

# An Introduction to Completing a NERC PRC-019-2 Study For Synchronous and Distributed Generation Sources

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# Presentation Goals

*Describe the PRC-019-2 reliability standard*

*Overview a typical synchronous generation PRC-019 study*

*Explain the impact of applying PRC-019 to include asynchronous generation facilities*

*Show an interpretation of how to demonstrate compliance for asynchronous generation facilities*

*Challenges and lessons learned*

# NERC Reliability Standards

- Developed in response to the 2003 Northeast United States Blackout
- Goal to improve the performance and reliability of the bulk electric power system (BES)
- Compliance requirements are typically clearly defined
- Protection and Control (PRC)

# NERC PRC-019-2

- PRC-019-2: Coordination of Generating Unit or Plant Capabilities, Voltage Regulating, Controls, and Protection
  - *Rev. 2 adopted by NERC board of trustees Nov. '15*
- Purpose-“verify coordination of generating unit facility or synchronous condenser voltage regulating controls, limit functions, equipment capabilities and protection system settings.”



R1

1.1.1 “The in-service limiters are set to operate before the Protection System of the applicable Facility in order to avoid disconnecting the generator unnecessarily.”



R1

1.1.2 “The applicable in-service Protection System devices are set to operate to isolate or de-energize equipment in order to limit the extent of damage when operating conditions exceed equipment capabilities or stability limits.”



R2

Resubmit PRC-019-2 documentation within 90 calendar days of applicable equipment or setting change

# PRC-019-2 Requirements

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P-Q Diagram

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R-X Diagram

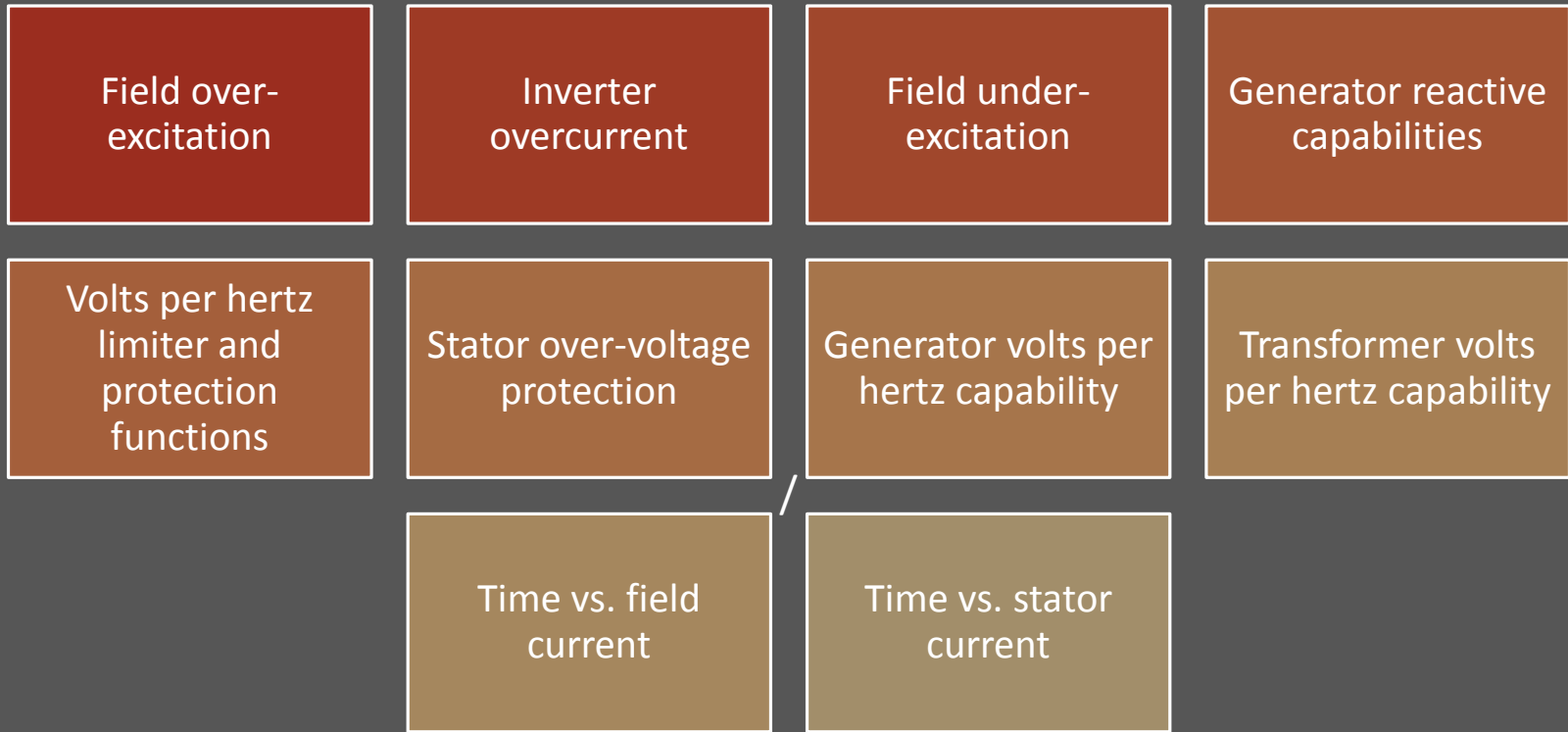
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Inverse Time Diagram

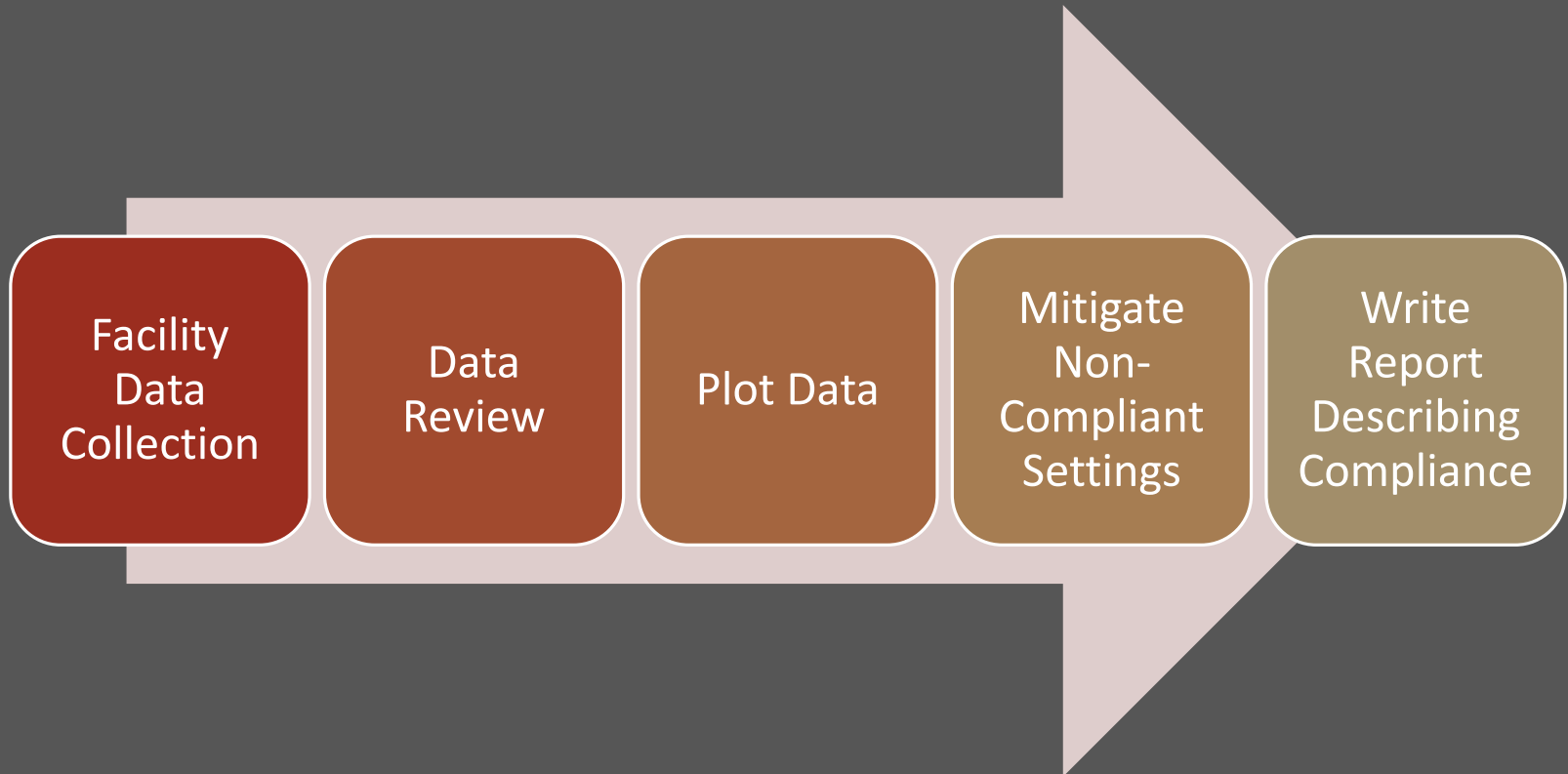
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Equivalent tables

Examples of Coordination Evidence



## Examples of Equipment Capabilities, Limiters, and Protection Functions



# Synchronous Generator Study Process



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Generator capability

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Limiter settings

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Protection settings

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GSU & generator Volts/Hertz capabilities

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Voltage regulation system manual

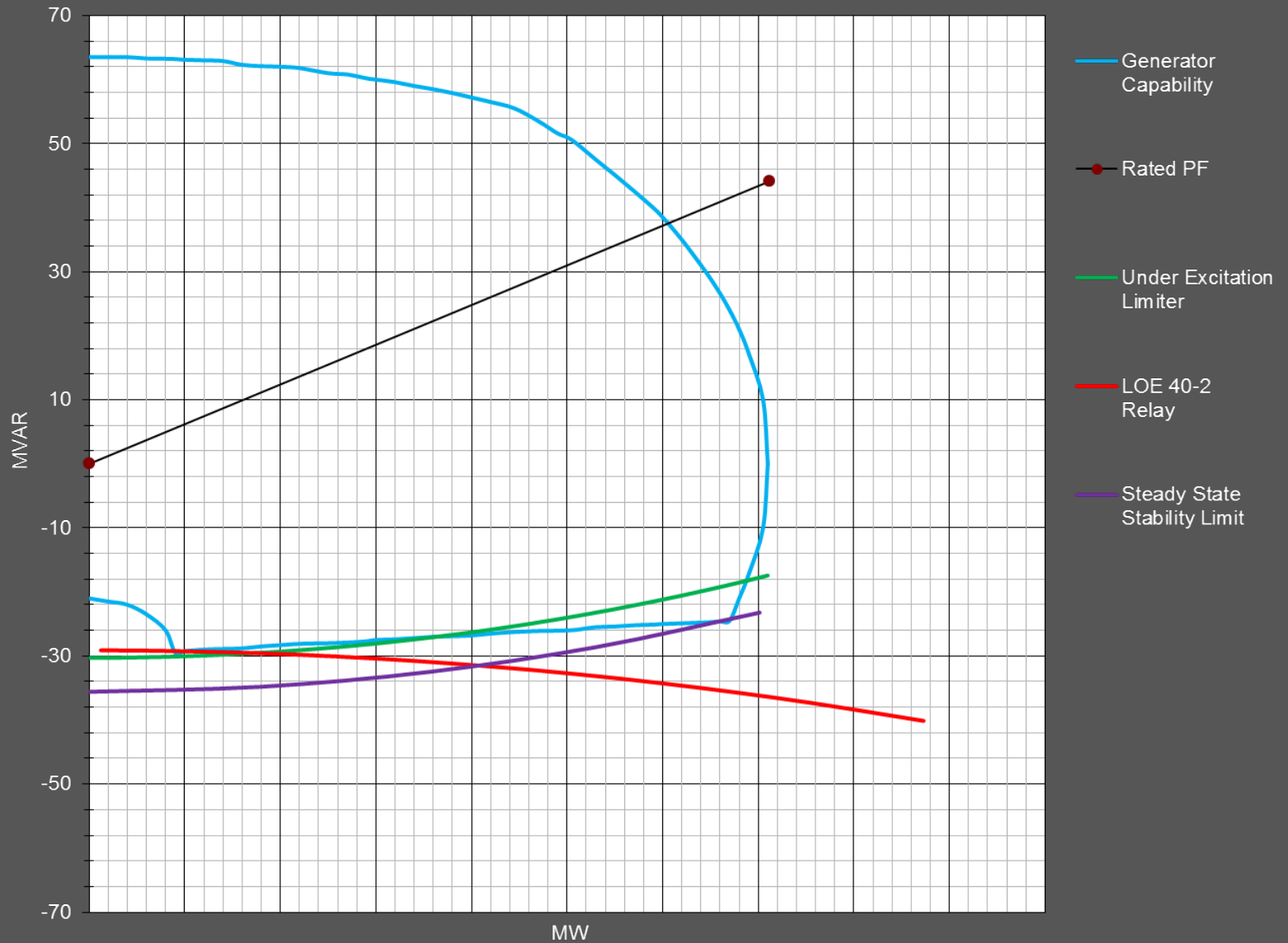
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One and three line diagrams

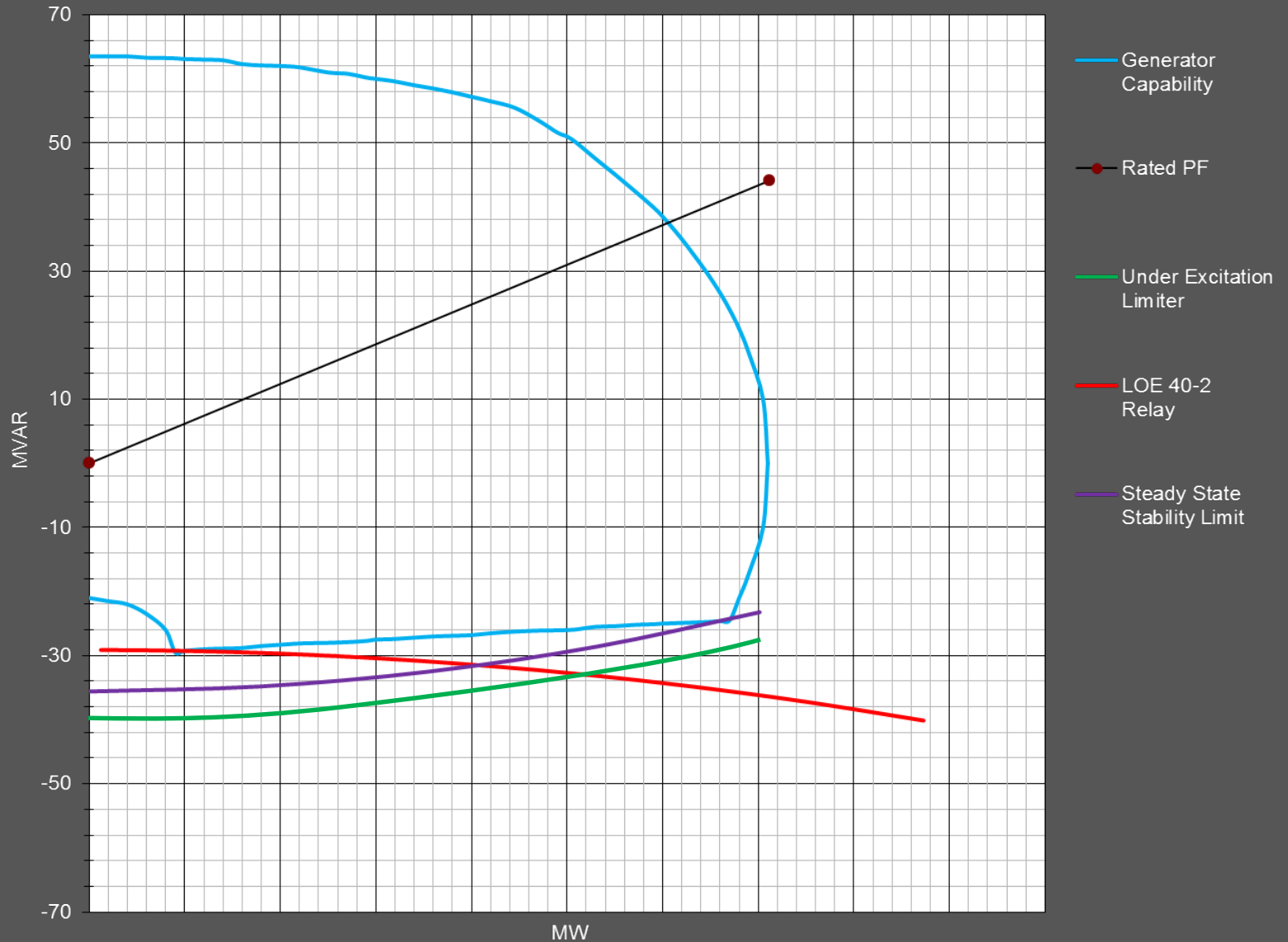
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# Facility Data Required

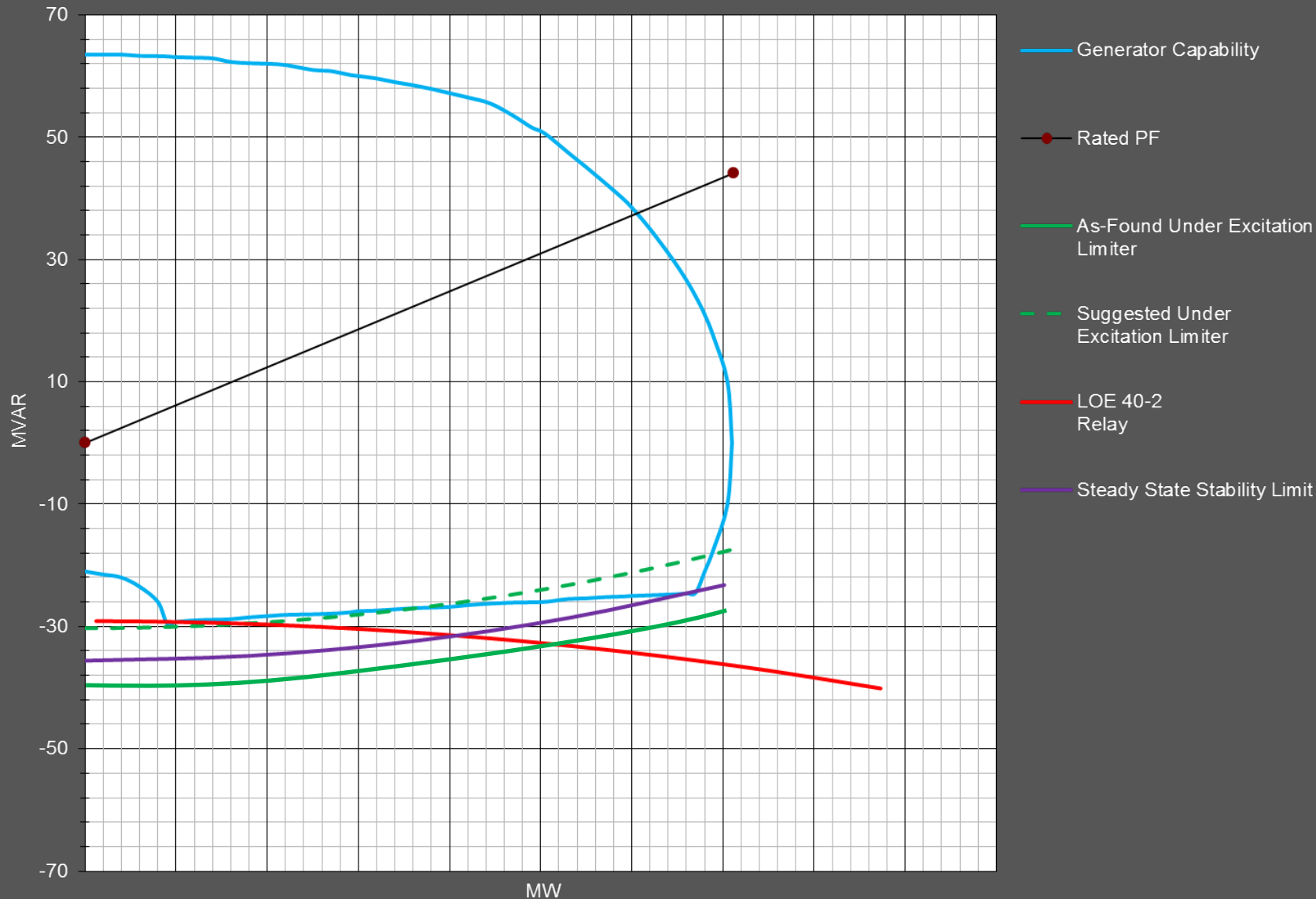
# Compliant P-Q Plot



# Non-Compliant P-Q Plot



# Suggested Settings P-Q Plot



# Final Report

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All conclusions from study in single, cohesive report

Progress from high-level summary to detailed discussion

Report should assist in generating audit worksheet

Report will have a range of audiences

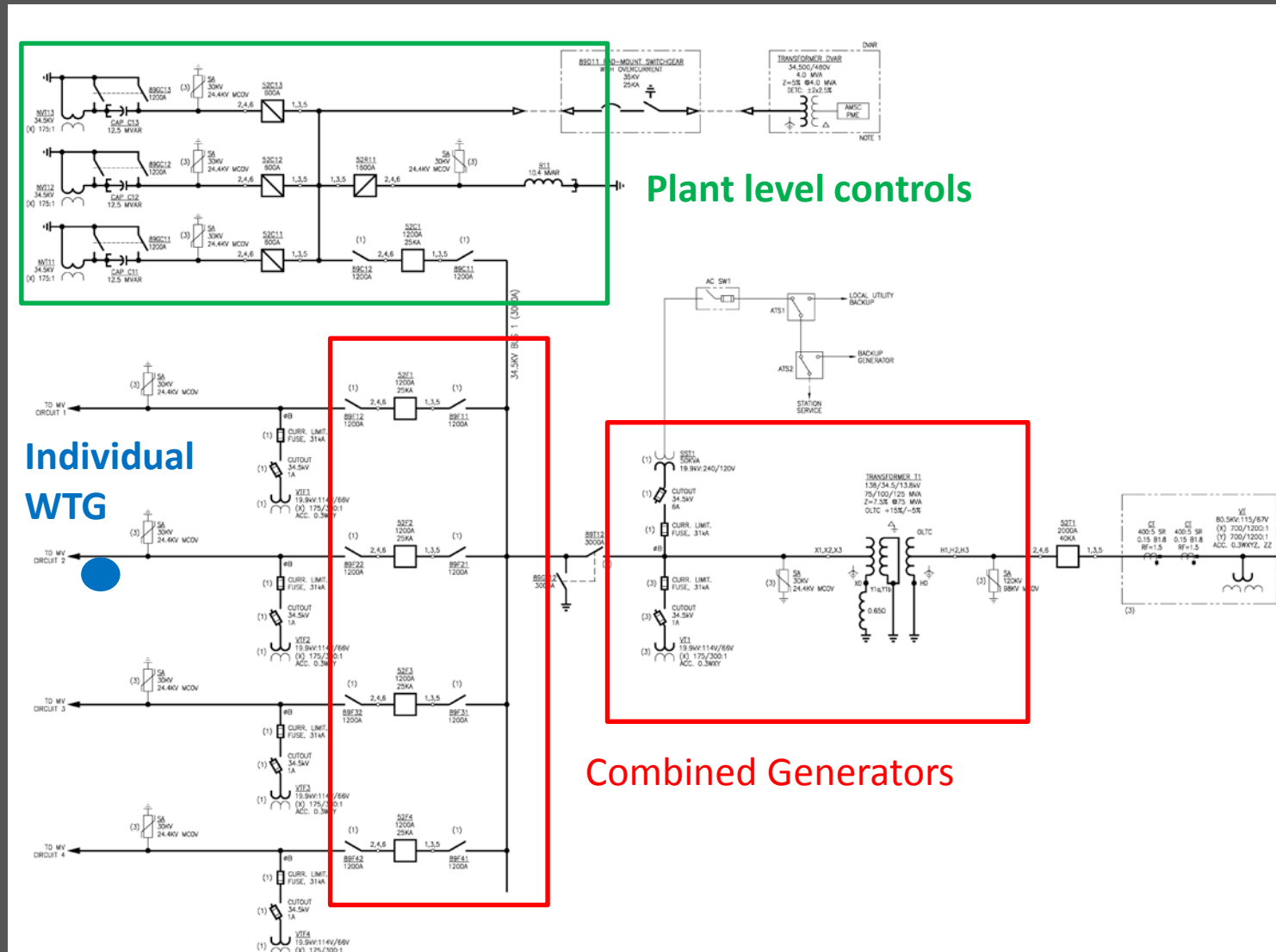
Document as-found and suggested settings if mitigation was necessary

**What about Asynchronous Generators?**

# Distributed or Asynchronous Generation Facilities

- Revision of the bulk electric power system (BES) definition
  - Includes dispersed generating facilities as applicable facilities
- NERC PRC-019 Revision 2
  - Addition of 4.2.3.1 identifies dispersed power producing resources, even where voltage regulating control is performed solely at the individual generating unit is included as applicable facilities.
- What are typical Asynchronous Generators?
  - Solar PV
  - Wind Turbines (Type I, II, III, IV)
- Synchronous vs. Asynchronous Generators

# Asynchronous Facility Analysis



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WTG diagram

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WTG characteristics

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Rotor power output limit

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Converter power output limit

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Short and long time total power output limits

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Main Breaker Protection Settings

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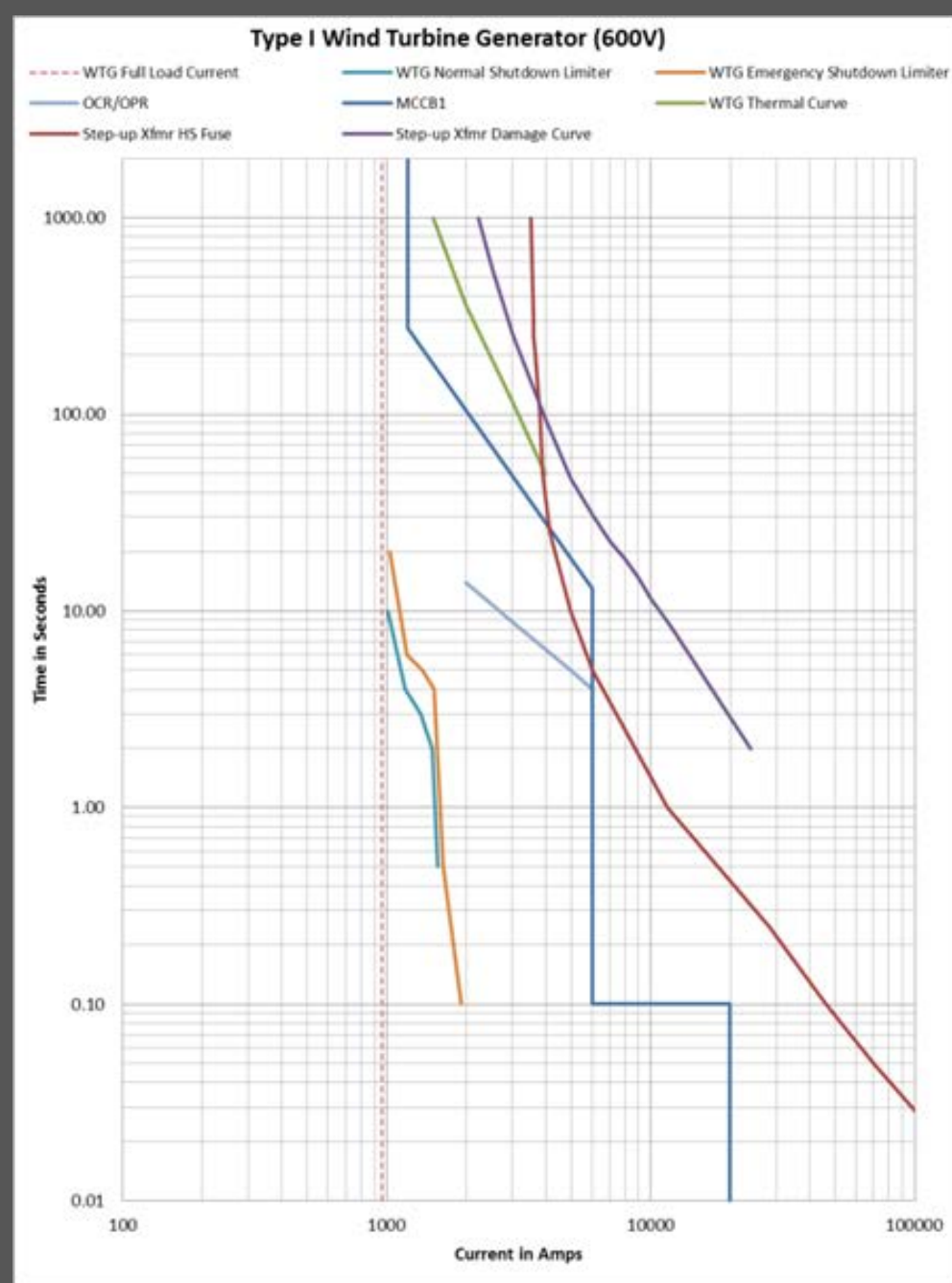
GSU protection settings

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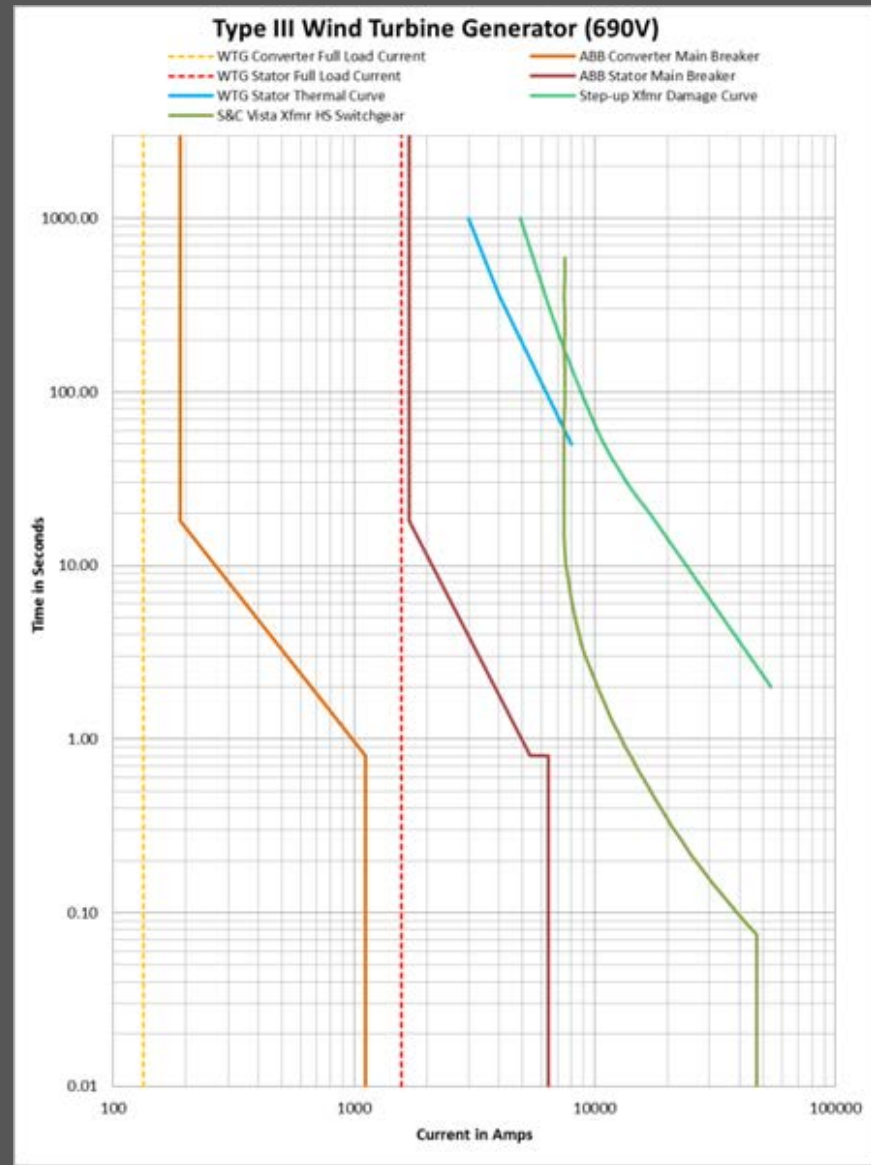
# Individual WTG Data



# Type I WTG TCC



# Type III WTG TCC





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One and three line diagrams

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Feeder protection settings

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Collector/GSU protection settings

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VAR support protection settings

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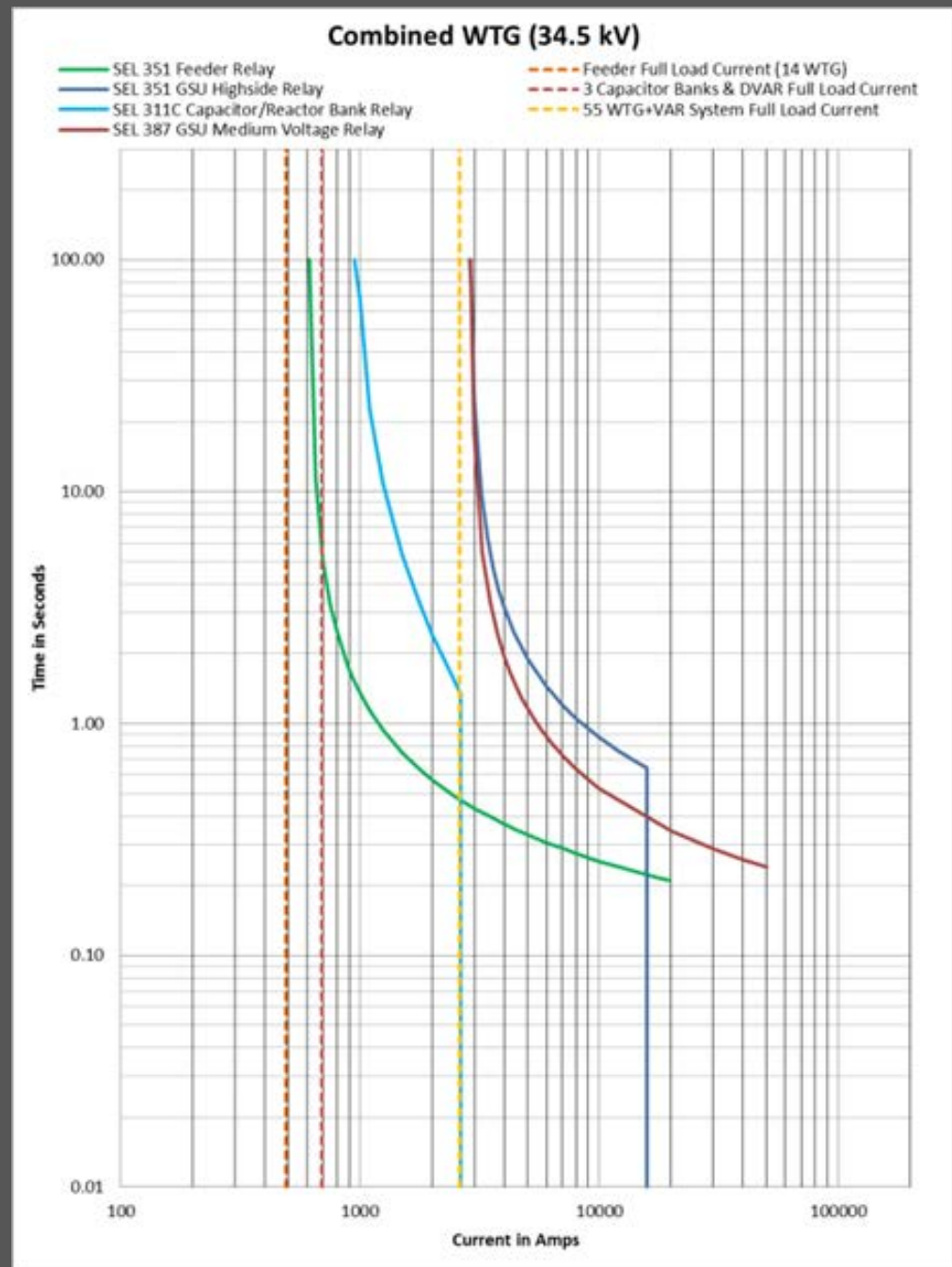
Capacitor bank ratings /

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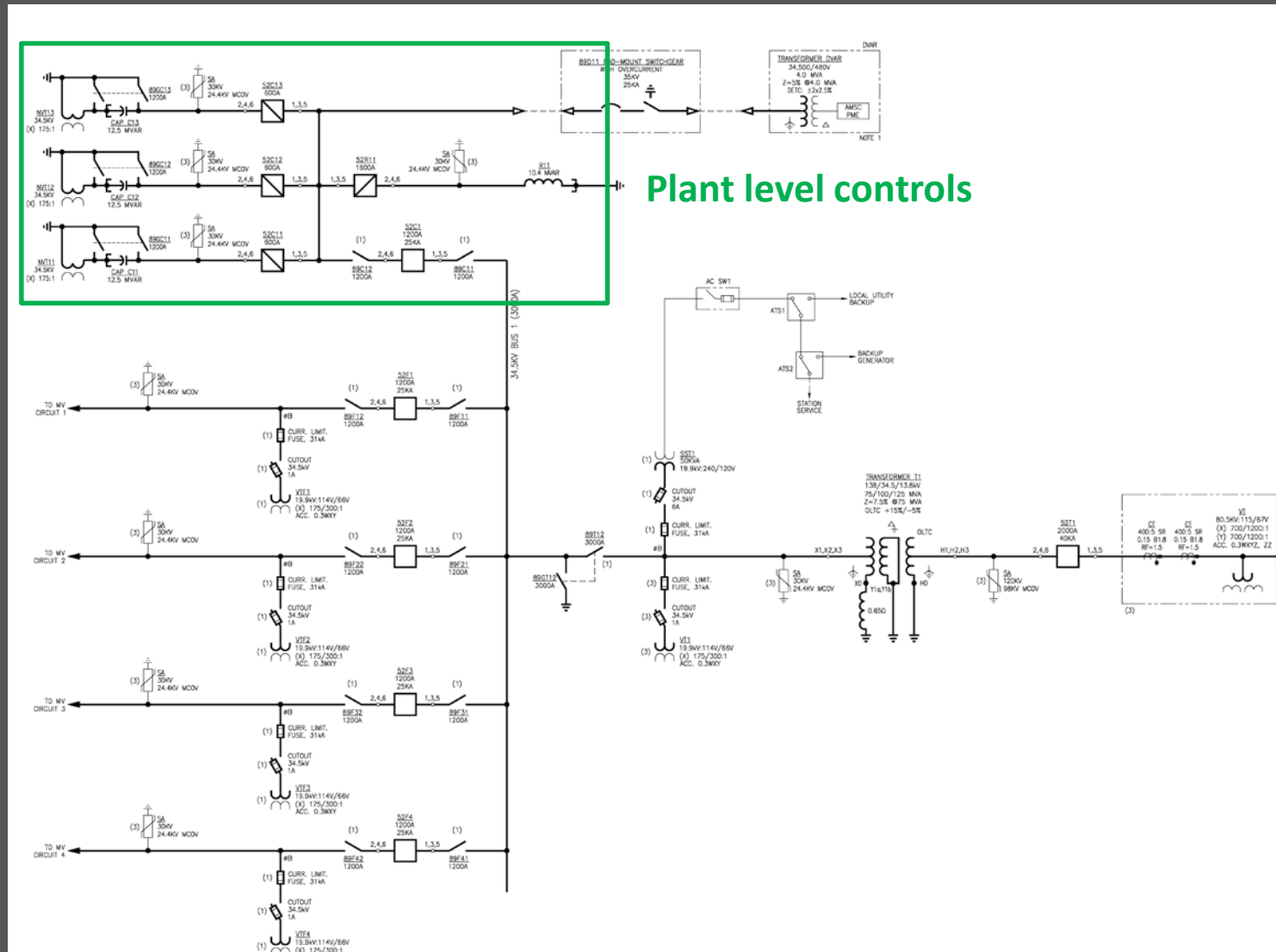
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Combined WTG Data

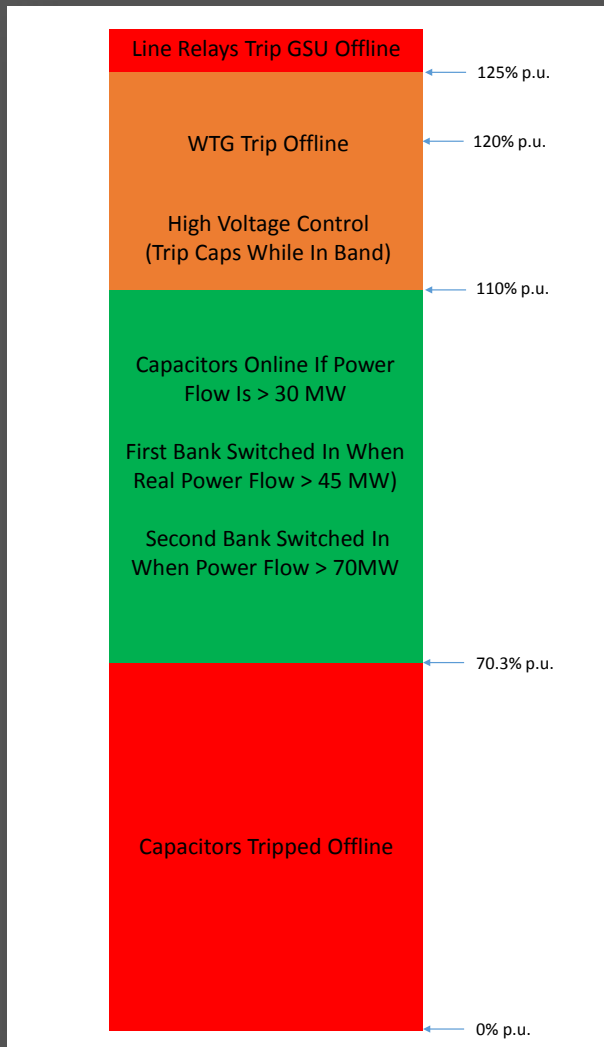
# Collector & GSU TCC



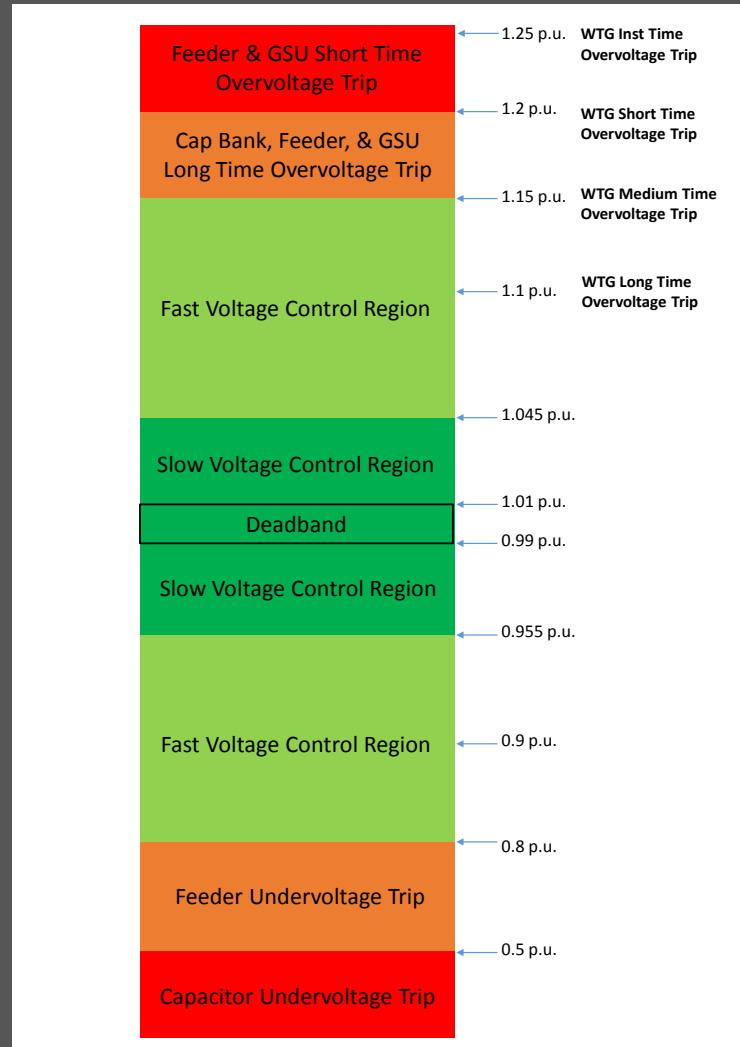
# Plant Level Control Analysis



# VAR Control Schemes

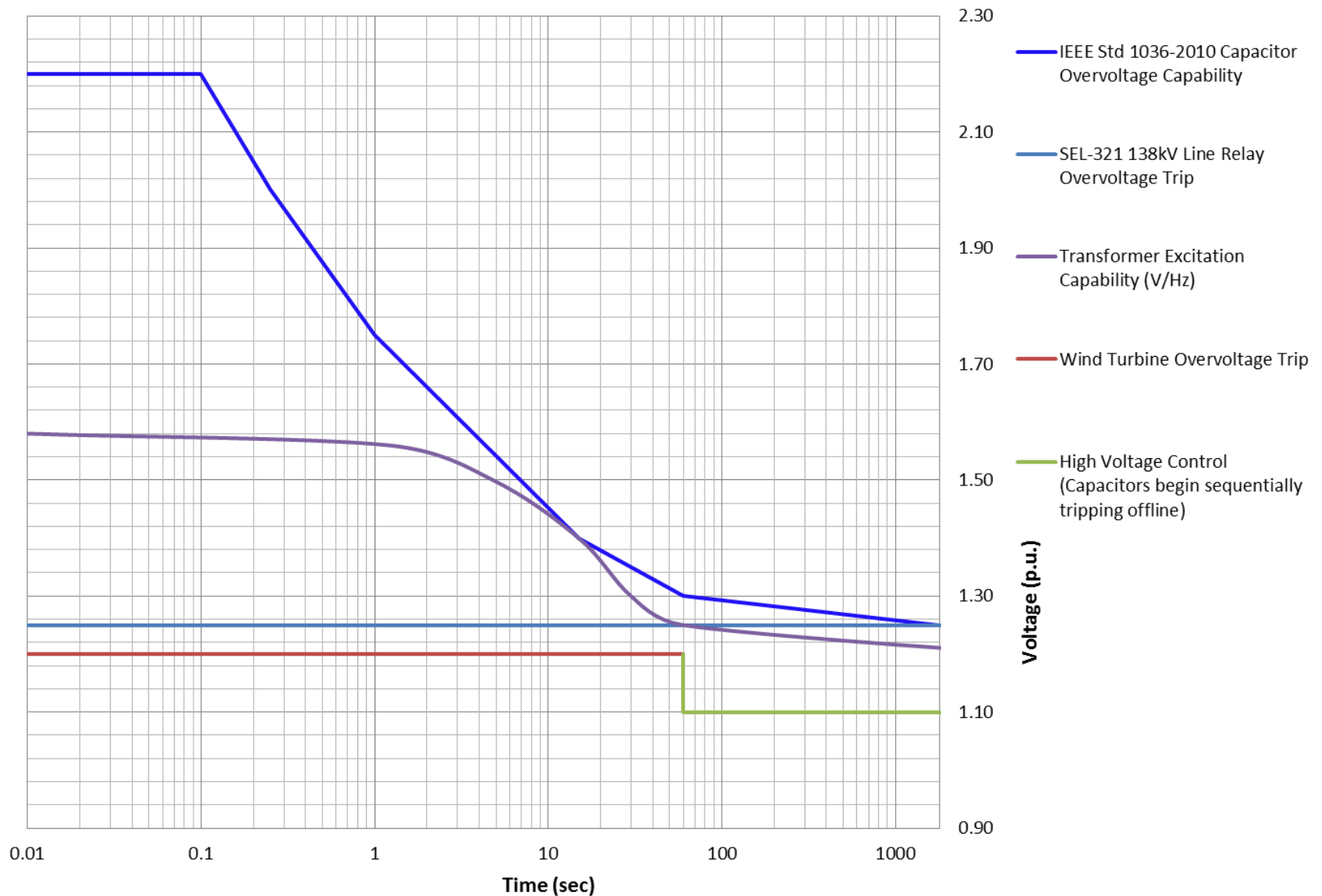


Power Flow Control



Voltage Control

# Voltage Coordination Plot





# Challenges & Lessons Learned

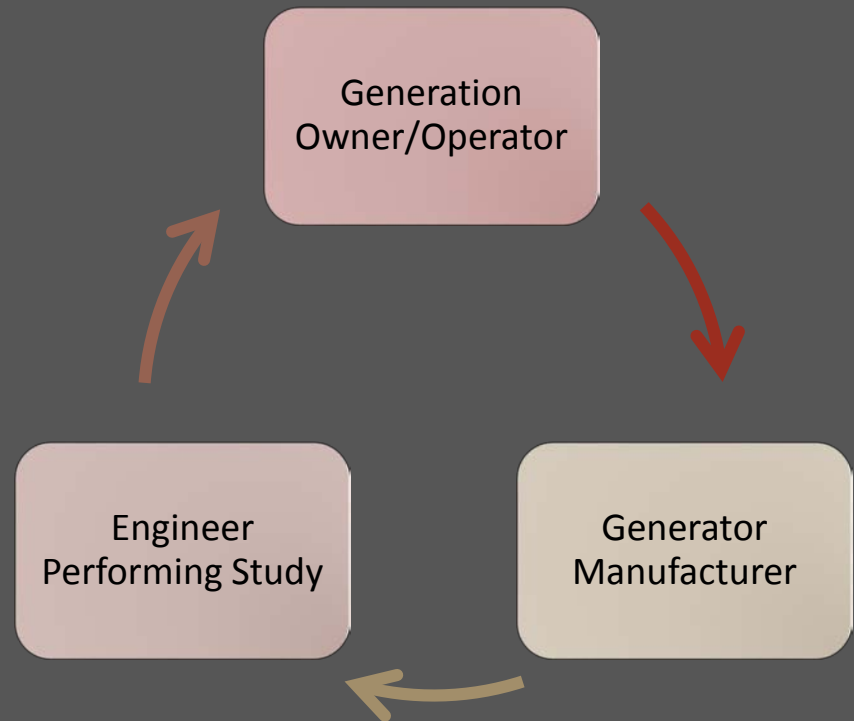
## Regulatory Interpretation

- Justify your interpretation to compliance auditor
- Documentation requirements can vary by regulatory district
- Focus on walking compliance auditor through study process to arrive at the same conclusions

# Challenges & Lessons Learned

## Data Availability

- Data lost, poor readability, or never delivered
- Atypical data forms
- Data required from manufactures considered proprietary



# Challenges & Lessons Learned

## Additional Questions

- Coordination of volts/hertz protection of the GSU transformer
- GSU Volts/Hertz equipment capability
- Capacitor bank equipment capability
- Tolerance of VAR support system (demonstrate the active voltage band for control)
- Coordination graphs showing VAR/Voltage control scheme, relay settings, and relevant equipment capabilities.

# Conclusions



Plan  
Ahead

Keep it  
Simple

Take it  
Slow

Combine  
Studies

Questions?