

## Agenda

### Generator Verification SDT — Project 2007-09

November 11, 2009 | 8 a.m. – 5 p.m. Mountain

November 12, 2009 | 8 a.m. – 4 p.m. Mountain

PacifiCorp  
1407 W. North Temple  
Salt Lake City, UT 84116

#### 1. **Introductions**

The vice chair, Lee Taylor will welcome everyone to the meeting and review the agenda.

#### 2. **Review NERC Antitrust Compliance Guideline** [Attachment 1]

#### 3. **Purpose and Agenda**

Purpose:

The Standard Drafting Team (SDT) is working on the following set of standards:

MOD-024-2 — Verification of Generator Gross and Net Real Power Capability

MOD-025-2 — Verification of Generator Gross and Net Reactive Power Capability

MOD-026-1 — Verification of Models and Data for Generator Excitation System  
Functions

MOD-027-1 — Verification of Generator Unit Frequency Response

PRC-019-1 — Coordination of Generator Voltage Regulator Controls with Unit  
Capabilities and Protection

PRC-024-1 — Generator Performance during Frequency and Voltage Excursions

The goal of this meeting are: 1) to review and appropriately modify the draft standards in response to NERC staff comments relating to the upcoming second posting of PRC-024, MOD-026, and the first posting of MOD-024, and 2) time permitting, review the progress made to date by the sub teams for the standards that have not yet been posted for industry comments (MOD-025, MOD-027, and potentially PRC-019) followed by full team input to the sub team regarding the proposed strategy for subsequent final first posting drafts.

#### AGENDA:

- I. Discuss status of NERC document to address modeling of equipment for reliability purposes that is deemed “confidential and/or proprietary” by manufacturers.  
[Attachment 2]

- II. Discuss possibility of requesting PRC-005 SDT to include anticipated draft requirements of PRC-019 – and withdrawing PRC-019 from the Generation Verification Standard Drafting Team Effort
  - III. Update on Reliability based Standard development (Maureen Long – 1pm – 2pm, Wednesday, November 11) Conference call details: call-in number (866) 740-1260; access code number 1134179.
  - IV. Sub team review and appropriate draft standard modifications of NERC staff comments (MOD-024, MOD-026, and PRC-024)
  - V. **MOD-025-1:** Full team review of strategy and draft documents. Formulate strategy to complete documents for first posting. [Attachments 3 and 3a]
  - VI. **MOD-027-1:** Full team review of strategy and draft documents. Formulate strategy to complete documents for first posting, and strategy to pull MOD-027-1 into the same timeline as MOD-026-1.
  - VII. **PRC-019-1** Full team review of strategy and draft documents. Formulate strategy to complete documents for first posting. [Attachment 4]
4. **Review current schedule.** [Attachment 5]
5. **Next Actions**  
Determine if a meeting in Dallas Texas, on Tuesday December 8 (8am – 5pm CST) and December 9 (8am – 4pm CST) will be necessary in order to discuss the draft standards that are yet to be posted (MOD-025, MOD-027, and potentially PRC-019).

A meeting will be held in Juno Beach on January 19 and 20, 2010. The main agenda topics will be associated with review of industry comments received from the postings of MOD-024, MOD-026, and PRC-024.

A follow up meeting to finalize those comments and discuss subsequent revisions to the standards, and discuss as the standards being prepared for their initial postings, will be held approximately 4 to 6 weeks after the Juno Beach meeting – exact time and place yet to be determined.

## Antitrust Compliance Guidelines

### I. General

It is NERC's policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition.

It is the responsibility of every NERC participant and employee who may in any way affect NERC's compliance with the antitrust laws to carry out this commitment.

Antitrust laws are complex and subject to court interpretation that can vary over time and from one court to another. The purpose of these guidelines is to alert NERC participants and employees to potential antitrust problems and to set forth policies to be followed with respect to activities that may involve antitrust considerations. In some instances, the NERC policy contained in these guidelines is stricter than the applicable antitrust laws. Any NERC participant or employee who is uncertain about the legal ramifications of a particular course of conduct or who has doubts or concerns about whether NERC's antitrust compliance policy is implicated in any situation should consult NERC's General Counsel immediately.

### II. Prohibited Activities

Participants in NERC activities (including those of its committees and subgroups) should refrain from the following when acting in their capacity as participants in NERC activities (e.g., at NERC meetings, conference calls and in informal discussions):

- Discussions involving pricing information, especially margin (profit) and internal cost information and participants' expectations as to their future prices or internal costs.
- Discussions of a participant's marketing strategies.
- Discussions regarding how customers and geographical areas are to be divided among competitors.

- Discussions concerning the exclusion of competitors from markets.
- Discussions concerning boycotting or group refusals to deal with competitors, vendors or suppliers.
- Any other matters that do not clearly fall within these guidelines should be reviewed with NERC's General Counsel before being discussed.

### **III. Activities That Are Permitted**

From time to time decisions or actions of NERC (including those of its committees and subgroups) may have a negative impact on particular entities and thus in that sense adversely impact competition. Decisions and actions by NERC (including its committees and subgroups) should only be undertaken for the purpose of promoting and maintaining the reliability and adequacy of the bulk power system. If you do not have a legitimate purpose consistent with this objective for discussing a matter, please refrain from discussing the matter during NERC meetings and in other NERC-related communications.

You should also ensure that NERC procedures, including those set forth in NERC's Certificate of Incorporation, Bylaws, and Rules of Procedure are followed in conducting NERC business.

In addition, all discussions in NERC meetings and other NERC-related communications should be within the scope of the mandate for or assignment to the particular NERC committee or subgroup, as well as within the scope of the published agenda for the meeting.

No decisions should be made nor any actions taken in NERC activities for the purpose of giving an industry participant or group of participants a competitive advantage over other participants. In particular, decisions with respect to setting, revising, or assessing compliance with NERC reliability standards should not be influenced by anti-competitive motivations.

Subject to the foregoing restrictions, participants in NERC activities may discuss:

- Reliability matters relating to the bulk power system, including operation and planning matters such as establishing or revising reliability standards, special operating procedures, operating transfer capabilities, and plans for new facilities.
- Matters relating to the impact of reliability standards for the bulk power system on electricity markets, and the impact of electricity market operations on the reliability of the bulk power system.
- Proposed filings or other communications with state or federal regulatory authorities or other governmental entities.
- Matters relating to the internal governance, management and operation of NERC, such as nominations for vacant committee positions, budgeting and assessments, and employment matters; and procedural matters such as planning and scheduling meetings.




NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

October, 2009

**DRAFT Letter to Turbine Generator Manufacturers  
and Vendors of Generator Modeling Software**

Review of the reliability of the bulk electric system has been an industry requirement since the inception of NERC in 1968. The primary tool for assessing day-to-day and future reliability of the power system during normal loading and fault conditions is through the use of software which simulates the interconnected generators and their controls, transmission lines and devices, and customer loads. These simulations use mathematical representations of the equipment ("models"), developed by the equipment vendors and standards organizations such as ANSI and IEEE, with device-specific "parameters" which identify the characteristics of the individual systems. Information about new equipment or changes to existing equipment are communicated by the generator, transmission provider or load entity in the form of model data sheets typically including the model block diagram and the device-specific parameters, or simply as an electronic file in a format suitable for the transmission planner to use in their simulation software.

There are a variety of different software vendors who provide appropriate tools for the purpose of performing these studies, and there are many equipment vendors who manufacture the equipment. In addition, equipment designs change over time, and new equipment becomes available which must be added to the simulation study data. It must be noted that these models and parameters do not constitute "design" data; the information supplied is of a generic nature to allow the performance of system stability studies, and does not include information specific to the construction, maintenance, cost or other commercial information about the device to be modeled. The model data by itself has no commercial value. Additionally, the transmission planner and generator or load entity has a contractual obligation via their interconnection agreement which prohibits the disclosure of one entities' data to another competing entity. Thus the data provided by the generator to the transmission planner for the purposes of system studies may be used by the transmission planner, but not retransmitted to other parties.



Despite these facts, it has become increasingly common for hardware and software vendors to include labels and disclaimers on their model block diagrams and data sheets such as "proprietary", "confidential", and "not be copied, disclosed, retransmitted" etc.

Clearly, the necessary studies cannot be performed without the subject models and data, and the transmission planner and generator or load entity or their designated agents must have free access to the study data in order to meet regulatory reliability requirements.

Specific examples, but not a comprehensive list of the required data is as follows:

- generator impedances,
- time constants and total rotor-turbine inertia
- generator open circuit saturation curve, "V" curves and capability curves
- excitation control system block diagram and parameters
- impedance compensator block diagram and parameters
- power system stabilizer block diagram and parameters
- excitation limiter block diagram and parameters
- turbine governor block diagram and parameters.

Sincerely,

Staff Name

Staff Title

## Standard MOD-025-1 — Verification of Generator Gross and Net Reactive Power Capability

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### A. Introduction

1. **Title:** Verification of Generator Gross and Net Reactive Power Capability
2. **Number:** MOD-025-1
3. **Purpose:** To ensure accurate information on generator gross and net Reactive Power capability is available for steady-state models used to assess Bulk Electric System reliability.
4. **Applicability**
  - 4.1. Regional Reliability Organization.
  - 4.2. Generator Owner.
5. **Effective Dates:**

Requirement 1 and Requirement 2 — January 1, 2007

Requirement 3:

  - January 1, 2008 — 1<sup>st</sup> 20% compliant
  - January 1, 2009 — 2<sup>nd</sup> 20% compliant
  - January 1, 2010 — 3<sup>rd</sup> 20% compliant
  - January 1, 2011 — 4<sup>th</sup> 20% compliant
  - January 1, 2012 — 5<sup>th</sup> 20% compliant

### B. Requirements

- R1. The Regional Reliability Organization shall establish and maintain procedures to address verification of generator gross and net Reactive Power capability. These procedures shall include the following:
  - R1.1. Generating unit exemption criteria including documentation of those units that are exempt from a portion or all of these procedures.
  - R1.2. Criteria for reporting generating unit auxiliary loads.
  - R1.3. Acceptable methods for model and data verification, including any applicable conditions under which the data should be verified. Such methods can include use of commissioning data, performance tracking, engineering analysis, testing, etc.
  - R1.4. Periodicity and schedule of model and data verification and reporting.
  - R1.5. Information to be reported:
    - R1.5.1. Verified maximum gross and net Reactive Power capability (both lagging and leading) at Seasonal Real Power generating capabilities as reported in accordance with Reliability Standard MOD-024 Requirement 1.5.1.
    - R1.5.2. Verified Reactive Power limitations, such as generator terminal voltage limitations, shorted rotor turns, etc.
    - R1.5.3. Verified Reactive Power of auxiliary loads.
    - R1.5.4. Method of verification, including date and conditions.
- R2. The Regional Reliability Organization shall provide its generator gross and net Reactive Power capability verification and reporting procedures, and any changes to those procedures, to the

Generator Owners, Generator Operators, Transmission Operators, Planning Authorities, and Transmission Planners affected by the procedure within 30 calendar days of the approval.

- R3.** The Generator Owner shall follow its Regional Reliability Organization's procedures for verifying and reporting its gross and net Reactive Power generating capability per R1.

**C. Measures**

- M1.** The Regional Reliability Organization shall have available for inspection the procedures for the verification and reporting of generator gross and net Reactive Power capability in accordance with R1.
- M2.** The Regional Reliability Organization shall have evidence that its procedures, and any revisions to these procedures, for verification and reporting of generator gross and net Reactive Power capability were provided to affected Generator Owners, Generator Operators, Transmission Operators, Planning Authorities, and Transmission Planners within 30 calendar days of approval.
- M3.** The Generator Owner shall have evidence it provided verified information of its generator gross and net Reactive Power capability, consistent with that Regional Reliability Organization's procedures.

**D. Compliance**

**1. Compliance Monitoring Process**

**1.1. Compliance Monitoring Responsibility**

For Regional Reliability Organization: NERC.

For Generator Owner: Regional Reliability Organization.

**1.2. Compliance Monitoring Period and Reset Timeframe**

One calendar year.

**1.3. Data Retention**

The Regional Reliability Organization shall retain both the current and previous version of the procedures.

The Generator Owner shall retain information from the most current and prior verification.

The Compliance Monitor shall retain any audit data for three years.

**1.4. Additional Compliance Information**

The Regional Reliability Organization and Generator Owner shall each demonstrate compliance through self-certification or audit (periodic, as part of targeted monitoring or initiated by complaint or event), as determined by the Compliance Monitor.

**2. Levels of Non-Compliance for Regional Reliability Organization:**

- 2.1. Level 1:** There shall be a level one non-compliance if either of the following conditions is present:

**2.1.1** Procedures did not meet one of the following requirements: R1.1, R1.2 or R1.4.

**2.1.2** No evidence that procedures were distributed as required in R2.

- 2.2. Level 2:** Procedures did not meet two or three of the following requirements: R1.1, R1.2 or R1.4.



- 2.3. **Level 3:** Procedures did not meet R1.3.
- 2.4. **Level 4:** Procedures did not meet R1.5.1, R1.5.2, R1.5.3, or R1.5.4.

**3. Levels of Non-Compliance for Generator Owner:**

- 3.1. **Level 1:** Complete, verified generator data were provided for 98% or more but less than 100% of a Generator Owner’s units as required by the regional procedures.
- 3.2. **Level 2:** Complete, verified generator data were provided for than 96% or more, but less than 98% of a Generator Owner’s units as required by the regional procedures.
- 3.3. **Level 3:** Complete, verified generator data were provided for 94% or more, but less than 96% of a Generator Owner’s units as required by the regional procedures.
- 3.4. **Level 4:** Complete, verified generator data were provided for less than 94% less of a Generator Owner’s units as required by the regional procedures.

**E. Regional Differences**

None identified.

**Version History**

| <b>Version</b> | <b>Date</b> | <b>Action</b>  | <b>Change Tracking</b> |
|----------------|-------------|--|------------------------|
| Version 1      | 12/01/05    | <ol style="list-style-type: none"> <li>1. Changed tabs in footer.</li> <li>2. Removed comma after 2004 in “Development Steps Completed,” #1.</li> <li>3. Changed incorrect use of certain hyphens (-) to “en dash” (–) and “em dash (—).”</li> <li>4. Added “periods” to items where appropriate.</li> <li>5. Changed apostrophes to “smart” symbols.</li> <li>6. Changed “Timeframe” to “Time Frame” in item D, 1.2.</li> <li>7. Lower cased all instances of “regional” in section D.3.</li> </ol> | 01/20/06               |

*For Field Test Purposes Only*

# SERC Field Test Guideline

## Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection

NERC Reliability Standard  
PRC-019



***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

**Revision History**

| <b>Revision</b> | <b>Date</b>     | <b>Comments</b>   |
|-----------------|-----------------|---|
| 0               | August 28, 2006 | GSFT-TF finalized SERC PRC-019-1 Guideline for Field Test purposes. |
|                 |                 |   |
|                 |                 |   |

**Responsible SERC Subgroup & Region Review Group**

The Generator Standard Field Test Task Force (GSFT-TF) has been tasked by the Engineering Committee to develop these field test guidelines and to provide assistance to SERC volunteer members. Responsible SERC Subgroup(s) and the Regional Review Group would be assigned only after the successful ballot and NERC B.O.T adoption of draft NERC Reliability Standard PRC-019.

**Review and Re-Certification Requirements**

Not applicable until the successful ballot and NERC B.O.T adoption of draft NERC Reliability Standard PRC-019.

**Effective Dates:**

Not applicable until the successful ballot and NERC B.O.T adoption of draft NERC Reliability Standard PRC-019.

***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

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**List of Attachments**

- Attachment 1: NERC Reliability Standard MOD-019
- Attachment 2: Example – Over Excitation Capability Coordination
- Attachment 3: Example – Generator Field Over Excitation Limiter/Protection Coordination
- Attachment 4: Example – Volts/Hertz Coordination
- Attachment 5: Example – Under Excitation Capability Coordination
- Attachment 6: Example – Circle and Radius Equations

***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

**I. Introduction**

This SERC field test guideline for the NERC Reliability Standards PRC-019 is intended to:

- 1) Provide guidance for SERC Generator Owners/Operators in conducting studies to show coordination of generator voltage regulator controls with unit capabilities and protection as specified by the NERC Reliability Standards (Section IIIA).
- 2) Document the GSFT-TF recommended exemption criteria (Section IIIA) and sister unit philosophy (Section IIIB).

**II. Definitions**

1. **Generator Capability Curve** –A graphical presentation of data that illustrates the thermal limits of the combined real and reactive power capability of the generator at the specified terminal voltage.
2. **Additional Definitions to be added as needed.**

***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

**III. Requirements/Expectations**

**A. Generator Exemption Criteria [Ref.PRC-019, R2.]**

In order to maximize the use of resources, it is prudent to exempt generators that are believed to have less significant impact on the reliability of the bulk electric system from maintaining rigorous documentation of generator control and protective relay coordination study results. The exemption criteria specified by this guideline are based on both the operating voltage of the bulk power system to which the generator is interconnected, and the MVA rating of the generator. When referring to the MVA rating of the generator, at facilities where multiple machines and/or prime movers are required for normal unit operation, the MVA rating refers to the total MVA capacity of the facility. Examples of this include combined cycle or cross compound units.

As documented in the NERC Glossary of Terms, the NERC Board of Trustees approved a definition for the bulk electric system on February 8, 2005 as follows:

“As defined by the Regional Reliability Organization, the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.”

Therefore, for generators interconnected to a power system operated at a voltage of less than 100 kV, a documented study demonstrating the coordination of generator voltage regulator controls with unit capabilities and protection is not required.

Generators with a nameplate rating less than or equal to 75 MVA or that are not connected to the bulk power system are exempt.

Table 1 summarizes the Generator Exemption Criteria.

***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

| Generator Interconnected kV or MVA Size | Study Documentation of Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection Required |
|---|--|
| < 100 kV                                | No   |
| > 100kV<br>&<br>≤ 75 MVA                | No   |
| >100kV<br>&<br>> 75 MVA                 | Yes  |

**Table 1: Generation Exemption Criteria**

**B. Sister Unit/Equipment Verification Guidelines**

If it can be demonstrated that the generators, voltage regulator and exciters along with their control and protection system equipment and settings are all identical, then the units can be considered sisters units. In those situations, an assumption can be made for a sister unit by coordinating the generator voltage regulator controls with unit capabilities and protection for one (sample) unit. Documentation must exist to demonstrate that the information about the sample unit can be applied to a sister unit.

**C. Requirements [Ref. PRC-019, R2.1]**

1. Generator owner/operator to develop (or retrieve from generator manufacturer) the Generator Capability Curve for each non-exempt generating unit. This curve shall include specification of nominal voltage, ambient air or cooling temperature, or hydrogen pressure as appropriate. [Ref. PRC-019, R2.1.1]

***For Field Test Purposes Only***

***SERC Guideline - Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection; NERC Reliability Standard PRC-019-1***

2. Generator owner/operator to show on the Generator Capability Curve and other appropriate curves (plots) that the coordination of the generator voltage regulator controls and limit functions are coordinated with the generator's capabilities and protective relays. The completed curves (plots) should show the following as appropriate (See Attachments 2 through 5):
  - a) Steady state over-excitation and under excitation limiter control characteristics. [*Ref. PRC-019, R2.1.2*]
  - b) Power output limit of the unit, as verified per MOD-024. [*Ref. PRC-019, R2.1.3*]
  - c) Other factors that could limit megawatt or megavar capability. [*Ref. PRC-019, R2.1.4*] Example: generator step-up transformer MVA rating, generator rotor with shorted turn, steady state transmission and station auxiliary bus voltage limits, etc.
  - d) Loss of excitation relay / field protection relay characteristics [*Ref. PRC-019, R2.1.5*]
  - e) Coordination of the volts per hertz protection system(s), including limiters, relating to the generator, generator step-up transformer, normal station service transformer. [*Ref. PRC-019, R2.1.6*]



***For Field Test Purposes Only***  
**Attachment 1**

**A. Introduction**

1. **Title:**           **Coordination of Generator Voltage Regulator Controls with Unit Capabilities and Protection**
2. **Number:**     PRC-019-1
3. **Purpose:**     Ensure generator voltage regulator controls and limit functions are coordinated with the generator's capabilities and protective relays.
4. **Applicability**
  - 4.1. Regional Reliability Organization.
  - 4.2. Generator Owner.
5. **Proposed Effective Dates:**   To be determined:
  - One year beyond Board of Trustee adoption for Requirement 1
  - Two years beyond Board of Trustee adoption 1<sup>st</sup> 20% compliant with Requirement 2 and Requirement 3
  - Three years beyond Board of Trustee adoption 2<sup>nd</sup> 20% compliant with R2, R3
  - Four years beyond Board of Trustee adoption 3<sup>rd</sup> 20% compliant with R2, R3
  - Five years beyond Board of Trustee adoption 4<sup>th</sup> 20% compliant with R2, R3
  - Six years beyond Board of Trustee adoption 5<sup>th</sup> 20% compliant with R2, R3

**B. Requirements**

- R1.** The Regional Reliability Organization shall establish and maintain criteria for exemptions to any of the Generator Owner requirements in R2.
- R2.** Unless exempted by the Regional Reliability Organization in accordance with R1, the Generator Owner shall have study results that show it verified that its generator voltage regulator controls and limit functions are coordinated with the generator's capabilities and protective relays. This study shall include the following:
  - R2.1.** Plots, or data that could be plotted for the following:
    - R2.1.1.** Generator capability curve, including specification of nominal voltage, ambient air or cooling temperature, or hydrogen pressure.
    - R2.1.2.** Steady state over-excitation limiter and under-excitation limiter control characteristics.
    - R2.1.3.** MW limit of the prime mover.
    - R2.1.4.** Any other limit that could restrict the megawatt or megavar capability.
    - R2.1.5.** Loss of excitation / field protective relay characteristics.
    - R2.1.6.** Volts-per-hertz protection settings including volts-per-hertz limiters in the automatic voltage regulator.
- R3.** The Generator Owner shall have the information in R2.1.1 through R2.1.6 available to show to the Regional Reliability Organization upon request (within 30 calendar days).

**C. Measures**

***For Field Test Purposes Only***

**Attachment 1**

- M1.** The Regional Reliability Organization shall, within 30 calendar days of a request, provide to Generator Owners its exemption criteria defined in accordance with R1.
- M2.** The Generator Owner shall have evidence it showed the Regional Reliability Organization the information identified in R2.1 through R2.1.6 within 30 calendar days of a request.

**D. Compliance**

**1. Compliance Monitoring Process**

**1.1. Compliance Monitoring Responsibility**

NERC for the Regional Reliability Organization.

Regional Reliability Organization for Generator Owners.

**1.2. Compliance Monitoring Period and Reset Timeframe**

The compliance reset period is one calendar year.

**1.3. Data Retention**

The Generator Owner shall retain all current information needed to show coordination. The Compliance Monitor shall retain any audit data for three years.

**1.4. Additional Compliance Information**

The Regional Reliability Organization and Generator Owner shall demonstrate compliance through self-certification or audit (periodic, as part of targeted monitoring or initiated by complaint or event), as determined by the Compliance Monitor.

**2. Levels of Non-Compliance**

**2.1. Level 1:** The Regional Reliability Organization did not provide the exemption criteria in accordance with R1.

**2.2. Level 2:** The Generator Owner information on coordination of the generator voltage regulator controls and limit functions does not address one of the requirements identified in accordance with R2.1.1 through R2.1.6.

**2.3. Level 3:** Not applicable.

**2.4. Level 4:** The Generator Owner information on coordination of the generator voltage regulator controls and limit functions does not address two or more of the requirements identified in accordance with R2.1.1 through R2.1.6.

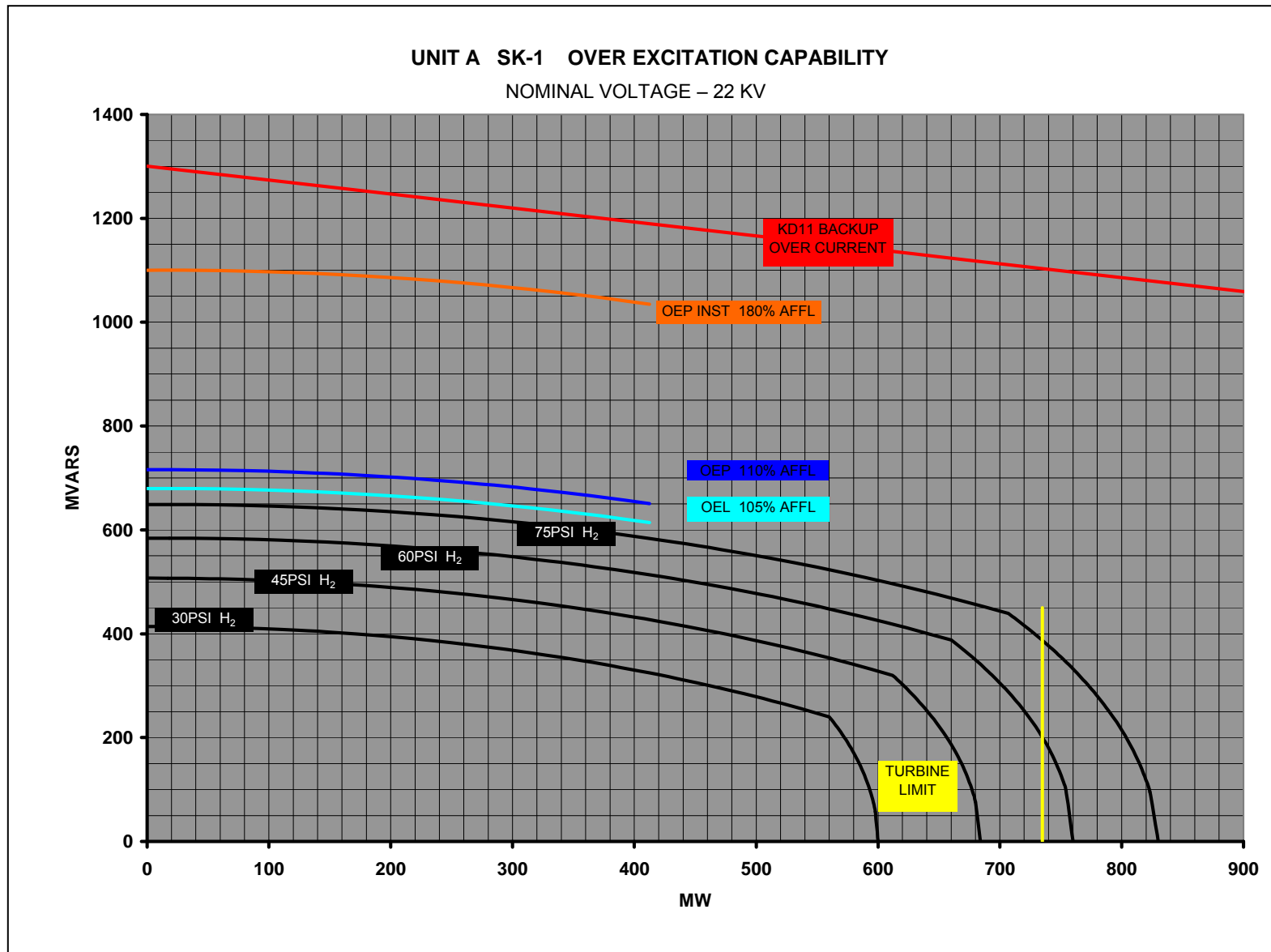
**E. Regional Differences**

None identified.

a. Version History

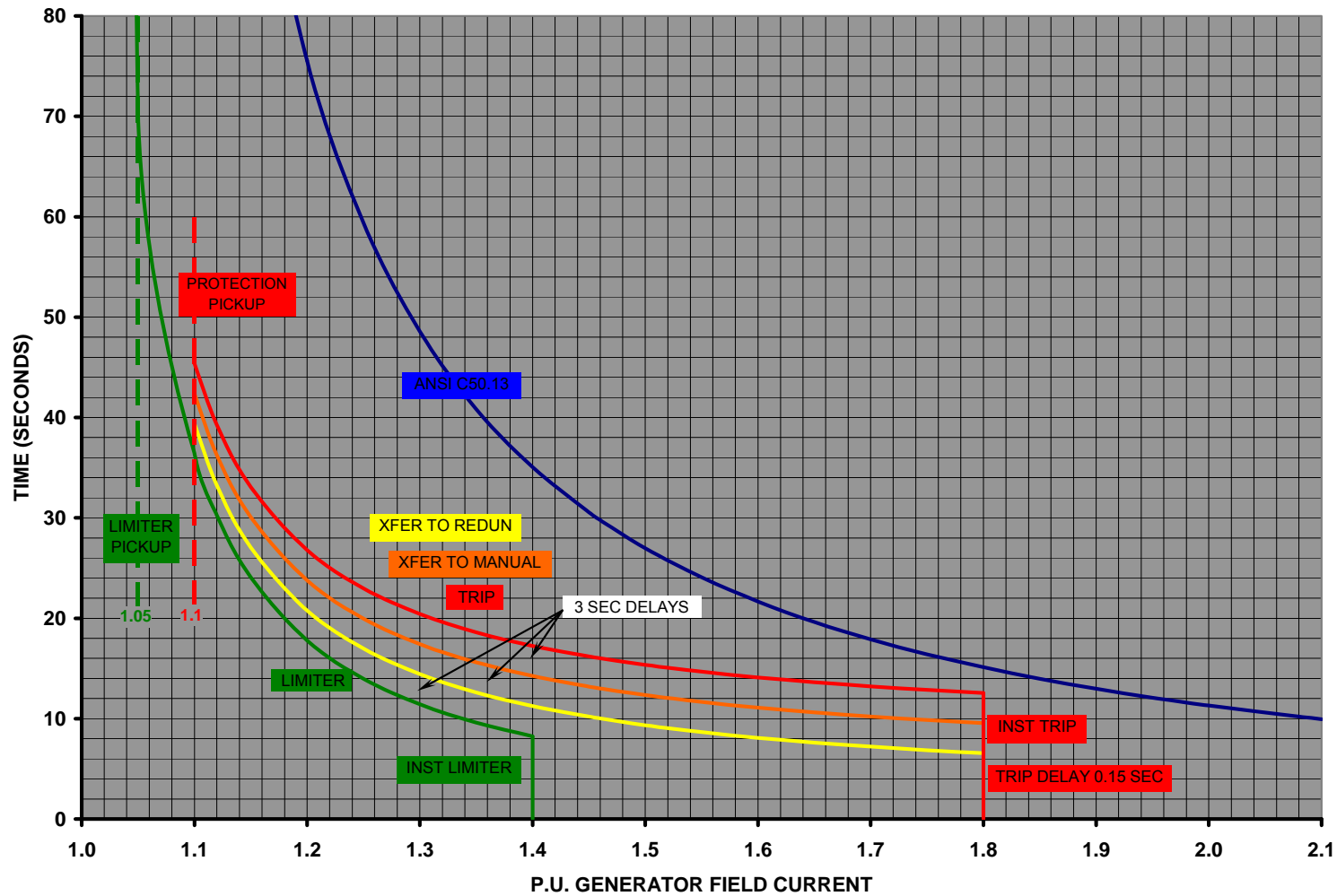
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|---------|------|--------|-----------------|
|---------|------|--------|-----------------|

*For Field Test Purposes Only*  
**Attachment 2**

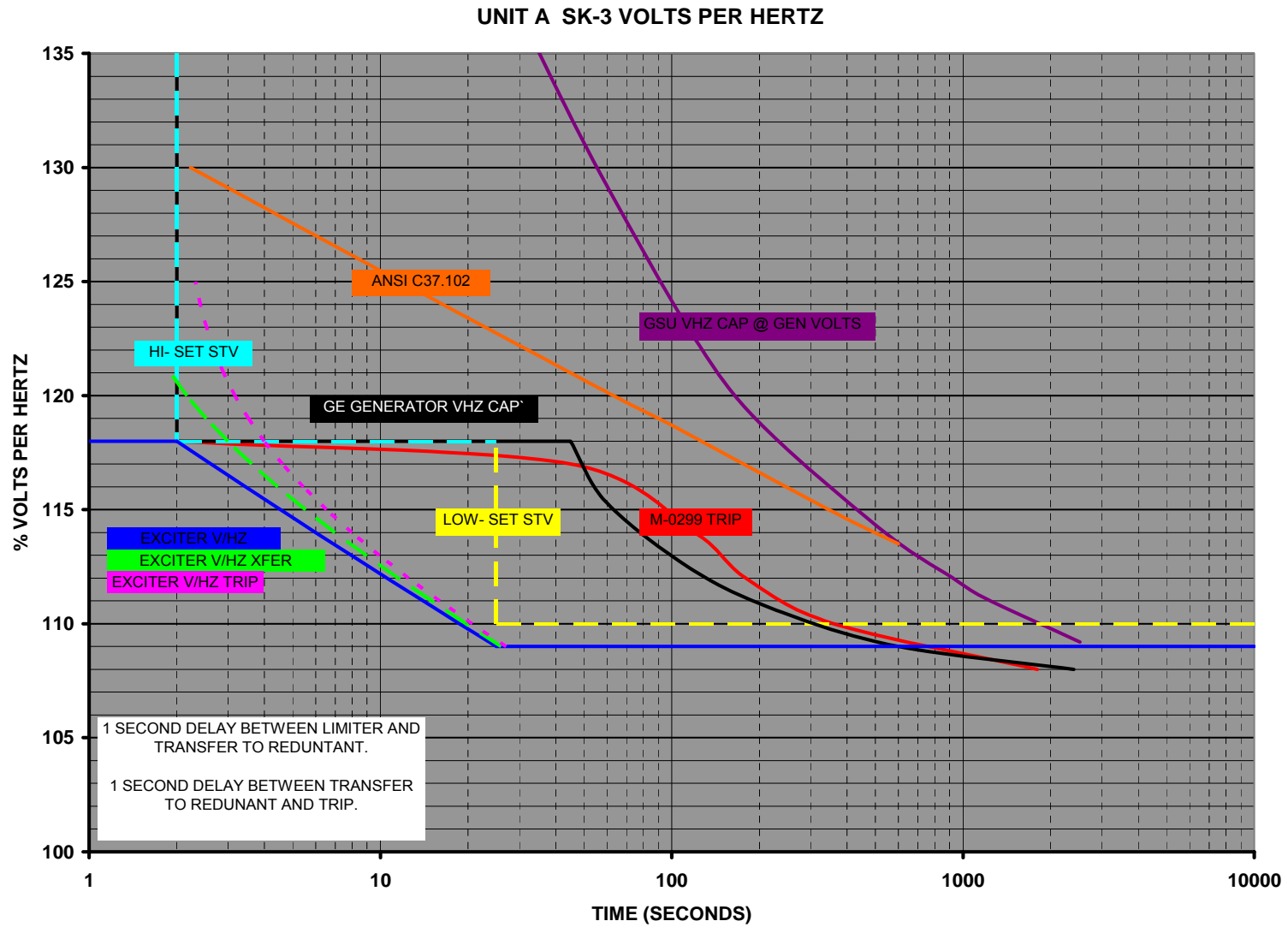


*For Field Test Purposes Only*  
**Attachment 3**

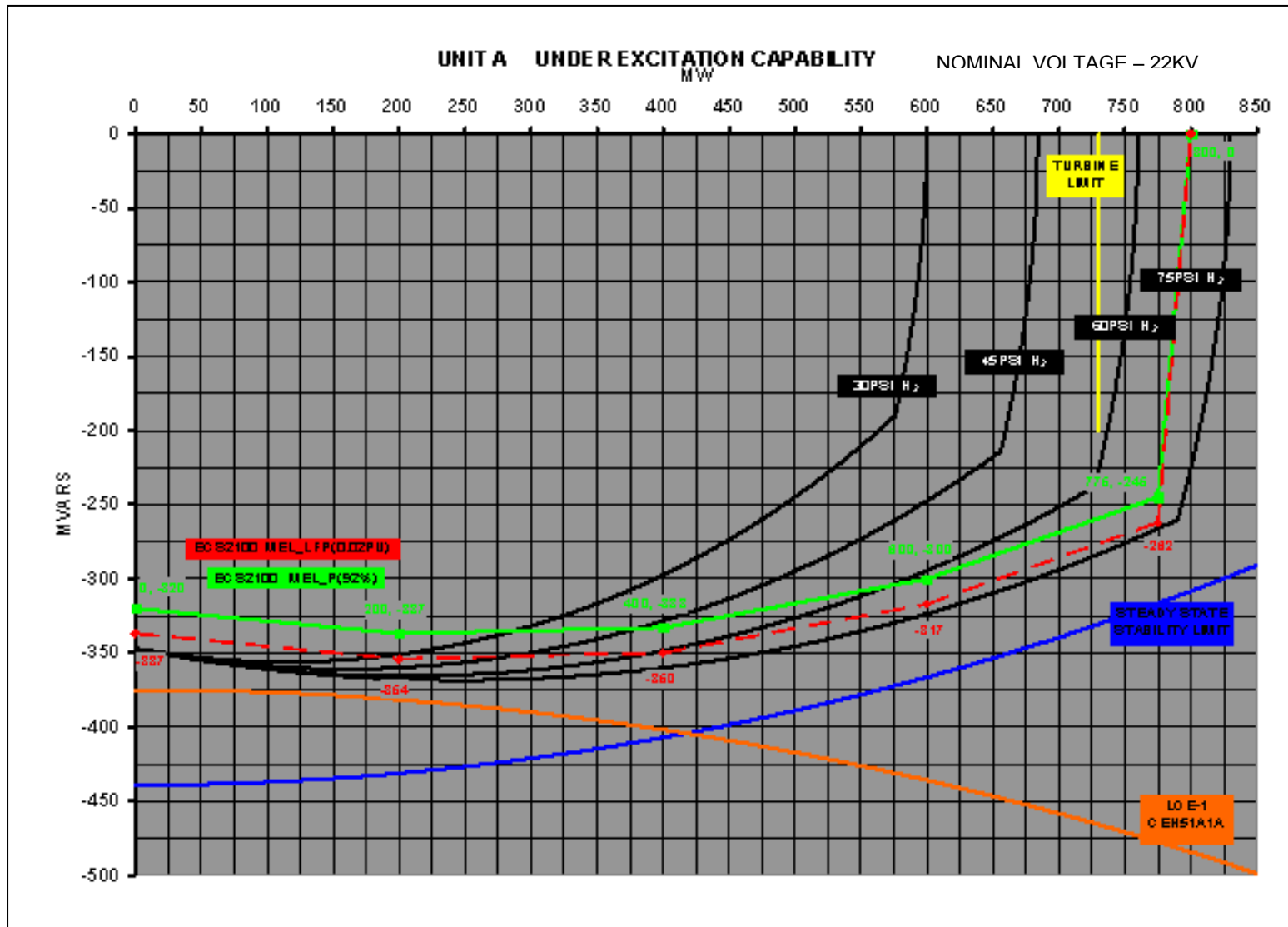
**UNIT A SK-2 GENERATOR FIELD OVER EXCITATION LIMITER/PROTECTION**



*For Field Test Purposes Only*  
**Attachment 4**



*For Field Test Purposes Only*  
Attachment 5



**For Field Test Purposes Only**  
**Attachment 6**

**Circle and Radius Equations**

Equations used to plot the different segments of the Generator Capability Curve.

**CENTER AND RADIUS OF CIRCLE GIVEN THREE POINTS  $(X_1, Y_1)$   $(X_2, Y_2)$   $(X_3, Y_3)$**

$$AX^2 + CY^2 + BXY + DX + EY + F = 0$$

WHERE:  $A = C$  and  $B = 0$

COMPLETING THE SQUARE:

STANDARD CIRCLE EQN.

$$A\left(X + \frac{D}{2A}\right)^2 + A\left(Y + \frac{E}{2A}\right)^2 + F - \frac{D^2 + E^2}{4A} = 0$$

$$(X - H)^2 + (Y - K)^2 = R^2$$

CENTER COORDINATES:  $X_c = -\frac{D}{2A}$        $Y_c = -\frac{E}{2A}$

RADIUS LENGTH:  $R = \sqrt{\frac{D^2 + E^2}{4A^2} - \frac{F}{A}}$

$$A = \begin{vmatrix} X_1 & Y_1 & 1 \\ X_2 & Y_2 & 1 \\ X_3 & Y_3 & 1 \end{vmatrix}$$

$$D = - \begin{vmatrix} (X_1^2 + Y_1^2) & Y_1 & 1 \\ (X_2^2 + Y_2^2) & Y_2 & 1 \\ (X_3^2 + Y_3^2) & Y_3 & 1 \end{vmatrix}$$

$$E = \begin{vmatrix} (X_1^2 + Y_1^2) & X_1 & 1 \\ (X_2^2 + Y_2^2) & X_2 & 1 \\ (X_3^2 + Y_3^2) & X_3 & 1 \end{vmatrix}$$

$$F = - \begin{vmatrix} (X_1^2 + Y_1^2) & X_1 & Y_1 \\ (X_2^2 + Y_2^2) & X_2 & Y_2 \\ (X_3^2 + Y_3^2) & X_3 & Y_3 \end{vmatrix}$$

