Entergy

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**Attachment 1 and Enclosure 1 contain PROPRIETARY information.**

GNRO-2011/00042

May 31, 2011

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: Responses to NRC Requests for Additional Information Pertaining to License Amendment Request for Power Range Neutron Monitoring System (TAC No. ME2531)

Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCES:

1. Entergy Operations, Inc. letter to the NRC (GNRO-2009/00054), *License Amendment Request – Power Range Neutron Monitoring System Upgrade*, November 3, 2009 (ADAMS Accession No. ML093140463)

2. NRC e-mail to Entergy Operations, Inc., *Grand Gulf Request for Additional Information Regarding Power Range Neutron Monitoring System License Amendment Request (TAC No. ME2531)*, April 27, 2011 (ADAMS Accession Nos. ML111170424 and ML111170432)

Dear Sir or Madam:

In Reference 1, Entergy Operations, Inc. (Entergy) submitted to the NRC a license amendment request (LAR), which proposes to revise the Grand Gulf Nuclear Station (GGNS) Technical Specifications (TS) to reflect the installation of the digital General Electric-Hitachi (GEH) Nuclear Measurement Analysis and Control (NUMAC) Power Range Neutron Monitoring (PRNM) System.

In Reference 2, the NRC staff transmitted 29 Requests for Additional Information (RAIs) to support their review and approval of Reference 1. Responses to RAIs 21, 22, 23 and 24 are provided in Attachment 1. With this submittal, Entergy has provided responses to all 29 RAIs.

GEH considers certain information contained in Attachment 1 and Enclosure 1 of Attachment 1 to be proprietary and, therefore, requests it be withheld from public disclosure in accordance with 10 CFR 2.390. Non-proprietary, redacted versions of Attachment 1 and

Enclosure 1 are provided in Attachment 2. The associated affidavits are provided in Attachments 3 and 4, respectively.

The No Significance Hazards Determination and the Environmental Consideration provided in Reference 1 are not impacted by these responses.

This letter contains no new commitments.

If you have any questions or require additional information, please contact Mr. Guy Davant at (601) 368-5756.

I declare under penalty of perjury that the foregoing is true and correct; executed on May 31, 2011.

Sincerely,

MAK/ghd

Attachment 1. Responses to NRC Requests for Additional Information Pertaining to License Amendment Request – Power Range Neutron Monitoring System Upgrade with Affidavit Supporting Request to Withhold Information from Public Disclosure (Proprietary Version)

Enclosures:

1. GEH Report 0000-0102-8815-R2 ,"Instruments Limits Calculation, Entergy Operations, Inc., Grand Gulf Nuclear Station, Average Power Range Monitor, Power Range Neutron Monitoring System (NUMAC)-CLTP Operation," Rev. 2 (Proprietary Version)

2. Replacement Technical Specification Marked-Up INSERT E

Attachment 2. Responses to NRC Requests for Additional Information Pertaining to License Amendment Request – Power Range Neutron Monitoring System Upgrade (Non-Proprietary Version)

Enclosures:

1. GEH Report 0000-0102-8815-R2 ,"Instruments Limits Calculation, Entergy Operations, Inc., Grand Gulf Nuclear Station, Average Power Range Monitor, Power Range Neutron Monitoring System (NUMAC)-CLTP Operation," Rev. 2 (Non-Proprietary Version)

2. Replacement Technical Specification Marked-Up INSERT E

Attachment 3. GEH Affidavit Supporting Proprietary Information provided in Attachment 1

Attachment 4. GEH Affidavit Supporting Proprietary Information provided in Enclosure 1 of Attachment 1

cc: Mr. Elmo E. Collins, Jr.
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**ATTACHMENT 2**

**GNRO-2011/00042**

**RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION PERTAINING TO LICENSE AMENDMENT REQUEST POWER RANGE NEUTRON MONITORING SYSTEM UPGRADE WITH AFFIDAVIT SUPPORTING REQUEST TO WITHHOLD INFORMATION FROM PUBLIC DISCLOSURE**

**(NON-PROPRIETARY VERSION)**

**NON-PROPRIETARY INFORMATION**

**RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION PERTAINING TO LICENSE AMENDMENT REQUEST POWER RANGE NEUTRON MONITORING SYSTEM UPGRADE**

By application dated November 3, 2009, Entergy Operations, Inc. (Entergy) requested NRC staff approval of an amendment to the Grand Gulf Nuclear Station, Unit 1 (GGNS) Technical Specifications (TS) to reflect installation of the digital General Electric - Hitachi (GEH) Nuclear Management Analysis and Control (NUMAC) Power Range Neutron Monitoring (PRNM) System.[5]

Entergy received an e-mail from the NRC GGNS Project Manager on April 27, 2011 requesting additional information needed to support their review and approval of the proposed amendment.[6] Responses to Requests for Additional Information (RAIs) 21, 22, 23, and 24 are provided in this attachment.

**NRC RAI 21**

*IEEE Std 603 Clause 5.4 states that safety system equipment shall be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it should be capable of meeting the performance criteria as specified in the design basis (e.g., IEEE Std 603 Clause 4.10), while being exposed to specified environmental conditions (e.g., IEEE Std 603 Clause 4.7). Regulatory Guide 1.209, "Guidelines for Environmental Qualification of Safety-related Computer-based Instrumentation and Control Systems in Nuclear Power Plants" (ML070190294), endorses IEEE 323-2003 Sections 6.2.3 and 6.3.1, which requires "qualification test programs to account for reasonable uncertainties in demonstrating satisfactory performance and normal variations in commercial production, thereby providing assurance that the equipment can perform under the most adverse service condition specified" and that "margin shall be added if not included in the specified service conditions."*

*Describe how the qualification levels identified for Humidity and Radiation were evaluated to satisfy the above criteria or to determine the levels identified are acceptable.*

*The following further clarifies the rationale for this RAI but does not include additional information requests. RAI 5's response in Attachment 1 to GNRO-2010/00070 (ADAMS Accession No, ML103490095) does not identify margin for the low end of the Humidity envelope or for the maximum Gamma Rate (rad/hr) for Radiation.*

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[5] Entergy Operations, Inc. letter to the NRC, *License Amendment Request – Power Range Neutron Monitoring System Upgrade*, dated November 3, 2009 (ADAMS Accession No. ML093140463)

[6] NRC e-mail to Entergy Operations, Inc., *Grand Gulf Request for Additional Information Regarding Power Range Neutron Monitoring System License Amendment Request (TAC No. ME2531)*, April 27, 2011 (ADAMS Accession Nos. ML111170424 and ML111170432)

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## Response

## Introduction

GEH Environmental Qualification Program description (GEQUAL) NEDO-30239 complies with IEEE Standard 603 Clause 5.4, which states that safety system equipment shall be qualified by type test, previous operating experience, or analysis, or any combination of these three methods. With the above methodology, the Logarithmic Radiation Monitor (LRM) was qualified in 1984. Since that time, additional NUMAC instruments and cards have also been qualified in accordance with this methodology. These NUMAC instruments were not affected by humidity or radiation dose during the qualification testing and analysis program.

The Grand Gulf Nuclear Station (GGNS) NUMAC Power Range Neutron Monitoring (PRNM) equipment has successfully passed the qualification program. Qualification records can be found in the Product Analysis Reports (PAR) and Addenda 1 thru 22, test reports and qualification summaries. These qualification records are available in the GEH archival system.

Table 2-2 provided in Attachment 1 to Entergy letter GNRO-2010/00070, contains the GGNS control room environment requirements the NUMAC PRNM instruments must meet. These parameters are listed in Table 21-1 as follows:

**Table 21-1: GGNS Control Room Environment Requirements**

| Parameter | Minimum | Nominal | Maximum |
|---|---|---|---|
| Temperature (ºF) | 60 | 72 to 78 | 90 |
| Humidity, Operating (% RH) | 20 | N/A | 50 |
| Pressure, Static (inch w.g.) | 0.1 | N/A | 1.0 |
| Radiation, Gamma Rate (rad/hr) | N/A | N/A | 0.0005 |
| Radiation, Gamma TID (rad) | N/A | N/A | 180 |

In accordance with GGNS Standard GGNS-E-100.0, “Environmental Parameters,” the above requirements apply to both normal and accident environments.

The NUMAC PRNM equipment supplied to GGNS meets the NUMAC Requirements Specification 23A5082AA (contained in Table 21-2 below), and also envelopes the GGNS control room environment requirements of Table 21-1.

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**Table 21-2: NUMAC Environmental Requirements**

| Parameter | Minimum | Nominal | Maximum |
|---|---|---|---|
| Humidity, Operating (% RH) | 20 | N/A | 90 |
| Radiation, Gamma Rate (rad/hr) | N/A | N/A | 0.0005 |
| Radiation, Gamma TID (rad) | N/A | N/A | 1,000 |

Each parameter is discussed below.

**Humidity**

The 20% minimum low humidity rating of the NUMAC environmental requirements is the same as the GGNS minimum control room environment requirement of 20%. However, GEH has performed environmental qualification of various NUMAC instruments and modules below 20% humidity. These additional margins, which are beyond the ranges of expected operating conditions, provide a very high level of confidence of satisfactory performance at GGNS and exceed the requirements of IEEE Standard 323-2003 Sections 6.2.3 and 6.3.1. Table 21-3 lists NUMAC instruments and modules that have successfully passed testing for low humidity (below 20%) and 90% high humidity environments. These instruments and cards represent a broad range of the NUMAC product line.

**Table 21-3: NUMAC Equipment Qualified by Test**

| NUMAC Equipment | Test Report | Tested Humidity | Comment |
|---|---|---|---|
| Average Power Range Monitor (APRM) | TR-0000-0118-9533, R0 NUMAC Instruments Environmental Qualification Test Report | 10% & 90% | Instrument |
| PRNM Communication Interface (PCI) | | 10% & 90% | Instrument |
| LRM | | 10% & 90% | Instrument |
| Wide Range Neutron Monitor (WRNM) | | 10% & 90% | Instrument |
| 2-Out-Of-4 Logic Module | GHNE-0000-0133-1495, R0 EQ Test Report | 10% & 95% | Instrument |
| Quad Low Voltage Power Supply (QLVPS) | | 10% & 95% | Instrument |

| NUMAC Equipment | Test Report | Tested Humidity | Comment |
|---|---|---|---|
| Universal Front Panel (UFP)(1) | QS-0000-0097-4761, R2 Universal Front Panel Qual Summary | 10% & 90% | Display Panel |
| Bypass Fiber Optic Card | EQDP-64.0222.2-03, R0 Appendix E NUMAC Instruments Environmental Qualification Testing | 10.5% & 92.5% | Card |
| 2-Out-Of-4 Fiber Optic Card | | 10.4% & 93% | Card |
| 4 - 20mA Analog Input | | 10% & 90% | Card |
| Fiber Optic 8-Ch Card | | 10.3% & 92.5% | Card |
| SSLC/RTIF Bypass Unit | | 10.9% & 95% | Instrument |
| MSIV OLU | | 7.4% & 94.7% | Instrument |
| SLC Logic Processor | | 11% & 94.7% | Instrument |

(1) The UFP is the display screen and keypad of the APRM, PCI, LRM and WRNM instruments.

From Table 21-3, the APRM, PCI, 2-Out-Of-4 Logic Module, QLVPS, and UFP are acceptable representative samples of the GGNS NUMAC PRNM equipment. This analysis performed for design differences between the GGNS PRNM equipment and qualified NUMAC instruments is documented in “NUMAC PRNM Equipment Qualification for Entergy GGNS” Revision 0, dated November 08, 2010,” which is under configuration control in the GEH archival system.

The other NUMAC instruments from Table 21-3 are not part of PRNMS, but are quite similar electrically and mechanically to PRNMS equipment. The same cards and electronic components are used; the cards are generally mounted in the same locations (e.g., CPU and display control cards are in the last 3 slots). The number of cards and their placement in an instrument may be different depending on the application; however, this does not affect the humidity qualification since the material composition is all the same. The cards use material common to the electronic component manufacturer and the components are assembled into circuit boards by GEH-approved vendors using the same IPC-600 requirements. These vendors operate under an approved 10 CFR Part 50 Appendix B quality assurance program and are audited by GEH periodically to maintain their safety-related status.

During testing, there were no known failure modes affecting the cards, instruments, or other components in the instruments due to low humidity. The above instruments and cards passed the low humidity environment with no anomalies. Electronic failure modes typically occur from condensation at high humidity levels, which has been successfully tested to 40% margin for the above instruments and cards without failures. The electronics in the GGNS equipment is no different from the above tested instruments and cards. Low humidity has no impact on equipment performance.

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Conclusion

The 10% and 90% relative humidity testing and evaluation conducted in accordance with the requirements of IEEE 323-2003 and endorsed by RG 1.209 provides adequate environmental test margins below and above the GGNS requirements of 20% to 50% relative humidity.

**Radiation**

Radiation qualification is based on testing, similarity analysis, and operating experience data. Previous analysis documented that the NUMAC instruments are qualified (Radiation Environment Extension, Report # A00-02506-2, dated 4/20/90) up to and including 1,000 rad Total Integrated Dose (TID) with a maximum dose rate of 10 rad/Hr. In 1990, military-grade and screened commercial components were employed wherever possible. The use of commercially-available parts is more prevalent today since military-grade and screened components are listed as "alternate" in the NUMAC designs. This does not diminish the radiation threshold of these parts since this report is still valid for today's electronic components as explained below and supported by the Total Dose Characterization Tests performed at the NASA Goddard Space Flight Center (see Table 21-4, which provides a partial list of components tested by NASA).

The NUMAC PRNM equipment is designed to operate in a control room environment. Based on the Radiation Environment Extension Report, the commonly used components [resistors, capacitors, diodes, transistors, silicon controlled rectifiers (SCRs), connectors, etc.] are still used in the NUMAC instruments. All have radiation tolerance above 1,000 rad except for the SCR, which can fail as low as 800 rad. However, failure at the 800-rad level is associated with dose rates much higher than the one postulated for the GGNS PRNM equipment. Therefore, damage below a TID of 1000 rad is highly unlikely. The design using these components has not changed and the same types of components are also in the GGNS PRNM equipment. Hence, the analysis incorporated into the Radiation Environment Extension Report still applies. In the same report, electronic components such as Bipolar, CMOS, MOSFET, and microprocessors, have a radiation threshold of 1,000 rad and higher with a maximum dose rate of 10 rad/Hr. The GGNS PRNM equipment also has these same types of devices in their cards. The report is in agreement with the Table 21-4-identified tests performed by NASA, which shows high radiation tolerance of the same types of electronic components from various manufacturers. The 27 components listed in Table 21-4 were randomly selected out of NASA's database of 431 components. These components have been tested for radiation tolerance at dose rates from 25 to 1590 rad/Hr for different projects. The total radiation dose test range was from 2,500 to over 100,000 rad TID, depending on the project requirements and the expected total-dose tolerance of the component. The footnotes in Table 21-4 list three devices not passing 100% of the tested lot. Similar to the SCR discussed above, these failures are associated with dose rates (250, 25 and 90 rad/Hr, respectively) much higher than the one postulated for the GGNS PRNM equipment. Therefore, damage below 1,000 rad and 10 rad/Hr is highly unlikely.

The new NUMAC UFP in the GGNS PRNM APRM and PCI instruments and NUMAC LRM and WRNM instruments contain the Actel ProASIC3 Field Programmable Gate Array (FPGA). This is a new device used in all NUMAC product lines after April 2009. Recent Actel tests (Radiation Performance of Actel Products, dated March 2004) for radiation effects in both x-ray and gamma ray environments on the silicon-based semiconductor devices (using 0.25 μm

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technology) show they withstand up to 100,000 rad TID with no change in power supply currents. For the line of Actel semiconductor devices, the DC/AC performance characteristics remain unchanged to 2,500 rad TID as described in the Actel report. In addition, these tests are conservative compared with control room environment operation because Actel tests were performed at high dose rates (417 rad/Hr minimum) to allow results to be analyzed within a few months.

NUMAC detector preamplifiers for Reactor Building radiation environments are qualified for 1,000 rad TID. The components used in the detector preamplifier are the same types of components (resistors, capacitors, diodes, transistors, connectors, etc.) referenced in the Radiation Environment Extension Report. The detector preamplifier (Detector Preamplifier EQ Report A00-02506-5, Index H, August 25, 1995) was tested to 240,000 rad TID at an average dose rate of 1.5E4 rad/Hr without any failures. This shows the insensitive nature of the components, thus having a very high threshold to radiation effects.

In addition, past NUMAC product history also demonstrated successful operating history. The NUMAC product line has been proven by almost 1,000 instruments, which have collectively accumulated more than 94,000 instrument-months of experience in nuclear power stations around the world. This operating experience extends over a 26-year timespan with no failure trends of electronic devices from radiation exposure. In addition to actual testing, this experience data provides margin for commercial component variation and supports the 1,000 rad TID rating (operation in gamma fields of 5.7 mrad/Hr over 20 years yield 1,000 rad).

Conclusion

Radiation tests performed on components of the NUMAC UFP, GEH Radiation Environment Extension Report, NUMAC detector preamplifier, and components in Table 21-4, provide tests at over 2,500 rad and a dose rate exceeding 10 rad/Hr. These tests adequately cover the components of the GGNS PRNM equipment and provide significant margin above the qualified 1,000 rad TID and dose rate of 10 rad/Hr. Furthermore, successful operating history of NUMAC instruments has been recorded in a control room environment at nuclear plants around the world. The GGNS PRNM equipment, having similar components, is qualified for 1,000 rad TID and dose rate of 10 rad/Hr, which provides significant margin above the required 180 rad and 0.0005 rad/Hr dose rate.

**Table 21-4: Total Dose Characterization Tests Performed at Goddard Space Flight Center (partial listing)**

| ID Locator | Test Date | Manufacturer | Part Tested | Type Technology | Dose Rate (rad/Hr) | Dose (rad) |
|---|---|---|---|---|---|---|
| 157 | 10/20/92 | Harris | MD82C59AB7011 Programmable Controller | CMOS | 70 | 10K |
| 188 | 4/23/93 | SEEQ | CJ28C256 32kx8 EEPROM | CMOS | 70 | 10K |

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| ID Locator | Test Date | Manufacturer | Part Tested | Type Technology | Dose Rate (rad/Hr) | Dose (rad) |
|---|---|---|---|---|---|---|
| 190 | 6/15/93 | Intel | MQ80386-20 Microprocessor | CMOS | 40 | 5K |
| 207 | 3/16/94 | Actel | A1020B FPGA<br>ProASIC3 FPGA(1) | CMOS 1 µm<br>0.25 µm | 130<br>417 | 75K<br>2.5K |
| 285 | 11/2/95 | SEI/Hitachi | 28C010 EEPROM | CMOS | 60 | 20K |
| 289 | 1/16/96 | SEI | 28C256 EEPROM | CMOS | 500 | 7K |
| 295 | 8/14/96 | Sprague | CLR79 Tantalum Capacitor | CMOS | 1590 | 1000K |
| 307 | 6/30/97 | AMD | AM29F016 EEPROM | CMOS | 125 | 5K |
| 313 | 6/5/97 | Samsung | KM48C8000 64Mbit DRAM | CMOS | 60 | 7.5K |
| 332 | 9/10/97 | UCSD | AD9050BR 10 bit AD Converter(2) | Bipolar | 250 | 5K |
| 341 | 10/17/97 | Cal Logic | SD5000A Hi Speed DMOS Quad | Hybrid | 25 | 2.5K |
| 342 | 10/17/97 | Cal Logic | SD5000B Hi Speed DMOS Quad(3) | Hybrid | 25 | 2.5K |
| 367 | 5/8/98 | Fairchild/ Raytheon | R29773 PROM | Bipolar | 1200 | 200K |
| 377 | 7/16/98 | SEEQ/ ATMEL | 28C256 32kx8 EEPROM | CMOS | 48 | 20K |
| 382 | 10/5/98 | Harris | HI506 16-Ch Multiplexer | CMOS | 130 | 50K |
| 399 | 1/8/99 | Samsung | KM684002 512kx8 Hi Speed SRAM | CMOS | 174 | 30K |
| 418 | 10/20/99 | APEX | PA07M/883B | Bipolar | 220 | 17.5K |
| 419 | 10/20/99 | Burr Brown | INA117SM Voltage Amp | Bipolar | 220 | 25K |
| 420 | 11/8/99 | National Semiconduct | LM117K 3-Terminal VR | Bipolar | 290 | 10K |

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| ID Locator | Test Date | Manufacturer | Part Tested | Type Technology | Dose Rate (rad/Hr) | Dose (rad) |
|---|---|---|---|---|---|---|
| 422 | 11/19/99 | Analog Devices | DAC08 8 Bit Hi Speed DAC | Bipolar | 170 | 25K |
| 423 | 11/30/99 | National Semiconduct | 54ABT245A Octal Bidirectional Xcvr | Not Listed | 170 | 17.5K |
| 425 | 11/30/99 | Analog Devices | AD7885AQ 16 Bit Hi Speed ADC | CMOS | 210 | 50K |
| 427 | 1/23/0 | National Semiconduct | LMC6464A Quad Micro Pwr Op Amp(4) | CMOS | 90 | 5K |
| 428 | 1/3/00 | Maxim | MX7225UQ/883B Quad 8 Bit DAC | CMOS | 150 | 10K |
| 429 | 1/3/00 | Siliconix | U310 N-Ch JFET | FET | 160 | 30K |
| 430 | 1/7/00 | Analog Devices | DAC08A 8 Bit Hi Speed DAC | Bipolar | 140 | 50K |
| 431 | 1/7/00 | Analog Devices | AD7821TQ/883B 8 Bit ADC | CMOS | 160 | 30K |

(1) ID 207, From Actel “Radiation Performance of Actel Products,” March 2004.

(2) ID 332, 6 of 7 tested passed. The failed unit had a missing code.

(3) ID 342, All 5 tested passed except for under limit for dVGS, same as during pre-radiation testing.

(4) ID 427, 3 of 4 tested passed. The failed unit had 7of 12 parameters outside the limits.

## NRC RAI 22

*Regulatory Guide1.209 endorses with the enhancements and exceptions IEEE 323-2003. Regulatory Position C (4) states that for safety-related computer-based I&C systems intended for implementation in a mild environment, “the NRC staff takes exception to Section 7.1 of IEEE Std. 323-2003. The evidence of qualification in a mild environment should be consistent with the guidance given in Section 7.2 selectively based on actual environmental conditions, and the records should be retained at a facility in an auditable and readily accessible form for review and use as necessary.”*

*Describe the testing performed in sufficient detail to satisfy the above criteria or to determine the proposed approach is an acceptable alternative.*

*The following further clarifies the rationale for this RAI but does not include additional information requests. RAI 5’s response in Attachment 1 to GNRO-2010/00070 (ADAMS Accession No, ML103490095) does not describe the unique test setup(s) and units under*

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*test. Information associated with qualification of digital upgrades is defined in Enclosure B of the ISG for the Licensing Process of Digital Instrumentation & Controls, Digital I&C-ISG-06, (ADAMS Accession No, ML110140103) for "Qualification Test Methodologies" and "Summary of Digital EMI, Temp., Humidity, and Seismic Testing Results."*

**Response**

Introduction

For safety-related computer-based I&C systems intended for implementation in a mild environment, the NRC staff takes exception to Section 7.1 of IEEE Std. 323-2003, i.e., evidence of qualification in a mild environment should be consistent with the guidance given in Section 7.2 (a through t) for a Harsh Environment. The harsh environment qualification documentation requirements of Section 7.2 of IEEE Standard 323-2003 are auditable and available in the GEH archives. Qualified life of NUMAC instruments is 40 years. The response below describes the testing performed in sufficient detail, including description of unique test setup(s) and units under test, to satisfy the above criteria for EMI, seismic, temperature, and humidity and meet the requirements of Section D.5 of Digital I&C-ISG-06. The response below shows that the qualification method type test per IEEE Standard 603-2009 Clause 5.4 was utilized for the qualification of the GGNS Power Range Neutron Monitoring System (PRNMS). The analysis method per IEEE Standard 603-2009 Clause 5.4 was also utilized to qualify components in the GGNS PRNMS that were previously qualified per the type test method. This response describes in detail the type test methods that were used for qualification of the GGNS PRNMS system. Radiation qualification is addressed in the response to RAI 21 provided in this attachment. Pressure qualification was done by analysis; thus, there is no specific test setups to describe in this RAI. This test information was retrieved from GEH archives where it is retained in an auditable and readily accessible form for review and use, as necessary, in an electronic database.

Configuration control of the design to the individual component in the PRNMS hardware is maintained by GEH. All components required for the assembly (see seismic, EMC and environmental test configuration sections of this response for the list of chassis assembly numbers that were used in qualification testing) and processes are identified by GEH documents. [[

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- EMC panel qualification is discussed in the response to RAI 23 provided in this attachment.

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## SEISMIC QUALIFICATION OF GGNS PRNMS INSTRUMENTS

### Introduction

The GGNS PRNMS safety-related electronics are seismically qualified by type testing and analysis to demonstrate they will perform their safety functions under the expected environmental conditions in which they are required to operate.

The generic components of PRNMS ( (Items “c” through “I” of Table 22-1) were tested as part of the original system qualification (Generic PRNM Qualification performed in 1996) in accordance with IEEE Standard 344-1975, “Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.” Additional testing was later performed to IEEE Standard 344-1987 requirements for PRNM components [2-Out-Of-4 Logic Module, Quad Low Voltage Power Supply (QLVPS), LPRM Connector Panel and APRM Fiber Optic bypass switch] whose results were used for the design difference analysis on the GGNS PRNMS. The Average Power Range Monitor (APRM) and the PRNM Communication Interface (PCI) (Items “a” and “b” of Table 22-1) were recently tested to the NUMAC generic requirements that envelop the GGNS requirements in accordance with IEEE Standard 344-2004. The NUMAC Interface Computer (NIC) modules (Item m) do not meet the definition of Class 1E equipment; therefore,they are not qualified.

**TABLE 22-1**

| Item | Component Name |
|---|---|
| a | APRM |
| b | PCI |
| c | QLVPS |
| d | 2-Out-Of-4 Logic Module |
| e | LPRM Connector Panels |
| f | 4-Channel Analog Isolator |
| g | APRM Fiber Optic Bypass Switch |
| h | PRNM Calibration and Monitoring Panel |
| i | Fiber Optic Cables |

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| Item | Component Name |
|---|---|
| j | Cables (electrical) |
| k | LPRM Display / Flow Interface Panel |
| l | PRNM Cabinet (installation parts) |
| m | NIC |

GGNS Panels 1H13-P669, P670, P671, and P672 contain the existing APRM hardware, which is to be replaced with the PRNMS upgrade. GGNS Panel 1H13-P680 contains the existing APRM bypass switches. GGNS 1C91-P865 and P866 will contain the NIC modules. Listed below are descriptions of these panels.

- Panels 1H13-P669, P670, P671, and P672

  GGNS control room panels P669 through P672 were analyzed based on the GGNS control room floor seismic spectrum to determine the seismic spectrum at the equipment mounting locations. The analysis was performed by generating a finite element dynamic model for the PRNM cabinet assembly with the new PRNMS installed. The analysis of the test data concluded that the NUMAC PRNMS equipment is qualified for the GGNS seismic input motions. This is demonstrated by analyzing the PRNMS instrument test input motion required response spectra (RRS) to confirm the Test Response Spectra (TSR), as recorded by the accelerometers mounted on the instrument, envelop the corresponding expected upper bound RRS (worst case instrument elevation in the GGNS panels) throughout the frequency range of interest. Stresses in the modified panels have been evaluated at critical locations (corner posts and unistrut) for the safe shutdown earthquake (SSE) and found to be within acceptable limits.

- Panel 1H13-P680

  The two existing APRM bypass switches, located on either side of the central reactor core display in the P680 panel, are replaced with one new fiber optic bypass switch. Entergy performed the seismic evaluation impact to the P680 panel due to the replacement of the previous switch with the fiber optic switch. This evaluation determined the new fiber optic bypass switch has no impact on the seismic qualification of the P680 panel.

- Panels 1C91-P865 and P866

  The NIC modules are non-safety-related and are to be installed in non-safety-related panels 1C91-P865 and P866. These panels are in proximity (approximately 15 feet) to safety-related panel Q1H13-P879. Although the NIC modules themselves are not required to be seismically qualified, Entergy performed a seismic evaluation to ascertain the potential impact of panels P865 and P866 with the NIC modules installed on panel P879. Taking into account panels P865 and P866 are rigidly mounted to the floor and are an appropriate distance from P879, the evaluation concluded P865 and P866, with the

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NIC modules installed, present no seismic concern. IEEE Std. 323-2003 only requires qualifying Class 1E equipment (safety classification of electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling and containment and reactor heat removal, or are essential in preventing significant release of radioactive material to the environment) for Nuclear Power Generating Stations. Since the NIC modules do not meet the definition of Class 1E equipment, they are not qualified and will not be discussed further in this RAI.

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***TEST CONFIGURATION OF THE SEISMIC QUALIFICATION FOR NUMAC INSTRUMENTS (APRM and PCI):***

Seismic qualification testing (type test) on the APRM ([[ {3}]]) and PCI ([[ {3}]]) chassis was conducted at Wyle Laboratories in Huntsville, Alabama on July 19 and 20, 2010. GEH personnel were present to observe these tests. A seismic test plan was prepared and reviewed by an independent verifier. The seismic qualification test was conducted per a verified GEH Test Plan and Procedure (TP&P). The following approach was used to seismically qualify the APRM and PCI instruments used in the GGNS PRNMS: Recent type test qualification program of the generic APRM ([[ {3}]])) and PCI ([[ {3}]]) chassis was performed on a configuration making up a worst-case condition. The GGNS configuration [APRM ([[ {3}]]) and PCI ([[ {3}]])] contained a subset of the number of cards in each of these chassis. An analysis was performed to demonstrate the acceptability of the test samples as representatives of the GGNS configuration. The test program on the APRM and PCI instruments consisted of the following seismic qualification tests:

- Baseline Functional Test
- Seismic Test
- Final Functional Test (Although this is not a safety-related requirement for either instrument, since they are not required to operate post-accident, this test was performed to show additional margin for seismic events).

**NON-PROPRIETARY INFORMATION**

Seismic qualification testing was performed on the APRM and PCI instruments installed in a simulated 1-bay rigid panel (see Figure 22-1). During testing, safety-related signals (functional and trip signals) were monitored.

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**Figure 22-1: Front View of Instruments on Seismic Table**

A functional test was conducted before and after each test sequence. A final functional test was also performed and the results were compared against the baseline functional test data.

The NUMAC APRM ([[ {3}]]) and PCI ([[ {3}]]) chassis were tested and qualified to the seismic criteria identified in IEEE 323-2003, “Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations,” and IEEE 344-2004’ “Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generation Stations.”

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The APRM and PCI instruments successfully completed five OBEs (Upset) and one SSE (Faulted) random multi-frequency tests on the tri-axial Seismic Simulator Table without structure or equipment failure. Only five OBEs and one SSE are required for the seismic qualification per IEEE 344-2004. During the required tests, the APRM and PCI were electrically powered and monitored for operability by GEH personnel using GEH-provided equipment. The instruments met all acceptance criteria. Wyle Laboratories provided the test data, which GEH analyzed. There was a testing anomaly of the TRS dipping below the RRS. This anomaly was analyzed by GEH as adequately meeting technical requirements. This was documented in a test report, which was reviewed by the independent verifier.

***TEST CONFIGURATION OF THE SEISMIC QUALIFICATION FOR GENERIC PRNMS HARDWARE (OTHER THAN APRM AND PCI )***:

Seismic qualification of GGNS PRNM components other than APRM and PCI was done by analysis and comparison to previous qualification of the Generic PRNM hardware, which was completed in May 1996 at Wyle Laboratories. The type test qualification program for the Generic PRNMS listed in Table 22-4 was performed on a configuration making up a worst-case condition. The GGNS configuration contains a subset of the number of cards in each of these chassis. An analysis was performed to demonstrate the acceptability of the test samples as representatives of the GGNS configuration. Seismic qualification of Generic PRNM hardware consisted of test specimens that are a representative sample of production models utilized in the GGNS PRNMS components. Table 22-4 correlates the generic hardware to the GGNS hardware.

**Table 22-4**

| TEST SPECIMENS (For the Generic PRNMS, 1996) | CORRELATES TO GGNS PRNMS COMPONENTS |
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**NON-PROPRIETARY INFORMATION**

| TEST SPECIMENS (For the Generic PRNMS, 1996) | CORRELATES TO GGNS PRNMS COMPONENTS |
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A seismic test plan was prepared and reviewed by an independent verifier. The test was performed at Wyle Laboratories. The seismic qualification test was conducted per a verified GEH TP&P. GEH personnel were present to observe testing.

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**NON-PROPRIETARY INFORMATION**

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The Generic PRNMS components successfully completed the test program. Wyle Laboratories provided the test data, which GEH analyzed and dispositioned any documented anomalies. There was a testing anomaly of PRNMS latching devices and retractor arms being damaged during testing. This anomaly was analyzed by GEH as adequately meeting technical requirements since the PRNMS continued to perform safety-related functions throughout test and this anomaly did not affect operation of other equipment. This was documented in a test report, which was reviewed by an independent verifier.

## EMC QUALIFICATION OF GGNS PRNMS INSTRUMENTS

### Introduction

The GGNS control room is identified and administratively controlled in accordance with procedure EN-DC-217, "Control of Temporary, Portable, or Hand Held EMI/RFI Emitting Equipment," as a "radio exclusion zone" in order to eliminate and/or mitigate radio frequency interference (RFI) that may affect safety-related instrumentation. This procedure requires that new equipment being installed in the plant be evaluated to determine its sensitivity to EMI/RFI and also its emission of EMI/RFI that may affect nearby equipment. See the response to RAI 23 provided in this attachment for EMC testing details.

## ENVIRONMENTAL QUALIFICATION OF GGNS PRNMS INSTRUMENTS

### Introduction

The GGNS PRNMS equipment covered by this report is mounted in the GGNS control room environment envelope at various locations. Except for the APRM fiber optic bypass switch, the PRNMS equipment is mounted in Panels 1H13-P669 thru P672, which are the four identical divisional panels housing the existing APRM equipment. The bypass switch is installed in the operator bench board Panel 1H13-P680.

The qualification evaluations for temperature and humidity are discussed separately below:

### Temperature

To demonstrate qualification of the PRNMS instruments at the installed locations, it is necessary to determine the temperature rise in the mounting cabinet. The qualification report demonstrates that the instruments qualification environment is greater than the ambient room temperature plus the cabinet temperature rise. A review of the panel layout and equipment for the mounting locations identifies no significant heat-generating equipment below the PRNMS instruments mounted in Panel P669 thru P672. Therefore, since the instruments are

**NON-PROPRIETARY INFORMATION**

"stacked" in Panels P669 thru P672 (resulting in the lower-mounted instruments becoming heat sources for higher-mounted instruments), it is concluded that the maximum temperature to which PRNMS instruments are exposed is at the higher locations in Panels P669 thru P672. Therefore, the qualification levels for these instruments will be based on the highest locations. The maximum operating environmental temperature for GGNS is 90°F based on worst-case conditions for a single failure within the environmental control system.

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Humidity

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{3}]] These qualification documents are archived in the GEH database. The analysis concluded that the test specimens are acceptable representatives of the GGNS PRNMS instruments.

**NON-PROPRIETARY INFORMATION**

***TEST CONFIGURATION OF THE ENVIRONMENTAL QUALIFICATION FOR NUMAC INTRUMENTS (APRM and PCI)***:

Environmental testing was conducted at the GEH facility in San Jose, California on August 19 and September 29, 2010. An environmental test plan was prepared and reviewed by an independent verifier. GEH personnel performed the environmental testing and recorded all test data. The environmental qualification test was conducted per a verified GEH TP&P.

The following approach was used to environmentally qualify the APRM and PCI instruments for the GGNS PRNMS. Combinations of environmental type tests were performed on the APRM (P/N 343A3623G001) and PCI ([[ {3}]]) chassis. These test specimens are acceptable (by analysis) representative samples of production models APRM ([[ {3}]]) and PCI ([[ {3}]]), which are utilized in the GGNS PRNMS. [[

**NON-PROPRIETARY INFORMATION**

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The APRM and PCI instruments successfully completed the test program. Upon completion of all environmental testing, the final test results were compared to previous performance characteristics. There were no anomalies for the APRM and PCI instruments. This was documented in a test report, which was reviewed by an independent verifier.

**NON-PROPRIETARY INFORMATION**

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**Figure 22-3: APRM and PCI EQ Testing Set Up**

**NON-PROPRIETARY INFORMATION**

***TEST CONFIGURATION OF THE ENVIRONMENTAL QUALIFICATION FOR NUMAC INTRUMENTS (2-OUT-OF-FOUR LOGIC MODULE AND QLVPS):***

Environmental testing was conducted at the GEH facility in Wilmington, NC April 30 through May 2, 2011. An environmental test plan was prepared and was reviewed by an independent verifier. GEH personnel performed the environmental testing and recorded all test data. The environmental qualification test was conducted per a verified GEH TP&P.

The following approach was used to environmentally qualify the 2-Out-Of-4 Logic Module and QLVPS instruments for the GGNS PRNMS. Combinations of environmental type tests were performed on the GGNS configuration of the 2-Out-Of-4 Logic Module ([[ {3}]]) and QLVPS chassis ([[ {3}]]). [[

**NON-PROPRIETARY INFORMATION**

{3}]]

The QLVPS and 2-Out-Of-4 Logic instruments successfully completed the test program. Upon completion of all the environmental testing, the final test results were compared to previous performance characteristics. There were no anomalies. This was documented in a test report, which was reviewed by an independent verifier.

**NON-PROPRIETARY INFORMATION**

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**Figure 22-4: 2-Out-Of-4 Logic Module and QLVPS in Environmental Chamber**

***TEST CONFIGURATION OF THE ENVIRONMENTAL QUALIFICATION FOR NUMAC INSTRUMENTS ( LPRM CONNECTOR PANEL, APRM FIBER OPTIC BYPASS SWITCH, PRNM CALIBRATION AND MONITORING PANEL):***

The APRM fiber optic bypass switch has no electronic components. The other assemblies contain no electrically-active components; the passive components are designed with specified temperature characteristics that satisfy the assembly environmental requirements. In addition, the passive filter networks contained in the LPRM Connector Panels and the interface connectors in the Calibration and Monitoring Panels are similar to passive components previously qualified. This analysis was performed in the environmental qualification test report of the Generic PRNMS, dated June 11, 1996. No temperature or humidity-sensitive components are in the PRNMS assemblies listed below:

- LPRM Connector Panel ([[ {3}]])
- APRM Fiber Optic Bypass Switch ([[ {3}]]). Aging (40-year equivalent) and cycle testing (10,000 cycles) was performed.
- PRNM Calibration and Monitoring Panel ([[ {3}]])

CONCLUSION

The response above describes the unique test setup(s) and units under test that were utilized for qualification testing of the GGNS PRNMS. The test specimens utilized in qualification testing were analyzed to be equivalent to GGNS production equipment. These qualification tests met the guidelines of section C (4) of Regulatory Guide 1.209 and Section 7.2 of IEEE 323-2003 for EMI, seismic, temperature, and humidity. All testing was performed by independently verified test procedures. All results were analyzed and any anomalies dispositioned and independently verified in a test report. Based on the results of the testing described above, the GGNS PRNMS successfully passed all qualification testing.

**NRC RAI 23**

*Regulatory Guide 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems" (ADAMS Accession No. ML032740277), identifies test methods acceptable to the staff to assure EMI/RFI compatibility. Application of Regulatory Guide 1.180 produces margin to ensure that systems are not exposed to EMI/RFI levels within 8 dB of the specified operating envelopes of identified sources.*

*Describe the EMI/RFI compatibility testing performed in sufficient detail for evaluation to satisfy the above criteria or to determine it to be an acceptable alternative.*

*The following further clarifies the rationale for this RAI but does not include additional information requests. RAI #5's response in Attachment 1 to GNRO-2010/00070 (ADAMS Accession No, ML103490095) does not summarize the basis for the test levels chosen for EMI/RFI compatibility to demonstrate margin in accordance with Regulatory Guide1.180. Any role that EN-DC-217 plays in establishing, justifying and maintaining EMI/RFI compatibility margin is not described with respect to the test levels and limits. Emission/susceptibility requirements for safety equipment and emission requirements for nonsafety equipment that*

**NON-PROPRIETARY INFORMATION**

*are non-conservative with respect to Regulatory Guide 1.180 or the referenced standard (e.g. MIL-S-461E) are neither highlighted nor justified. Within Tables 3-3 through 3-6 of Attachment 1 to GNRO-2010/00070 (ML103490095), the licensee identified qualification tests and limits, some of which differ from the approved LTR and current Regulatory Guidance. These qualification tests were identified as GGNS specific; therefore, the staff evaluation is not considering these qualification tests and limits for general applicability as an LTR update.*

**Response**

1. Introduction and Organization

1.1 Introduction

1.1.1 This document provides additional information regarding electromagnetic compatibility (EMC) qualification for the Grand Gulf Nuclear Station (GGNS) NUMAC Power Range Neutron Monitor System (PRNMS) supplied by GE Hitachi Nuclear Energy (GEH). As GGNS site-specific electromagnetic emissions and susceptibility data is unavailable, U.S. Nuclear Regulatory Commission Regulatory Guide 1.180 Revision 1 is accepted, without exception, as the complete set of EMC requirements for the GGNS PRNMS. The GGNS control room is identified and administratively controlled as a radio exclusion zone. However, GGNS Procedure, EN-DC-217, "Control of Temporary, Portable, or Hand Held EMI/RFI Emitting Equipment," is not considered in establishing EMC requirements for the GGNM PRNMS. RG 1.180 Revision 1 endorses Military Standard MIL-STD-461E and the International Electrotechnical Commission (IEC) 61000 series of EMI/RFI test methods. The test protocols from these endorsed standards are used to demonstrate the EMC performance of the GGNS PRNMS. EMC qualification testing and GGNS specific hardware are described in Sections 2 and 3, respectively. The following discussion regarding EMC qualification pertains only to the GEH NUMAC PRNMS for GGNS. The NUMAC Interface Computers (NICs), installed in non-safety panels N1C91-P865 and N1C91-P866, are not safety-related and have been tested for EMI/RFI emissions in accordance with RG 1.180 Revision 1. The existing systems that remain in Panels P669, P670, P671, and P672 are not included in this response.

1.2 Organization

1.2.1 Table 23-1 provides quantities and identification information for the equipment provided with the GGNS PRNMS. Sections 2.1 through 2.5 provide information and test results for the EMC testing that is used to demonstrate the GGNS PRNMS compliance with RG 1.180 Revision 1, while Tables 23-2 through 23-7 compare the required protocols and required test levels with the actual test protocols and actual test levels. Section 2.1 pertains to recent EMC tests and supports the qualification of the chassis that make up the PRNMS [[

{3}]].

**NON-PROPRIETARY INFORMATION**

Section 2.2 provides test results from the [[ {3}]] PRNMS testing. Many of the [[ {3}]] modules are the same as or similar to those used in the GGNS PRNMS.

Section 2.3 cites test results from the [[ {3}]]. Some components from the [[ {3}]].

Section 2.4 provides test results for some GGNS-specific components and any remaining tests needed to demonstrate compliance with RG 1.180 Revision 1.

Section 2.5 describes the NIC EMI/RFI emissions tests and results.

Sections 3.1 through 3.10 address each hardware chassis or panel and provide information regarding qualification, test results, and analyses.

Section 4 provides the conclusion for this response.

**Table 23-1: Summary of GGNS PRNMS Equipment**

| Chassis/ Component | Identification | Channel Quantity | System Quantity | Section for Hardware Information | Section for Qualification Test Information (Protocols)[1] |
|---|---|---|---|---|---|
| [[ | | | | 3.1 | 2.1 [[ {3}]] |
| | | | | 3.2 | 2.1 [[ {3}]] |
| | | | | 3.3 | 2.1 [[ {3}]] |
| | | | | 3.4 | 2.1 [[ {3}]] |
| | | | | 3.5 | 2.2 [[ {3}]] 2.3 [[ {3}]] |

**NON-PROPRIETARY INFORMATION**

| Chassis/ Component | Identification | Channel Quantity | System Quantity | Section for Hardware Information | Section for Qualification Test Information (Protocols)[1] |
|---|---|---|---|---|---|
| | | | | 3.6 | 2.2 [[ {3}]] 2.3 [[ {3}]] |
| | | | | 3.7 | 2.2 [[ {3}]] 2.3 [[ {3}]] |
| | | | | 3.8 | 2.4 [[ {3}]] |
| | | | | 3.9 | 2.2 [[ {3}]] 2.4 [[ {3}]] |
| | | | | 3.10 | 2.4 [[ {3}]] |
| | | | {3}]] | 3.11 | 2.5 [[ {3}]] |

Table 23-1 Note 1: Protocols CE101, CE102, RE101, RE102, CS101, CS114, CS115, RS101, and RS103 refer to MIL-STD-461E test protocols. IEC test protocols refer to International Electrotechnical Commission EMC test protocols.

**NON-PROPRIETARY INFORMATION**

2. EMC Qualification Testing

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**NON-PROPRIETARY INFORMATION**

**Table 23-2:** [[

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| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [4] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Emissions, Low Frequency | [[ | MIL-STD-461E CE101 | [[ | 120dBμA (60Hz) to 90dBμA (1.15kHz) to 86dBμA (10kHz) | Pass | Test Results Meet RG 1.180 Required Level [5] |
| Conducted Emissions, High Frequency | | MIL-STD-461E CE102 | | 100dBμV (10kHz) to 79dBμV (112kHz - 500kHz) to 73dBμV (500kHz - 2MHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Radiated Emissions, Magnetic Field | | MIL-STD-461E RE101 | | 160dBpT (30Hz) to 90dBpT (100kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Emissions, Electric Field | | MIL-STD-461E RE102 | | 59dBμV/m (2MHz - 25MHz) to 72dBμV/m (1GHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Conducted Susceptibility, Low Frequency | | MIL-STD-461E CS101 | | 136dBμV (30Hz - 5kHz) to 105.5dBμV (150kHz) | Pass | Test Level Envelops RG 1.180 Required Level |

**NON-PROPRIETARY INFORMATION**

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [4] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Susceptibility, High Frequency | | MIL-STD-461E CS114 | | 100dBµA (10kHz to 200kHz) to 97dBµA (200kHz - 30MHz) | Pass [6] | Test Level Envelops RG 1.180 Required Level |
| Radiated Susceptibility, Magnetic Field | | MIL-STD-461E RS101 | | 180 dBpT (30Hz - 60Hz) to 116dBpT (100kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Susceptibility, Electric Field | | MIL-STD-461E RS103 | | 10V/m (30MHz – 1GHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Ring Wave | | IEC 61000-4-12 | | +/- 2kV Power Lines (100kHz, 0.5µs Rise Time) Ring Wave | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Combination Wave | | IEC 61000-4-5 | | +/- 2kV Open Circuit, +/- 1kA Short Circuit | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Electrical Fast Transient | {3}]] | IEC 61000-4-4 | {3}]] | +/- 2kV Power Lines, +/- 1kV Other Lines, 5kHz Repetition | Pass | Test Level Equal to RG 1.180 Required Level |

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**Figure 23-1. MIL-STD-461E CE101 Requirements and Measured Emissions**

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**Table 23-3:** [[

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| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Emissions, Low Frequency | [[ | MIL-STD-461E CE101 | [[ | 120dBµA (60Hz) to 90dBµA (1.15kHz) to 86dBµA (10kHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Conducted Emissions, High Frequency | | MIL-STD-461E CE102 | | 100dBµV (10kHz) to 79dBµV (112kHz - 500kHz) to 73dBµV (500kHz - 2MHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Emissions, Magnetic Field | | MIL-STD-461E RE101 | | 160dBpT (30Hz) to 90dBpT (100kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Emissions, Electric Field | | MIL-STD-461E RE102 | | 59dBµV/m (2MHz - 25MHz) to 72dBµV/m (1GHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Conducted Susceptibility, Low Frequency | | MIL-STD-461E CS101 | | 136dBµV (30Hz - 5kHz) to 105.5dBµV (150kHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Conducted Susceptibility, High Frequency | | MIL-STD-461E CS114 | | 100dBµA (10kHz to 200kHz) to 97dBµA (200kHz - 30MHz) | Pass | Test Level Equal to RG 1.180 Required Level |

**NON-PROPRIETARY INFORMATION**

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation | | MIL-STD-461E CS115 | | 2A (30Hz, <=2ns Rise Time, >=30ns Duration) | Pass [2] | Test Level Equal to RG 1.180 Required Level |
| Radiated Susceptibility, Magnetic Field | | MIL-STD-461E RS101 | | 180 dBpT (30Hz - 60Hz) to 116dBpT (100kHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Radiated Susceptibility, Electric Field | | MIL-STD-461E RS103 | | 10V/m (30MHz – 1GHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Combination Wave | | IEC 61000-4-5 | | +/- 2kV Open Circuit, +/- 1kA Short Circuit | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Ring Wave | {3}]] | IEC 61000-4-12 | {3}]] | +/- 2kV Power Lines (100kHz, 0.5μs Rise Time) Ring Wave | Pass | Test Level Envelops RG 1.180 Required Level |

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**Table 23-4:** [[

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| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Surge Withstand Capability, Surge Immunity | [[ | IEC 61000-4-5 | [[ | +/- 2kV Open Circuit, +/- 1kA Short Circuit | Pass | Tested Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Electrical Fast Transient | {3}]] | IEC 61000-4-4 | | +/- 2kV Power Lines, +/- 1kV Signal Lines, 5kHz Repetition | Pass | Tested Level Envelops RG 1.180 Required Level |

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**NON-PROPRIETARY INFORMATION**

**Table 23-6: Comparison of RG 1.180 Rev 1 Required EMC Test Levels and GGNS Specific PRNM Hardware Qualification EMC Test Levels**

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Emissions, Low Frequency | [[ | MIL-STD-461E CE101 | [[ | 120dBμA (60Hz) to 90dBμA (1.15kHz) to 86dBμA (10kHz) | Pass | Test Results Meet RG 1.180 Required Level [2] |
| Conducted Emissions, High Frequency | | MIL-STD-461E CE102 | | 100dBμV (10kHz) to 79dBμV (112kHz - 500kHz) to 73dBμV (500kHz - 2MHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Radiated Emissions, Magnetic Field | | MIL-STD-461E RE101 | | 160dBpT (30Hz) to 90dBpT (100kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Emissions, Electric Field | | MIL-STD-461E RE102 | | 59dBμV/m (2MHz - 25MHz) to 72dBμV/m (1GHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Conducted Susceptibility, Low Frequency | | MIL-STD-461E CS101 | | 136dBμV (30Hz - 5kHz) to 105.5dBμV (150kHz) | Pass | Test Level Envelops RG 1.180 Required Level |

**NON-PROPRIETARY INFORMATION**

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Conducted Susceptibility, Low Frequency (Harmonics and Interharmonics) | | IEC 61000-4-13 | | Class 2 Test Levels (16Hz to 2.4kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Conducted Susceptibility, High Frequency | | IEC 61000-4-6 | | 140dBµV (150kHz to 80MHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Radiated Susceptibility, Magnetic Field | | MIL-STD-461E RS101 | | 180 dBpT (30Hz - 60Hz) to 116dBpT (100kHz) | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Susceptibility, Electric Field | | IEC 61000-4-3 | | 10V/m (26MHz – 1GHz) | Pass | Test Level Envelops RG 1.180 Required Level |
| Surge Withstand Capability, Electrical Fast Transient | | IEC 61000-4-4 | | +/- 2kV Power Lines, +/- 1kV Signal Lines | Pass | Test Level Equals RG 1.180 Required Level |
| Surge Withstand Capability, Ring Wave | | IEC 61000-4-12 | | +/- 2kV Power Lines (100kHz, 0.5µs Rise Time) Ring Wave | Pass | Test Level Envelops RG 1.180 Required Level |

**NON-PROPRIETARY INFORMATION**

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result [1] | Remarks |
|---|---|---|---|---|---|---|
| Surge Withstand Capability, Combination Wave | | IEC 61000-4-5 | | +/- 2kV Open Circuit, +/- 1kA Short Circuit | Pass | Test Level Envelops RG 1.180 Required Level |
| Radiated Susceptibility, Magnetic Fields | | IEC 61000-4-8 | | 30A/m | Pass | Test Level Equal to RG 1.180 Required Level |
| Radiated Susceptibility, Magnetic Fields | {3}]] | IEC 61000-4-9 | {3}]] | 300A/m, 50/60Hz | Pass | Test Level Equal to RG 1.180 Required Level |

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**Figure 23-2. MIL-STD-461E CE101 Requirements and Measured Emissions**

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**Table 23-7:** [[ {3}]]

| Test Description | Test Protocol | RG 1.180 Rev 1 Test Protocol | Test Level | RG 1.180 Rev 1 Level | Result | Remarks |
|---|---|---|---|---|---|---|
| Conducted Emissions, Low Frequency | [[ | MIL-STD-461E CE101 | [[ | 120dBµA (60Hz) to 90dBµA (1.15kHz) to 86dBµA (10kHz) | Pass | Test Results Meet RG 1.180 Required Level [1] |
| Conducted Emissions, High Frequency | | MIL-STD-461E CE102 | | 100dBµV (10kHz) to 79dBµV (112kHz - 500kHz) to 73dBµV (500kHz - 2MHz) | Pass | Test Results Meet RG 1.180 Required Level [1] |
| Radiated Emissions, Magnetic Field | | MIL-STD-461E RE101 | | 160dBpT (30Hz) to 90dBpT (100kHz) | Pass | Test Results Meet RG 1.180 Required Level [1] |
| Radiated Emissions, Electric Field | {3}]] | MIL-STD-461E RE102 | {3}]] | 59dBµV/m (2MHz - 25MHz) to 72dBµV/m (1GHz) | Pass | Test Results Meet RG 1.180 Required Level [1] |

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3. GGNS-Specific Hardware

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4. Conclusion

4.1 The sections above document how the components of the GGNS PRNMS have been tested for EMI/RFI emissions and susceptibility performance and SWC performance. [[

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4.2 The testing discussed in Sections 2.1 through 2.5 is used to demonstrate compliance with RG 1.180, Revision 1. Sections 3.1 through 3.11 demonstrate that the results of the tested equipment can be applied to the GGNS-specific PRNMS design.

4.3 Based on the information presented above, the GGNS PRNMS meets the requirements of RG 1.180, Revision 1.

**NRC RAI 24**

*Regulatory Guide 1.105, "Setpoints for Safety-Related Instrumentation" (ADAMS Accession No, ML993560062), Regulatory Position C.1 states that "Section 4 of ISA-S67.04-1994 specifies the methods, but not the criterion, for combining uncertainties in determining a trip setpoint and its allowable values. The 95/95 tolerance limit is an acceptable criterion for uncertainties. That is, there is a 95% probability that the constructed limits contain 95% of the population of interest for the surveillance interval selected."*

*Describe in detail the following to satisfy the above criteria or to determine the proposed approach is an acceptable alternative:*

*e) the channel performance data that has been used to establish the basis for determining acceptable values of the limiting setpoints (NSPs);*

*f) the channel performance data that has been used to establish the basis for determining acceptable values for the as-found and as-left tolerances;*

*g) the documentation of representative of the PRNM and OPRM sensor, signal conversion, and NUMAC chassis error performance data that has been (or will be) used within the calculation, to demonstrate that the analysis of this data for each PRNMS channel meets the NRC acceptance criteria of 95/95 for the margin between the analytical limit and the NTSP1;*

*h) how the performance data is used to establish the final setpoint, and as-left and as-found tolerances,*

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*The following further clarifies the rationale for this RAI but does not include additional information requests. RAI 10's response in Attachment 1 to GNRO-2010/00040 (ADAMS Accession No, ML101790436) does not provide sufficient detail of the proposed approach for evaluation to satisfy RG 1.105's criteria or to determine it as an acceptable alternative.*

**Response**

General Description

GEH setpoint calculations are based on the GEH setpoint methodology contained in NEDC 31336P-A, "General Electric Instrument Setpoint Methodology" (Reference 1), which has been approved and licensed by the NRC. Conceptually, the GEH method is based on ISA Method 2, but leads to more conservative setpoints and is referred to as "Method 2 plus". During the original licensing of the GEH setpoint methodology, the NRC Safety Evaluation Report (SER) concluded that the GEH setpoint methodology used acceptable methods for calculating setpoints that provide 95% probability at high confidence (95%) of getting channel trip before the process variable reaches the Analytical Limit (AL).

The GEH setpoint calculation process for Technical Specification setpoints starts with the AL when there is an analytical basis in the safety analysis for the setpoint function. For some Technical Specification setpoint functions there is no analytical basis for an AL because the setpoint function is not credited in any safety analysis. However these setpoints have an Allowable Value (AV) in the Technical Specifications. The setpoint calculation procedure for the case where there is no AL is a subset of the setpoint calculation procedure for the general case where there is an AL, and is discussed below.

For the general case where there is an AL, an overview of the methodology used by GEH to calculate the AV, Limiting Trip Setpoint (LTSP), called the first NTSP in GEH methodology (NTSP1), and the final adjusted $NTSP_F$, was previously explained in the response to RAI 10 provided in Entergy letter GNRO-2010/00040 (Reference 2) and is repeated here in response to this RAI with additional clarifications and explanations.

A pictorial representation of the methodology is shown in Figure 24-1. The methodology for calculating the setpoints shown in Figure 24-1 is the same as what was previously described in Figure 10-1 of Reference 2. However, Figure 24-1 has been simplified to discuss the pertinent features described in the response to this RAI. Some of the terminology has been changed for clarity. For example, the final setpoint called "NTSP(Adj)" in Figure 0-1 of Reference 2 is called "$NTSP_F$" in Figure 24-1 and in the text response to this RAI. Additional features (such as "spurious trip avoidance" and "leave alone tolerance") that are not germane to this response have been removed for clarity. Also additional features such as the As-Found and As-Left Tolerances that are needed for this response, along with a description of the terminology, have been added in Figure 24-1 for clarity.

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**Figure 24-1: GEH Setpoint Methodology**

The GEH setpoint calculation methodology determines an AV that has margin to the AL based on all errors for an instrument channel during operating conditions, except drift. [[

{3}]] Conservative values for each of the error components are used to assure, with high confidence (95%) [[

{3}]] The GEH methodology then calculates an initial value for the nominal trip setpoint (NTSP1), which has margin to the AL, based on all errors (i.e., all errors used in the AV calculation and also including conservative values for drift of all devices in the channel), as illustrated in Figure 24-1. NTSP1 is calculated using all errors (including drift) and is referred to as the Limiting Trip Setpoint (LTSP) because it meets the Regulatory Guide (RG) 1.105 Rev. 3 (RG 1.105) requirement of providing 95% probability of not exceeding the AL with high confidence (95%).

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Although NTSP1 has the required margin to the AL to meet RG 1.105, GEH methodology also requires the final setpoint to have an adequate margin to the AV, which is referred to as the LER (Licensee Event Report) avoidance margin. The LER margin is prescribed by GEH methodology. Therefore, in the GEH setpoint calculation process, the setpoint is adjusted conservatively from NTSP1 to the final value ($NTSP_F$) to assure with high confidence (95%) [[

{3}]] as defined by the AL/AV margin provided in GEH methodology. $NTSP_F$ is always equal to or more conservative (further from the AL) than NTSP1. Thus, generally, and specifically for PRNM setpoints, $NTSP_F$ is more conservative than NTSP1 and has margin to the AL that is significantly larger than the AL/NTSP1 margin required to meet RG 1.105. Therefore, generally, and specifically for PRNM, $NTSP_F$ implemented in the instrument conservatively exceeds the 95% RG 1.105 probability requirement for not exceeding the AL.

Note that meeting the RG 1.105 requirement of 95% probability of not exceeding the AL at 95% confidence is assured by the following two basic steps:

- Using values for the random instrument errors, measured in terms of standard deviation (or sigma) of the normal error distribution function that has high confidence, and statistically combining the standard deviation of pertinent random errors for each device in the channel using the Square Root of the Sum of the Squares (SRSS) technique gives the channel error standard deviation (StndDev) that has high confidence (95%). Also, adding all the non-conservative bias errors algebraically gives the channel bias error (B) that is incorporated in the setpoint margin calculation.

- Calculating the setpoint margins by multiplying StndDev by 1.645 for setpoints where the variables approach the setpoints in one direction as described in Reference 1, and algebraically adding the channel bias error B. It has been shown from statistical first principles (Reference 3) that when StndDev is known to 95% confidence, a setpoint margin of B + 1.645 * StndDev meets the RG 1.105 setpoint margin 95/95 requirement (i.e. it provides 95% probability at 95% confidence) of not exceeding the AL for setpoints approached from one direction. Use of the single-sided 1.645 statistical factor for setpoint margin calculations where the variable approaches the setpoint from one direction, has been endorsed by the NRC staff for GEH setpoint methodology (Reference 1) and also by Instrumentation Society of America (ISA) Standard ISA-RP67.04, Part II, 1994 (and later revision ISA-RP67.04.02-2000).

During licensing of the GEH setpoint methodology, GEH presented field data that demonstrated, and the NRC agreed (Reference 1), that the margins calculated by GEH setpoint methodology bounded 95% of the data with high confidence (95% confidence limits).

Note that the final safety margin is the $NTSP_F$ margin to the AL or the AL/$NTSP_F$ margin. This is the margin that needs to be large enough to meet or exceed the 95/95 requirements specified in RG 1.105. Thus, since the AL/NTSP1 meets the 95/95 margin requirement and $NTSP_F$ is generally (and specifically for PRNM) more conservative than NTSP1, the AL/$NTSP_F$ margin is larger and, therefore, more conservative than that required to meet the 95/95 requirements. Moreover, the larger the AL/$NTSP_F$ margin, the more conservative the setpoint is with respect to the 95/95 requirement.

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The margin of $NTSP_F$ to the AV (or AV/$NTSP_F$ margin) is based on the errors during calibration and is not the safety margin for which RG 1.105 is applicable. The requirement for the AV/$NTSP_F$ margin is the LER avoidance margin, which is an operational requirement [[

{3}]] and that it is small enough to detect when instruments are not performing as expected.

The NRC criterion and allowance for acceptable performance is based on errors during calibration and is given in Technical Specification Task Force report TSTF-493 Revision 4 (TSTF-493). When the as-found value is within this margin, the instrument is performing acceptably. As long as the AV/$NTSP_F$ margin is less than or equal to the performance margin allowance in TSTF-493, the AV/$NTSP_F$ margin is an acceptable margin for performance monitoring. Note that from the performance monitoring point of view a small AV/$NTSP_F$ margin means that performance is controlled more tightly.

For conformance with NRC requirements in RG 1.105 and TSTF-493, the $NTSP_F$ calculated by GEH methodology has to meet the following two conditions:

3) $NTSP_F$ must be far enough on the conservative side of AL so that the AL/$NTSP_F$ margin is equal to or greater than 95/95 margin based on all errors during trip conditions. This complies with RG 1.105. If $NTSP_F$ is further from the AL than this 95/95 margin then the AL/$NTSP_F$ margin is more conservative than required and, therefore, complies with RG 1.105.

4) $NTSP_F$ must be far enough on the conservative side of the AV (i.e., away from the AL) to assure [[
{3}]] Also, $NTSP_F$ must be close enough on the conservative side of the AV so the AV/$NTSP_F$ margin is equal to or less than the TSTF-493 performance allowance margin based on all errors during calibration conditions. If $NTSP_F$ is closer to the AV than this TSTF-493 margin allowance, then the AV/$NTSP_F$ margin provides for tighter performance monitoring than required by TSTF-493, which is conservative from the performance monitoring point of view. Note that since by GEH methodology $NTSP_F$ cannot be closer to the AL than NTSP1, the 95/95 safety margin to the AL is assured. Moreover, by GEH methodology the AV/$NTSP_F$ margin (or LER margin) is smaller than the margin required by TSTF-493 and is, therefore, compliant with TSTF-493 since it leads to tighter control of instrument performance during surveillance tests. Note also there is no NRC requirement that the AV/$NTSP_F$ margin be equal to or greater than the 95/95 margin based on errors during calibration, which is essentially the TSTF-493 performance margin allowance. As stated earlier, an AV/$NTSP_F$ margin that is less than the TSTF-493 performance margin allowance based on all errors during calibration conditions leads to tighter control of instrument performance during calibration and is therefore more conservative from the TSTF-493 performance monitoring point of view.

As mentioned, above, for some setpoints there is no safety analysis basis for an AL since the function is not credited in any safety analysis (accident or anticipated operational occurrence). However, the AVs associated with these functions have been historically included in the Technical Specifications because they are part of safety-related trip systems. For these setpoints, the AVs in the Technical Specifications are based on operational experience and engineering judgment. RG 1.105 is not applicable to the setpoints of these functions because

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there is no AL, and, therefore, the 95/95 margin to the AL specified in RG 1.105 is also not applicable. Only the TSTF-493 performance monitoring requirement is applicable, specifically for those Technical Specification setpoints that are annotated in TSTF-493. Thus, the setpoint calculation procedure for setpoints without ALs but with AVs is a subset of the setpoint calculation procedure described above for the general case where there is an AL. The starting point for the setpoint calculation procedure for this case of setpoints without ALs, is the AV.

Note that since there is no AL there is no safety analysis basis for the setpoint, and there is no corresponding NTSP1 (LTSP). The $NTSP_F$ is calculated from the AV using the same procedure as described earlier for the general case with an AL. The errors involved in the AV/$NTSP_F$ margin are the errors during calibration. As for the general case, the requirements for this AV/$NTSP_F$ margin are that $NTSP_F$ must be far enough from the AV to provide [[ {3}]] and close enough on the conservative side of AV (i.e., away from the AL) so the AV/$NTSP_F$ margin is equal to or less than TSTF-493 performance allowance margin based on all errors during calibration. If $NTSP_F$ is closer to the AV than this TSTF-493 margin allowance, then AV/$NTSP_F$ margin provides tighter performance monitoring than required by TSTF-493, and, therefore, complies with TSTF-493. Since, for GEH methodology, the AV/$NTSP_F$ margin is only a performance monitoring margin and not a safety margin, there is no NRC requirement that the AV/$NTSP_F$ margin be equal to or greater than the 95/95 margin based on errors during calibration. A smaller margin would provide tighter performance monitoring and would therefore be more conservative from the performance monitoring point of view.

Each of the four topic items identified in the RAI is discussed below.

(a) *The channel performance data that has been used to establish the basis for determining acceptable values of the limiting setpoints (NSPs)*

Setpoint Calculation Data - General

The data needed for a general GEH setpoint calculation is shown in Figure 24-1, and includes the following errors:

- Process Measurement Accuracy (PMA)
- Primary Element Accuracy (PEA)
- Accuracies under Trip and Calibration conditions for all devices in the loop ($A_T$, $A_C$)
- Drift between calibrations for all devices in the loop (D)
- Calibration error for all devices in the loop (C)

The error for the channel (or loop) is a statistical combination of all these errors. The combination requires all errors to be in the same units, so when calculations are done in process variable engineering units, appropriate transfer functions are used to convert instrument errors into process variable engineering units.

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Setpoint Calculation Data - PRNM

The PRNM uses an analog front end to interface with the reactor recirculation loops flow sensors and the Local Power Range Monitor (LPRM) sensors. Processed data from this analog front end is converted to digital data using 16 bit analog to digital (A/D) conversion. For the electronic signal processing errors used in the setpoint calculations, only the errors (accuracy and drift) of the PRNM analog front end (and associated sample and hold circuit and A/D conversion) are pertinent. There is no error associated with the downstream digital signal processing since that is done by firmware algorithms. The trip function is also performed digitally, so it has no error, and a trip setting in firmware will not drift from one calibration to the next. Therefore, there is no setting tolerance (such as an As-Left Tolerance) for the PRNM digital trip setting.

The specified errors of the pertinent PRNM components are based on extensive testing that verified that the accuracy of the equipment designed according to the design specifications was within the performance specifications at the specified temperature and humidity extremes. The performance specifications were based on the highest error observed in the testing, and additional error margin was added for conservatism. Each pertinent PRNM component is tested to meet its performance specification before shipment, so there is high confidence (95%) that the specified errors are applicable to all PRNMS in the field.

For the PRNM fixed Average Power Range Monitor (APRM) Neutron Flux High setpoint and APRM setdown setpoint functions, the error from components that can be calibrated are the components with the PRNM APRM electronics. These PRNM errors are due to the accuracy and drift of the analog LPRM processing modules in the front end which process the LPRM detector signals, and their associated A/D conversion. The errors for each LPRM processor are specified conservatively in the PRNM specifications. These independent, random errors are combined statistically to determine the overall APRM electronics error. For these setpoints, the use of the conservative and high confidence (95%) PRNM accuracy specifications together with GEH setpoint methodology provides assurance that RG 1.105 requirements are met.

For the APRM Flow Biased APRM Simulated Thermal Power – High setpoint, additional errors are considered, including errors due to accuracy, drift, and calibration of the reactor recirculation loop flow transmitters (FTs), and errors due to the accuracy and drift of the analog flow processing modules in the PRNM front end that are used to process the flow signals. The errors specified for the PRNM flow channel electronics in the PRNM specifications are conservative and have high confidence (95%). The specified errors for the FT are conservatively treated and also have high confidence.

The error data used in the calculation of PRNM setpoints are summarized below:

- PMA (includes random errors due to APRM tracking and neutron noise for the neutron flux loop and flow noise error for the Recirculation Flow loops)

- PEA (includes bias and random errors due to non-linearity and drift of the LPRM detectors, and error due to accuracy of the flow elements used in the Recirculation Loop flow measurements)

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- Accuracy of the PRNM APRM electronics under trip conditions (same as accuracy under calibration conditions)
- Drift of PRNM APRM neutron flux measurement electronics and PRNM APRM flow measurement electronics
- PRNM calibration errors
- Accuracy of the flow transmitters
- Drift of the flow transmitters
- Calibration error of the flow transmitters

Values and inputs for these errors for the GGNS PRNM equipment are shown in the summary APRM Inputs/Outputs document (Reference 4) and were used in the setpoint calculations. This summary APRM Inputs/Outputs document is provided in Enclosure 1 for the NRC's review of the instrument uncertainty inputs used in the setpoint calculation. The associated setpoint calculation spreadsheets for Reference 4 may be viewed by the NRC at a GEH office, upon request.

*(b) The channel performance data that has been used to establish the basis for determining acceptable values for the as-found and as-left tolerances*

AFT/ALT Data - General

The GEH As-Found Tolerance (AFT) and As-Left Tolerance (ALT) values comply with the guidance in TSTF-493 Revision 4 for instrument performance monitoring and instrument resetting. Consistent with TSTF-493, the AFT and ALT requirements only apply to Surveillance Tests for setpoint functions that are annotated in TSTF-493, and do not apply to Surveillance Tests that test purely digital components in the channel.

[[

{3}]] This includes the following error components:

- Accuracy under calibration conditions ($A_c$)
- Drift (D) between calibrations
- Calibration error (C)

The errors are specific to the applicable surveillance tests. For example, for device calibrations, the accuracy of the devices and the drift and calibration errors that are applicable to the device calibration tests are used. The loop error components are combined statistically by GEH methodology and provide a loop AFT value that is generally smaller (and therefore tighter than) or equal to, but never greater than the loop AFT value provided in the TSTF-493 guidance. [[

{3}]]

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The AFT values by GEH methodology [[ {3}]] is never larger than the AFT values based on TSTF-493 methodology. The GEH AFT is a two-sided tolerance, so that as-found values outside GEH AFT on either side of the setpoint are to be dispositioned as described in TSTF-493.

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{3}]]

The calculated ALT values by GEH methodology [[ {3}]] are never larger than the ALT values based on TSTF-493 methodology. The ALT margin by TSTF-493 methodology for [[ {3}]] is based on the following errors applicable during [[ {3}]] calibrations:

- Accuracy under calibration conditions ($A_c$)
- Calibration error (C)

The GEH ALT is a two-sided tolerance, so the setpoint can be set at $NTSP_F$ ± ALT after calibration.

AFT/ALT Data for PRNM

The APRM and its components are calibrated by several different surveillance tests in the Technical Specifications. Each APRM channel is calibrated every 7 days as a system in GGNS Surveillance Requirement SR 3.3.1.1.2 where the APRM gain is adjusted so that the APRM output matches the heat balance to within a prescribed amount (2%). The gain adjustment compensates for changes in all parts of the system and is the appropriate test basis for calculating the AV and setpoints (NTSP1 and $NTSP_F$) for the APRM setpoint functions. The pertinent errors for this SR are used to calculate APRM setpoints by GEH methodology for both the new digital PRNM and the older analog APRM equipment that the PRNM replaced. For PRNM, the APRM trip setpoint is set in firmware and does not drift once it is set. The individual components of the PRNM APRM system that could drift and are calibrated are the analog components at the front end of the PRNM that process the inputs from the LPRM detectors and flow transmitters. The PRNM front end is tested and calibrated by GGNS SR 3.3.1.1.10 and the flow transmitters by GGNS SR 3.3.1.1.17. TSTF-493 only annotates SR 3.3.1.1.10 and so requires that the AFT and ALT tolerances for the analog devices in the PRNM front end used in the SR are equivalent or more conservative than those based on the PRNM device accuracy and drift specifications.

For SR 3.3.3.1.10, all the analog components in PRNMS that could drift are calibrated, so that after calibration the entire PRNM chassis is calibrated to perform according to its design and performance specifications for the next operating cycle. In this calibration, the analog front end of the PRNM equipment is calibrated once every 24 months[7] and the LPRM detectors and reactor recirculation flow transmitters are excluded because they are calibrated separately according to SR 3.3.1.1.17.[8] The calibration is performed by the PRNM "Auto-Calibration" procedure which involves sending a known calibrated current into each LPRM and flow amplifier and determining the as-found value of the output after it is processed by the amplifier, and the associated sample-and-hold and A/D converter circuits. This [[ {3}]] as-found value is automatically compared to the [[ {3}]] AFT values stored in the PRNM firmware data base. The [[ {3}]] AFT values are based on the [[ {3}]] accuracy and drift specifications and are compliant with TSTF-493 requirements. Consistent with the "Auto-Calibration" process, if the as-found values are within the [[ {3}]] AFT, the gain and off-set of each amplifier are adjusted automatically by embedded software (firmware) in PRNMS, to provide the correct output. No manual adjustments are made. If the as-found values are beyond the AFT tolerance limits, then the "Auto-Calibration" returns a "Calibration Failed" message and the device is inoperable. The "Auto-Calibration" procedure returns each analog front end processor to the desired state after calibration, and the As-Left Tolerances are small and compliant with TSTF-493 guidance. The [[ {3}]] AFT and ALT values built into the PRNM are less than or equal to the values determined following the guidance of TSTF-493:

- Device accuracy under calibration conditions
- Drift between calibrations
- Internal Calibrator Error

Note that the pertinent portions of the GGNS Surveillance Requirement SR 3.3.1.1.10 tests and calibrates all the analog LPRM neutron flux and Recirculation Flow signal processing devices at the front end of the PRNM, because these devices can drift. It does not test the portion of the PRNM that performs the downstream processing of these signals in firmware. Thus, the SR does not test the APRM signal processing portion of the PRNM (which averages the signals from the various LPRM amplifiers) or the APRM flow processing (which adds the flow signals from the two Recirculation Flow loops), nor does it test the processing that generates the APRM trip signal because this processing is done in PRNM firmware and is not subject to drift. So the As-Found and As-Left tolerances for any surveillance of this portion of the PRNM signal processing and trip signal generation are zero.

*(c) The documentation of representative of the PRNM and OPRM sensor, signal conversion, and NUMAC chassis error performance data that has been (or will be) used within the calculation, to demonstrate that the analysis of this data for each PRNMS channel meets the NRC acceptance criteria of 95/95 for the margin between the analytical limit and the NTSP1.*

See Sections (a), (b), and (d) for the response to this item for the APRM setpoints. The response in this section deals specifically with the OPRM setpoints.

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7 Section 4.4.2.1 of the PRNMS License Amendment Request (LAR) provided in Entergy letter GNRO-2010-000054 (Reference 5) proposes and justifies extending the current 18-month surveillance frequency to 24 months.

8 These exclusions are currently specified in Technical Specification SR 3.3.1.1.17, which is not being changed by Reference 5.

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The OPRM is a sub-system within PRNMS for stability monitoring and mitigation, which is enabled above a predetermined power level (24% for GGNS). OPRM trip setpoints correspond to a pre-determined number of confirmed oscillations and pre-determined oscillation amplitude, and are not calculated by GEH setpoint methodology. These OPRM setpoints do not have ALs, AVs, and NTSPs with margins based on instrument error and GEH setpoint methodology. This was explained in the response to RAI 10 of Reference 2. The following information is excerpted from that response:

- The OPRM setpoints are nominal setpoints, which are established using a comprehensive BWR Owners' Group (BWROG) methodology for stability analysis approved by the NRC. There is no AL or AV with defined instrument error margins to the NTSP for the OPRM setpoints. Note that OPRM setpoints are not considered to be Limiting Safety System Settings (LSSSs) since stability is a special event, and not an Anticipated Operational Occurrence (AOO), which defines LSSSs.

- These OPRM setpoints are established as nominal values based on cycle specific reload stability analysis and are included in the Core Operating Limits Report (COLR).

- Use of nominal setpoints for the OPRM Upscale function has been addressed during the licensing of PRNMS at Browns Ferry Unit 1 and at Monticello, previously. Note also that the OPRM trip setpoints are not listed in the BWR/6 Standard Technical Specifications.

- Demonstration calculations for the nominal setpoints of the OPRM Upscale function are available for review. They may be viewed by the NRC at a GEH office, upon request.

The power level at which OPRM is enabled is also a nominal setpoint determined by stability methodology and not by GEH setpoint methodology. This enabling setpoint is considered a permissive and is not annotated in TSTF-493.

*(d) How the performance data is used to establish the final setpoint, and as-left and as-found tolerances*

<u>Setpoint Calculations</u>

The PRNM setpoints are calculated as described in the "General Description" section, above, using errors specified in the PRNM specifications as described Section (a), above. The specified PRNM errors are conservative and have high confidence (95%). Thus, the PRNM setpoint calculations based on specified PRNM errors and the approved GEH setpoint methodology meet the RG 1.105 95/95 requirements for AL/$NTSP_F$ margin. Specifically, since NTSP1 (LTSP) has the required margin to the AL to meet RG 1.105 requirements and since $NTSP_F$ is equal or more conservative than NTSP1, it also meets RG 1.105 requirements.

The equations for calculating the setpoints (AV, NTSP1, and $NTSP_F$) and relevant explanations are given in the response to RAI 10 of Reference 2. In that response, the final setpoint is referred to as "NTSP(Adj)" whereas in this response it is referred to as "$NTSP_F$" for clarity. Because NTSP1 (LTSP) meets the RG 1.105 requirements and $NTSP_F$ is generally more and never less conservative than NTSP1, it also meets RG 1.105 requirements. As an example, according to GEH methodology, the AL/NTSP1 margin is the algebraic addition of the bias errors plus a random error margin equal to 1.645 * StndDev of the total channel

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random error under trip conditions, whereas the AL/$NTSP_F$ margin for APRM Neutron Flux High setpoint with typical PRNM errors, is much larger and equal to the same bias errors plus a random error margin which is larger than 2.5 * StndDev of the total channel random error under trip conditions.

In GEH methodology, $NTSP_F$ is based on satisfying the following two criteria as described in the "General Description" section, above:

- Minimum margin to the AL to satisfy RG 1.105 and assure 95% probability of not exceeding the AL with high confidence (95%).

  This calculation uses all the errors under trip conditions and includes the process errors and primary element errors that are present during operation but not during calibration, and the accuracy calibration and drift errors of the measuring equipment. The setpoint with this required minimum margin to the AL is referred to as NTSP1 in GEH methodology and corresponds to the LTSP in TSTF-493 terminology. This criterion is only applicable to setpoints with ALs.

- [[
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  This calculation uses all the errors under calibration conditions and includes the accuracy calibration and drift errors of the measuring equipment. For setpoints with ALs, this requirement generally, and specifically for PRNM, results in $NTSP_F$ being significantly more conservative than NTSP1, and never less conservative than NTSP1. The reasons for this are as follows:

  - Generally, and specifically for PRNM, there is not a significant difference between NTSP1 and AV because, by GEH methodology, the AL/AV margin is calculated with all the same errors used in the AL/NTSP1 (i.e., AL/LTSP) calculation except drift, and the drift generally (and specifically for PRNM) does not increase the margin significantly.

  - Generally, and specifically for PRNM, the margin between AV and $NTSP_F$ is significantly larger than between AV and NTSP1 because this margin includes the same calibration and drift errors used in the AV and NTSP1 calculations, and also includes the accuracy under calibration conditions. Calculation of $NTSP_F$ [[

    {3}]]

  Note that AV/$NTSP_F$ margin is a measure of the performance of the instrument, and is not a safety margin. The safety margin is the margin to the AL (for setpoints where the AL protects a Safety Limit). The fact that $NTSP_F$ is equal to or more conservative than NTSP1 assures that the safety setpoint margin to the AL is equal to or more conservative than the 95/95 requirement in RG 1.105. So the AV/$NTSP_F$ margin is merely an instrument performance margin which assures that when the measured value is within this margin the instrument is performing as expected.

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For PRNMS, the setpoint calculation method described above is applicable to the APRM Neutron Flux High setpoint, which is used in a safety analysis and has an AL. On the other hand, no credit is taken for the APRM Flow Biased Simulated Thermal Power - High scram in any GEH safety analysis including the Minimum Critical Power Ratio (MCPR) determination. So the APRM Flow Biased Simulated Thermal Power - High setpoint does not protect a plant Safety Limit and does not have an AL. However, this setpoint is part of the Reactor Protection System providing protection against slow flux excursions, and has an AV in the Technical Specifications. The setpoint calculation for the flow biased setpoint, and other APRM setpoints without an AL, is a subset of the calculation of setpoints with ALs, and starts from the AV as described in the "General Description" section, above.

AFT and ALT Calculations

The calculation of the AFT and ALT [[ {3}]] are described in Section *(b)*, above. Note that in GEH methodology, the AFT and ALT are applied to $NTSP_F$ implemented in the equipment, and not to the interim setpoints (such as NTSP1) used in the calculation of $NTSP_F$. The GEH AFT and ALT values also depend on the surveillance test and the devices or components tested in the surveillance test. The GEH AFT and ALT values are generally smaller, and never greater than the allowances in TSTF-493 and are therefore compliant with TSTF-493. The GEH AFT is a two-sided tolerance, so that as-found values outside GEH AFT on either side of the setpoint are to be dispositioned as described in TSTF-493.

For PRNMS, the TSTF-493 requirements are only applied to the GGNS Surveillance Requirement SR 3.3.1.1.10 for APRM Neutron Flux – High, Setdown, APRM Flow Biased Simulated Thermal Power - High, and APRM Fixed Neutron Flux - High setpoints. As described in Section (b), above, this SR calibrates the PRNMS analog input devices individually, so that after the SR is successfully completed, the entire PRNM equipment is calibrated to perform according to its design and performance specifications. The calibration required by SR 3.3.1.1.10 is to be performed once every 24 months (Reference 5), through the PRNM "Auto-Calibration" process. The "Auto-Calibration" process is initiated manually, and then performs the required calibration steps automatically. This "Auto-Calibration" process involves injecting known input signals and measuring the output, and automatically adjusting the output (specifically the offset and gain) using correction factors built in the firmware if the as-found value [[ {3}]] is less than the [[ {3}]] AFT which is also built into the PRNM firmware. The [[ {3}]] AFT is less than the statistical combination of the specified [[ {3}]] accuracy and drift and is compliant with the guidance in TSTF-493. If the [[ {3}]] as-found value is not within the [[ {3}]] AFT limit, then the "Calibration Failed" message is sent and the device is inoperable, and must be repaired or replaced and brought back into calibration before being declared operable. The "Auto-Calibration" process adjusts the output of each analog device to its desired value within a small ALT which is less than the specified accuracy of the device, and also complies with TSTF-493 requirements.

**NON-PROPRIETARY INFORMATION**

PRNMS LAR (Reference 5) Corrections

Regarding the OPRM Upscale trip function and its inclusion into Technical Specifications Table 3.3.1.1-1, *Reactor Protection System Instrumentation*, Section 4.4.3.1.c of Reference 5 proposed to add a new note to the table applied to this new function. Specifically, Section 4.4.3.1 states in part:

> "c. In accordance with Section 8.4.6.1 of the NUMAC PRNM LTR, add new Note (f) to denote that the Allowable Value is contained in the Core Operating Limits Report (COLR). Note (f) states:
>
> > " 'The Allowable Value for the OPRM Upscale Period-Based Detection algorithm is specified in the COLR.' "

Also, Section 4.4.3.7.g of Reference 5 states:

> "g. Apply new Note (f) to the Allowable Value reflecting that it is contained in the COLR, as discussed in Section 4.4.3.1.c, above."

This change was reflected in INSERT E in the Technical Specification marked-up pages provided in Attachment 3 to Reference 5.

However, as explained in the response to RAI 10 of Reference 2 and also in Section (c), above, the OPRM trip setpoints do not have associated AVs with margins based on instrument error and GEH setpoint methodology. Therefore, Sections 4.4.3.1.c and 4.4.3.7.g of Reference 5 are in error by stating the Allowable Value for the OPRM Upscale trip function will be specified in the Core Operating Limits Report (COLR) since no such value exists.

Entergy proposes to correct these errors by revising Sections 4.4.3.1.c and 4.4.3.7.g to read as follows (changes marked):

> "c. In accordance with Section 8.4.6.1 of the NUMAC PRNM LTR, add new Note (f) to denote that the ~~Allowable Value~~ ***setpoint*** is contained in the Core Operating Limits Report (COLR). Note (f) states:
>
> > " 'The ~~Allowable Value~~ ***setpoint*** for the OPRM Upscale Period-Based Detection algorithm is specified in the COLR.' "
>
> "g. Apply new Note (f) ~~to~~ ***in*** the Allowable Value ***column*** reflecting that ~~it~~ ***the setpoint*** is contained in the COLR, as discussed in Section 4.4.3.1.c, above."

A revised INSERT E reflecting the correction to proposed Note (f) is provided in Enclosure 2.

The justification for maintaining the Allowable Value of the OPRM Upscale trip function in the COLR currently provided in Section 4.4.3.1.c is also applicable to maintaining the setpoint in the COLR.

References

1. GE Nuclear Energy Licensing Topical Report NEDC-31336P-A, "General Electric Instrument Setpoint Methodology," September 1996

**NON-PROPRIETARY INFORMATION**

2. M. A. Krupa (Entergy Operations Inc.) to U.S Nuclear Regulatory Commission Document Control Desk, "Responses to NRC Requests for Additional Information Pertaining to License Amendment Request for Power Range Neutron Monitoring System (TAC No. ME2531)," GNRO-2010/00040, June 3, 2010 (ADAMS Accession No. ML 101790436)

3. "Response to NRC Summary Points on Application of Single-Sided Factor for Setpoint Margin Calculations," Enclosure 1, MFN 10-334, Letter GEH to NRC, October 25, 2010

4. GEH Report 0000-0102-8815-R2, "Instruments Limits Calculation, Entergy Operations, Inc., Grand Gulf Nuclear Station, Average Power Range Monitor, Power Range Neutron Monitoring System (NUMAC)-CLTP Operation", GEH Proprietary, Rev. 2, May 2011

5. M. A. Krupa (Entergy Operations Inc.) to U.S Nuclear Regulatory Commission Document Control Desk, "License Amendment Request – Power Range Neutron Monitoring System Upgrade," GNRO-2009-00054, November 3, 2009 (ADAMS Accession No. ML093140463)

**NON-PROPRIETARY INFORMATION**

**ENCLOSURE 1**

**GEH Report 0000-0102-8815-R2**

**"Instruments Limits Calculation, Entergy Operations, Inc., Grand Gulf Nuclear Station, Average Power Range Monitor, Power Range Neutron Monitoring System (NUMAC)-CLTP Operation," Rev. 2**

**(NON-PROPRIETARY VERSION)**

GE Hitachi Nuclear Energy
3901 Castle Hayne Road
Wilmington, NC 28401

0000-0102-8815-R2
Revision 2
DRF 0000-0102-8808
May 2011

*GEH Non-Proprietary Information-Class I (Public)*

# Instrument Limits Calculation

Entergy Operations, Inc.
Grand Gulf Nuclear Station

# Average Power Range Monitor

Power Range Neutron Monitoring System (NUMAC)-
CLTP Operation

## Safety Analysis Setpoints

**Non-Proprietary Notice**

This is a non-proprietary version of 0000-0102-8815-R2 which has the proprietary information removed. Portions of the document that have been removed are indicated by an open and closed bracket as shown here [[ ]].

**REVISION SUMMARY:**

| Rev | Required Changes to Achieve Revision |
|---|---|
| 0 | Initial Issue |
| 1 | a. Expanded Proprietary Information Notice, including adding the description of special markings.<br>b. Identified GEH Proprietary Information within the report with special markings.<br>c. Removed uses of "As Found Tolerance", because it is different from the "Leave Alone Tolerance".<br>d. Added new comment to correlate the setpoint function terminology used in this report to the NUMAC equipment terminology.<br>e. Made miscellaneous editorial changes. |
| 2 | a. Revised Comment 6 and Comment 20 to correctly identify safety related Scram setpoint functions, and to explain that the GEH safety analysis does not take credit for the APRM Flow Biased STP Scram.<br>b. Added the Technical Specification Bases to Ref. 4.1 and cited Ref. 4.1 Bases in Comment 22.<br>c. Updated the GEH Proprietary Information markings.<br>d. Made miscellaneous editorial changes. |

**Contents:**

This document is a supplement analysis data sheet to Reference 1. Included in this document in sequential order are:

- The setpoint functions for the system,
- The setpoint function analyses inputs and the source reference of the inputs,
- The devices in the setpoint function instrument loop,
- The component analysis inputs and input sources,
- The calculated results,
- Input comments and result recommendations (if any),
- References.

**System: Average Power Range Monitor (APRM)**

The following setpoint functions are included in this document:

- APRM Flow-Biased Simulated Thermal Power (STP) Scram with Clamp (TLO)
- APRM Flow-Biased STP Rod Block with Clamp (TLO)
- APRM Flow-Biased STP Scram (SLO)
- APRM Flow-Biased STP Rod Block (SLO)

## 1. Function: Flow-Biased STP Scram, Flow-Biased Rod Block

| Setpoint Characteristics: | Definition | Reference(s) |
|---|---|---|
| Event Protection: | Limiting event for the setpoint:<br><br>**Scram:**<br>The APRM Flow Biased STP scram setpoint function is designed to protect against slow reactivity transients.<br><br>**Rod Block:**<br>The APRM Flow Biased STP rod block function prevents operation significantly above licensed power level; the function precedes a flow-biased scram. | Ref. 2 (Section 3.21); |
| Function After Earthquake | ☐ Required ☒ Not Required | Comment 6 |
| Setpoint Direction:<br>▪ APRM Flow Biased STP Scram (TLO)<br>▪ APRM Flow Biased STP Rod Block (TLO)<br>▪ APRM Flow Biased STP Scram (SLO)<br>▪ APRM Flow Biased STP Rod Block (SLO) | <br>☒ Increasing ☐ Decreasing<br>☒ Increasing ☐ Decreasing<br>☒ Increasing ☐ Decreasing<br>☒ Increasing ☐ Decreasing | Ref. 2 (Section 3.21) |
| Single or Multiple Channel | ☐ Single ☒ Multiple | Ref. 2 (Section 3.21) |
| LER Calculation Basis if Multiple Channel | Standard (Conservative) LER Calculation ☒ or<br>Configuration Specific LER Calculation ☐ | Ref. 1; Ref. 2 |
| Trip Logic for Configuration Specific LER Calculation | n/a | |

n/a: Not applicable
LER: Licensee Event Report
STP: Simulated Thermal Power
SLO: Single Loop Operation
TLO: Two Loop Operation

| Plant Data: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Flow Primary Element (Flow Elbow)<br>a.) Accuracy (APEA)<br>b.) Drift (DPEA) | a.) ± 2% rated Recirc Flow<br>b.) n/a | | |
| Flow Process Measurement Accuracy (PMA)<br>a.) PMA (flow noise)<br>b.) PMA (static head) | a.) ± 1.6% rated Recirc Flow<br>b.) Negligible | | Comment 15<br>Comment 23 |

| Plant Data: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Power Primary Element (LPRM Detector)<br>(% Power)<br>a.) $APEA_{Accuracy}$<br>b.) $APEA_{PowerSupply\ Effect}$<br>c.) DPEA | a.) ± 1%; bias 0.49%<br>b.) Negligible<br>c.) ± 0.2%/ 7days; bias 0.33 %/ 7days | | Comment 16 |
| Power Process Measurement Accuracy (PMA)<br>(% Power)<br>a.) Tracking (fixed and flow-biased)<br>b.) Noise (STP) | a.) ± 1.11%<br>b.) ± 0.0% | | Comment 13 |

**Components (or Devices) in Setpoint Function Instrument Loop:**

- Flow Element
- LPRM Detector
- Flow Transmitter
- Nuclear Measurement Analysis and Control (NUMAC) Chassis:
  - Instrument Loop Flow Electronics (Recirculation Flow Monitor System)
  - Instrument Loop Power Electronics (LPRM, APRM, Trip Circuit)

1.1 APRM Flow Biased Simulated Thermal Power Scram (TLO)

| Current Function Limits: | Value/Equation Current –CLTP (% RTP) | Value/Equation PRNMS-CLTP (% RTP) | Reference(s) |
|---|---|---|---|
| Analytical Limit | n/a | n/a | Comment 20 |
| Tech Spec Allowable Value | n/a | $0.65\ W_d + 62.9$ clamped at 113 | Comment 21; Comment 22 |
| Nominal Trip Setpoint | n/a | Results in Section 3 | Comment 21 |
| Operational Limit | n/a | 100% (at 77.0% Recirc flow rate) | Comment 18 |

1.2 APRM Flow Biased Simulated Thermal Power Rod Block (TLO)

| Current Function Limits: | Value/Equation Pre-E1A stability – CLTP (% RTP) | Value/Equation PRNMS-CLTP (% RTP) | Reference(s) |
|---|---|---|---|
| Analytical Limit | n/a | n/a | Comment 20 |
| Tech Spec Allowable Value | n/a | $0.65\ W_d + 59.9$ clamped at 110 | Comment 21; Comment 22 |
| Nominal Trip Setpoint | n/a | Results in Section 3 | Comment 21 |
| Operational Limit | n/a | n/a | Comment 3 |

## 1.3 APRM Flow Biased Simulated Thermal Power Scram (SLO)

| **Current Function Limits:** | **Value/Equation Pre-E1A stability – CLTP (% RTP)** | **Value/Equation PRNMS-CLTP** (% RTP) | **Reference(s)** |
|---|---|---|---|
| Analytical Limit | n/a | n/a | Comment 20 |
| Tech Spec Allowable Value | n/a | $0.65W_d + 42.3$ | Comment 21; Comment 22 |
| Nominal Trip Setpoint | n/a | Results in Section 3 | Comment 21 |
| Operational Limit | n/a | n/a | Comment 19 |

## 1.4 APRM Flow Biased Simulated Thermal Power Rod Block (SLO)

| **Current Function Limits:** | **Value/Equation Pre-E1A stability – CLTP (% RTP)** | **Value/Equation PRNMS-CLTP** (% RTP) | **Reference(s)** |
|---|---|---|---|
| Analytical Limit | n/a | n/a | Comment 20 |
| Tech Spec Allowable Value | n/a | $0.65\ W_d + 39.3$ | Comment 21; Comment 22 |
| Nominal Trip Setpoint | n/a | Results in Section 3 | Comment 21 |
| Operational Limit | n/a | n/a | Comment 3 |

CLTP: Current Licensed Thermal Power

RTP: Rated Thermal Power

$W_d$: % Recirculation drive flow; may also be referred to as “W” or “WD”

## 2. Components:

### 2.1 Flow Transmitter

| Component Information: | Value/Equation | Reference(s) |
|---|---|---|
| Plant Instrument ID No. | 1B33 N014A-D,<br>1B33 N024A-D | |
| Instrument vendor | Rosemount | |
| Model ID No. (including Range Code) | 1152DP5N | |
| Plant Location(s) | Containment Building, el. 133’ | |
| Process Element | Flow elbow (No component ID available) | |

**Inputs:**

| Vendor Specifications | Value / Equation | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Top of Scale | 430.3 InWC (20mA) | | Ref. 5.6 (Step 5.4.10) |
| Bottom of Scale | 0 InWC (4mA) | | Ref. 5.6 (Step 5.4.10) |
| Upper Range Limit | 750 InWC | | Ref 6.6 |
| Accuracy | ± 0.25% Span | | Ref 6.6 |
| Temperature Effect | ± (0.5% URL + 0.5% Span) per 100ºF | | Ref 6.6 |
| Seismic Effect | ± 0.25% URL during and after 3g over range of 5-100 Hz in 3 major axes | | Ref 6.6 |
| Radiation Effect | ± 8% URL during and after 5 x $10^6$ Rads TID of gamma radiation at 0.4 Mrad/hr | | Ref 6.6 |
| Humidity Effect | Included in accuracy | | Ref 6.6 |
| Power Supply Effect | ± 0.005% of output span per volt | | Ref 6.6 |
| RFI/EMI Effect | negligible | | Ref 6.6; Comment 4 |
| Insulation Resistance Effect | negligible | | Ref 6.6; Comment 4 |
| Over-pressure Effect | ± 1% URL after 2000 psig | | Ref 6.6 |
| Static Pressure Effect<br>a.) Random zero effect<br>b.) Random span effect (Correction uncertainty)<br>c.) Bias span effect | a.) ± 0.25% URL per 2000 psi<br>b.) ± 0.25% input reading per 1000 psi<br>c.) n/a | | Ref 6.6 |
| Mounting Position Effect<br>a.) Zero Shift<br>b.) Span Effect | a.) Up to 1 $InH_20$<br>b.) None | | Ref 6.6 |

2.1 Flow Transmitter
(cont'd)

| **Plant Data:** | **Value** | **Sigma if not 2** | **Reference(s)** |
|---|---|---|---|
| Calib Temperature Range | 60 to 105 ºF | | Ref 5.2 (Table 1, Areas 1A311, 1A313) |
| Normal Temperature Range | 60 to 105 ºF | | Ref 5.2 (Table 1, Areas 1A311, 1A313) |
| Trip Temperature range | 60 to 105 ºF | | Comment 24 |
| Plant seismic value | n/a | | Comment 6 |
| Plant Radiation value | negligible | | Ref 5.2 (Table 1, Areas 1A311, 1A313); Comment 25 |
| Plant Humidity value | 20 to 90% | | Ref 5.2 (Table 1, Areas 1A311, 1A313) |
| Power Supply Variation value | +/- 0.9 Vdc | | |
| RFI/EMI value | negligible | | |
| Over-pressure value | 1100 psig | | |
| Static Pressure value | 1060 psig | | |

Vdc: DC voltage

| **Drift:** | **Value** | **Sigma if not 2** | **Reference(s)** |
|---|---|---|---|
| Current Calib. Interval | 18 mo. ☐Includes extra 25% | n/a | Ref 4.1 (SR 3.3.1.17) |
| Desired Calib. Interval | 24 mo. ☐Includes extra 25% | n/a | |
| Drift Source | ☒Vendor ☐Calculated | n/a | Ref 6.6 |
| Drift Value | ± 0.2% URL / 30 months | | Ref 6.6; Ref 1; Ref 2; Comment 7 |

2.1 Flow Transmitter (cont'd)

| **Calibration:** | **Value / equation** | **Sigma if not 3** | **Reference(s)** |
|---|---|---|---|
| As Left Tolerance | ± 0.25% Span (± 0.04 mA) | | |
| Leave Alone Tolerance | =ALT | | |

| | | | |
|---|---|---|---|
| **Input Calibration Tool:** | Wallace & Tiernan Model 65-120 | n/a | Ref 5.4 |
| Accuracy | ± 1.075 inWC (= 0.13% of Full Scale; Full Scale=850 inWC) | | Ref. 5.6 (Step 3.3); Ref 5.4 |
| Resolution / Readability | 0.5 inWC | | Comment 26 |
| Minor Division | 1 inWC | | |
| Upper Range | | n/a | |
| Temperature Effect | negligible | | Ref 5.4 |
| | | | |
| **Input Calibration Standard:** | Mensor model 8100 quartz pressure calibrator | n/a | 5.4a |
| Accuracy | =1/4 input calibration tool accuracy | | Comment 8 |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |
| | | | |
| **Output Calibration Tool:** | Fluke model 45 Multimeter | n/a | Ref 5.7 |
| Accuracy | ± 0.04 mA | | Ref 5.6 (Step 3.2; Ref 5.7 (Pg 1-9) |
| Resolution / Readability | 0.005 | | Ref 5.7 (Pg 1-9); Comment 26 |
| Minor Division | n/a | | |
| Upper Range | | n/a | |
| Temperature Effect | Included in accuracy | | Ref 5.7 (Pg 1-4); Comment 4 |
| | | | |
| **Output Calibration Standard:** | Fluke model 5700A Calibrator | n/a | Ref 5.7a |
| Accuracy | =1/4 output calibration tool accuracy | | Comment 8 Ref 5.7a (Pg 1-23) |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |

| **Application Specific Input:** | **Value** | **Sigma if not 2** | **Reference(s)** |
|---|---|---|---|
| n/a | | | |
| | | | |

## 2.2 Flow Electronics (Recirculation Flow Monitor System)

| Component Information: | Value/Equation | Reference(s) |
|---|---|---|
| Plant Instrument ID No. | Undefined | Comment 2 |
| Instrument vendor | GEH | |
| Model ID No. (including Range Code) | NUMAC | |
| Plant Location(s) | Control Room area, El 166-0”;<br>Control cabinet area, El 190-0” | Ref 5.2 (Table 1) |
| Process Element | n/a | |

**Inputs:**

| Vendor Specifications | Value / Equation | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Top of Scale | FS = 125% loop flow | n/a | |
| Bottom of Scale | 0% loop flow | n/a | |
| Upper Range Limit | n/a | n/a | |
| Accuracy | ± 0.122 mAdc<br>(where 16 mAdc input span from FT corresponds to 125% flow) | | Comment 9 |
| Temperature Effect | included in accuracy | | |
| Seismic Effect | included in accuracy | | Comment 4 |
| Radiation Effect | included in accuracy | | Comment 4, Comment 10 |
| Humidity Effect | included in accuracy | | Comment 4 |
| Power Supply Effect | included in accuracy | | Comment 4 |
| RFI/EMI Effect | negligible | | Comment 4 |
| Insulation Resistance Effect | negligible | | Comment 4 |
| Over-pressure Effect | n/a | | Comment 5 |
| Static Pressure Effect | n/a | | Comment 5 |

2.2 Flow Electronics (cont'd)

| Plant Data: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Calib Temperature Range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Normal Temperature Range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Trip Temperature range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Plant seismic value | n/a | n/a | Comment 6 |
| Plant Radiation value | 1.8 E2 Rad TID | n/a | Ref 5.2 (N-028 Data Sheet) |
| Plant Humidity value | 20 to 50% | n/a | Ref 5.2 (N-028 Data Sheet) |
| Power Supply Variation value | +/- 0.9 Vdc | n/a | |
| RFI/EMI value | negligible | n/a | |
| Over-pressure value | n/a | n/a | Comment 5 |
| Static Pressure value | n/a | n/a | Comment 5 |

| Drift: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Current Calib. Interval | 184 days ☐Includes extra 25% | n/a | Ref 4.1 (SR 3.3.1.10) |
| Desired Calib. Interval | 24 mo. ☐Includes extra 25% | n/a | |
| Drift Source | ☐Vendor ☒Calculated | n/a | Ref. 1; Ref. 2 |
| Drift Value<br>• (% rated drive flow) | Not specified;<br>[[ ]]<br>= ± 0.122 mAdc / 6 months | | Ref. 1 (Section 3.3);<br>Ref. 2 |

2.2 Flow Electronics (cont'd)

| Calibration: | Value / equation | Sigma if not 3 | Reference(s) |
|---|---|---|---|
| As Left Tolerance | n/a | | |
| Leave Alone Tolerance | n/a | | |
| | | | |
| **Input Calibration Tool:** | Internal to NUMAC | n/a | |
| Accuracy | ± (1.1)*0.192% units on 125% scale | | Comment 14 |
| Resolution / Readability | included in accuracy | | |
| Minor Division | included in accuracy | | |
| Upper Range | 125% | n/a | |
| Temperature Effect | included in accuracy | | |
| | | | |
| **Input Calibration Standard:** | included in calibration tool | | |
| Accuracy | n/a | | |
| Resolution / Readability | n/a | | |
| Minor Division | n/a | | |
| Upper Range | n/a | | |
| Temperature Effect | n/a | | |
| | | | |
| **Output Calibration Tool:** | n/a | | |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |
| | | | |
| **Output Calibration Standard:** | n/a | | |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |

| Application Specific Input: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| n/a | | | |
| | | | |

## 2.3 Power Electronics (LPRM, APRM, Trip Circuit)

| **Component Information:** | **Value/Equation** | **Reference(s)** |
|---|---|---|
| Plant Instrument ID No. | Undefined | Comment 2 |
| Instrument vendor | GEH | |
| Model ID No. (including Range Code) | NUMAC | |
| Plant Location(s) | Control Room area, El 166-0”;<br>Control cabinet area, El 190-0” | Ref 5.2 (Table 1) |
| Process Element | Local Power Range Monitor (LPRM) Neutron detector | |

**Inputs:**

| **Vendor Specifications** | **Value / Equation** | **Sigma if not 2** | **Reference(s)** |
|---|---|---|---|
| Top of Scale | FS = 125% | n/a | |
| Bottom of Scale | 0% | n/a | |
| Upper Range Limit | n/a | n/a | |
| Accuracy<br>• LPRM Detector<br>• LPRM Electronics | $A_{LPRM\ Detector}$ = APRM PEA<br>± 0.943% (% local power) | | Ref. 1; Ref. 2; |
| Temperature Effect | included in accuracy | | |
| Seismic Effect | included in accuracy | | Ref. 6.5 (Sections 4.1.1, 4.2.6); Comment 4 |
| Radiation Effect | included in accuracy | | Ref. 6.5 (Sections 4.2); Comment 4, Comment 10 |
| Humidity Effect | included in accuracy | | Comment 4 |
| Power Supply Effect (Detector) | See APRM PEA | | |
| RFI/EMI Effect | negligible | | Comment 4 |
| Insulation Resistance Effect | negligible | | Comment 4 |
| Over-pressure Effect | n/a | | Comment 5 |
| Static Pressure Effect | n/a | | Comment 5 |

2.3 Power Electronics (LPRM, APRM, Trip Circuit) (cont'd)

| Plant Data: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Calib Temperature Range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Normal Temperature Range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Trip Temperature range | 60 to 90 ºF | n/a | Ref 5.2 (N-028 Data Sheet) |
| Plant seismic value | n/a | n/a | Comment 6 |
| Plant Radiation value | 1.8 E2 Rad TID | n/a | Ref 5.2 (N-028 Data Sheet) |
| Plant Humidity value | 20 to 50% | n/a | Ref 5.2 (N-028 Data Sheet) |
| Power Supply Variation value | +/- 0.9 Vdc | n/a | |
| RFI/EMI value | negligible | n/a | |
| Over-pressure value | n/a | n/a | Comment 5 |
| Static Pressure value | n/a | n/a | Comment 5 |

| Drift: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Current Calib. Interval | 7 days ☐Includes extra 25% | n/a | Ref. 4.1 (SR 3.3.1.1.2) |
| Desired Calib. Interval | 7 days ☐Includes extra 25% | n/a | Ref. 4.1 (SR 3.3.1.1.2) |
| Drift Source | ☒Vendor ☐Calculated | n/a | Ref. 1, Ref. 2 |
| Drift Value<br>▪ (% power) | ± 0.5% FS / 700 hours | | |

2.3 Power Electronics (LPRM, APRM, Trip Circuit) (cont'd)

| Calibration: | Value / equation | Sigma if not 3 | Reference(s) |
|---|---|---|---|
| | Included in APRM calibration | | |
| As Left Tolerance | AGAF | | Comment 11 |
| Leave Alone Tolerance | = ALT | | Ref 4.1 (SR 3.3.1.1.2); Comment 11 |
| | | | |
| **Input Calibration Tool:** | n/a | | Comment 11 |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |
| | | | |
| **Input Calibration Standard:** | n/a | | Comment 11 |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |
| | | | |
| **Output Calibration Tool:** | n/a | | Comment 11 |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |
| | | | |
| **Output Calibration Standard:** | n/a | | Comment 11 |
| Accuracy | | | |
| Resolution / Readability | | | |
| Minor Division | | | |
| Upper Range | | | |
| Temperature Effect | | | |

| Application Specific Input: | Value | Sigma if not 2 | Reference(s) |
|---|---|---|---|
| Minimum no. of LPRMs per APRM Channel | 21 of 44 | n/a | |
| APRM Gain Adjustment Factor (AGAF) | ± 2% RTP | 3 | Ref 4.1 (SR 3.3.1.1.2) |

## 3. Summary Results:

**Calculated Values**

| Setpoint Function | Analytical Limit (AL) (from Section 1) %RTP | Allowable Value (AV) (from Section 1) %RTP | Nominal Trip Setpoint (NTSP) %RTP | Meets LER Avoidance Criteria | Meets Spurious Trip Avoidance Criteria |
|---|---|---|---|---|---|
| APRM Flow Biased STP Scram (TLO) | n/a | $0.65\ W_d + 62.9$ clamped at 113.0 | $0.65\ W_d + 60.9$ clamped at 111.0 | Y | Y |
| APRM Flow Biased STP Rod Block (TLO) | n/a | $0.65\ W_d + 59.9$ clamped at 110.0 | $0.65\ W_d + 57.9$ clamped at 108.0 | Y | n/a |
| APRM Flow Biased STP Scram (SLO) | n/a | $0.65\ W_d + 42.3$ | $0.65\ W_d + 38.8$ | Y | n/a |
| APRM Flow Biased STP Rod Block (SLO) | n/a | $0.65\ W_d + 39.3$ | $0.65\ W_d + 35.8$ | Y | n/a |

$W_d$: % Recirculation drive flow
n/a: Not applicable
Y: Yes

**Application Specific Setpoint Adjustments**

APRM Flow Biased STP Scram Nominal Trip Setpoints (NTSPs):

- Two Loop Operation (TLO): $0.65\ W_d + 60.9$ %RTP clamped at 111.0 %RTP
- Single Loop Operation (SLO): $0.65\ W_d + 38.8$ %RTP

where "$W_d$" is defined as the % Recirculation drive flow; 77.0% drive flow is that required to achieve 100% core power and flow. The TLO to SLO Setting adjustment, $SLO_{SettingAdj}$, is found as indicated below:

| Function | Calculated TLO to SLO Setting Adjustment | Reference |
|---|---|---|
| TLO to SLO Setting Adjustment for NUMAC setpoints | $SLO_{SettingAdj}$ = 34.0% | Comment 12 |

## 4. Comments and Recommendations:

1. Unless specifically identified as "bias" errors in this document, all instrument uncertainty errors will be considered to be random in nature, even when the "±" symbol is not shown.

2. Some plant specific information has not been provided or is not currently available in the current GGNS documentation, but is considered unnecessary because the effects of this information are included within the instrument accuracy values or are not necessary for setpoint evaluation.

3. STA evaluations are not performed for rod blocks or permissives per GEH setpoint methodology (References 1 and 2), such as the APRM Rod Blocks. Therefore, the Operational Limits (OLs) are not applicable.

4. Seismic effect, radiation effect, humidity effect, power supply effect, Radio Frequency Interference / Electromagnetic Interference (RFI/EMI) effect, and insulation resistance effect errors are marked "negligible" or "included in accuracy" and are considered to have negligible impact on the manufacturer's accuracy terms if they are not identified separately. Temperature effect of the Output Calibration Tool is assumed to be included in the accuracy as specified for the Input Calibration Tool.

5. Per References 1 and 2, overpressure effects are applicable only to pressure measurement devices (e.g., differential pressure transmitters), and static pressure effects are applicable only to differential pressure measurement devices. These effects are marked "n/a" for other devices or not considered.

6. The APRM Flow Biased STP Scram setpoint function is a safety function. However, the GEH safety analysis conservatively does not take credit for the APRM Flow Biased STP scram in the Minimum Critical Power Ratio (MCPR) determination, so the APRM Flow Biased STP setpoint does not protect a safety limit, and therefore has no AL. Consequently, for GEH methods and calculations, the Flow Biased STP setpoint margin does not have any safety significance. Also, there are no safety functions associated with the Rod Blocks. Therefore, these setpoint functions are not required to function after a seismic event and the Seismic Effect for the flow transmitters and associated electronics is not considered in this evaluation.

7. The current approach in GEH setpoint calculation methodology treats the Flow Transmitter drift for this instrument to be a 2-sigma value.

8. Per Ref. 5.5 (Item 10), the error of the calibration standard used to calibrate a calibration tool will not exceed ¼ of the error associated with the calibration tool. Temperature effects and readability errors need not be considered for calibration standards.

9. The accuracy of the flow electronics is not given in the NUMAC specifications, and [[

   ]] The combined error for the loop flow electronics is ± 0.122 mA at 2σ .

10. The NUMAC electronics are located in the Control Room or Control Room area at GGNS, where the radiation dose is expected to be within equipment qualification requirements as indicated by Ref. 5.2 (Area N-028).

11. The APRM subsystem is calibrated on-line weekly (Reference 4.1) using the AGAF process, where the gain of the APRMs is adjusted to read the Core Thermal Power determined by the Process Computer, within a specified As Left Tolerance. This is equivalent to a standard calibration of the APRM electronics sub-loop (consisting of the LPRM and APRM signal conditioning electronics), where the Process Computer is the calibration tool and standard. The Process Computer and heat balance error is already accounted for in transient analyses. Thus, the only calibration error to consider for the APRM electronics sub-loop is the As Left Tolerance specified by the AGAF process.

12. [[ ]] As indicated in Section 3, the NTSP for TLO is 0.65 $W_d$ + 60.9 %, indicating an intercept of 60.9%. The NTSP for SLO, 0.65$W_d$ + 38.8%, has an intercept of 38.8%. [[ ]] For example, for the SLO Flow Biased STP scram NTSP of 0.65$W_d$ + 38.8%, [[ ]] The resulting TLO to SLO setting adjustment is 34.00. Because the Setting Adjustment is programmed into the NUMAC equipment to one decimal place, each calculated number is rounded up to one decimal place for conservatism. This adjustment may be used in the implementation of the new NUMAC equipment.

13. The neutron noise value is not applied to the APRM flow-biased setpoints because they are based on an STP signal.

14. Complete inputs are unavailable for the Flow Electronic calibration errors for all Maintenance and Testing Equipment (M&TE) to be used at GGNS. Therefore, the Flow Electronics calibration errors are based on using errors that are 10% higher than the errors for assumed calibration tools. Moreover, the error of the calibration standard used to calibrate a calibration tool is conservatively assumed to be equal to the error of the calibration tool.

15. For the flow noise PMA, a typical value of ±1% rated Recirc flow can be used. However, that study reviewed several plants, some with Recirculation System flow elements being a venturi, and some being a flow elbow. Grand Gulf Nuclear Station has flow elbows, so the largest number for a plant with flow elbows from the referenced study is used, rounded up to one decimal place for conservatism.

16. [[ ]] (Reference 2, Section 4.5.3)

17. Some of the references were submitted to GEH in support of related tasks.

18. The Operational Limit in the non-clamped region is determined by maintaining the same margin between the NTSP at the intercept point and OL as between the NTSP and OL in the clamped region.

19. An STA evaluation is not performed for single loop operation due to the rarity of plant operation in this configuration; thus, the OL is not applicable.

20. The APRM Flow Biased Simulated Thermal Power (STP) Scram (TLO and SLO) functions are safety functions after installation of the PRNMS. However, note that the GEH safety analysis conservatively does not take credit for the APRM Flow Biased STP Scram in the Minimum Critical Power Ratio (MCPR) determination, so the APRM Flow Biased STP setpoint does not protect a safety limit, and therefore has no AL. Consequently, for GEH methods and calculations, the Flow Biased STP setpoint margin does not have any safety significance. Also, there are no safety functions associated with the Rod Blocks. Thus, an Analytical Limit is not applicable. The Nominal Trip Setpoint is calculated based on the Allowable Value.

21. Values for this setpoint at CLTP are considered “n/a” because the setpoint function changes after PRNM installation. The APRM Flow Biased STP setpoints perform a power excursion mitigation function but no longer perform a stability monitoring function.

22. The “Tech Spec Allowable Value” may be retained in the Technical Specifications or a supporting document such as the Core Operating Limits Report (Ref. 4.1 Bases). The calculations were performed based on the AV point values indicated; a “≤” sign typically accompanies the values retained in licensing documentation.

23. For the static head portion of Flow PMA, installation of the differential pressure (dP) transmitter nozzle taps on the Recirculation pipes and instrument lines must be evaluated for a random error due to ambient temperature fluctuations in the section of instrument line producing a static head. This error is negligible if the static head difference for the dP measurement is less than 1 foot, and the high and low pressure instrument lines are routed close together. The static head difference for the taps is 16.8 inWC at room temperature. Consideration of system operating temperatures reduces the static head to less than 1 foot, thus, this error is considered to be negligible.

24. The Neutron Monitoring System performs its trip functions before accident temperatures are reached, so temperatures for trip and normal conditions are assumed to be the same.

25. Ref. 5.2 provides a Total Integrated Dose (TID) of 2.8 x $10^3$ Rads for 40 yrs and dose rate of 0.008 Rad/hr gamma for “Normal Environment N-028”. These values are negligible in comparison to flow transmitter capability as indicated in Ref 6.6.

26. Readability of the analog Input Calibration Tool is based on ½ of minor division, which is more conservative than 0.02% full-scale value. Readability of the digital Output Calibration Tool (Ref. 5.7) is based on three digits after decimal on range used, but conservatively assumes staff does not use last decimal.

27. For the Nuclear Measurement Analysis and Control (NUMAC) Power Range Neutron Monitor System, the terminology for the APRM Scram and Rod Block setpoint functions is different than what GGNS uses in the TS. The For the examples below, the APRM Flow Biased STP - Scram TLO NTSP [**0.65** $\mathbf{W_d}$ + **60.9** %RTP], the APRM Flow Biased STP Rod Block SLO NTSP [**0.65** $W_d$ + 38.8 %RTP], and the TLO to SLO setting adjustment (e.g., $\mathbf{SLO_{SettingAdj}}$) of 34.0 are used.

The APRM flow-biased STP setpoints will vary with total Recirculation (Recirc) flow as follows:

- Run_Setpoint = ( Slope * ( Flow - ΔFlow )) + Offset

  where:

  - Slope = Slope of the Power/Flow level line (e.g., **0.65** in the above example for TLO and for SLO)
  - Flow = Total Recirc flow the APRM system is using (e.g., $\mathbf{W_d}$ in the above example)
  - ΔFlow = Delta flow setpoint for single Recirc loop operation (SLO). The ΔFlow setting applies only when SLO is active (e.g., $SLO_{SettingAdj}$ in the above example).
  - Offset = The flux offset (i.e., setpoint) at zero Recirc flow (e.g., **60.9** in the above example for TLO)

- "STP Upscale Trip" - relates to APRM Flow Biased STP - Scram
- "STP Upscale Alarm" - relates to APRM Flow Biased STP Rod Block

28. Transfer functions used in this calculation:

| | |
|---|---|
| Flow Transmitter: | Output (mA) linearly converted from input (InWC). |
| Flow Electronics: | Output proportional to the square root of the two inputs, which are then summed. |
| Power Electronics: | Output is proportional to the average of the inputs and a comparison of the APRM signal with the flow-biased reference is made. |

## 5. References:


1. NEDC-32889P, Rev. 3, GEH Proprietary, "General Electric Methodology for Instrumentation Technical Specification and Setpoint Analysis", November 2002.

2. NEDC-31336P-A, GEH Proprietary, "General Electric Instrument Setpoint Methodology", September 1996.

3. Current applicable Grand Gulf Nuclear Station setpoint calculations:

   3.1. Not used.

4. Grand Gulf Nuclear Station Licensing and related documents:

   4.1. Grand Gulf Nuclear Station Technical Specifications and Bases, as revised through Amendment 182.

5. Applicable Grand Gulf Nuclear Station procedures/documents:

   5.1. Not used.

   5.2. GGNS-E-100, "System Energy Resources, Inc. Grand Gulf Nuclear Station Environmental Parameters for GGNS Safety Related", Rev. 6, 04/23/08.

   5.3. Not used.

   5.3a Not used.

   5.4. Vendor Manual 460001012, "Wallace & Tiernan Portable Pneumatic Calibrator, Series 65-120", 06/26/95.

   5.4a. Vendor User's Manual PN 0017108001A, "Mensor 8100 Quartz Pressure Calibrator", March 2001.

   5.5. Not used.

   5.6. Surveillance Procedure 06-IC-1C51-R-0075, "APRM Recirculation Flow Transmitter Calibration", Rev. 103, 03/08/07.

   5.7. Vendor Service Manual 460003671, "Fluke Model 45 Multimeter", July 1989.

   5.7a Vendor Operator Manual 460003696, "Fluke 5700A Calibrator", 02/8/89.

6. Vendor Specifications:
    6.1. Not used.
    6.2. Not used.
    6.3. Not used.
    6.4. Not used.
    6.5. Not used.
    6.6. Rosemount Nuclear Product Data Sheet 00813-0100-4235, Rev. BA, “Model 1152 Alphaline® Nuclear Pressure Transmitter”, April 2007.
    6.7. Not used.
7. GEH Letters / Reports:
    7.1. Not used.
    7.1a Not used.
    7.2. Not used.
    7.3. Not used.
    7.4. Not used.
    7.5. Not used.

**NON-PROPRIETARY INFORMATION**

# ENCLOSURE 2

## REPLACEMENT TECHNICAL SPECIFICATION MARK-UP INSERT E

**NON-PROPRIETARY INFORMATION**

**INSERT E – New Table Notes (c), (d), (e), and (f)**

(c) Each channel provides inputs to both trip systems.

(d) If the as-found channel setpoint is outside its predefined as-found tolerance, then the channel shall be evaluated to verify that it is functioning as required before returning the channel to service.

(e) The instrument channel setpoint shall be reset to a value that is within the as-left tolerance around the Nominal Trip Setpoint (NTSP) at the completion of the surveillance; otherwise, the channel shall be declared inoperable. Setpoints more conservative than the NTSP are acceptable provided the as-found and as-left tolerances apply to the actual setpoint implemented in the Surveillance procedures to confirm channel performance. The NTSP and the methodologies used to determine the as-found and as-left tolerances are specified in the Technical Requirements Manual.

(f) The setpoint for the OPRM Upscale Period-Based Detection algorithm is specified in the COLR.

**ATTACHMENT 3**

**GNRO-2011/00042**

**<u>GEH AFFIDAVIT SUPPORTING PROPRIETARY INFORMATION CONTAINED IN ATTACHMENT 1</u>**

# GE Hitachi Nuclear Energy Americas LLC

# AFFIDAVIT

**I, Edward D. Schrull,** state as follows:

(1) I am the Vice President, Regulatory Affairs, Services Licensing, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GEH letter, GG-PRNM-168777-EC136, "NRC Instrumentation and Controls Branch RAIs 21, 22, 23, & 24," dated May 26, 2011. The GEH proprietary information in Enclosure 1, which is entitled "GEH Responses to GGNS NRC I&CB RAIs 21, 22, 23, & 24" is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] Large figures containing GEH proprietary information are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited to a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary and/or confidentiality agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed GEH design information of the instrumentation and control equipment used in the design and analysis of the power range neutron monitoring system for the GEH Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 26th day of May 2011.

Edward D. Schrull, PE
Vice President, Regulatory Affairs
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**ATTACHMENT 4**

**GNRO-2011/00042**

**<u>GEH AFFIDAVIT SUPPORTING PROPRIETARY INFORMATION CONTAINED IN ENCLOSURE 1 OF ATTACHMENT 1</u>**

# GE-Hitachi Nuclear Energy Americas LLC

## AFFIDAVIT

**I, Edward D. Schrull, PE** state as follows:

(1) I am the Vice President, Regulatory Affairs, Services Licensing, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GEH letter, GEH-GGNS-AEP-443, L. King (GEH) to M. Smith (Entergy Operation, Inc.), "GGNS EPU Instrument Limits Calculation," dated May 25, 2011. The GEH proprietary information in Enclosure 1, which is entitled "GGNS EPU Instrument Limits Calculation" is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited to a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary and/or confidentiality agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed GEH design information of the methodology used in GEH setpoint calculations for the GEH Boiling Water Reactor (BWR). Development of these methods, techniques, and information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 25th day of May 2011.

Edward D. Schrull, PE
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