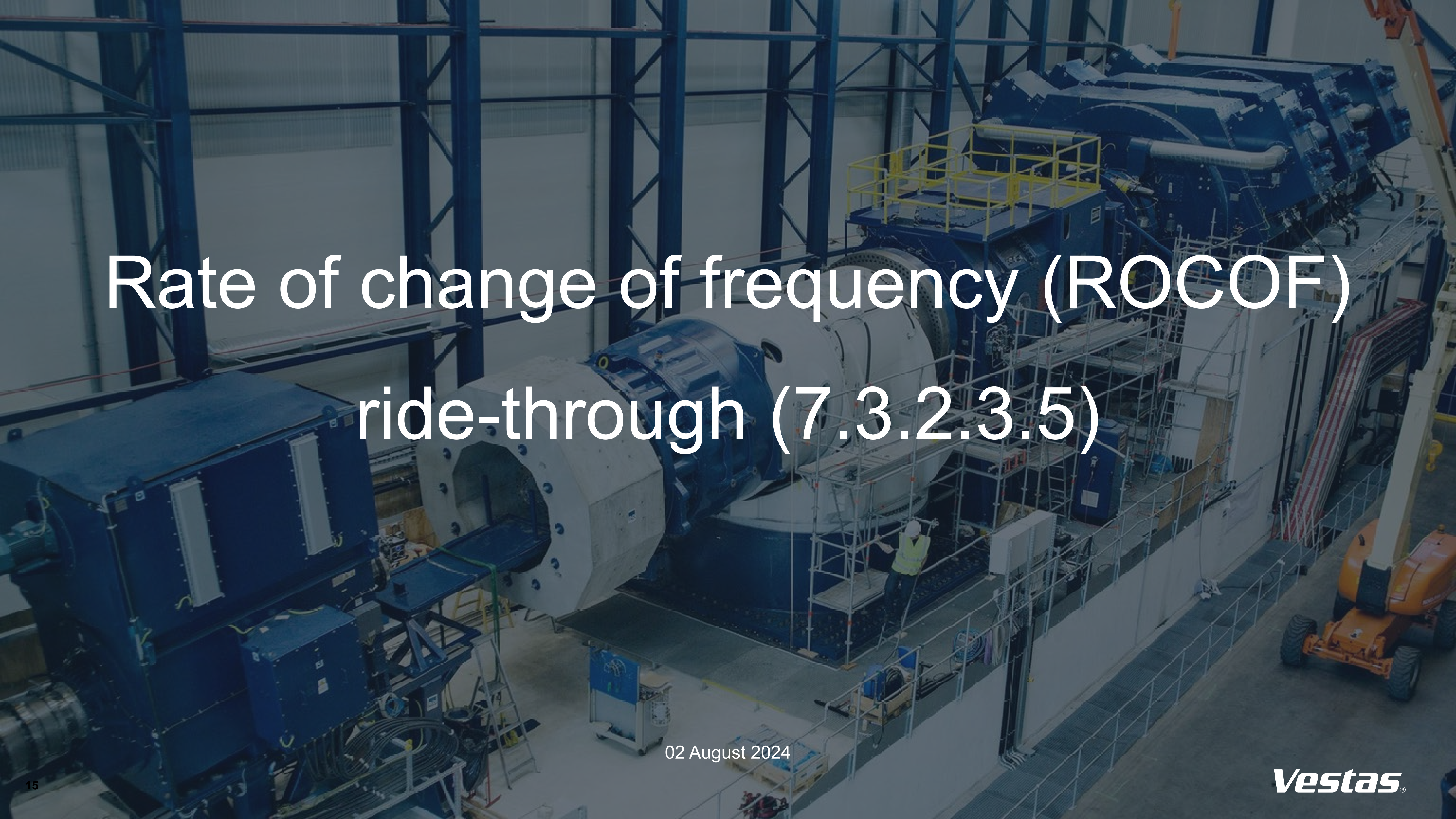

Rate of change of frequency (ROCOF) ride-through (7.3.2.3.5)

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Rate of change of frequency (ROCOF) ride-through (7.3.2.3.5)

Evaluation

Rate of change of frequency (RoCoF) is the time derivative of the power system frequency (df/dt):

$$RoCoF|_{t=0^+} = \frac{\Delta P_{imbalance}}{P_{LOAD}} \cdot \frac{f_0}{2 \cdot H}$$

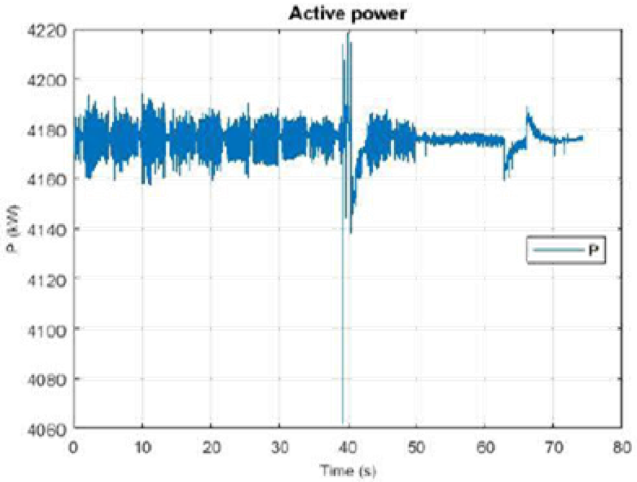
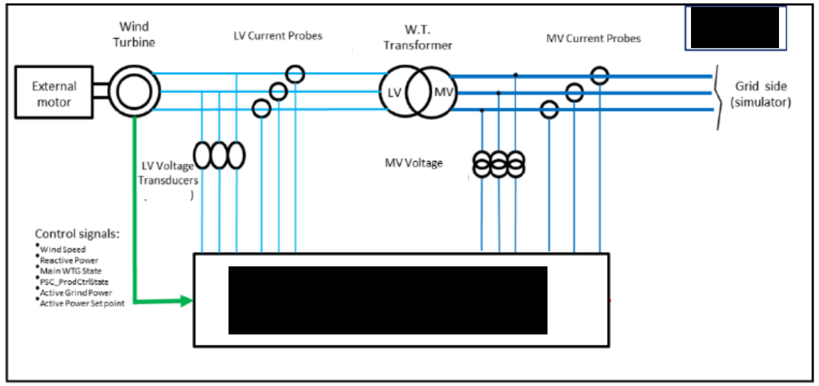
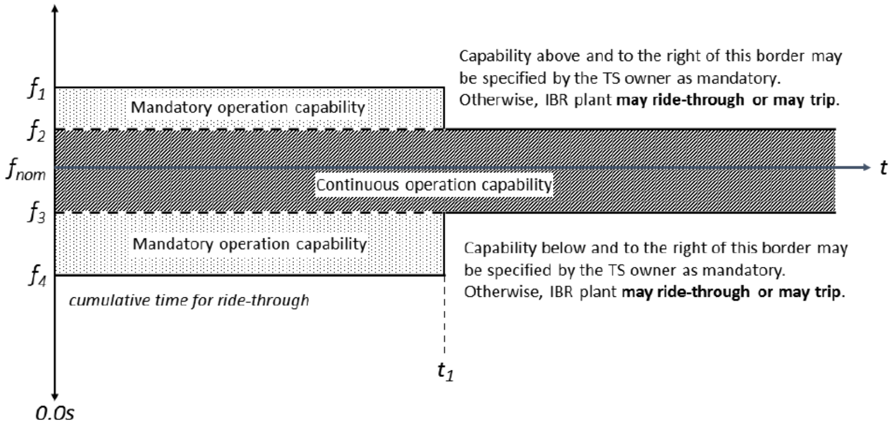


Figure 46 Test 21 Active power





7.3.2 Frequency disturbance ride-through requirements

Turbines have been tested to ride through 6.5Hz/s+ Hz/s. However, not all corner points have been tested to ensure +-5Hz/s. Vestas WTG might operate at 6% error permanently.

Important to note EMT or any other model will be useless for ROCOF verification, unless all Auxiliary equipment are modeled and included

Table 15—Frequency ride-through capability for an *IBR plant* (see Figure 12)

Frequency range (Hz)	Percent from f_{nom}	Minimum time (s) (design criteria)	Operation
f_1, f_4	+3, −5	299.0 (t_1)	Mandatory operation
f_2, f_3	+2, −2	∞	Continuous operation

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Final Remarks

IEEE 2800-2022 Vestas's Perspective

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Moving Ahead with IEEE 2800

Suggestions, Reflections and Key Considerations

- Will each Independent System Operator (ISO) interpret the IEEE-2800 standard on an individual basis, potentially resulting in **multiple variants of 'IEEE-2800**' within the United States and Canada?
- Do ISOs have a definitive understanding of the evidence required by Generation Owners (GO) and Original Equipment Manufacturers (OEM) to **demonstrate compliance** with the IEEE-2800 requirements as of today?
- Could site-specific parameters, which are designed to enhance the grid's stability, **supersede** IEEE 2800-2022 standards?
- Necessary to **specify test conditions** and **deliverables** for assessing requested features including attestations, simulation reports, and simulations at both plant and turbine levels.
- **Granted Partial Exemptions to Retrofit or Repower Wind Farms from the IEEE 2800 Standards Requirements**

Vestas

Wind. It means the world to us.™

Thank you

Miguel A. Cova Acosta
miaca@vestas.com

SMA

DOE i2x First
SMA Readiness IEEE2800

Ravi Dodballapur | Senior Director Application Engineering
Scott Karpiel | Principal Applications Engineer

July 30th, 2024

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IEEE2800 Readiness

IEEE2800 outlines Plant Level Requirements. SMA Power Conversion Solutions enable Plant Compliance through proper behavior at the Inverter Terminals.

Additional Plant Design considerations on both DC and AC side are required and outside of the Power Conversion Suppliers' scope.

- 7.2.1 Voltage Protection Requirements
- 7.2.2 Voltage Disturbance RT Requirements
- 7.2.3 Trans. OV Ride Through Requirements
- 7.3.1 Mandatory Freq Trip Requirements
- 7.3.2 Frequency Disturbance
- 7.4 Return to Service

Comments

- FreqRT and VRT require proper parameter settings, but requirements fall within capabilities
- FaultRT behavior is programmable for variable k-factors according to severity of voltage drops
- ROCOF of 5hz/s is met with appropriate parameter settings
- Phase angle jump ride through of 25 deg is met, up to 60 deg has been tested successfully with proper settings
- Fault recording – high resolution data is captured and stored, but plant level storage is needed to avoid overwriting data if events exceed storage capacity

IEEE2800 7.2.2 Voltage Disturbance Ride Through

- 7.2.2.1 General Requirements
- 7.2.2.2 Voltage Disturbance Continuous Op
- 7.2.2.3 LV & HV RT Mandatory Op
- 7.2.2.4 Consec V Deviation RT Capability
- 7.2.2.5 Dynamic Voltage Support
- 7.2.2.6 Restore Output After V RT

Comments

- Requires consideration by the Engineer of Record during the plant design phase
- Voltage disturbance continuous operation requirements are implemented in current products
- Four cycle setting time and -2.5% settling band is aggressive
  - Cannot be generally confirmed
  - Needs to have EMT or RMS simulations for each project and various fault conditions.
  - Passing of this requirement will be dependent on each fault case
    - Lower voltage excursions
    - Lower short circuit ratios
- Consecutive requirements may be difficult to meet, hardware adaptions are implemented in current products.
  - Multiple fault scenarios in combination with each other could create difficulty.
- Dynamic Voltage support requirements are already implemented in current products
- Restore outpower after voltage ride through are implemented in current products

IEEE2800 Readiness Summary

- Current product meets requirements for new installs if hardware and firmware is configured correctly
- Upgrades needed for fielded projects that were not configured correctly (engineered kits are released) and firmware parameters may need to updated.
- Older products (pre-2015) under review
- IEEE2800.2 needs to completed and fully reviewed for self declaration

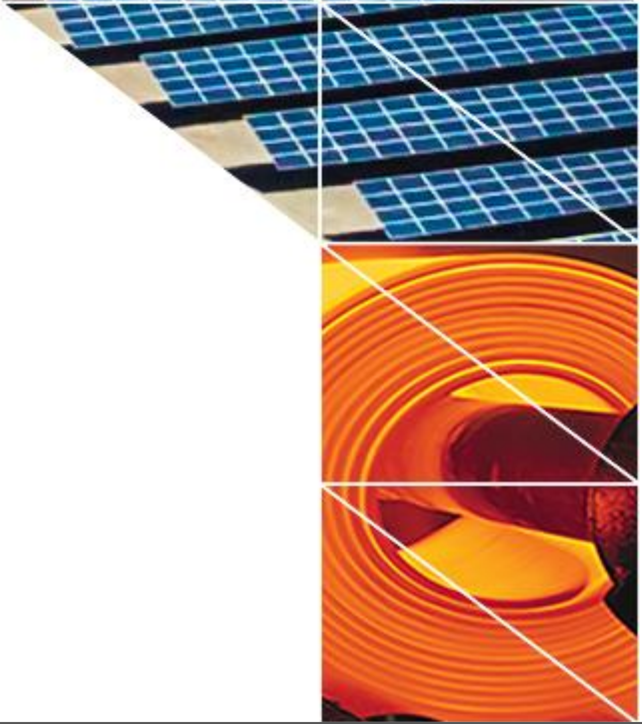
Questions?

THANK YOU

SMA America, LLC

IEEE 2800-2022 - Clause 7 Requirements

TMEIC’s Perspective



WWW.TMEIC.COM

TMEIC Solar Ware Inverters

- **>30GW** of utility scale PV inverters shipped worldwide since 2009
- **>20GW** of inverters shipped in North America

Solar Ware Ninja™

Benefits:

- Cost Competitive
- Increased Reliability
- Increased Availability
- Greater Energy Yield
- Simpler Installation and O&M
- Max Plant Design Optimization

Solar Ware Ninja™ Inverter

- Released in 2019
- **Scalable Power Blocks-** 800kW-880kW block, scalable up to ~5MVA per Skid
- **Modular Design**: Independent Operation, Controls, & Cooling
- Fully Integrated MV Skid for ease of Installation
- 99.2% Fleet availability

Standards for Inverters and Certification

- UL certification is essential to an OEM for selling in North America. UL supplement standards govern grid protection settings. As an OEM, we have rigorous certification and testing requirements to be met for compliance.
- For most of our existing inverters in the field in North America - Ride-through and protection functions implemented are based on UL1741-SA
- We incorporate additional software to meet NERC/ISO requirements for transmission connected systems such as elimination of momentary cessation, reactive injection during faults, extended overvoltage/phase angle ride-through etc.
- New standard UL1741-SB is now adopted recently by the industry and required by many states. TMEIC now has a PV inverter to certified UL1741-SB.

UL1741-SB vs IEEE 2800 requirements

- TMEIC views compliance to UL1741-SB as an intermediate step in meeting 2800 requirements.
- Many requirements from UL1741-SB are synonymous with IEEE 2800 with some higher requirements for IEEE 2800.
- We tested with the higher of the two requirements during certification tests to ensure compliance.

Examples of similar requirements

- Clause 7.3 RoCoF ride-through – 3Hz/s in SB vs 5Hz/s in IEEE 2800
- Clause 7.3 Phase angle ride-through – 20° change in SB vs 25° change in IEEE 2800

Note: Testing procedure for IEEE2800 (plant level) is different from UL1741-SB (Inverter level)

While UL1741-SB is a distribution connected standard, some requirements are still synonymous. Due to lack of finalized 2800.2 test procedures, this is used as a placeholder for testing.

UL1741-SB vs IEEE 2800 requirements

Examples of similar requirements

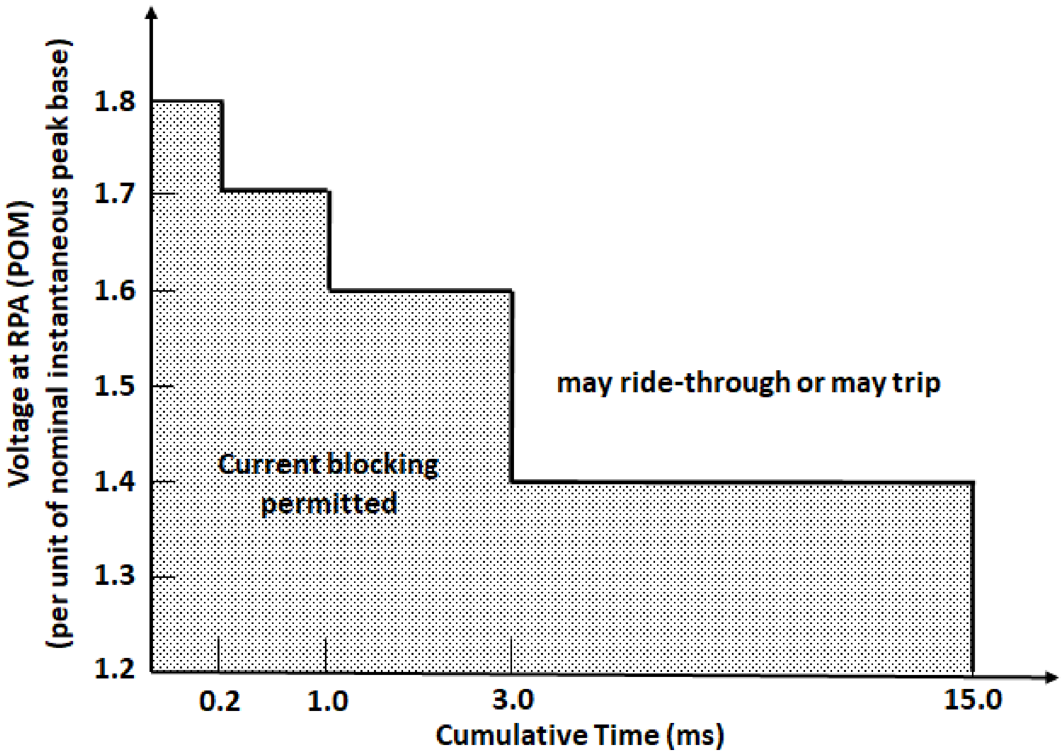
- Clause 7.2 Low/High voltage ride-through (Table 12) – Wide curve in SB generally compared to IEEE 2800.
- Clause 7.2.2.4 Consecutive voltage deviations ride-through capability – Definitions are different in SB, but the capability is generally deemed wider from an inverter perspective in SB.
    - Our inverters do no actively monitor for consecutive disturbances

Current injection during ride-through mode

- Most of our inverters ***can do reactive injection*** today. They operate in reactive current priority mode. This is a requirement in many ISOs today.
- **Active current priority** is not available today. TMEIC does not see this being used since most ISOs require prioritizing reactive injection during faults. TMEIC can implement active current priority as a software feature if needed.
- **Negative sequence injection -** We have some negative sequence injection capability, but this is not enabled. No specific requirements from ISOs today on negative sequence injection. We are concerned about how this can affect inverter tripping in the field and caution against using functions without detailed studies.
- **Response time and accuracy** – Can meet these requirements tentatively today.

Transient Overvoltage ride-through

- Hard to judge compliance from an inverter unit perspective since transient overvoltage is balance of plant dependent.
- Due to the faster timescale nature of the protection, many balance of plant components can affect compliance such as surge arrestors in the plant, collector system, etc.
- Based on internal studies, we think we can meet this requirement with some of our SA and all our SB inverters. However, final test procedures from IEEE 2800 are required.
- Concerns about differences between actual plant and model modeling accuracies due to faster time scale nature.



Perspective on Improving Ride-through

- The industry widely views 2800 as means of improving IBR performance and mitigating trip events.
- There has been a significant focus on ride-through curves in 2800 and backwards compatibility of existing inverters in the field to comply to 2800.

- **Reliability issues associated with the inability of some IBRs to ride-through system disturbances are not necessarily solved by specifications IEEE 2800**
  - None of the disturbances that have caused inverter trips have exceeded or even come close to any ride-through curve existing today in PRC-024-3.
  - Many issues root from old perspective of distributed generation -> do no harm and get off as soon as possible.
  - In some cases, overstretched requirements based on old studies and lack of detailed EMT studies have caused many grid events that we have seen today. These still pose a risk to the electric grid. E.g., Requiring aggressive reactive injection without clear evidence on the benefits have caused overvoltage events

Improving Inverter performance during grid events

- Ensure plant settings match EMT studies
- Read NERC reports of past grid events
- Consult with OEM on best possible settings and improving inverter performance.
- EMT studies are critical and must be performed to tune inverter settings. Use manufacturer suggested settings as starting point.