MONTICELLO NUCLEAR GENERATING PLANT		3494
TITLE:	**CALCULATION COVER SHEET**	Revision 17
		Page 1 of 1

Title *Instrument Setpoint Calculation - Average Power Range Monitor (APRM) Non-Flow Biased PRNM Setpoints for CLTP and EPU* CA- *08* - *050* Rev. *0*

10 CFR50.59 Screening or Evaluation No: *50.59 Screening not required. Calculation is submitted as part of LAR*

Associated Reference(s): *EC 12899 Plant Impact from CA-08-050*

Does this calculation:	YES	NO	Calc No(s), Rev(s), Add(s)
Supercede another calculation?	☒	☐	*Ref QF-0549 (Calculation Signature Page, attached).*
Augment (credited by) another calculation?	☐	☒	
Affect the Fire Protection Program per Form 3765?	☐	☒	If Yes, attach Form 3765
Affect piping or supports?	☐	☒	If Yes, attach Form 3544
Affect IST Program Valve or Pump Reference Values, and/or Acceptance Criteria?	☐	☒	If Yes, inform IST Coordinator and provide copy of calculation

What systems are affected?

DBD Section (if any): DBD-B.05.01, Neutron Monitoring System

Topic Code (See Form 3805): NIP Power Range Monitors

Structure Code (See Form 3805): RATE - Rerate/Power Uprate

Other Comments: Section 9, Future Needs - List of impacted documents

Prepared by: Joseph Balitski Date: 8-11-08

Print/Signature Joseph Balitski

M/cah

A_L	Loop Instrument Accuracy
AFT	As-Found Tolerance
AFT_L	Loop As-Found Tolerance
AGAF	APRM Gain Adjustment Factor
AL	Analytical Limit
ALT	As-Left Tolerance
ALT_L	Loop As-Left Tolerance
$APEA_L$	Loop APRM Primary Element Accuracy
$APEA_R$	Loop APRM Primary Element Accuracy Random
$APEA_b$	APRM Primary Element Accuracy bias
$APMA_L$	Loop APRM Process Measurement Accuracy
APRM	Average Power Range Monitor
AV	Allowable Valve
C_L	Loop Calibration Accuracy Error
CLTP	Current Limiting Thermal Power
D_L	Loop Instrument Drift
$DPEA_L$	Loop Drift Primary Element Accuracy
$DPEA_R$	Loop Drift Primary Element Accuracy Random
DTE	Drift Temperature Effect
$DPEA_b$	Drift Primary Element Accuracy bias
EPU	Expanded Power Uprate
FS	Full Span
GEH	GE-Hitachi Nuclear Energy
IRM	Intermediate Range Monitor
LER	Licensee Event Report
LPRM	Local Power Range Monitor
NMS	Neutron Monitoring System
NTSP	Nominal Trip Setpoint
NUMAC	Nuclear Measurement Analysis and Control
OL	Operational Limit
P/C	Plant Process Computer
PEA	Primary Element Accuracy
PMA	Process Measurement Accuracy
PRNM	Power Range Neutron Monitoring
PRNMS	Power Range Neutron Monitoring System
RTP	Rated Thermal Power
SRM	Startup Range Monitor
STP	Simulated Thermal Power
STA	Spurious Trip Avoidance

1. PURPOSE

This calculation provides design basis setpoint analysis for the Allowable Values (AV) and Nominal Trip Setpoints (NTSP) for the Power Range Neutron Monitoring (PRNM) APRM setpoints associated with the installation of EC 10856. EC-12899 documents the plant impact and configuration changes from the calculation. The following setpoints are evaluated for PRNM CLTP and EPU operation in accordance with setpoint control program and NRC commitment M87051A:

- APRM Neutron Flux - High Scram
- APRM Neutron Flux - High (Setdown) Scram
- APRM Neutron Flux - High (Setdown) Rod Block
- APRM Downscale Rod Block

The NUMAC PRNM retrofit is a digital neutron monitoring system that replaces the analog NIP System - Power Range Monitoring System. This calculation evaluates the above setpoints and determines the available margin based on PRNM retrofit uncertainty parameters for CLTP and EPU operation. The PRNM retrofit affects the above setpoints as follows:

1. PRNM adds two new neutron monitoring setpoints for CLTP and EPU operation. These are identified above as the APRM Neutron Flux – High (Setdown) Scram and APRM Neutron Flux – High (Setdown) Control Rod Block. The function of the setpoints is described in Section 7.1.2.

2. The PRNM retrofit changes how the current APRM Flow Referenced Neutron Flux - High High setpoint functions and changes the setpoint name. The existing APRM Flow Referenced Neutron Flux – High High setpoint is changed to a non-flow biased setpoint identified as APRM Neutron Flux - High Scram, which is independent of core recirculation flow. The function is described in Section 7.1.2.

3. The APRM Downscale Rod Block is an existing CLTP setpoint. The setpoint does not change for PRNM CLTP and EPU operation. GEH setpoint documentation, Input 4.3, recommended a NTSP setpoint of 4.0 % RTP for EPU operation. This calculation provides the design bases to use the existing CLTP NTSP setpoint of 3.5 % RPT.

This PRNM based neutron monitoring system (NMS) calculation supersedes calculations CA-05-153 (Reference 5.8) and CA-96-224 (Reference 5.7). Section 9 (Future Needs) describes the affect on these calculations due to PRNM implementation.

In addition to the PRNM non-flow bias neutron monitoring setpoints identified above, the PRNM retrofit also creates new or changes other neutron monitoring setpoints. For completeness of the PRNM affected NMS setpoints, the following neutron monitoring setpoints will be evaluated in other calculations:

A. Calculation CA-08-051, Instrument Setpoint Calculation – Rod Block Monitor (RBM) PRNM Setpoints for CLTP and EPU Operation, which includes the following sub-calculations:
   - RBM Low Trip Setpoint (LTSP)
   - RBM Intermediate Trip Setpoint (ITSP)
   - RBM High Trip Setpoint (HTSP)

B. Calculation CA-08-052, Instrument Setpoint Calculation – Average Power Range Monitor (APRM) Flow Biased PRNM Setpoints for CLTP and EPU, which includes the following sub-calculations for Two Loop Operation (TLO) and Single Loop Operation (SLO):
   - APRM Simulated Thermal Power – High Scram (TLO)
   - APRM Simulated Thermal Power – High Scram (SLO)
   - APRM Simulated Thermal Power – High Rod Block (TLO)
   - APRM Simulated Thermal Power – High Rod Block (SLO)

C. Calculation CA-08-053, Average Power Range Monitor (APRM) Recirc Flow Instrumentation Calibration for PRNM CLTP and EPU, which includes the following subsections:
   - Recirc Flow transmitter Gain Scaling
   - NUMAC Recirc Flow Grain Factor Equation for Procedure 1383 (Core Flow Measurement System Calibration). Note: Procedure 1383 is to be renumbered to ISP-NIP-1383 under EC 10856.

2. METHODOLOGY

This calculation is performed in accordance with ESM-03.02-APP-I (Input 4.1). ESM-03-02-APP-I setpoint methodology is based on the following documents: General Electric Instrument Setpoint Methodology NEDC-31336 (Input 4.11) and Setpoint Calculation Guidelines for the Monticello Nuclear Generating Plant, GE-NE-901-021-0492 (Input 4.13). The General Electric Setpoint Methodology is a statistically based methodology. It recognizes that most of the uncertainties that affect instrument performance are subject to random behavior, and utilizes statistical (probability) estimates of the various uncertainties to achieve conservative, but reasonable, predictions of instrument channel uncertainties. The objective of the statistical approach to setpoint calculations is to achieve a workable compromise between the need to ensure instrument trips when appropriate, and the need to avoid spurious trips that may unnecessarily challenge safety systems or disrupt plant operation.

Drift Analysis: This calculation uses GE specified drift parameters for the applicable PRNM equipment and for the existing LPRM detectors.

The uncertainties associated with the overall PRNMS including the LPRMs, APRMs and associated hardware are appropriately considered and consistent with NRC approved GE methodology in establishing the APRM setpoints. The calculation uses GEH specified ALT and AFT tolerances to calculate loop uncertainty. These parameters are specified in Inputs 4.2 and 4.3 (GE PRNM documentation) and were converted to a 2σ value in accordance with Engineering Standards Manual ESM-03.02-APP-I, Rev 4 (Input 4.1). In addition to ALT and AFT tolerances for loop uncertainty, Sections 7.3.1.3 and 7.3.1.4 evaluated AFT/ALT for digital PRNMS surveillance calibration. The setpoints are numerical values stored in the digital hardware and not subject to drift. The ALT and AFT values for the setpoint are the same as the trip setpoint. Therefore, there is no tolerance band for the surveillance calibration test. Attachment 1, Setpoint Diagrams, states AFT/ALT tolerance will not be applied to surveillance calibration of the setpoints because PRNMS setpoints are digital and stored in PRNMS database.

3. ACCEPTANCE CRITERIA

The Scram Setpoint and Allowable Values should be such that the Analytical Limit (AL) will not be exceeded when all applicable instrumentation uncertainties are considered. For the Allowable Value (AV), the minimum required margin is calculated and compared to the available margin, which is AL minus AV. For the Nominal Trip Setpoint (NTSP) evaluation, the minimum required margin is calculated and compared to the available margin, which is AL minus NTSP.

For parameters that do not have AL, such as Setdown Scram and Rod block and Downscale Rod Block, the difference between the minimum required margins (AL to AV and AL to NTSP) constitute the minimum required margin between AV and NTSP. This minimum required margin is compared to the available margin, which is AV minus NTSP.

For the Licensee Event Report (LER) Avoidance Test setpoint evaluation, sufficient margin is verified between the NTSP and AV setpoints to prevent an LER condition. A Spurious Trip Avoidance (STA) setpoint evaluation is performed where applicable to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoints.

4. INPUTS

4.1 Engineering Standards Manual ESM-03.02-APP-I, Appendix I (GE Methodology Instrumentation & Controls), Revision 4. The ESM provides plant specific guidance on the implementation of the General Electric guidelines (Input 4.13) and methodology (Input 4.11).

4.2 GEH: 0000-0077-9068 MNGP-PRNMS-APRM Calc-2008, Revision 2, DRF: 0000-0076-1670, March 2008, Average Power Range Monitor Selected PRNM Licensing Setpoints - CLTP Operation (NUMAC). This is a GEH basis document for the digital PRNM equipment and includes setpoint functions and instrument uncertainties for PRNM CLTP operation. This document is Attachment 2.

4.3 GEH: 0000-0081-6958 MNGP-PRNMS-APRM Calc 2008, Revision 0, DRF: 0000-0081-4903, March 2008, Average Power Range Monitor Selected PRNM Licensing Setpoints - EPU Operation (NUMAC). This is a GEH basis document for the digital PRNM equipment and includes setpoint functions and instrument uncertainties for PRNM EPU operation. This document is Attachment 3.

4.4 GEH-NE-0000-0076-2388, DRF 0000-0076-2387, Revision 1, MNGP PRNM Licensing Setpoints - CLTP Operation, December 2007. This document discusses the setpoint changes needed to license PRNM for CLTP operation.

4.5 NEDC-32410P-A, Volume 1 – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, October 1995. The LTR was used to provide descriptions of the PRNM equipment. Input and output signal data was obtained from this document.

4.6 NEDC-32410P-A, Volume 2 – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, October 1995. The LTR was used to provide description of the PRNM equipment.

4.7 NEDC-32410P-A, Supplement 1 – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, Supplement 1, November 1997. The LTR was used to provide description of the PRNM equipment.

4.8 Task Report T0506, Revision 1, Project Task Report, NMC Monticello Nuclear Generating Plant Extended Power Uprate, Technical Specifications Setpoints, March 2008. This document provides PRNM CLTP and EPU setpoints addressed in this calculation.

4.9 Design Input Request (DIR) T0500, Rev 2, DRF 000-0040-9168, Neutron Monitoring System. This DIR provides design information on the LPRMs used for input to the PRNM equipment.

4.10 Specification 257HA594, Rev 1, Neutron Monitoring System, 12/3/85. Specification provides information on LPRM detectors and the existing analog neutron monitoring system. This document provides design specifications for the LPRMs.

4.11 NEDC-31336P-A, Class III, General Electric Instrument Setpoint Methodology, September 1996. Setpoint equations are referenced from this document.

4.12 I.S. Sokolnikoff and R.M. Redheffer, Mathematics of Physics and Modern Engineering, 1966. The equation for statistical averaging of inputs is referenced from this book. Pages are contained in Attachment 4.

4.13 GE-NE-901-021-0492, DRF A00-01932-1, Setpoint Calculation Guidelines for the Monticello Nuclear Generating Plant, October 1992. This calculation references this document for the inclusion of bias for the Spurious Trip Avoidance (STA) calculation.

5. REFERENCES

5.1 GEH: 0000-0077-9068 MNGP-PRNMS-APRM Calc-2008, Revision 2, DRF: 0000-0076-1670, March 2008, Average Power Range Monitor Selected PRNM Licensing Setpoints - CLTP Operation (NUMAC)

5.2 GEH: 0000-0081-6958 MNGP-PRNMS-APRM Calc 2008, Revision 0, DRF: 0000-0081-4903, March 2008, Average Power Range Monitor Selected PRNM Licensing Setpoints - EPU Operation (NUMAC)

5.3 NEDC-32410-A, Volume I – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, October 1995.

5.4 NEDC-32410-A, Volume II – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, October 1995.

5.5 NEDC-32410-A, Supplement 1 – Nuclear Measurement Analysis and Control Power Range Neutron Monitor (NUMAC PRNM) Retrofit Plus Option III Stability Trip Function, Licensing Topical Report, Supplement 1, November 1997.

5.6 GEH-NE-0000-0076-2388, Revision 1, MNGP PRNM Licensing Setpoints - CLTP Operation, December 2007

5.7 CA-96-224, Rev 1, Instrument Setpoint Calculation - Average Power Range Monitor (APRM) Flow-Biased Upscale Scram and Rod Block.

5.8 CA-96-153, Revision 0, Instrumentation Setpoint Calculation – Average Power Range Monitor (APRM) Downscale CR Block..

5.9 GE-NE-901-021-0492, DRF A00-01932-1, Setpoint Calculation Guidelines for the Monticello Nuclear Generating Plant, October 1992.

5.10 Monticello Nuclear Generating Plant Technical Specifications, as revised through Amendment 155. GAR 01146762 initiated to update Technical Specification in accordance with EC 10856 and calculation CA-08-050.

5.11 Monticello Nuclear Generating Plant Technical Requirements Manual (TRM), as revised through Revision 2. LAR 01128839 updates TRM in accordance with EC 10856 and calculation CA-08-050.

5.12 Regulation Guide 1.105, R3 – Instrument Setpoints for Safety-Related Instrumentation.

5.13 Task Report T0506, Revision 1, Project Task Report, NMC Monticello Nuclear Generating Plant Extended Power Uprate, Technical Specifications Setpoints, March 2008.

5.14 NEDC-31336P-A, Class III, General Electric Instrument Setpoint Methodology, September 1996.

5.15 Procedure 0017, Revision 25, "APRM Heat Balance Calibration." This procedure is used to calibrate the APRM gains such that the absolute difference between the Average Power Range Monitor (APRM) channels and the calculated power is $\leq$ 2 % RTP while operating at $\geq$ 25 % RTP.

5.16 I.S. Sokolnikoff and R.M. Redheffer, Mathematics of Physics and Modern Engineering, 1966

5.17 RIS 2006-17, NRC Staff Position on the Requirements of 10 CFR 50.36, "Technical Specifications," Regarding Limiting Safety System Settings During Periodic Testing and Calibration of Instrument Channels, August 24, 2006

5.18 TSTF-493, Rev 3, Clarify Application of Setpoint Methodology for LSSS Functions. Date of issue 18 Jan 08. Rev 3 is not approved. Included as a reference document.

5.19 EC 10856, Rev 0, EPU – Mod 4 – Neutron Monitoring System (PRNM)

5.20 EC 12899, Rev 0, PRNMS Setpoint Calculations – 08-050 (Non-Flow Biased Setpoints)

5.21 Specification 257HA594, Rev 1, Neutron Monitoring System, 12/3/85. Specification provides information on LPRM detectors and the existing analog neutron monitoring system

5.22 Engineering Standards Manual ESM-03.02-APP-I, Appendix I (GE Methodology Instrumentation & Controls), Revision 4

5.23 Procedure C.6-005-A-22, Rev 3, APRM Hi Hi INOP CH 1, 2, 3, is a flow-bias APRM Neutron Flux Hi Hi setpoint. PRNM retrofit converts this setpoint to a non-flow bias APRM Neutron Flux High setpoint. The PRNM APRM Neutron Flux High setpoint is part of this calculation. C.6-005-A-22 will be revised under EC-10856. PCR 01129100.

5.24 Procedure C.6-005-A-30, Rev 3, APRM Hi Hi INOP CH 4, 5, 6, is a flow-bias APRM Neutron Flux Hi Hi setpoint. PRNM retrofit converts this setpoint to a non-flow bias APRM Neutron Flux High setpoint. The PRNM APRM Neutron Flux High setpoint is part of this calculation. C.6-005-A-30 will be revised under EC-10856. PCR 01133816.

5.25 Procedure C.6-005-A-06, Rev 3, APRM Downscale, states a NTSP setpoint of 3.5 % RTP. This is correct for the present neutron monitoring system. Even though the PRNM CLTP and EPU operation NTSP setpoints are 3.5 % RTP, the procedure does not address that the PRNM retrofit NTSP setpoints remain the same for CLTP and EPU operation. PCR 01146778 initiated to revise procedure for EC 10856 and calculation CA-08-050.

5.26 Procedure C.6-005-A-03, Rev 1, Annunciator procedure for window 5-A-3. PRNMS adds a new rod withdraw block setpoint: APRM Neutron Flux – High (Setdown) Rod Block. PCR 01146750 initiated to revise procedure for EC 10856 and calculation CA-08-050.

5.27 Procedure B.05.06-02, Rev 18, Operations Manual Section - Plant Protection System, specifies APRM Hi Hi and APRM Downscale and other setpoints. This calculation evaluates the APRM Downscale Rod Block setpoints and documents the PRNM EPU change in this setpoint. The APRM Hi Hi setpoint is flow biased and is PRNM changes this setpoint to non-flow bias APRM Neutron Flux High. B.05.06-02 will be revised under EC-10856 by PCR 01133455.

5.28 DBD B5.1, Rev C, Design Bases Document for Neutron Monitoring System, discusses NMS setpoints, margin, uncertainty parameters such as drift, etc. This calculation validated certain NMS setpoints using the PRNM parameter uncertainties specified in GE documentation. Changes will be made under GAR 1138038.

5.29 Procedure 8211, Rev 2, APRM Calibration Readjustment for Single Loop, discusses APRM setpoint voltage adjustments including Downscale Rod Block, Hi-Hi Scram, etc. Changes have been made by PRNM and this calculation evaluates the non-flow biased PRNM setpoints. Procedure 8211 will be deleted under EC-10856 by PCR 01133437 and replaced with directions in B.05.01.02-05 by PCR 01133449.

5.30 Procedure 8212, Rev 2, APRM Calibration Readjustment for Two Loop, discusses APRM setpoint voltage adjustments including Downscale Rod Block, Hi-Hi Scram, etc. Changes have been made by PRNM and this calculation evaluates the non-flow biased PRNM setpoints. Procedure 8212 will be deleted under EC-10856 by PCR 01133445 and replaced with directions in B.05.01.02-05 by PCR 01133449.

5.31 Procedure 0012, Rev 41 APRM/Flow Reference Scram Functional Check, performs the calibration of the APRM including the Neutron Flux High Scram, Setdown Scram, Setdown Rod Block, and Downscale Rod Block setpoints. Setpoints are revised as a result of this calculation. 0012 will be deleted under EC-10856, PCR 01133332. Procedures ISP-NIP-0588, ISP-NIP-0588-01, ISP-NIP-0589-02 will be developed to replace Procedure 0012 by PCRs 01129124, 01129125, and 01129126.

5.32 MNGP Technical Specifications Bases, Rev 8, Bases will be revised to discuss the PRNM APRM Neutron Flux High setpoint, which is non-flow bias, in place of the existing Flow Referenced Neutron Flux-High High setpoint. GAR 01146762 initiated to update Technical Specification Bases in accordance with EC 10856 and calculation CA-08-050.

5.33 Specification 24A5221, Specification for PRNM MUMAC Power Range Neutron Monitoring System.

5.34 B.05.01.02-02, Rev 6, Operations Manual Section - Power Range Neutron Monitoring, specifies NMS trip setpoints, which are being changed due to PRNMS. B.05.01.02-02 will be revised under EC-10856 by PCR 01137808.

5.35 B.05.01.02-05, Rev 16, Operations Manual Section – Power Range Neutron Monitoring, System Operation. B.05.01.02-05, Rev 16 refers to the six APRM channels, which applies to the existing NMS. PRNMS has four APRM channels as stated is Section 7.2.2.1 of this calculation. PCR 01146778 issued to revise B.05.01.02-05, Rev 16, upon implementation of EC 10856.

5.36 Design Input Request (DIR) T0500, Neutron Monitoring System, DRF 000-0040-9168. This DIR provides design information on the LPRMs used for input to the PRNM equipment.

5.37 Engineering Standards Manual ESM-03.02-APP-I, Appendix I (GE Methodology Instrumentation & Controls), Revision 4.

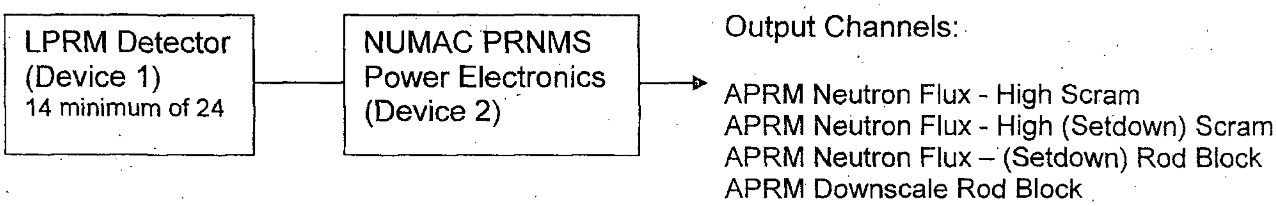
6. ASSUMPTIONS

None.

7. ANALYSIS

7.1 APRM Non-Flow Biased PRNM Licensing Setpoints

7.1.1 Channel Diagram for APRM Neutron Flux Setpoints



7.1.2 Channel Function:

The APRM system calculates an average of the incore Local Power Range Monitor (LPRM) chamber signals. The LPRMs are averaged such that the APRM signal is proportional to the core average neutron flux and can be calibrated as a means of measuring core thermal power. The number of APRM channels is reduced to four from six and the LPRM's are re-assigned to increase the number of LPRM's in the APRM average. The logic of the trip output signals from the APRM channels is modified from the original design to implement a Two-out-of-Four (2/4) trip logic that eliminates half Scrams resulting from a single PRNM channel failure. A neutron flux trip in any two APRM channels will cause a Scram.

The APRM Neutron Flux High Scram is capable of generating a trip signal to prevent fuel damage or excessive RCS pressure in high power range. For rapid neutron flux increase events, the thermal power lags the neutron flux and APRM Neutron Flux High Scram will provide a Scram signal before the APRM Flow Biased Simulated Thermal Power (STP) Scram. The APRM Neutron Flux High Scram is based on unfiltered neutron flux signal.

The APRM Setdown Scram is capable of generating a trip signal that prevents fuel damage resulting from abnormal operating transients in the low power range. The APRM Setdown Rod Block is a precursor to the APRM Setdown Scram. The setdown Scram is a redundant Scram, which overlaps the IRM region, for reactivity transients in the startup mode. This provides defense-in-depth for reactivity transients in the startup mode.

The APRM Downscale Rod Block initiation ensures that there is sufficient overlap of the operating regions of the APRMs and IRMs with the IRM detectors fully inserted. APRM Downscale Rod Block function provides indication of instrument failure or insensitivity.

7.2 Instrument Definition and Device Uncertainty Terms

The APRM Non-Flow Biased Loop is composed of LPRM Detectors (Device 1) and NUMAC PRNMS Power Electronics (Device 2).

7.2.1 Device 1: LPRM Detector Data

7.2.1.1 Instrument Definition:

Device 1 – LPRM Detectors

Component IDs:

:

Total: 24 LPRM Detector strings containing 4 detectors each = 96 LPRM Detectors

INDREC LPRM-04-29	INDREC LPRM-12-13	INDREC LPRM-12-21	INDREC LPRM-12-29
INDREC LPRM-12-37	INDREC LPRM-20-13	INDREC LPRM-20-21	INDREC LPRM-20-29
INDREC LPRM-20-37	INDREC LPRM-20-45	INDREC LPRM-28-05	INDREC LPRM-28-13
INDREC LPRM-28-21	INDREC LPRM-28-29	INDREC LPRM-28-37	INDREC LPRM-28-45
INDREC LPRM-36-13	INDREC LPRM-36-21	INDREC LPRM-36-29	INDREC LPRM-36-37
INDREC LPRM-36-45	INDREC LPRM-44-21	INDREC LPRM-44-29	INDREC LPRM-44-37

		Sigma	Reference(s)
Location	Drywell	n/a	Input 4.9, Item 2
Make	GE/Reuter Stokes	n/a	Input 4.9, Item 22
Model	GE NA300	n/a	Input 4.9, Item 22
Process Element	Local Power Range Monitor (LPRM) Neutron detector	n/a	Input 4.2, Section 1-CLTP Input 4.3, Section 1-EPU
Upper Range Limit (UR)	n/a	n/a	n/a
Calibrated Span (SP)	n/a	n/a	n/a
Input (neutron flux)	Design maximum neutron flux of 2.3E14 nv	n/a	Input 4.9, Item 23
Output (LPRM electronics)	0.0 to 3 ma	n/a	Input 4.5, Section 5.3.17.6
Minimum # of LPRMs per APRM	14 of 24	n/a	Input 4.2,Section 2.3-CLTP Input 4.3,Section 2.3-EPU

7.2.1.2 Process and Physical Interfaces:

Device 1 – LPRM Detectors Process and Physical Interfaces		Sigma	Reference(s)
Calibration Temperature Range	n/a for LPRM detector due to in-core location	n/a	n/a
Calibration/Surveillance Interval	7 Days	n/a	Technical Specifications
Normal Plant Conditions: • Temperature • Radiation • Pressure • Humidity at Assembly Connector	LPRM detectors are exposed to reactor operating conditions: • Design Temperature 546 deg F • Gamma 2.4 R/hr; Neutrons 10 R/hr • Design Pressure 1250 psig • Condensation Dripping water is present	n/a	Input 4.10
Trip Environment Conditions	Not applicable for setpoint calculation	n/a	n/a
Long Term Post Accident Conditions	Not applicable for setpoint calculation	n/a	n/a
Seismic Conditions	Not applicable for setpoint calculation	n/a	n/a
Process Conditions: During Calibration Worst Case During Function	Not applicable for setpoint calculation	n/a	n/a

7.2.1.3 Individual Device Accuracy

LPRM Detectors				
Symbol	**Term**	**Value (% RTP)**	**Sigma**	**Reference**
A_1	Instrument Accuracy – LPRM Detector	0 %, LPRM detector accuracy is included in APEA	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
D_1	LPRM Drift	0 %, LPRM detector drift in included in DPEA	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
APEA	APEA - Accuracy per LPRM detector	$= \pm APEA_R + APEA_b$ ± 1.00 % RTP + bias 0.49 % RTP	2	Input 4.2, Section 1-CLTP Input 4.3, Section 1-EPU
DPEA	DPEA – Drift per LPRM detector	$= \pm DPEA_R + DPEA_b$ ± 0.2 % RTP/ 7days + bias 0.33 % RTP	2	Input 4.2, Section 1-CLTP Input 4.3, Section 1-EPU
ATE	Accuracy Temperature Effect	0 %, Design temperature is normal in-core temperature of 546 deg F. LPRM electronics temperature effect is included in accuracy	n/a	Input 4.9, Item 2 Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
OPE	Overpressure Effect	n/a – Overpressure effect is not applicable for LPRM Detector accuracy. Detector is designed for 1250 psig.	n/a	Input 4.9, Item 2
SPE	Static Pressure Effect	n/a – Static pressure effect is not applicable for LPRM Detector accuracy due to in-core location.	n/a	n/a
SE	Seismic Effect	n/a – Seismic effect is not applicable because APRM Scram and rod block are only required during normal operating conditions.	n/a	n/a
RE	Radiation Effect	n/a – Radiation effect is not applicable because LPRM detector is designed for a lifetime nv of 1.2E14 nv @ 1E9 Rem/hr.	n/a	Input 4.9, Item 2
HE	Humidity	n/a – Humidity is not applicable because LPRM detector is located in-core.	n/a	n/a
PSE	Power Supply Effect	Negligible for LPRM detector	n/a	Input 4.2, Section 1-CLTP Input 4.3, Section 1-EPU Comment 16 in each of the above Inputs.
REE	RFI/EMI Effect	n/a - RFI/EMI effect is not applicable because LPRM detector is located in-core.	n/a	n/a

7.2.2 Device 2: NUMAC PRNMS Power Electronic Data (LRPM, APRM, Trip Circuits)

7.2.2.1 Instrument Definition

Device 2 – NUMAC PRNMS Power Electronic Data

Component ID's:
INDREC APRM 1 INDREC APRM 2 INDREC APRM 3 INDREC APRM 4

Device 2 – NUMAC PRNMS Power Electronic Data		Sigma	Reference(s)
Location	Power Electronics: Admin Building, El 951'	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Make	GE	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3 –EPU
Model	NUMAC	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Calibration Scale	Full Scale = 125 % RTP	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Upper Range Limit	n/a	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Input signal	0 – 3 ma from each LPRM	n/a	Input 4.5, Section 5.3.17.6
Analog Output signal: Outputs to: Flux Recorders, Flow Recorders, Flow Indicatiors, Computer Points	- 10 to + 10 VDC (maximum)	n/a	Input 4.5, Section 5.3.17.7

7.2.2.2 Process and Physical Interfaces

Device 2 - NUMAC PRNMS Power Electronic Data		Sigma	Reference(s)
Calibration Temperature Range	72 to 78 deg F	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Calibration/Surveillance Interval	700 hours	2	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Normal Plant Conditions: Temperature Radiation Pressure Humidity	 72 to 78 deg F Negligible n/a Included in Accuracy	 n/a 2 2 2	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Trip Environment Conditions	72 to 78 deg F Same as Normal Plant Conditions	n/a	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
Long Term Post Accident Conditions	n/a – Scram and Rod Block functions are only required during normal conditions.	n/a	n/a
Seismic Conditions	Included in Accuracy	2	Input 4.2, Section 2.3-CLTP, Comment 4 Input 4.3, Section 2.3-EPU, Comment 4
Process Conditions: During Calibration Worst Case During Function	n/a for APRM calibration	n/a	n/a

7.2.2.3 Individual Device Accuracy

Device 2 – NUMAC PRNMS Power Electronic Data

Symbol	Term	Value (% RTP)	Sigma	Reference
A_2	Instrument Accuracy of LPRM flux channel electronics	± 0.943 % RTP	2	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
D_2	Power Electronics Drift	± 0.50 RTP FS/700 Hours	2	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
APMA a. tracking b. noise	Process Measure Accuracy	a. ± 1.11 % RTP b. ± 2.00 % RTP	2	Input 4.2, Section 1-CLTP Input 4.3, Section 1-EPU
C_L	Loop Calibration Accuracy Error	ALT specified by the AGAF process = ± 2.0 % RTP	3	Input 4.2, Section 2.3-CLTP and Comment 11 Input 4.3, Section 2.3-EPU and Comment 11
ALT_L	As-Left Tolerance	± 2.0% RTP based on APRM Gain Adjustment Factor (AGAF)	3	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
AFT_L	As-Found Tolerance	= ALT, = ± 2.0 % RTP	3	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
ATE	Accuracy Temperature Effect	Included in Accuracy	2	Input 4.2, Section 2.3-CLTP Input 4.3, Section 2.3-EPU
OPE	Overpressure Effect	n/a for APRM Power electronic	n/a	Input 4.2, Section 2.3-CLTP and Comment 5; Input 4.3, Section 2.3-EPU and Comment 5
SPE	Static Pressure Effect	n/a for APRM Power electronic	n/a	Input 4.2, Section 2.3-CLTP and Comment 5; Input 4.3, Section 2.3-EPU and Comment 5
SE	Seismic Effect	Included in Accuracy	2	Input 4.2, Section 2.3-CLTP and Comment 4; Input 4.3, Section 2.3-EPU and Comment 4
RE	Radiation Effect	Negligible	2	Input 4.2, Section 2.3-CLTP and Comment 4; Input 4.3, Section 2.3-EPU and Comment 4
HE	Humidity	Included in Accuracy	2	Input 4.2, Section 2.3-CLTP and Comment 4; Input 4.3, Section 2.3-EPU and Comment 4
PSE	Power Supply Effect (LPRM Detector)	Negligible	2	Input 4.2, Sections 1 and 2.3-CLTP, Comment 4&16; Input 4.3, Sections 1 and 2.3, Comment 4&16-EPU
REE	RFI/EMI Effect	Negligible	2	Input 4.2, Section 2.3-CLTP and Comment 4; Input 4.3, Section 2.3-EPU and Comment 4

7.3 Loop Instrument Uncertainty Evaluation

7.3.1 CLTP Operation Loop Instrument Uncertainty:
The loop uncertainty associated with the replacement of analog neutron monitoring system with the digital NUMAC PRNMS for CLTP operation is discussed and calculated in this section.

7.3.1.1 Loop Instrument Accuracy (A_L)

Loop Instrument Accuracy (A_L) is defined as the accuracy of the LPRM flux channel electronics. The GEH Input documents, Input 4.2 and 4.3, for the digital PRNMS specify a LPRM flux channel electronic accuracy for PRNM chassis. The accuracy of the LPRM detector is specified as APRM PEA or APEA (Accuracy) as defined in Section 7.2.1.3. Since the accuracy of the LPRM detector is included in APEA (Accuracy), it will be used in the calculation of Loop Primary Element Accuracy ($APEA_L$). Calculation of Loop Accuracy (A_L) will use the LPRM Electronics accuracy value.

Loop Instrument Accuracy depends on number of LPRMs averaged by the PRNM APRM. As indicated below, the statistical average is based on Input 4.12, which is shown in Attachment 4. The fewer LPRMs averaged, the greater the accuracy error. Averaging the minimum number of LPRM detectors (14) versus a larger number (24) equals the following accuracy errors:

Averaging Calculation Example:
The following shows how number of LPRM detectors affects the accuracy error. For example, the APEA for each LPRM is $\pm 1.0\% RTP$ $\pm$ bias of 0.49 % RTP as indicated in Section 7.1.2.3.

Input 4.12 (Attachment 4) can be interrupted as the following:

Accuracy Error = $\dfrac{Accuracy(perLPRM)}{\sqrt{n}}$ n = number of LPRM detectors used

14 LPRM Detectors: Accuracy Error = $\pm \dfrac{1.0\% RTP}{\sqrt{14}} = \pm$ 0.267 % RPT

24 LPRM Detectors: Accuracy Error = $\pm \dfrac{1.0\% RTP}{\sqrt{24}} = \pm$ 0.204 % RPT

For conservatism, the minimum number of LPRM detectors (14) is used in the accuracy calculations.

Individual Device Accuracy

Device 1: LPRM Detector (A_1)

As stated above, the LPRM Detector accuracy is included in APRM PEA (APEA) term. Section 7.3.1.6 calculates Loop Primary Element Accuracy ($APEA_L$) using this term. Therefore, LPRM flux channel electronics accuracy for Device 1 will be considered 0 % RPT.

A_1 = LPRM flux channel electronics accuracy for LPRM Detector
A_1 = 0 % RPT since it is included in APEA term. Section 7.2.1.3

Device 2: Power Electronics (NUMAC PRNMS) (A_2)

As stated above, the PRNM chassis electronics for the flux generated analog signal is the term below for one LPRM detector.

Accuracy (LPRM Electronics) = ± 0.943 % RTP. (Section 7.2.2.3)

GEH does not breakdown the components of the LPRM flux channel electronics accuracy in their submitted PRNM documents. The calculation of the LPRM electronics accuracy is considered proprietary. The LPRM module, which receives analog input from the LPRM detector, is part of the new PRNM chassis. Another component is the digital processing of the LPRM detector signal. The LPRM electronics accuracy specified applies to one LPRM detector.

The APRM averages the LPRM signals to obtain reactor power indication. The minimum number of LPRMs is 14 in accordance Section 7.2.1.1.

Per Input 4.12, the accuracy will be 1/14 of the square root of the sum of the squares of the 14 LPRMs as expressed by:

A_2 = Overall (mean) accuracy for the LPRM flux channel Electronics

$$A_2 = \pm\frac{1}{14}\sqrt{0.943^2 \times 14}$$

A_2 = ± 0.253 % RTP

Loop Instrument Accuracy (A_L)

A_1 = ± 0.00 % RTP
A_2 = ± 0.253 % RTP

$A_L = \pm\sqrt{(A_1)^2 + (A_2)^2}$

$A_L = \pm\sqrt{(0.000)^2 + (0.0253)^2}$

$A_L = \pm$ 0.253 % RTP

7.3.1.2 <u>Loop Instrument Drift (D_L)</u>

Loop Instrument Drift (D_L) is defined as the Square Root of the Sum of the Squares (SRSS) of the individual Device drifts.

For this calculation, Section 7.2.1.3 states the drift of the LPRM detectors (Device 1) is included in DPEA. Discussions with GE Instrument Engineers confirmed that the total drift error for GE LPRM detectors is known and is accurate for the LPRM detector Random drift error and the Bias drift error components.

For Device 2, Section 7.2.2.3 states the NUMAC PRNM Power Electronics drift is 0.5 % RTP Full Span when calibration every 700 hours. The source of this drift value is Input 4.2.

Methodology, Section 2, states that this calculation uses GE specified drift parameters for the applicable PRNM equipment and for the existing LPRM detectors. Standards Manual ESM-03.02-APP-I, Section 5.2.4, shows a alternate methodology for determination of individual device drift. For this application, it is considered more accurate to use GE specified device drift values since both PRNM equipment and LPRM detectors are provided by the manufacturer.

<u>Individual Device Drift</u>

<u>Device 1</u>

Drift of Device 1 = $D_1 = \pm$ 0.00 % RTP (FS) / 700 days because the LPRM (Device 1) drift is included in DPEA as specified in Section 7.2.1.3.

<u>Device 2</u>

Drift of Device 2 = $D_2 = \pm$ 0.50 % RTP FS / 700 Hours (Section 7.2.2.3)

Since the APRMs will be calibrated against the reactor heat balance every 7 days, 700 hours drift value is conservative. Converting percent full span (FS) to the percent power yields:
$D_2 = \pm$ 0.50 x (125 % RTP/ 100 % RTP FS)

$D_2 = \pm\ 0.625$ % RTP

Loop Instrument Drift (D_L)
$D_1 = \pm\ 0.000$ % RTP
$D_2 = \pm\ 0.625$ % RTP

Loop Instrument Drift = $D_L = \pm\sqrt{(D_1)^2 + (D_2)^2}$

$D_L = \pm\sqrt{(0.000)^2 + (0.625)^2} = \pm\ 0.625$ % RTP

7.3.1.3 Loop As-Left Tolerance (ALT_L)

The loop As-Left tolerance (ALT_L) is being evaluated from two perspectives. The first is based on GEH Input 4.2, Section 2.3 and Comment 11. Input 4.2 states that the As-Left Tolerance is equal to the Auto Gain Adjustment Factor (AGAF), which is ± 2.00 % RTP at 3σ. Input 4.2, Comment 11, states the basis for AGAF equaling ± 2.00 % RTP is as follows:

The APRM subsystem is calibrated every 7 days using the AGAF process, where the gain of the APRMs is adjusted to read the Rated Thermal Power (RTP), also called Core Thermal Power, determined by the Process Computer (P/C), 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 P/C is the calibration tool and standard. The P/C and heat balance error is already accounted for in the 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.

A. Loop As-Left Tolerance (ALT_L) used in uncertainty calculations is determined by the AGAF process:
As described above, the basis for this ALT_L calculation is GEH Input 4.2, Section 2.3.

ALT_L = AGAF which is equal to: ± 2.00 % RTP at 3σ. (Section 7.2.2.3)

The tolerance is normalized to a 2σ confidence level in accordance with ESM-03.02- APP-I, Section 4.3 (Input 4.1),
Converting to 2 σ:

$ALT_L = \pm\ 2.00 \times (2/3)$ % RTP at 2σ.
$ALT_L = \pm\ 1.334$ % RTP for use in uncertainty calculations

The second analysis of ALT_L is based on PRNM surveillance calibration of PRNM electronics. The LPRM detector loop is not involved. The electronics being calibration checked is PRNM digital equipment. The setpoints being checked are numerical values stored in the digital hardware and are not subject to drift.

B. ALT_L used for PRNM surveillance calibration procedures:

ALT_L = 0.00 % RTP based on PRNM digital hardware without LPRM detectors

7.3.1.4 Loop As-Found Tolerance (AFT_L)

The As-Found Tolerance (AFT_L) is being evaluated from two perspectives similar to ALT_L, Section 7.3.1.3. The results are indicated below:

A. Loop As-Found Tolerance (AFT_L), used in loop uncertainty calculations, is determined by GEH Input 4.2, Section 2.3, which states:

$AFT_L = ALT_L$ (Section 7.2.2.3)
$ALT_L = \pm 2.00$ % RTP at 3σ as defined in Section 7.3.1.3.

The tolerance is normalized to a 2σ confidence level In accordance with ESM-03.02-APP-1, Section 4.3 (Input 4.1).

$AFT_L = \pm 2.00$ % x (2/3) % RTP at 2σ
$AFT_L = \pm 1.334$ % RTP for use in uncertainty calculations

The tolerance is normalized to a 2σ confidence level in accordance with ESM-03.02- APP-I, Section 4.3 (Input 4.1),
Converting to 2σ:

$AFT_L = \pm 2.00$ x (2/3) % RTP at 2σ.
$AFT_L = \pm 1.334$ % RTP used for uncertainty calculations

The second analysis of AFT_L is based on PRNM surveillance calibration of only PRNM electronics. The LPRM detector loop is not involved. The setpoints being checked are numerical values stored in the digital hardware and are not subject to drift.

B. AFT_L used for PRNM surveillance calibration procedures:

AFT_L = 0.00 % RTP based on PRNM digital hardware without LPRM detectors

7.3.1.5 Loop Calibration Accuracy Error (C_L)

In accordance with GEH specification in Input 4.2, Comment 11, the only calibration error to consider for the APRM electronics sub-loop is the loop As-Left Tolerance (ALT_L) specified by the AGAF process. Calibration Accuracy Error (C_L) is the As-Left Tolerance (AFT_L) defined for uncertainty calculations.

Loop Calibration Accuracy Error = C_L
$C_L = ALT_L = \pm 1.334$ % RTP (Section 7.3.1.3)

7.3.1.6 Loop Primary Element Accuracy ($APEA_L$)

APEA is equal to the Random Accuracy per LPRM detector plus the Bias Accuracy Error per LPRM detector. Section 7.2.1.3 indicates that the Power Supply Effect of the LPRM Detector in included in the APEA. This is in accordance with Inputs 4.2 and 4.3.

APEA = Random Accuracy Error/LPRM detector + Bias Accuracy/LPRM Detector

Random Accuracy Error = $\pm APEA_R = \pm 1.00$ % RTP/ LPRM (Section 7.2.1.3)
Bias Accuracy Error = $APEA_b = 0.49$ % RTP bias

APEA = ± 1.00 % RTP/ LPRM + 0.49% RTP bias/ LPRM (Section 7.2.1.3)

Loop Primary Element Accuracy ($APEA_L$) = overall (mean) accuracy

$APEA_L$ is equal to the Random Accuracy per LPRM detector divided by the square root of the minimum number of LPRM detectors plus the Bias Accuracy Error per LPRM detector.

$$APEA_L = \frac{\pm 1.0\% RTP}{\sqrt{14}} \pm 0.49\% RTPbias \qquad \text{(Input 4.12)}$$

For conservatism, Bias terms are positive.

$APEA_L = \pm 0.268$ % RTP + 0.49 % RTP bias

7.3.1.7 Loop Drift Primary Element Accuracy ($DPEA_L$)

DPEA is equal to the Random Drift Error per LPRM detector plus the Bias Drift Error per LPRM detector. (Section 7.2.1.3)

Therefore, DPEA is defined as:
DPEA = Random Drift Error/LPRM detector + Bias Drift Error/LPRM Detector

Random Drift Error = $DPEA_R$ = ± 0.20 % RTP/ LPRM (Section 7.2.1.3)
Bias Drift Error = $DPEA_b$ = 0.33 % RTP bias

DPEA = ± 0.20 % RTP/ LPRM + 0.33 % RTP bias/ LPRM (Section 7.2.1)

Loop Drift Primary Element Accuracy ($DPEA_L$) = overall (mean) accuracy

$DPEA_L$ is equal to the Random Drift Error per LPRM detector divided by the square root of the minimum number of LPRM detectors plus the Bias Drift Error per LPRM detector.

$$DPEA_L = \frac{\pm 0.20\% RTP}{\sqrt{14}} \pm 0.33\% RTPbias$$ (Input 4.12)

For conservatism, the Bias terms are positive.
$APEA_L$ = ± 0.054 % RTP + 0.33 % RTP bias

7.3.1.8 Loop APRM Process Measurement Accuracy ($APMA_L$)

$APMA_{tracking}$ = ± 1.11 % RTP (Section 7.2.2.3)
$APMA_{noise}$ = ± 2.00 % RTP (Section 7.2.2.3)

$$APMA_L = \pm\sqrt{(APMA_{tracking})^2 + (APMA_{noise})^2}$$

$$APMA_L = \pm\sqrt{(1.11\%)^2 + (2.00\%)^2}$$

$APMA_L$ = ± 2.288 % RTP

7.3.1.9 Tabulation of Loop Uncertainties - PRNM CLTP Operation

Uncertainty Type	Term	Random ± % RTP	Bias + % RTP	Section
A_L	Loop Instrument Accuracy	0.253		7.3.1.1
D_L	Loop Instrument Drift	0.625		7.3.1.2
ALT_L (uncertainty)	Loop As-Left Tolerance for uncertainty calculations	1.334		7.3.1.3
ALT_L (calibration)	Loop As-Left Tolerance for electronic calibrations	0.00		7.3.1.3
AFT_L (uncertainty)	Loop As-Found Tolerance for uncertainty calculations	1.334		7.4.1.4
AFT_L (calibration)	Loop As-Found Tolerance for electronic calibrations	0.00		7.3.1.4
C_L	Loop Calibration Accuracy Error	1.334		7.3.1.5
$APEA_L$	Loop APRM Primary Element Accuracy	0.268		7.3.1.6
$DPEA_L$	Loop Drift Primary Element Accuracy	0.054		7.3.1.7
$APMA_L$	Loop APRM Process Measurement Accuracy	2.288		7.3.1.8
$APEA_b$	APRM Primary Element Accuracy Bias		0.49	7.3.1.6
$DPEA_b$	Drift Primary Element Accuracy Bias		0.33	7.3.1.7

7.3.2 EPU Operation Loop Uncertainty

The comparison of Inputs 4.2 and 4.3 shows the individual device uncertainties associated with the EPU operation are identical to the individual device uncertainties associated with the CPTP operation. The uncertainty terms tabulated in Sections 7.2.1 and 7.2.2 list both CLTP (Input 4.2) and EPU (Input 4.3) references. Operating at EPU condition will not change the methodology used to combine the individual device uncertainties to produce the loop uncertainties. Therefore, the loop uncertainties calculated for the PRNM CLTP operation (Section 7.3.1) will be applicable to the PRNM EPU Operation (Section 7.3.2). The EPU uncertainties are tabulated in the table below:

7.3.2.1 Tabulation of Loop Uncertainties – PRNM EPU Operation

Tabulation of Loop Uncertainties – PRNM EPU Operation

Uncertainty Type	Term	Random ± % RTP	Bias + % RTP	Section
A_L	Loop Instrument Accuracy	0.253		7.3.1.1
D_L	Loop Instrument Drift	0.625		7.3.1.2
ALT_L (uncertainty)	Loop As-Left Tolerance for uncertainty calculations	1.334		7.3.1.3
ALT_L (calibration)	Loop As-Left Tolerance for electronic calibrations	0.00		7.3.1.3
AFT_L (uncertainty)	Loop As-Found Tolerance for uncertainty calculations	1.334		7.3.1.4
AFT_L (calibration)	Loop As-Found Tolerance for electronic calibrations	0.00		7.3.1.4
C_L	Loop Calibration Accuracy Error	1.334		7.3.1.5
$APEA_L$	Loop APRM Primary Element Accuracy	0.268		7.3.1.6
$DPEA_L$	Loop Drift Primary Element Accuracy	0.054		7.3.1.7
$APMA_L$	Loop APRM Process Measurement Accuracy	2.288		7.3.1.8
$APEA_b$	APRM Primary Element Accuracy Bias		0.49	7.3.1.6
$DPEA_b$	Drift Primary Element Accuracy Bias		0.33	7.3.1.7

7.4 PRNM CLTP Operation Setpoint Evaluation

7.4.1 PRNM CLTP APRM Neutron Flux – High Scram

Input 4.2, Section 3, states the following Analytical Limit (AL), the recommended Allowable Value (AV) and the Nominal Trip Setpoint (NTSP) for CLTP operation with NUMAC - PRNM equipment installed.

PRNM CLTP Setpoint (% RTP)	AL	AV	NTSP
APRM Neutron Flux – High Scram	125.0	122.0	119.5

The following calculations will determine the minimum required margin between the specified AL of 125.0 % RTP, AV of 122.0 % RTP and NTSP of 119.5 % RTP.

7.4.1.1 Allowable Value (AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formulas for calculating the AV from the AL:

$$AV \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and AV can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (APMA_L)^2 + (APEA_L)^2} \pm APEA_b$$

<u>Minimum Required Margin (AL-AV)</u> = RM = AL – AV

RM = AL - AV = $\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (2.288)^2 + (0.268)^2} + (0.490)$

RM = AL - AV = 2.69 % RTP

Available Margin (AL - AV) =AM = AL - AV

AM = AL - AV = (125.0 - 122.0) % RTP
AM = AL - AV = 3.00 % RTP

PRNM CLTP Setpoint (% RTP)	AL	AV	Available Margin (AL - AV)	Minimum Required Margin	AV Acceptable
APRM Neutron Flux – High Scram	125.0	122.0	3.0	2.69	Yes

Since the available margin is greater than the minimum required margin (3.0 % RTP versus 2.69 % RTP), the recommended AV is acceptable.

7.4.1.2 Nominal Trip Setpoint (NTSP) Evaluation

Input 4.11, Section 1.2.3.3 provides the following formula for calculating the NTSP from the AL:

$$NTSP \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and NTSP can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA_L)^2 + (APEA_L)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Minimum Required Margin (AL- NTSP) = RM = AL - NTSP

RM = AL – NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

RM = AL - NTSP = 3.08 % RTP

Available Margin (AL - NTSP) = AM = AL - NTSP

AM = AL - NTSP = (125.0 - 119.5) % RTP = 5.50 % RTP

PRNM CLTP Setpoint (% RTP)	AL	NTSP	Available Margin (AL-NTSP)	Minimum Required Margin	NTSP Acceptable
APRM Neutron Flux - High Scram	125.0	119.5	5.5	3.08	Yes

Since the available margin is greater than the minimum required margin (5.5 % RTP versus 3.08 % RTP), the recommended NTSP is acceptable.

7.4.1.3 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violations of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

Where n is the number of standard deviations used (2σ)

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between NTSP and AV as specified in ESM-03.02-APP-I, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}} = \frac{|(122.0 - 119.5)\%RTP|}{(0.75)\%RTP} = 3.33$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 119.5 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum margin (% RTP) between AV and $NTSP_2$ with Z of 0.81 used.

$NTSP_2$ Offset = Z x σ_{LER}
$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

$NTSP_2$ is calculated to provide an NTSP based on the minimum LER avoidance criteria:
$NTSP_2 \leq AV - NTSP_2$ Offset
$NTSP_2 \leq 122.0$ % RTP - 0.61 % RTP
$NTSP_2 \leq 121.4$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 121.4 % RTP.

A conservative NTSP of 119.5 % RTP is used. Attachment 1, Setpoint Diagrams, shows margin for the APRM Neutron Flux – High Scram setpoint.

7.4.1.4 Spurious Trip Avoidance (STA) Test

A Spurious Trip Avoidance test is performed to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint.

Input 4.11, Section 1.2.3.4, provides the following formula for determining Spurious Trip avoidance. Input 4.13, Sections 4.5.4.b and 4.5.9.b, state that any bias associated with PMA or PEA should also be included. Therefore, $APEA_b$ shown in CLTP Loop Uncertainty table in Section 7.3.1.9 is being included.

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} + APEA_b$$

Where n is the number of standard deviations used (2σ)

$DPEA_L$ and $DPEA_b$ were defined and evaluated in Section 7.3.1.7. These terms are to be included in the above σ_{STA} equation as follows:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Using APRM terms, σ_{STA} is defined as:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA)^2 + (APEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

$$\sigma_{STA} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

σ_{STA} = 2.20 % RTP

Input 4.1, STA Section 5.6.8, states Z is equal to the following:

$$Z = \frac{|(Adjusted\_NTSP) - (Operational\_Limit)|}{(\sigma_{STA})}$$

Input 4.1, Section 5.6.8, states that Adjusted NTSP is the selected setpoint minus ALT_L (more conservative). Since Adjusted NTSP is ($NTSP-ALT_L$), Z is equal to the following:

$$Z = \frac{NTSP - ALT - (Operational\_Limit)}{(\sigma_{STA})}$$

In Input 4.2, Sections 1.3 and 1.7, GEH defines the Operational Limit (OL) as 100 % RTP for MNGP. Therefore:

$$Z = \frac{(119.5 - 1.334 - 100.0)\%RTP}{(2.20)\%RTP}$$

Z= 8.25

As specified in Input 4.1, Section 5.6.8, Z should be equal to or greater that 1.65 for the setpoint to be adequately separated from the Operational Limit to reasonably avoid Spurious trip conditions.

Since the actual value of 8.25 is greater than the required value of 1.65, an adequate separation exists between the NTSP and the Operational Limit (OL), and the STA criterion is satisfied.

7.4.2 PRNM CLTP: APRM Neutron Flux – High (Setdown) Scram and APRM Neutron Flux – High (Setdown) Rod Block

Input 4.2, Section 3, states that the following Analytical Limit (AL) and the following recommended Allowable Valve (AV) and the Nominal Trip Setpoint (NTSP):

PRNM CLTP Setpoints (% RTP)	AL	AV	NTSP
APRM Neutron Flux – High (Setdown) Scram	N/A	20.0	18.0
APRM Neutron Flux – High (Setdown) Rod Block	N/A	15.0	13.0

Input 4.2 shows that Setdown Scram and Setdown Rod Block functions do not have AL. These functions only have AV and NTSP. This calculation will determine the minimum required margin for AL to AV, and AL to NTSP. The difference between the minimum required margins for AL to AV, and AL to NTSP becomes the minimum required margin for AV to NTSP.

7.4.2.1 Minimum Required Margin (AL to AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formula for calculation the AV from the AL.

$$AV \le AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between the AL and AV and be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (APMA_L)^2 + (APEA_L)^2} + APEA_b$$

Minimum Required Margin (AL - AV) = RM = AL - AV

$$RM = AL - AV = \left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (2.288)^2 + (0.268)^2} + (0.490)$$

RM = AL - AV = 2.69 % RTP

7.4.2.2 Minimum Required Margin (AL to NTSP) Evaluation

Input 4.11, Section 1.2.3.3, provides the following formula for calculating the AV from the AL:

$$NPSP \le AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} \pm bias.$$

Minimum required margin between AL and NTSP can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA_L)^2 + (APEA_L)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Minimum Required Margin (AL - NTSP) = RM = AL - NTSP

RM = AL – NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

RM = AL – NTSP = 3.08 % RTP

7.4.2.3 Minimum Required Margin (AV to NTSP) Evaluation

RM = AV – NTSP =
Minimum Required Margin (AL to NTSP) - Minimum Required Margin (AL to AV)

RM = AV to NTSP = (3.08 - 2.69) % RTP
RM = AV to NTSP = 0.39 % RTP

PRNM CLTP Setpoints (% RTP)	AV	NTSP	Available Margin (AV-NTSP)	Minimum Required Margin	AV Acceptable
APRM Neutron Flux – (Setdown) Scram	20.0	18.0	2.0	0.39	Yes
APRM Neutron Flux – (Setdown) Rod Block	15.0	13.0	2.0	0.39	Yes

Since the available margin is greater than the minimum required margin (2.0 % RTP versus 0.39 % RTP), the recommended NTSP is acceptable.

7.4.2.4 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violation of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

where n is the number of the standard deviations used (2σ)

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between the NTSP and AV as specified in ESM-03.02-APP-I, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}}$$

For APRM Neutron Flux – High (Setdown) Scram setpoint:

$$Z = \frac{|(20.0 - 18.0)\%RTP|}{(0.75)\%RTP} = 2.66$$

For APRM Neutron Flux – High (Setdown) Rod Block setpoint:

$$Z = \frac{|(15.0 - 13.0)\%RTP|}{(0.75)\%RTP} = 2.66$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 18.0 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum required margin between AV and NTSP with Z of 0.81 used.

$NTSP_2$ Offset = Z x σ_{LER}
$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

APRM Neutron Flux – High (Setdown) Scram Setpoint

For APRM Neutron Flux – High (Setdown) Scram setpoint: $NTSP_2$ is calculated to provide a NTSP based on the minimum LER avoidance criteria:

$NTSP_2 \le AV - NTSP_2$ Offset
$NTSP_{2(\text{Setdown Scram})} \le (20.0 - 0.61)$ % RTP
$NTSP_{2(\text{Setdown Scram})} \le 19.4$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 19.4 % RTP.

Therefore, a conservative NTSP of 18.0 % RTP is used for the APRM Neutron Flux – High (Setdown) Scram setpoint.

APRM Neutron Flux – High (Setdown) Rod Block Setpoint

For APRM Neutron Flux – High (Setdown) Rod Block setpoint: $NTSP_2$ is calculated below to indicate margin of the recommended NTSP:

$NTSP_2 \le AV - NTSP_2$ Offset
$NTSP_{2(\text{Setdown Rod Block})} \le (15.0 - 0.61)$ % RTP
$NTSP_{2(\text{Setdown Rod Block})} \le 14.4$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 14.4 % RTP.

Therefore, a conservative NTSP of 13.0 % RTP is used for the APRM Neutron Flux – High (Setdown) Rod Block setpoint.

Attachment 1, Setpoint Diagrams, shows the setpoint margin for CLTP APRM Neutron Flux – High (Setdown) Scram and APRM Neutron Flux – High (Setdown) Rod Block setpoints.

7.4.2.5 Spurious Trip Avoidance (STA) Test

A Spurious Trip Avoidance test is performed to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint.

Input 4.11, Section 1.2.3.4, provides the following formula for determining Spurious Trip avoidance. Input 4.13, Sections 4.5.4.b and 4.5.9.b, provides setpoint guidance to add bias term for APEA.

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} + APEA_b$$

Where n is the number of standard deviations used (2σ)

Terms $DPEA_L$ and $DPEA_b$ were defined and evaluated in Section 7.3.1.7. These terms are to be included in the above σ_{STA} equation as follows:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Using APRM terms, σ_{STA} is defined as:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA)^2 + (APEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

$$\sigma_{STA} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

σ_{STA} = 2.20 % RTP

Input 4.1, STA Section 5.6.8, states Z is equal to the following:

$$Z = \frac{|(Adjusted\_NTSP) - (Operational\_Limit)|}{\sigma_{STA}}$$

Input 4.1, Section 5.6.8, states that Adjusted NTSP is the selected setpoint minus ALT_L (more conservative). Since Adjusted NTSP is ($NTSP-ALT_L$), Z is equal to the following:

$$Z = \frac{[NTSP - ALT - (Operational\_Limit)]}{\sigma_{STA}}$$

Input 4.2, Section 1.1, defines the Operational Limit for the APRM Neutron Flux – High (Setdown) Scram as 11.0 % RTP.

$$Z = \frac{(18.0 - 1.334 - 11.0)\%RTP}{(2.20)\%RTP}$$

Z= 2.57

As specified in Input 4.1, Section 5.6.8, Z should be equal to or greater that 1.65 for the setpoint to be adequately separated from the Operational Limit to reasonably avoid Spurious trip conditions.

Since the actual value of 2.57 is greater than the required value of 1.65, an adequate separation exists between the NTSP and the Operational Limit (OL), and the STA criterion is satisfied.

7.4.3 PRNM CLTP - APRM Downscale Rod Block

Input 4.2 for PRNM CLTP setpoints does not address the Downscale Rod Block setpoint for PRNM CLTP operation. Input 4.8, Item 12, provides recommended AV and NTSP setpoints indicated below.

The PRNM CLTP APRM Downscale Rod Block setpoint is the same as the current CLTP setpoint.

PRNM CLTP Setpoint % RTP	AL	AV	NTSP
APRM Downscale Rod Block	N/A	2.0	3.5

Input 4.8, Item 12, indicates that the APRM Downscale Rod Block function does not have an AL. This calculation will determine the minimum required margin for AL to AV, and AL to NTSP. The difference between the minimum required margins for AL to AV, and AL to NTSP becomes the minimum required margin for AV to NTSP.

7.4.3.1 Minimum Required Margin (AL to AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formula for calculation the AV from the AL.

$$AV \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and AV can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (APMA_L)^2 + (APEA_L)^2} + APEA_b$$

Minimum Required Margin (AL - AV) = RM = AL - AV

$$\text{RM = AL - AV} = \left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (2.288)^2 + (0.268)^2} + (0.490)$$

RM = AL - AV = 2.69 % RTP

7.4.3.2 Minimum Required Margin (AL to NTSP) Evaluation

Input 4.11, Section 1.2.3.3, provides the following formula for calculating the AV from the AL:

$$NPSP \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and NTSP can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA_L)^2 + (APEA_L)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Minimum Required Margin (AL - NTSP) = RM = AL - NTSP

RM = AL - NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

RM = AL - NTSP = 3.08 % RTP

7.4.3.3 Minimum Required Margin (AV to NTSP) Evaluation = RM = AV to NTSP

RM = AV to NTSP =
Minimum Required Margin (AL to NTSP) - Minimum Required Margin (AL to AV)

RM = AV to NTSP = 3.08 % - 2.69 % % RTP
RM = AV to NTSP = 0.39 % RTP

PRNM CLTP Setpoint (% RTP)	AV	NTSP	Available Margin (NTSP-AV)	Minimum Required Margin	AV Acceptable
APRM Downscale Rod Block	2.0	3.5	1.5	0.39	Yes

Since the available margin is greater than the minimum required margin (1.5 % RTP versus 0.39 % RTP), the recommended NTSP is acceptable.

7.4.3.4 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violation of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

where n is the number of the standard deviations used (2σ)

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between the NTSP and AV as specified in ESM-03.02-APP-I, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}} = \frac{|(2.0 - 3.5)\%RTP|}{(0.75)\%RTP} = 2.0$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 3.5 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum margin (% RTP) between AV and $NTSP_2$ with Z of 0.81.

$NTSP_2$ Offset = Z x σ_{LER}
$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

$NTSP_2$ is calculated to provide an NTSP based on the minimum LER avoidance criteria:
$NTSP_2 \geq$ AV + $NTSP_2$ Offset
$NTSP_2 \geq$ 2.0 % RTP + 0.61 % RTP
$NTSP_2 \geq$ 2.61 % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be greater than 2.61 % RTP.

Therefore, a conservative NTSP of 3.5 % RTP is used. Attachment 1, Setpoint Diagrams, shows the setpoint margin for CLTP APRM Downscale Rod Block setpoint.

7.5 PRNM EPU Operation Setpoint evaluation

7.5.1 PRNM EPU APRM Neutron Flux – High Scram

The setpoints that will be implemented for APRM Neutron Flux - High are defined in Input 4.8, Item 8. Input 4.3, GE's recommended setpoint document, has slight differences in the setpoints. As shown in the table below, Input 4.8 specifies slightly more conservative values for AV and NTSP. These EPU setpoints are the same values being used for PRNM CLTP operation.

PRNM EPU Setpoints (% RTP)	AL	AV	NTSP
APRM Neutron Flux – High Scram Input 4.8, Item 8	125.0	122.0	119.5
GE Recommended Setpoints (not used)			
APRM Neutron Flux – High Scram Input 4.3	125.0	122.3	120.3

7.5.1.1 Allowable Value (AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formula for calculating the AV from the AL.

$$AV \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and AV can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (APMA_L)^2 + (APEA_L)^2} + APEA_b$$

Minimum Required Margin (AL - AV) = RM = AL - AV

RM = AL - AV = $\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (2.288)^2 + (0.268)^2} + (0.490)$

RM = AL - AV = 2.69 % RTP

Available Margin (AL - AV) = AM = AL - AV

AM = AL - AV = (125.0 - 122.0) % RTP
AM = AL - AV = 3.0 % RTP

EPU Setpoint (% RTP)	AL	AV	Available Margin (AL- AV)	Minimum Required Margin	AV Acceptable
APRM Neutron Flux – High Scram	125.0	122.0	3.0	2.69	Yes

Since the available margin is greater than the minimum required margin (3.0 % RTP versus 2.69 % RTP), the recommended AV is acceptable.

7.5.1.2 Nominal Trip Setpoint (NTSP) Evaluation

Input 4.11, Section 1.2.3.3, provides the following formula for calculating the AV from the AL.

$$NPSP \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and NTSP can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA_L)^2 + (APEA_L)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Minimum Required Margin (AL - NTSP) = RM = AL - NTSP

RM = AL – NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

RM = AL - NTSP = 3.08 % RTP

Available Margin (AL - NTSP) = AM = AL - NTSP

AM = AL - NTSP = (125.0 - 119.5) % RTP
AM = AL - NTSP = 5.5 % RTP

PRNM EPU Setpoint (% RTP)	AL	NTSP	Available Margin (AL- NTSP)	Minimum Required Margin	AV Acceptable
APRM Neutron Flux – High Scram	125.0	119.5	5.5	3.08	Yes

Since the available margin is greater than the minimum required margin (5.5 % RTP versus 3.08 % RTP), the recommended the NTSP is acceptable.

7.5.1.3 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violations of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

where n is the number of the standard deviations used (2σ)

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between NTSP and AV as specified in ESM-03.02-APP-1, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}} = \frac{|(122.0 - 119.5)\%RTP|}{(0.75)\%RTP} = 3.33$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 119.5 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum margin (% RTP) between AV and $NTSP_2$ with Z of 0.81 used.

$NTSP_2$ Offset = Z x σ_{LER}
$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

$NTSP_2$ is calculated to provide an NTSP based on the minimum LER avoidance criteria:
$NTSP_2 \leq$ AV - $NTSP_2$ Offset
$NTSP_2 \leq$ 122.0 % RTP - 0.61 % RTP
$NTSP_2 \leq$ 121.4 % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 121.4 % RTP.

A conservative NTSP of 119.5 % RTP is used.

7.5.1.4 Spurious Trip Avoidance (STA) Test

A spurious trip avoidance test is performed to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint.

Input 4.11, Section 1.2.3.4, provides the following formula for determining Spurious Trip avoidance. Input 4.13, Sections 4.5.4.b and 4.5.9.b, state that any bias associated with PMA or PEA should also be included. Therefore, $APEA_b$ shown in EPU Loop Uncertainty table in Section 7.3.2 is being included.

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} + APEA_b$$

where n is the number of standard deviations used (2σ)

Terms $DPEA_L$ and $DPEA_b$ were defined and evaluated in Section 7.3.1.7 for CLTP operation but also apply to EPU operation as discussed in Sections 7.3.2 and 7.3.2.1. These terms are to be included in the above σ_{STA} equation as follows:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Using APRM terms, σ_{STA} is defined as:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA)^2 + (APEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

$$\sigma_{STA} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

σ_{STA} = 2.20 % RTP

Input 4.1, Section 5.6.8, states Z is equal to the following:

$$Z = \frac{|(Adjusted\_NTSP) - (Operational\_Limit)|}{\sigma_{STA}},$$

Input 4.1, Section 5.6.8, states that Adjusted NTSP is the selected setpoint minus ALT_L (more conservative). Since Adjusted NTSP is ($NTSP-ALT_L$), Z is equal to the following:

$$Z = \frac{NTSP - ALT - (Operational\_Limit)}{\sigma_{STA}}$$

In Input 4.3, Sections 1.3 and 1.7, GEH defines the Operational Limit for MNGP as 100%

$$Z = \frac{(119.5 - 1.334 - 100.0)\% RTP}{(2.20)\% RPT}$$

Z = 8.25

In accordance with Input 4.1, a minimum value of Z is to be 1.65. Since the actual value of 8.25 is greater than the required value of 1.65, adequate separation exists between the NTSP and the Operational Limit (OL), and the STA criterion is satisfied.

7.5.2 EPU APRM Neutron Flux - High (Setdown) Scram and APRM Neutron Flux – High (Setdown) Rod Block

Input 4.3, Section 3, specifies the following Analytical Limit (AL) and the following recommended Allowable Value (AV) and the Nominal Trip Setpoint (NTSP):

PRNM EPU Setpoints (% RTP)	AL	AV	NTSP
APRM Neutron Flux - High (Setdown) Scram	N/A	20.0	18.0
APRM Neutron Flux – High (Setdown) Rod Block	N/A	15.0	13.0

Input 4.3 indicates that Setdown Scram and Setdown Rod Block functions do not have AL. These functions only have AV and NTSP. This calculation will determine the minimum required margin for AL to AV, and AL to NTSP. The difference between the minimum required margins for AL to AV, and AL to NTSP becomes the minimum required margin for AV to NTSP.

7.5.2.1 Minimum Required Margin (AL to AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formula for calculating the AV from the AL.

$$AV \le AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and AV can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (APMA_L)^2 + (APEA_L)^2} + APEA_b$$

Minimum Required Margin (AL - AV) = RM = AL - AV

RM = AL - AV = $\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (2.288)^2 + (0.268)^2} + (0.490)$

RM = AL - AV = 2.69 % RTP

7.5.2.2 Minimum Required Margin (AL to NTSP) Evaluation

Input 4.11, Section 1.2.3.3, provides the following formula for calculating the NTSP from the AL.

$$NTSP \leq AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and NTSP can be expressed as:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA_L)^2 + (APEA_L)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Minimum Required Margin (AL - NTSP) = RM = AL - NTSP

RM = AL - NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

RM = AL - NTSP = 3.08 % RTP

7.5.2.3 Minimum Required Margin (AV to NTSP) Evaluation

RM = AV to NTSP =
Minimum Required Margin (AL to NTSP) - Minimum Required Margin (AL to AV)

RM = AV to NTSP = 3.08 % RTP – 2.69 % RTP
RM = AV to NTSP = 0.39 % RTP

PRNM EPU Setpoint (% RTP)	AV	NTSP	Available Margin (AV- NTSP)	Minimum Required Margin	AV Acceptable
APRM Neutron Flux - High (Setdown) Scram	20.0	18.0	2.0	0.39	Yes
APRM Neutron Flux – High (Setdown) Rod Block	15.0	13.0	2.0	0.39	Yes

Since the available margin is greater than the minimum required margin (2.0 % RTP versus 0.39 % RTP), the recommended NTSP is acceptable.

7.5.2.4 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violation of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

where n is the number of the standard deviations used (2σ).

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between NTSP and AV as specified in ESM-03.02-APP-1, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}}$$

For APRM Neutron Flux – High (Setdown) Scram setpoint:

$$Z = \frac{|(20.0 - 18.0)\%RTP|}{(0.75)\%RTP} = 2.66$$

For APRM Neutron Flux – High (Setdown) Rod Block setpoint:

$$Z = \frac{|(15.0 - 13.0)\%RTP|}{(0.75)\%RTP} = 2.66$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 18.0 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum required margin between AV and NTSP with Z of 0.81 used.

$NTSP_2$ Offset = Z x σ_{LER}
$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

APRM Neutron Flux – High (Setdown) Scram Setpoint

For APRM Neutron Flux – High (Setdown) Scram setpoint: $NTSP_2$ is calculated to provide a NTSP based on the minimum LER avoidance criteria:

$NTSP_2 \leq$ AV - $NTSP_2$ Offset
$NTSP_{2(\text{Setdown Scram})} \leq (20.0 - 0.61)$ % RTP
$NTSP_{2(\text{Setdown Scram})} \leq 19.4$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 19.4 % RTP.

Therefore, a conservative NTSP of 18.0 % RTP is used for the APRM Neutron Flux – High (Setdown) Scram setpoint.

APRM Neutron Flux – High (Setdown) Rod Block Setpoint

For APRM Neutron Flux – High (Setdown) Rod Block setpoint:
$NTSP_2$ is calculated below to indicate margin of the recommended NTSP:

$NTSP_2 \leq$ AV - $NTSP_2$ Offset
$NTSP_{2(\text{Setdown Rod Block})} \leq (15.0 - 0.61)$ % RTP
$NTSP_{2(\text{Setdown Rod Block})} \leq 14.4$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be less than 14.4 % RTP.

Therefore, a conservative NTSP of 13.0 % RTP is used for the APRM Neutron Flux – High (Setdown) Rod Block setpoint

7.5.2.5 Spurious Trip Avoidance (STA) Test

A Spurious Trip Avoidance test is performed to assure that there is a reasonable probability that spurious trips will not occur using the selected setpoint.

Input 4.11, Section 1.2.3.4, provides the following formula for determining Spurious Trip avoidance. Input 4.13, Sections 4.5.4.b and 4.5.9.b, provides setpoint guidance to add bias term for APEA.

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2} + APEA_b$$

Where n is the number of standard deviations used (2σ).
Terms $DPEA_L$ and $DPEA_b$ were defined and evaluated in Section 7.3.1.7 for CLTP operation but also applies to EPU operation as discussed in Section 7.3.2 and 7.3.2.1. These terms are to be included in the above σ_{STA} equation as follows:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (PMA)^2 + (PEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

Using APRM terms, σ_{STA} is defined as:

$$\sigma_{STA} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (APMA)^2 + (APEA)^2 + (DPEA_L)^2} + APEA_b + DPEA_b$$

$$\sigma_{STA} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2 + (2.288)^2 + (0.268)^2 + (0.054)^2} + 0.49 + 0.33$$

σ_{STA} = 2.20 % RTP

Input 4.1, STA Section 5.6.8, states Z is equal to the following:

$$Z = \frac{|(Adjusted\_NTSP) - (Operational\_Limit)|}{\sigma_{STA}}$$

Input 4.1, Section 5.6.8, states that Adjusted NTSP is the selected setpoint minus ALT_L (more conservative). Since Adjusted NTSP is ($NTSP-ALT_L$), Z is equal to the following:

$$Z = \frac{NTSP - ALT - (Operational\_Limit)}{\sigma_{STA}}$$

Input 4.3, Section 1.1, states the Operational Limit is 11.0%

$$Z = \frac{(18.0 - 1.334 - 11.0)\%RTP}{(2.20)\%RTP}$$

Z= 2.57

As specified in Input 4.1, Section 5.6.8, Z should be equal to or greater that 1.65 for the setpoint to be adequately separated from the Operational Limit to reasonably avoid Spurious trip conditions.

Since the actual value of 2.57 is greater than the required value of 1.65, an adequate separation exists between the NTSP and the Operational Limit (OL), and the STA criterion is satisfied.

7.5.3 PRNM EPU APRM Downscale Rod Block

This section of the calculation provides the basis for the NTSP setpoint to be 3.5 % RTP. The existing CLTP and PRNM CLTP NTSP setpoints (Section 7.4.3) are also 3.5 % RTP. EPU Input 4.3, Section 1.8, indicates the recommended NTSP setpoint is 4.0 % RTP. This section shows there is sufficient margin to keep the NTSP setpoint at 3.5 % RTP. Input 4.8, Item 12, also indicates the NTSP setpoint as 4.0 % RPT for EPU. This calculation provides the design basis to keep the setpoint at 3.5 % RTP.

Input 4.3 and Input 4.8 indicate the APRM Downscale Rod Block does not have an Analytical Limit (AL) setpoint. Both Inputs state the recommended value for the Allowable Valve (AV) is 2.0 % RTP. This section will evaluate the following Setpoints:

PRNM EPU Setpoint (% RTP)	AL	AV	NTSP
APRM Downscale Rod Block	N/A	2.0	3.5

This calculation will determine the minimum required margin for AL to AV, and AL to NTSP. The difference between the minimum required margins for AL to AV, and AL to NTSP becomes the minimum required margin for AV to NTSP.

7.5.3.1 Minimum Required Margin (AL to AV) Evaluation

Input 4.11, Section 1.2.3.2, provides the following formula for calculation the AV from the AL.

$$AV \le AL - \left(\frac{1.645}{2}\right)\sqrt{(A_L)^2 + (C_L)^2 + (PMA)^2 + (PEA)^2} \pm bias$$

Minimum required margin between AL and AV can be defined by:

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2+(C_L)^2+(APMA_L)^2+(APEA_L)^2}+APEA_b$$

Minimum Required Margin (AL - AV) = RM = AL - AV

RM = AL - AV = $\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2+(1.334)^2+(2.288)^2+(0.268)^2}+(0.490)$

RM = AL - AV = 2.69 % RTP

7.5.3.2 Minimum Required Margin (AL to NTSP) Evaluation

Input 4.11, Section 1.2.3.3, provides the following formula for calculating the AV from the AL:

$$NPSP \leq AL-\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2+(C_L)^2+(D_L)^2+(PMA)^2+(PEA)^2}\pm bias$$

Minimum required margin between AL and NTSP can be defined by::

$$\left(\frac{1.645}{2}\right)\sqrt{(A_L)^2+(C_L)^2+(D_L)^2+(APMA_L)^2+(APEA_L)^2+(DPEA_L)^2}+APEA_b+DPEA_b$$

Minimum Required Margin (AL - NTSP) = RM = AL - NTSP

RM = AL - NTSP =

$$\left(\frac{1.645}{2}\right)\sqrt{(0.253)^2+(1.334)^2+(0.625)^2+(2.288)^2+(0.268)^2+(0.054)^2}+0.49+0.33$$

RM = AL - NTSP = 3.08 % RTP

7.5.3.3 Minimum Required Margin (AV to NTSP) Evaluation = RM = AV to NTSP

RM = AV to NTSP =
Minimum Required Margin (AL to NTSP) - Minimum Required Margin (AL to AV)

RM = AV to NTSP = 3.08 % RTP – 2.69 % RTP
RM = AV to NTSP = 0.39 % RTP

EPU Setpoint (% RTP)	AV	NTSP	Available Margin (AV-NTSP)	Minimum Required Margin	AV Acceptable
APRM Downscale Rod Block	2.0	3.5	1.5	0.39	Yes

Since the available margin is greater than the minimum required margin (1.5 % RTP versus 0.39 % RTP), the recommended NTSP is acceptable.

7.5.3.4 Licensee Event Report (LER) Avoidance Test

The purpose of the LER Avoidance Test is to assure that there is sufficient margin between the AV and NTSP to reasonably avoid violation of the AV.

Input 4.11, Section 1.2.3.5, provides the following formula for determining LER avoidance criteria.

$$\sigma_{LER} = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2}$$

where n is the number of the standard deviations used (2σ)

$$\sigma_{LER} = \left(\frac{1}{2}\right)\sqrt{(0.253)^2 + (1.334)^2 + (0.625)^2}$$

σ_{LER} = 0.75 % RTP

For multiple instrument channels, a Z value of greater than 0.81 provides sufficient margin between the NTSP and AV as specified in ESM-03.02-APP-I, Section 5.6.3 (Input 4.1).

In accordance with Input 4.1, Section 5.6.3, Z is defined as:

$$Z = \frac{|AV - NTSP|}{\sigma_{LER}} = \frac{|(2.0 - 3.5)|\%RTP}{(0.75)\%RTP} = 2.0$$

Since Z is greater than 0.81, sufficient margin exists between the specified AV and NTSP.

Minimum margin $NTSP_2$ will be calculated using the minimum Z value of 0.81. Minimum margin $NTSP_2$ will be compared with the current NTSP of 3.5 % RTP. This will indicate the amount of conservatism for the NTSP.

$NTSP_2$ Offset is defined as the minimum margin (% RTP) between AV and $NTSP_2$ with Z of 0.81.

$NTSP_2$ Offset = Z x σ_{LER}

$NTSP_2$ Offset = (0.81 x 0.75) % RTP = 0.61 % RTP

$NTSP_2$ is calculated to provide an NTSP based on the minimum LER avoidance criteria:
$NTSP_2 \geq AV + NTSP_2$ Offset
$NTSP_2 \geq 2.0$ % RTP + 0.61 % RTP
$NTSP_2 \geq 2.61$ % RTP

For the minimum valve of Z equal to 0.81, $NTSP_2$, which is defined as the LER Avoidance NTSP, is to be greater than 2.61 % RTP.

Therefore, a conservative APRM Downscale Rod Block NTSP setpoint of 3.5 % RTP is to be used.

8. CONCLUSIONS

The Analytical Limits (AL), Allowable Values (AV), and Nominal Trip Setpoints (NTSP), for APRM Neutron Flux High Scram, Setdown Scram, Setdown Rod Block and APRM Downscale Rod Block are listed below for EC-10856, which includes NUMAC PRNMS setpoints at CLTP and EPU conditions.

8.1 Loop Uncertainties for PRNM CLTP and EPU Operation

Term	Value	Section
A_L – Loop Instrument Accuracy	± 0.253 % RTP	7.3.1.1
D_L - Loop Instrument Drift	± 0.625 % RTP	7.3.1.2
ALT_L - Loop As-Left Tolerance for uncertainty calculations	± 1.334 % RTP	7.3.1.3
ALT_L - Loop As-Left Tolerance for PRNM electronic calibration	0.00 % RTP	7.3.1.3
AFT_L - Loop As-Found Tolerance for uncertainty calculations	± 1.334 % RTP	7.3.1.4
AFT_L - Loop As-Found Tolerance for PRNM electronic calibration	0.00 % RTP	7.3.1.4
C_L - Loop Calibration Accuracy Error	± 1.334 % RTP	7.3.1.5
$APEA_L$ - Loop APRM Primary Element Accuracy	± 0.268 % RTP	7.3.1.6
$DPEA_L$ - Loop Drift Primary Element Accuracy	± 0.054% RTP	7.3.1.7
$APMA_L$ - Loop APRM Process Measurement Accuracy	± 2.288 % RTP	7.3.1.8
$APEA_b$ – APRM Primary Element Accuracy bias	+0.49 % RTP bias	7.3.1.6
$DPEA_b$ - Drift Primary Element Accuracy bias	+ 0.33 % RTP bias	7.3.1.7

8.2 PRNM - CLTP Operation Setpoint (EC-10856)

PRNM CLTP Setpoint	Setpoint, % RTP		
	AL	AV	NTSP
APRM Neutron Flux - High Scram	125.0	122.0	119.5
APRM Neutron Flux – High (Setdown) Scram	N/A	20.0	18.0
APRM Neutron Flux – High (Setdown) Rod Block	N/A	15.0	13.0
APRM Downscale Rod Block	N/A	2.0	3.5

8.3 PRNM - EPU Operation Setpoint (EC-10856)

PRNM EPU Setpoint	Setpoint, % RTP		
	AL	AV	NTSP
APRM Neutron Flux - High Scram	125.0	122.0	119.5
APRM Neutron Flux – High (Setdown) Scram	N/A	20.0	18.0
APRM Neutron Flux – High (Setdown) Rod Block	N/A	15.0	13.0
APRM Downscale Rod Block	N/A	2.0	3.5

9. FUTURE NEEDS

This calculation impacts the following documents, which are listed in EC-10856:

9.1 Calculation CA-05-153, Rev 0, *Instrument Setpoint Calculation - APRM Downscale CR Block*, calculated the APRM Downscale CR Block NTSP setpoint of 3.5 % RTP for ITS and CLTP operation. PRNM CLTP operation does not change this setpoint. For PRNM EPU operation, NTSP setpoint of 3.5 % RTP has also been evaluated in accordance with Section 7.5.3. CA-05-153 will be superseded when PRNM retrofit is installed because the PRNM uncertainties are used as the basis for the APRM Downscale Rod Block setpoint. GAR 01146760 was initiated to track calculation CA-05-0153 be superseded due to EC 10856.

9.2 Calculation CA-96-224, Rev 1, *Instrument Setpoint calculation - APRM Flow-Biased Upscale Scram and Rod Block*, includes the APRM Flow-Referenced Neutron Flux - High High setpoint. PRNM changes this setpoint to non-flow bias APRM Neutron Flux High. The current setpoint of 0.66W + 67.6 % RTP clamped at 122 % RTP is being changed to 122 % RTP. This applies to PRNM CLTP and EPU operation. GAR 01146761 was initiated to track calculation CA-96-224 be superseded due to EC 10856.

9.3 Procedure C.6-005-A-03, Rev 1, *Rod Withdraw Block*. This is the annunciator procedure for window 5-A-3. PRNMS adds a new rod withdraw block setpoint: APRM Neutron Flux – High (Setdown) Rod Block. Sections 7.4.2 and 7.5.2 evaluate the setpoint. This annunciator procedure will be changed to add the new rod withdraw block setpoint. PCR 01146750 has been initiated to track changes to C.6-005-A-03 due to EC 10856 PRNM retrofit.

9.4 Procedure C.6-005-A-06, Rev 3, *APRM Downscale*, states a NTSP setpoint of 3.5 % RTP. This is correct for the present neutron monitoring system. Even though the PRNM CLTP and EPU operation NTSP setpoints are 3.5 % RTP, the procedure does not address that the PRNM retrofit NTSP setpoints remain the same for APRM Downscale Rod Block. PCR 01146778 was initiated to revise C.6-005-A-03, Rev 1, when EC 10856 PRNM retrofit is installed.

9.5 Procedure C.6-005-A-22, Rev 3, *APRM Hi Hi INOP CH 1, 2, 3*, is a flow-bias APRM Neutron Flux Hi Hi setpoint. PRNM retrofit converts this setpoint to a non-flow bias APRM Neutron Flux High setpoint. The PRNM APRM Neutron Flux High setpoint is part of this calculation. C.6-005-A-22 will be revised under EC-10856 and PCR 01129100.

9.6 Procedure C.6-005-A-30, Rev 3, *APRM Hi Hi INOP CH 4, 5, 6*, is a flow-bias APRM Neutron Flux Hi Hi setpoint. PRNM retrofit converts this setpoint to a non-flow bias APRM Neutron Flux High setpoint. The PRNM APRM Neutron Flux High setpoint is part of this calculation. C.6-005-A-30 will be revised under EC-10856 and PCR 01133816.

9.7 Procedure B.05.06-02, Rev 18, *Operations Manual Section - Plant Protection System*, specifies APRM Hi Hi and APRM Downscale and other setpoints. This calculation evaluates the APRM Downscale Rod Block setpoints and documents the PRNM EPU change in this setpoint. The APRM Hi Hi setpoint is flow biased and is PRNM changes this setpoint to non-flow bias APRM Neutron Flux High. B.05.06-02 will be revised under EC-10856 and PCR 01133455.

9.8 Procedure B.05.01.02-02, Rev 6, *Operations Manual Section - Power Range Neutron Monitoring*, specifies NMS trip setpoints, which are being changed due to PRNMS. B.05.01.02-02 will be revised under EC-10856 and PCR 01137808.

9.9 B.05.01.02-05, Rev 16, Operations Manual Section – Power Range Neutron Monitoring, System Operation. B.05.01.02-05, Rev 16 refers to the six APRM channels, which applies to the existing NMS. PRNMS has four APRM channels as stated is Section 7.2.2.1 of this calculation. PCR 01146778 issued to revise B.05.01.02-05, Rev 16, upon implementation of EC 10856.

9.10 DBD B5.1, Rev C, *Design Bases Document for Neutron Monitoring System*, discusses NMS setpoints, margin, uncertainty parameters such as drift, etc. This calculation validated certain NMS setpoints using the PRNM parameter uncertainties specified in GE documentation. DBD B5.1 will be revised under EC 10856. GAR 1138038 tracks revision to DBD B5.1 for EC 10856 PRNM setpoint changes.

9.11 *MNGP Technical Specification*, Amendment 155, Table 3.3.1.1-1, for APRM Flow Referenced Neutron Flux High High is replaced by PRNM APRM Neutron Flux High. New setpoint PRNM Neutron Flux-High (Setdown) is added. APRM Downscale Rod Block is being removed from Tech Specs when PRNM retrofit is installed. GAR 01146762 was initiated to track changes to the Technical Specifications due to EC 10856.

9.12 *MNGP Technical Specifications Bases*, Rev 8, Bases will be revised to discuss the PRNM APRM Neutron Flux High setpoint, which is non-flow bias, in place of the existing Flow Referenced Neutron Flux-High High setpoint. PRNM Neutron Flux-High (Setdown) setpoint to being added. GAR 01146763 has been initiated to track changes to the Technical Specification Bases due to EC 10856.

9.13 *MNGP Technical Requirements Manual* (TRM), Rev 2, New PRNM Setdown Rod Block setpoint is to be discussed in the TRM. The APRM Downscale Rod Block setpoint is being removed from the Tech Specs and will be added to the TRM. APRM Downscale Rod Block setpoint is the same for CLTP and EPU. This calculation provides the design basis for the EPU APRM Downscale Rod Block NTSP setpoint because the GEH Input documents have a slightly different value. LAR 01128839 has been initiated to track PRNM setpoint changes to the TRM due to EC 10856.

9.14 Procedure 8211, Rev 2, *APRM Calibration Readjustment for Single Loop*, discusses APRM setpoint voltage adjustments including Downscale Rod Block, Hi-Hi Scram, etc. Changes have been made by PRNM and this calculation evaluates the non-flow biased PRNM setpoints. Procedure 8211 will be deleted under EC-10856, PCR 01133437. SLO operation will be enabled under Operations procedure in B.05.01.02-05. PCR 1133449 has been initiated to track these procedure changes.

9.15 Procedure 8212, Rev 2, *APRM Calibration Readjustment for Two Loop*, discusses APRM setpoint voltage adjustments including Downscale Rod Block, Hi-Hi Scram, etc. Changes have been made by PRNM and this calculation evaluates the non-flow biased PRNM setpoints. Procedure 8212 will be deleted under EC-10856, PCR 01133445. TLO operation will be enabled under Operations procedure in B.05.01.02-05. PCR 1133449 has been initiated to track these procedure changes.

9.16 Procedure 0012, *APRM/Flow Reference Scram Functional Check*, performs the calibration of the APRM including the Neutron Flux High Scram, Setdown Scram, Setdown Rod Block, and Downscale Rod Block setpoints. Setpoints are revised as a result of this calculation. 0012 will be deleted under EC-10856, PCR 01133332. Procedures ISP-NIP-0588, ISP-NIP-0589-01, ISP-NIP-0589-02 will be developed to replace 0012. APRM Calibration will be created under EC-10856. PCR 01129124 has been initiated to track these procedure changes.

APRM Neutron Flux - High Scram – CLTP and EPU Operation

		% RTP		
		125.0	AL	
	LER Avoidance	122.0	AV	
		121.4	$NTSP_2$	
See Note 1	As Found/ As Left Tolerance	120.8	As Found/As Left	
		119.5	NTSP	ALT = AFT ± 1.34%
		118.2	As Found/As Left	

APRM Neutron Flux (Setdown) Scram for CLTP and EPU Operation

		% RTP		
		n/a	AL	
	LER Avoidance	20.0	AV	
		19.4	$NTSP_2$	
See Note 1	As Found/ As Left Tolerance	19.3	As Found/As Left	
		18.0	NTSP	ALT = AFT ± 1.34%
		16.7	As Found/As Left	

APRM Neutron Flux (Setdown) Rod Block – CLTP and EPU Operation

	% RTP		
	n/a	AL	
	15.0	AV	
	14.3	As Found/As Left	
See Note 1 As Found/ As Left Tolerance	13.0	NTSP	ALT = AFT ± 1.34 %
	11.7	As Found/As Left	

APRM Downscale Rod Block – CLTP and EPU Operation

	% RTP		
	4.8	As Found/As Left	
See Note 1 As Found/ As Left Tolerance	3.5	NTSP	ALT = AFT ± 1.34 %
	2.2	As Found/As Left	
LER Avoidance	2.61	$NTSP_2$	
	2.0	AV	
	n/a	AL	

Note 1: The As-Left and As-Found uncertainty tolerances are specified as 1.34 % RTP because GEH Inputs 4.2 and 4.3 state tolerance of 2 % RTP, 3σ. Converting AFT/ALT to 2σ confidence level results in 1.34 % RTP.. However, AFT/ALT tolerances are 0.00 % RTP when used for PRNM surveillance calibration. PRNMS is a digital system and the setpoint is a single number in the database not susceptible to drift. Sections 7.3.1.3 and 7.3.1.4 evaluate the uncertainty and calibration tolerances for AFT and ALT.