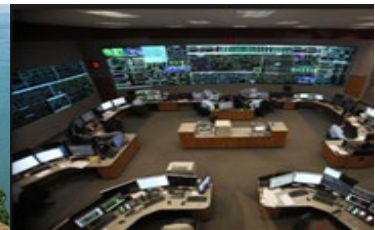


New Standard Version PRC-024-3

Mallory Carlone, Technical Auditor

May 16, 2022

Independence, Ohio



Agenda

- **Non-Compliance and Trends**
- **Effective Date**
- **Standard Overview**
- **Drivers Behind Standard Revision**
- **Changes**
- **How can RF Support?**



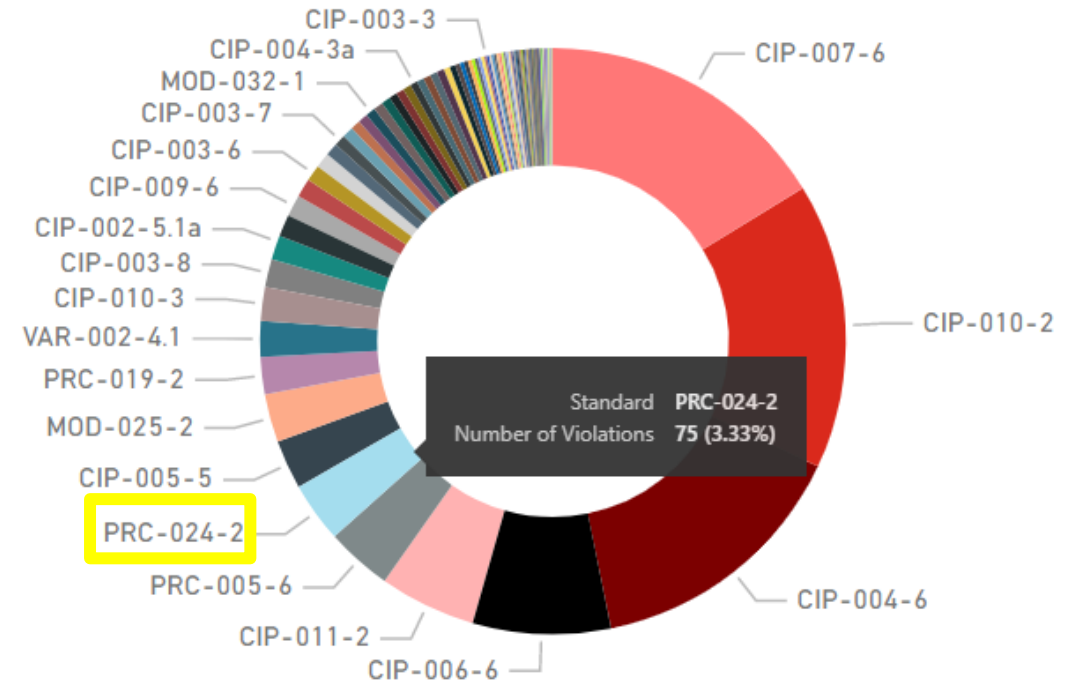
Non-Compliance and Trends

- **PRC-024 continues to be one of the most violated Operations and Planning Standard that RF observes**

| Standard | Req. | NO FINDING | NOT APPLICABLE | OPEN ENFORCEMENT ACTION (OEA) | POTENTIAL NON COMPLIANCE (PNC) | Grand Total | Percent PNC+OEA |
|-----------|------|------------|----------------|-------------------------------|--------------------------------|-------------|-----------------|
| PRC-024-2 | R1. | 70 | 3 | 1 | 11 | 85 | 14.12% |
| PRC-024-2 | R2. | 66 | 5 | 2 | 14 | 87 | 18.39% |
| PRC-024-2 | R3. | 35 | 2 | - | - | 37 | 0.00% |
| PRC-024-2 | R4. | 25 | 1 | - | 1 | 27 | 3.70% |

Note: Findings are over the last five years (2017 - 2021)

RF Most Violated Standards



Effective Date

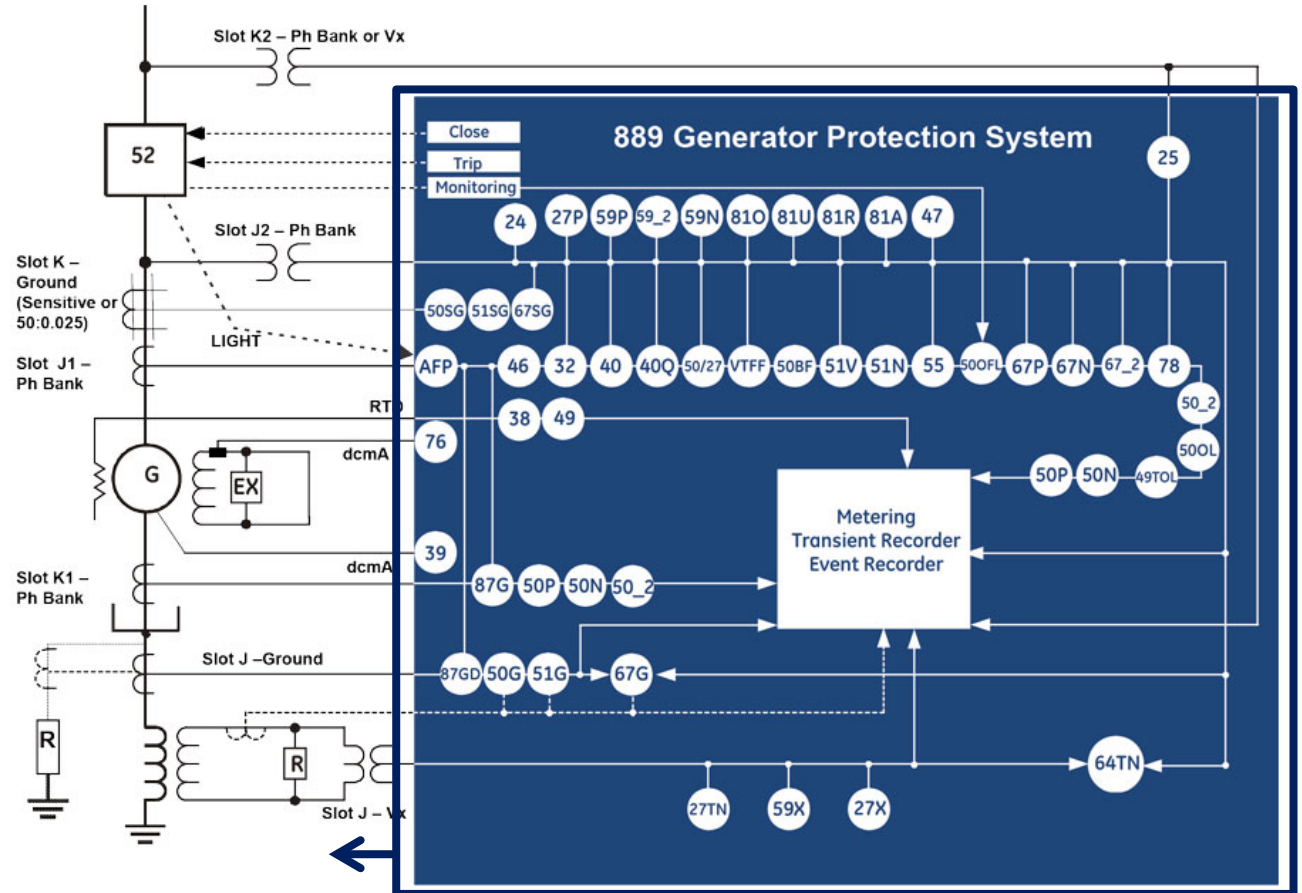
- **NERC filed with FERC on March 20, 2020**
- **FERC Approved July 9, 2020**
 - Allows at least 24 months for affected generators to schedule outages and make changes
- **Effective date is October 1, 2022**



Standard Overview

➤ PRC-024

- Frequency and Voltage Protection Settings for Generating Resources
- Requirements:
 - R1: Each GO is responsible for setting their frequency protection
 - R2: Each GO is responsible for setting their voltage protection
 - R3: Each GO shall document each known regulatory or equipment limitation that prevents generating resource(s) from meeting protection criteria in R1 or R2
 - R4: Each GO shall provide its applicable protection settings to the Planning Coordinator or Transmission Planner



Standard Overview

➤ PRC-024

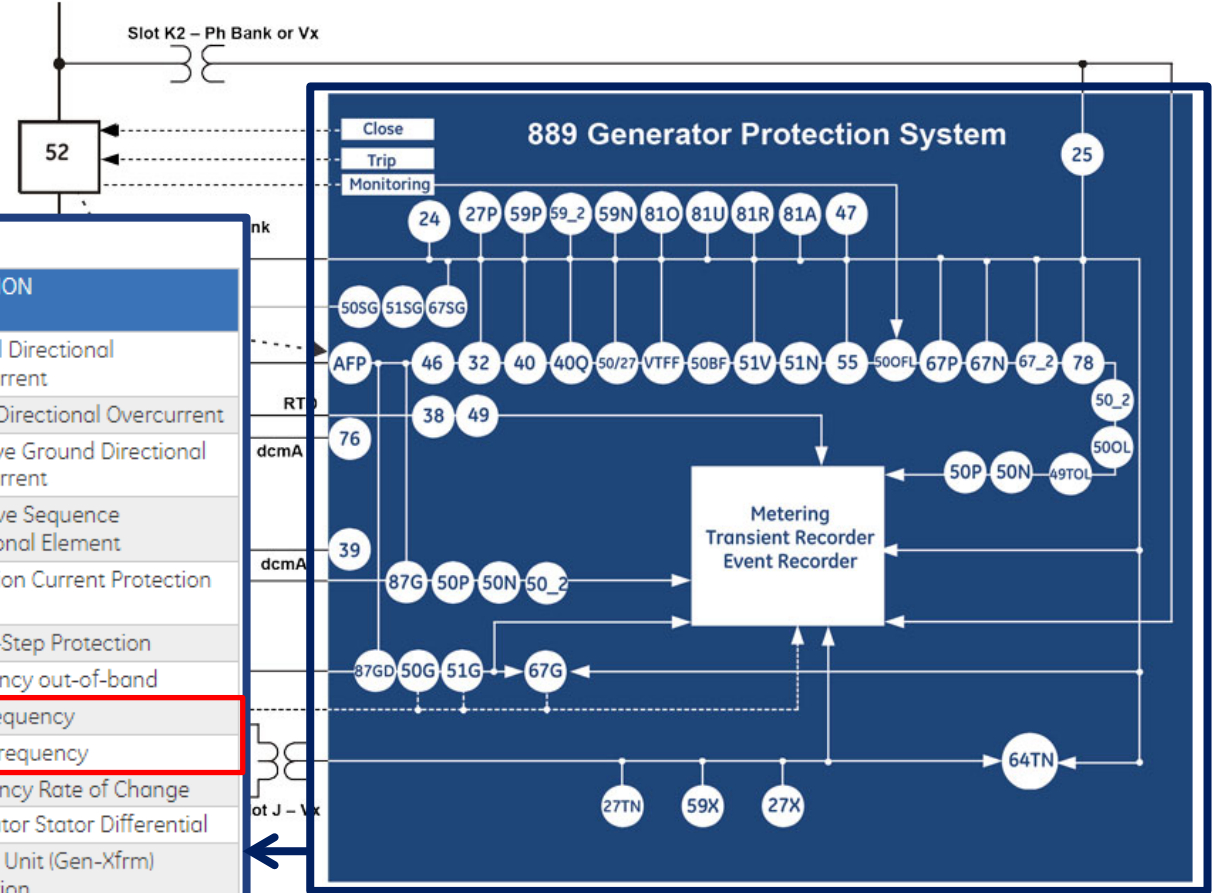
- Frequency and Voltage Protection Settings for Generating Resources

ANSI Device Numbers & Functions

| DEVICE NUMBER | FUNCTION |
|---------------|--|
| 24 | Volts per Hertz |
| 25 | Synchrocheck |
| 27P | Phase Undervoltage |
| 27X | Auxiliary Undervoltage |
| 27TN | Third Harmonic Neutral Undervoltage |
| 32 | Directional Power |
| 38 | Bearing Overtemperature (RTD) |
| 39 | Bearing Vibration (dcmA) |
| 40 | Loss of Excitation |
| 40Q | Reactive Power |
| 46 | Generator Unbalance |
| 47 | Phase Reversal |
| 49 | Thermal (RTD) |
| 49TOL | Thermal Overload |
| 50/27 | Inadvertent Energization |
| 50BF | Breaker Failure |
| 50G | Ground Instantaneous Overcurrent |
| 50SG | Sensitive Ground Instantaneous Overcurrent |

| DEVICE NUMBER | FUNCTION |
|---------------|--|
| 50N | Neutral Instantaneous Overcurrent |
| 50P | Phase Instantaneous Overcurrent |
| 50_2 | Negative Sequence Instantaneous Overcurrent |
| 50OFL | Offline Overcurrent |
| 50OL | Overload |
| 51G | Ground Time Overcurrent |
| 51N | Neutral Time Overcurrent |
| 51SG | Sensitive Ground Time Overcurrent |
| 51V | Voltage Restrained Time Overcurrent |
| 55 | Power Factor |
| 59N | Neutral Overvoltage |
| 59P | Phase Overvoltage |
| 59X | Auxiliary Overvoltage |
| 59_2 | Negative Sequence Overvoltage |
| 64TN | 100% Stator Ground using 3rd Harmonic Voltage Differential |
| 67G | Ground Directional Overcurrent |

| DEVICE NUMBER | FUNCTION |
|---------------|--|
| 67N | Neutral Directional Overcurrent |
| 67P | Phase Directional Overcurrent |
| 67SG | Sensitive Ground Directional Overcurrent |
| 67_2 | Negative Sequence Directional Element |
| 76 | Excitation Current Protection (dcmA) |
| 78 | Out-of-Step Protection |
| 81A | Frequency out-of-band |
| 81O | Overfrequency |
| 81U | Underfrequency |
| 81R | Frequency Rate of Change |
| 87O | Overall Unit (Gen-Xfrm) Protection |
| 87GD | Restricted Ground Fault |
| AFP | Arc Flash Protection |
| VTFE | VT Fuse Failure |



Drivers Behind Standard Revision

➤ Blue Cut Fire

- August 16, 2016, ~1,200 MW of solar resources tripped offline or momentarily
- ~700 MW was attributed to incorrect, low system frequency condition that the inverters responded to by “tripping”
- ~450 MW was determined to be inverter momentary cessation due to system voltage reaching the low voltage ride-through setting of the inverters

➤ Canyon 2 Fire

- On October 9, 2017 ~ 900 MW of solar resources tripped offline or momentarily
- Two normally cleared phase-to-phase faults occurred on a 220 and 500 kV transmission line and most of the affected solar PV inverters that did not trip entered momentary cessation

➤ Multiple Solar PV Disturbances in CAISO



What Changed in the Standard?

➤ “Ride-Through” Standard vs. Protection Settings Standard

- PRC-024 is specific solely to the voltage and frequency protective settings and not to the overall plant

➤ Momentary Cessation

- Requirements R1 and R2 are modified to specify that a generating resource may neither trip **NOR** enter momentary cessation inside the No Trip Zone

➤ May Trip Zone

- To clarify confusion regarding tripping or entering momentary cessation outside the No Trip Zone, the area outside the boundary is now labeled as a “May Trip Zone”

➤ Point of Interconnection (POI)

- To address ambiguity concerns, removed the term altogether and replaced with precise language for this standard: “at the high side of the GSU or collector transformer”

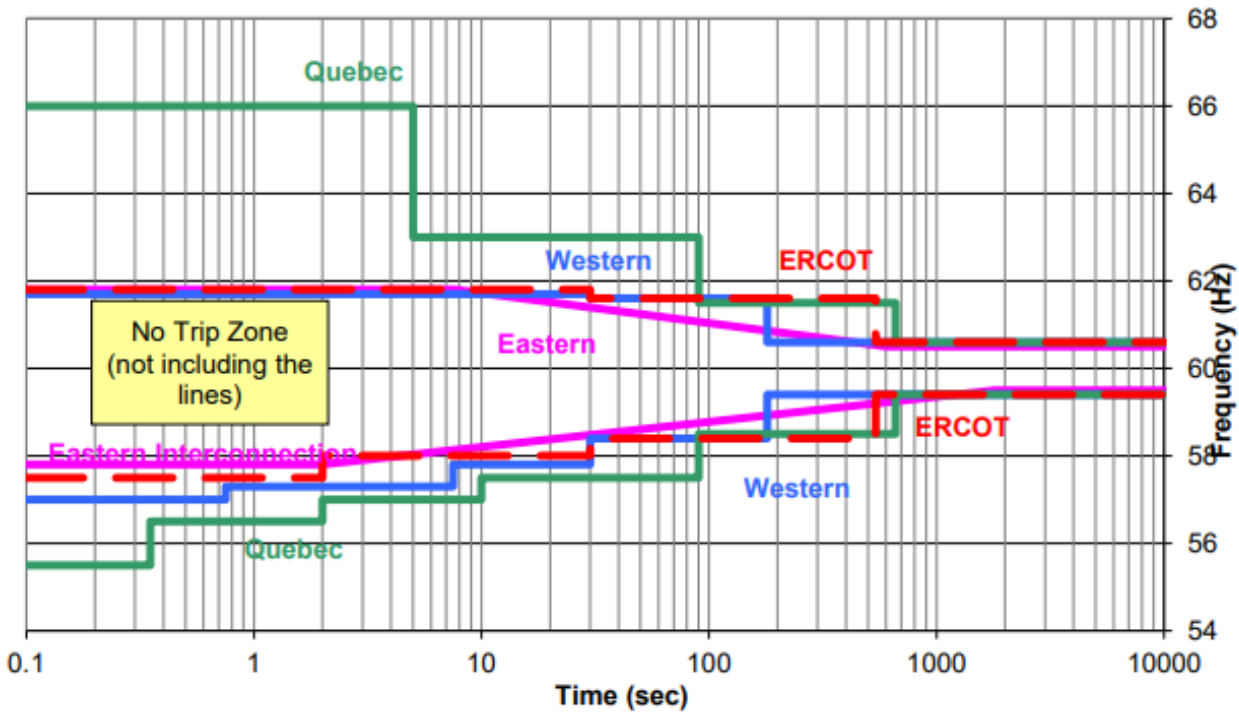
➤ Figures and Tables



Attachment 1 Changes

➤ PRC-024-2

OFF NOMINAL FREQUENCY CAPABILITY CURVE



➤ PRC-024-3

Attachment 1

(Frequency No Trip Boundaries by Interconnection⁸)

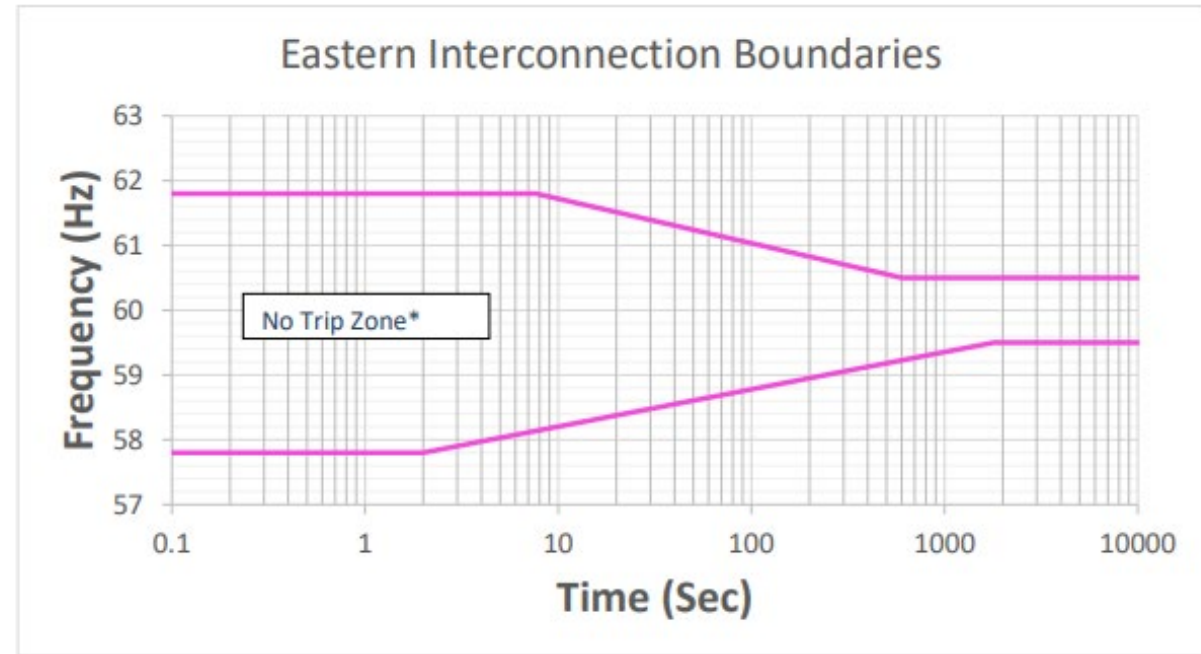


Figure 1

* The area outside the "No Trip Zone" is not a "Must Trip Zone."



Frequency No Trip Boundaries Examples

➤ Non-Compliant

Attachment 1
(Frequency No Trip Boundaries by Interconnection⁸)

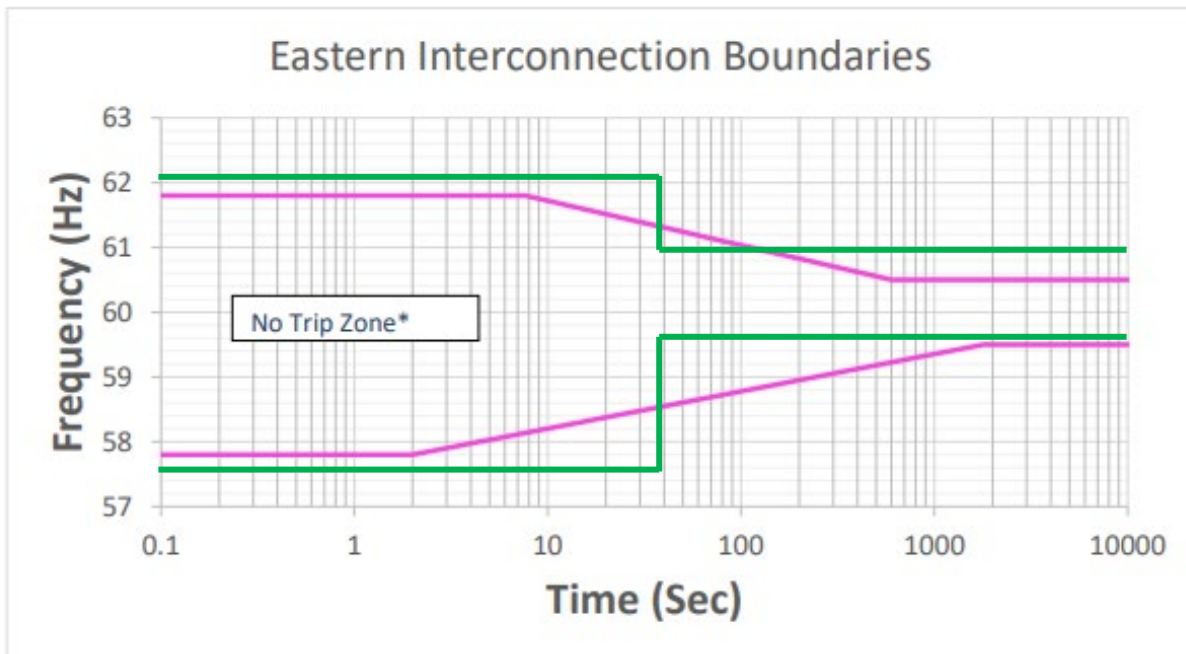


Figure 1

* The area outside the "No Trip Zone" is not a "Must Trip Zone."

➤ Compliant

Attachment 1
(Frequency No Trip Boundaries by Interconnection⁸)

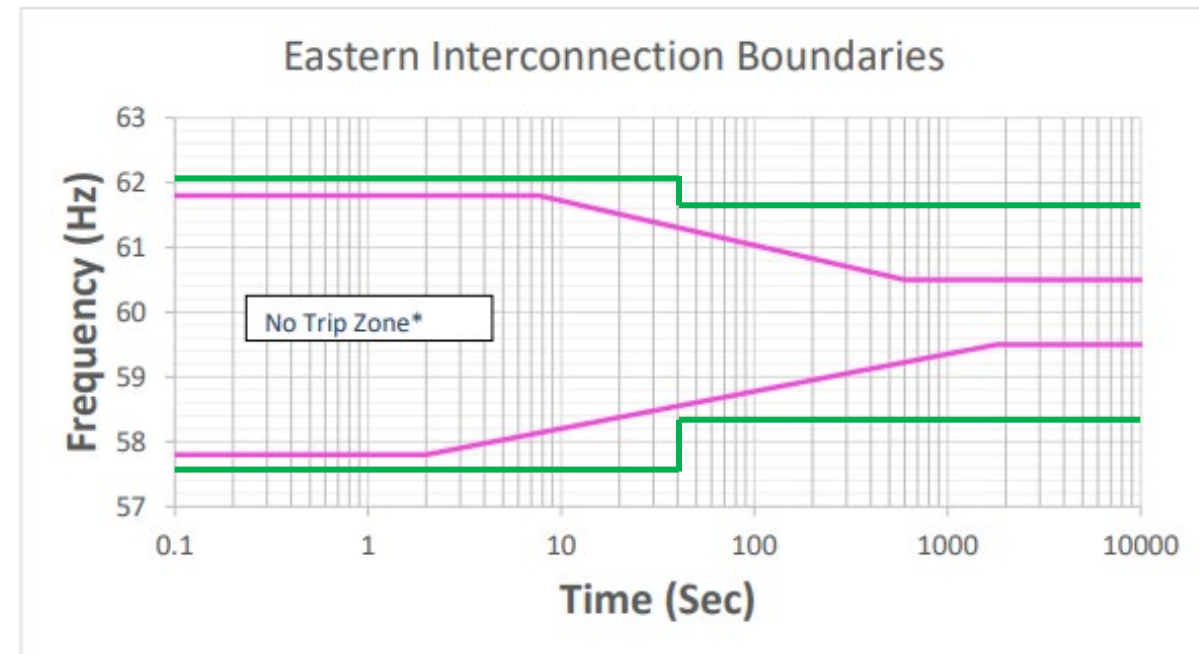
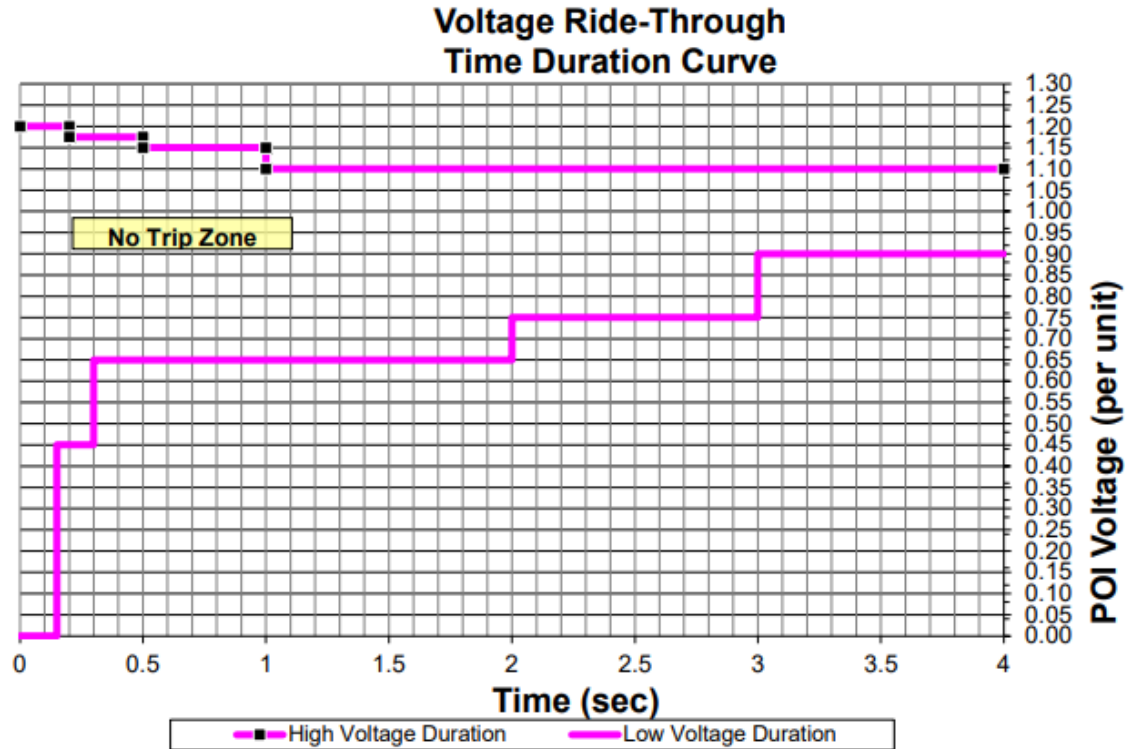


Figure 1

* The area outside the "No Trip Zone" is not a "Must Trip Zone."

Attachment 2 Changes

➤ PRC-024-2



➤ PRC-024-3

PRC-024 — Attachment 2
(Voltage No-Trip Boundaries – Eastern, Western, and ERCOT Interconnections)

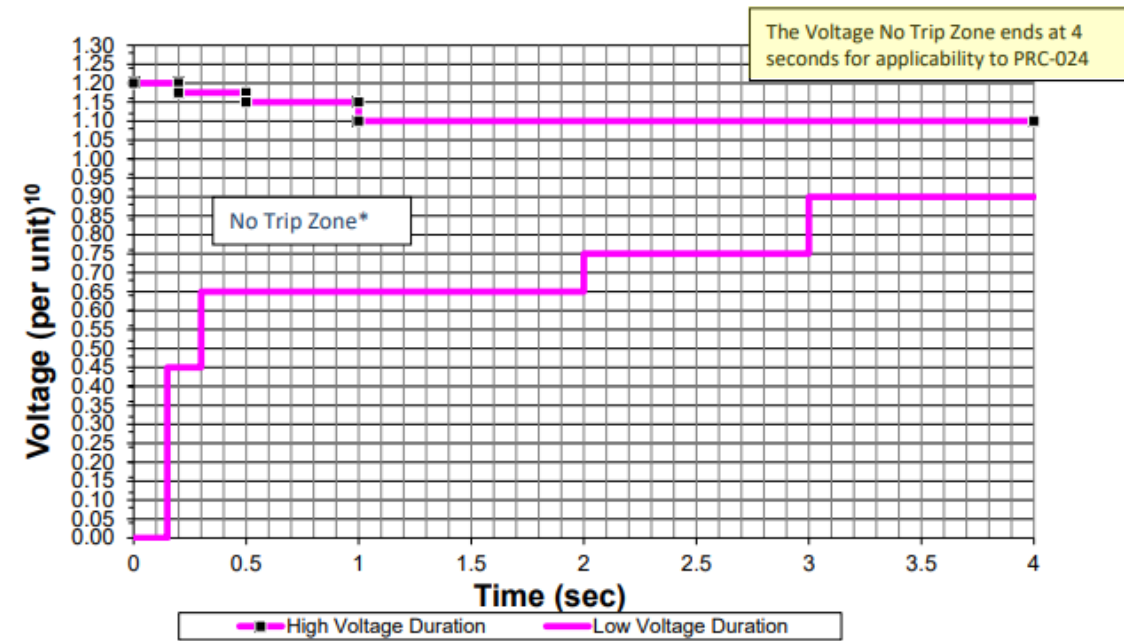


Figure 1

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Voltage No Trip Boundaries Examples

➤ Non-Compliant

PRC-024 — Attachment 2

(Voltage No-Trip Boundaries – Eastern, Western, and ERCOT Interconnections)

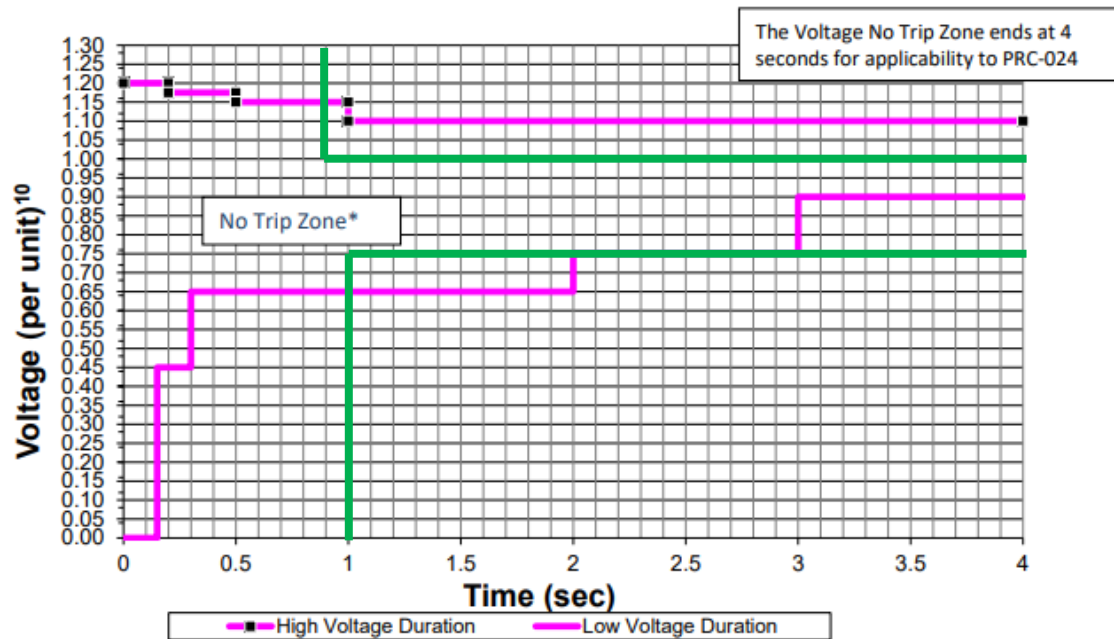


Figure 1

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➤ Compliant

PRC-024 — Attachment 2

(Voltage No-Trip Boundaries – Eastern, Western, and ERCOT Interconnections)

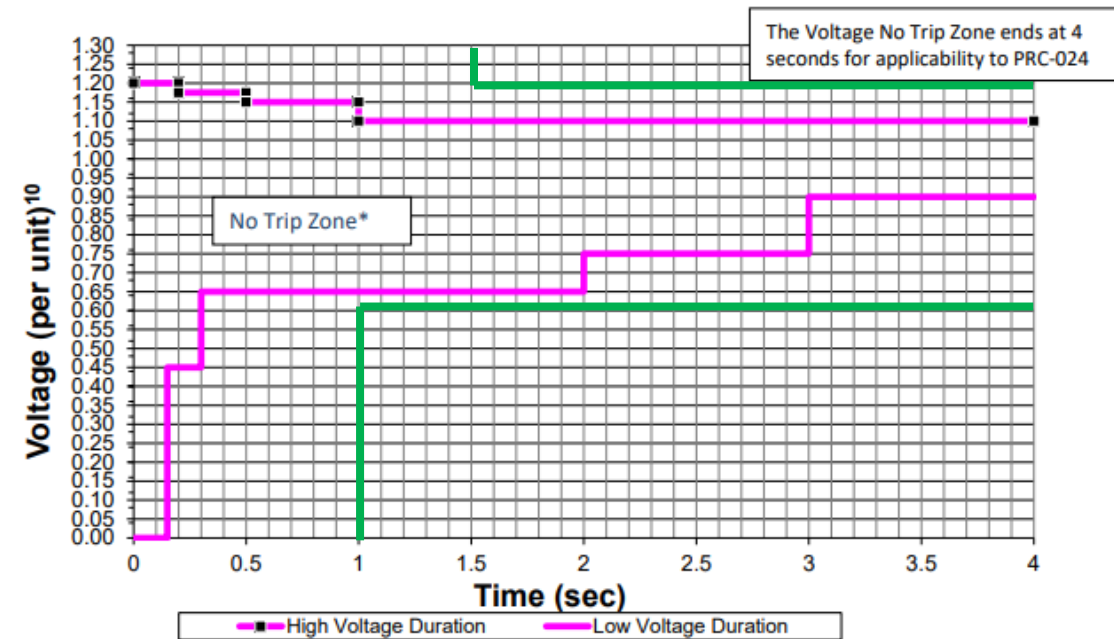


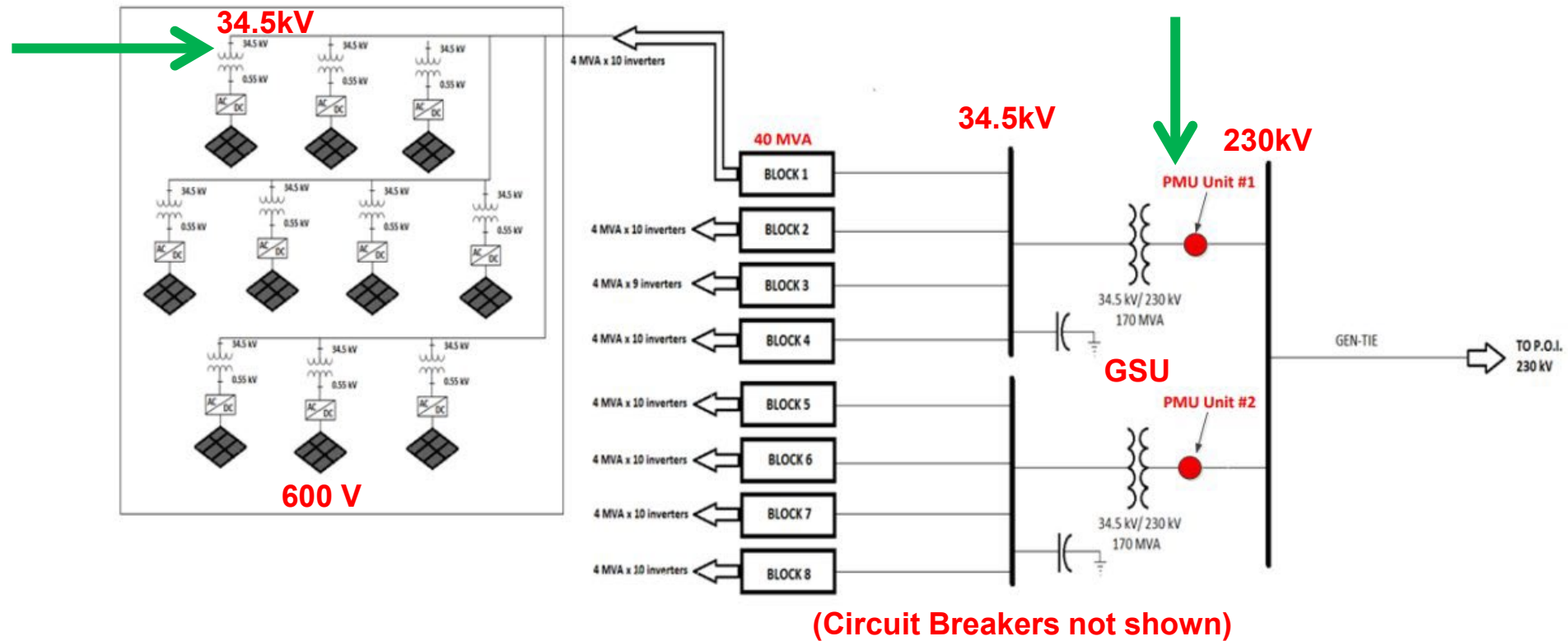
Figure 1

* The area outside the "No Trip Zone" is not a "Must Trip Zone."



Evaluating Voltage Protection Settings

- ***“The voltage values in the Attachment 2 voltage boundaries are voltages at the high side of the GSU/MPT.”***



Related Links

➤ Generator Voltage Protective Relay Settings

- https://www.nerc.com/pa/comp/guidance/EROEndorsedImplementationGuidance/PRC-024-2%20R2%20Generator%20Frequency%20and%20Voltage%20Protective%20Relay%20Settings%20.._.pdf

➤ Multiple Solar PV Disturbances in CAISO

- https://www.nerc.com/pa/rrm/ea/Documents/NERC_2021_California_Solar_PV_Disturbances_Report.pdf

➤ PRC-024-2 Gaps Whitepaper

- <https://www.nerc.com/pa/Stand/Project%20201804%20Modifications%20to%20PRC0242/NERC%20IRPTF%20PRC-024-2%20Gaps%20Whitepaper.pdf>

➤ PRC-024-3 – Summary of Key Changes

- https://www.nerc.com/pa/Stand/Project%20201804%20Modifications%20to%20PRC0242/2018-04_PRC-024-3_Summary_of_Key_Changes_04232019.pdf

➤ Reliability Guideline BPS-Connected Inverter-Based Resource Performance

- https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Inverter-Based_Resource_Performance_Guideline.pdf



Recap

- **Non-Compliance and Trends**
- **Effective Date**
- **Standard Overview**
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- **Changes**
- **How can RF Support?**



How Can RF Support?

Assist Visits

- Answer technical questions outside of an audit
- Discuss challenges and lessons learned
- Get started with our online [Assist Visit Form](#)

Evaluations

- Management Practice Self Assessment
- Incident Response Preparedness Assessment
- Resilience Assessment

Additional Resources

- Quarterly Newsletter
- Knowledge Center
- Webinars and Workshops



Questions & Answers

Forward Together  **ReliabilityFirst**