Dominion

Technical Report Cover Sheet
EE-0116, Rev. 8
NDCM-3.11 Attachment 1

TECHNICAL REPORT No. EE-0116, REVISION 8

ALLOWABLE VALUES FOR NORTH ANNA IMPROVED TECHNICAL SPECIFICATIONS (ITS) TABLES 3.3.1-1 AND 3.3.2-1, SETTING LIMITS FOR SURRY CUSTOM TECHNICAL SPECIFICATIONS (CTS), SECTIONS 2.3 AND 3.7, AND ALLOWABLE VALUES FOR KEWAUNEE POWER STATION IMPROVED TECHNICAL SPECIFICATIONS (ITS) FUNCTIONS LISTED IN SPECIFICATION 5.5.16

NORTH ANNA POWER STATION, SURRY POWER STATION, AND KEWAUNEE POWER STATION

CORPORATE ELECTRICAL/I&C/COMPUTERS
DOMINION NUCLEAR ENGINEERING

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Record of Revision

Rev 0 Original Issue.

Rev 1

1 Changed the calculation of the Allowable Values for North Anna's High Steam Flow in 2/3 Steam Lines ESFAS initiation on Page 23. The revised Allowable Values are based on using only 1 Rack Drift (RD) term for the function. This change yields more conservative Allowable Values.

2. Changed the calculation of the Allowable Values for Surry's High Steam Flow in 2/3 Steam Lines ESFAS initiation on Pages 29 and 30. The revised Allowable Values are based on using only 1 Rack Drift (RD) term for the function. This change yields more conservative Allowable Values.

3. Changed the Allowable Values and verbiage on Page 42 for the North Anna High Steam Flow in 2/3 Steam Lines ESFAS initiation.

4. Deleted the Allowable Values for the enable manual block of Safety Injection for North Anna Permissives P-11 and P-12 and revised the verbiage accordingly on Page 47.

5. Changed the Allowable Values and verbiage on Page 56 for the Surry High Steam Flow in 2/3 Steam Lines ESFAS initiation.

6. Deleted the Allowable Values for the enable manual block of Safety Injection for Surry Permissives P-11 and P-12 and revised the verbiage accordingly on Page 63.

Rev 2

1. Page 16 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span in Figure 3.2-5 to obtain a more conservative Allowable Value for the OTΔT Reactor Trip Setpoint.

2. Page 18 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span to be consistent with Calculation EE-0415. This change yields a more conservative Allowable Value for the OTΔT Reactor Trip Setpoint.

3. Page 24 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span in Figure 3.3-2 to obtain a more conservative Allowable Value for the OTΔT Reactor Trip Setpoint.

4. Page 25 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span to be consistent with Calculation EE-0434. This change yields a more conservative Allowable Value for the OTΔT Reactor Trip Setpoint.

5. Pages 25 and 26 – Revised calculations shown in Methods 1a through 2b based on Rack Drift Term RD_4 = 0.0 % span.

6. Page 31 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span in Figure 3.3-4 to obtain a more conservative Allowable Value for the OPΔT Reactor Trip Setpoint.

7. Page 32 - Changed Rack Drift term RD_4 from 1.0 % span to 0.0 % span to be consistent with Calculation EE-0415. This change yields a more conservative Allowable Value for the OPΔT Reactor Trip Setpoint. The Allowable Value calculation shown on Page 32 was revised based on RD_3 = 0.0 % span.

8. Pages 34 and 35 – Revised NAPS OTΔT Reactor Trip Allowable Value and associated verbiage in Item 4.1.8.

9. Page 47 – Added another Allowable Value for NAPS Permissive P-12 and revised associated verbiage in Item 4.2.38.

10. Page 49 – Revised SPS OTΔT Reactor Trip Allowable Value and associated verbiage in Item 4.3.6.

11. Page 49 – Revised verbiage associated with the SPS OPΔT Reactor Trip Allowable Value in Item 4.3.7.

12. Page 63 - Added another Allowable Value for SPS Permissive P-12 and revised associated verbiage in Item 4.4.42.

Rev 3 Revision 3 to this Technical Report is a major revision. The Allowable Values for North Anna's ITS and the Setting Limits for Surry's CTS are derived and based on Methods 1 or 2 as described in Part II of ISA-RP67.04.02-2000. This revision will require a complete review from cover to cover. This Technical Report will be used as the design basis for Technical Specifications Change Request 318 at Surry Power Station. In addition, this Technical Report will also be used as the design input for a future Technical Specifications Change Request for North Anna to change selected Allowable Values as noted in this report. In accordance with NDCM 3.11 the "Required Actions" and "Tracking Mechanism" will be documented in Engineering Transmittal ET-CEE-06-0020, Rev. 0 "Transmittal of CDS and PRC for Technical Report EE-0116, Rev. 3". In addition, the results of Technical Report EE-0116, Rev. 3 will be screened as part of ET-CEE-06-0020, rev. 0 and will not be repeated herein.

Rev 4

1. Page 5 - Added Cot or Non-Cot to the error terms in Table 2.1.

2. Page 9 – Changed the wording under item 3 to reflect that some Allowable Values have been rounded as per discussions with the NRC and Surry TSCR 318.

3. Page 13 – Changed the Rack Error Terms for M1MTE and M5MTE due to the revised CSA calculation EE-0063.

4. Page 33 - Changed the Power Range Neutron Flux High Setpoint Reactor Trip due to the revised CSA calculation EE-0063.

5. Page 34 - Changed Figure 4.1.2 for the Power Range Neutron Flux High Reactor Trip and changed the Power Range Neutron Flux Low Setpoint Reactor Trip due to the revised CSA calculation EE-0063.

6. Page 35 – Changed Figure 4.1.3 for the Power Range Neutron Flux Low Setpoint Reactor Trip due to the revised CSA calculation EE-0063.

7. Page 45 – Changed the Pressurizer High Pressure Reactor Trip due to the Safety Analysis Limit being changed from 2381.3 PSIG to 2391.3 PSIG based on ET-NAF-08-0061.

8. Page 47 – Changed Figure 4.1.10 for the Pressurizer High Pressure Reactor Trip due to the Safety Analysis Limit being changed from 2381.3 PSIG to 2391.3 PSIG based on ET-NAF-08-0061.

9. Page 48 – Changed the Reactor Coolant Flow Low Reactor trip due to the revised CSA calculation EE-0060.

10. Page 49 – Changed Figure 4.1.12 for Low Reactor Coolant Flow Reactor Trip due to the revision of CSA calculation EE-0060.

11. Page 53 – Changed the Permissive P-8, Power Range Neutron Flux due to the revised CSA calculation EE-0063.

12. Page 54 – Changed Figure 4.1.24 for the Power Range Reactor Trip Permissive P-8 due to the revised CSA calculation EE-0063.

13. Page 57 – Changed Figure 4.2.3 for Containment Pressure HI-1 ESFAS Initiation due to the revised Containment Partial Pressure operating Limits per Technical Report NE-1472, Revision 0.

14. Page 62 – Changed the T_{AVG} Low-Low ESFAS Initiation due to the revised CSA calculation EE-0434.

15. Page 64 – Changed Figure 4.2.7 for T_{AVG} Low Low ESFAS Initiation due to the revised CSA calculation EE-0434.

16. Page 68 – Changed Figure 4.2.11 for Containment Pressure HI-3 ESFAS Initiation due to the revised Containment Partial Pressure operating Limits per Technical Report NE-1472, Revision 0.

17. Page 71 – Changed Figure 4.2.20 for Containment Pressure HI-2 ESFAS Initiation due to the revised Containment Partial Pressure operating Limits per Technical Report NE-1472, Revision 0.

18. Page 75 – Deleted the Analysis for $\geq$ 19.0 % Wide Range Level and the Analysis for $\leq$ 20.0 Wide Range Level for the Refueling Water Storage Tank Level – Low Low. With the implementation of DCP 06-013 and 06- 015 these analysis are no longer valid.

19. Page 77 – Deleted Figure 4.2.34a. This Figure is no longer applicable with the implementation of DCP 06-013 and 06-015. Changed Figure number to 4.2.34.

20. Page 78 – Changed the T_{AVG}, P-12 ESFAS Permissive due to the revised CSA calculation EE-0434.

21. Page 79 – Changed Figure 4.2.38 for ESFAS Permissive P-12 due to the revised CSA calculation EE-0434.

22. Page 103 – Incorporated Addendum 1 for the Turbine First Stage Pressure Input to Permissive P-7.

23. Page 106 – Changed the word “or” to “and” for Permissive P-10, Power Range Neutron Flux.

24. Page 107 – Changed the Containment Pressure – High, Engineered Safety Features Actuation System (EFAS) Instrumentation Setting Limits due to the revised Safety Analysis Limits in Technical Report NE-0994, Revision 15.

25. Page 108 – Changed Figure 4.4.2 for the new Safety Analysis Limit from Technical Report EE-0994, Revision 15 and updated operating limits per Technical Report NE-1460, Revision 1.

26. Page 119 – Determined the Voltage and Time corresponding to the new Allowable Value for Low Intake Canal Level.

27. Page 122 – Changed the Refueling Water Storage Tank Level Low – Low RMT Initiation, EFAS Instrumentation Setting Limits due to the revised Safety Analysis Limits in Technical Report NE-0994, Revision 14.

28. Page 124 – Changed Figure 4.4.12 due to the revised Safety Analysis Limit in technical Report NE-0994, Revision 14.

29. Page 128 – Changed References 5.1, 5.2, and 5.15 to reflect the current revision.

30. Page 129 – Changed References 5.18, 5.21, 5.23, 5.26, 5.27, 5.33 to reflect the current revision.

31. Page 130- Changed References 5.35, 5.36, 5.40, 5.41, 5.44 through 5.62 to reflect the current revision.

32. Page 132 – Changed References 5.63 through 5.65 and 5.67 through 5.69 to reflect the current revision. Deleted Reference 5.77.

33. Page 133 – Changed References 5.80 through 5.82 to reflect the current revision. Added Reference 5.88, ET-NAF-08-0061, Rev. 0 "Implementation of Revised Safety Analysis Limit for High Pressurizer Pressure Reactor Trip, North Anna Units 1 and 2".

Rev. 5 Revision 5 to this Technical Report is a major revision. Kewaunee Power Station's Setpoint Control Program has been added to the report to support Kewaunee's conversion to Improved Technical Specifications (ITS).

1. Page 3 – Added Kewaunee's Setpoint Control Program to Section 1.1, Purpose.

2. Page 3 – Added Kewaunee LCO's 3.3.1, 3.3.2, 3.3.5, 3.3.6, and 3.3.7 to Section 1.2, Scope.

3. Page 4 – Added and updated definitions in Section 2.1 to reflect Kewaunee's Setpoint Control Program and the adoption of TSTF-493, Rev. 4, Option B.

4. Page 5 – Added and updated definitions in Section 2.1 to reflect Kewaunee's Setpoint Control Program and the requirements from TSTF-493, Rev. 4 and RIS 2006-17.

5. Page 9 – Updated Section 2.2.2 to reflect current conditions for North Anna and Surry. Also, a discussion for Kewaunee was added to address the Setpoint Control Program.

6. Page 10 – Added a discussion in Sections 2.2.2 and 2.2.3 pertaining to the issuance of RIS 2006-17.

7. Page 11 – Added a discussion in Section 2.2.4 pertaining to the issuance of TSTF-493, Rev. 4.

8. Pages 12 and 13 – Added Section 2.2.6 to address Kewaunee's adoption of TSTF-493, Rev. 4, Option B.

9. Page 14 – Added Kewaunee to the discussion in Sections 3.1 and 3.2.

10. Page 15 – Updated information to reflect current conditions for North Anna and Surry and to add Kewaunee's Setpoint Control Program nomenclature.

11. Page 18 - Updated information to reflect current conditions for Surry.

12. Page 19 – Added discussion for Kewaunee's Protection and Control System.

13. Page 20 - Continued discussion of Kewaunee's Protection and Control System and updated information to reflect current conditions for North Anna.

14. Pages 21, 22, and 23 – Revised the Multiple Parameter Protection Functions discussion to evaluate Kewaunee's OTΔT instead of Surry's.

15. Page 24 - Added Kewaunee in the Notes section where applicable.

16. Pages 39 Through 45 - Added Section 3.5 to describe Kewaunee's Setpoint Methodology.

17. Page 65 – Revised wording of the Allowable Value for North Anna's Steam Flow Feed Flow Mismatch Reactor Trip.

18. Pages 74 through 76 – Revised North Anna's High Steam Flow ESFAS analysis to reflect the results of Calculation EE-0736, Rev. 5 and to reflect conditions at 20 % power.

19. Page 91 and 92 – Added the analysis for North Anna's RWST Low Level ESFAS function based on DCP 59-DCP-06-013 and DCP 59-DCP-06-015.

20. Pages 104 through 107 – Corrected error in Surry's OTΔT analysis. There is no change to the current LSSS and there is still positive margin to the Safety Analysis Limit for the three conditions analyzed.

21. Page 118 – Corrected error in the description of the operation of P-7 and P-10.

22. Page 129 and 130 – Updated Surry's High Steam Flow ESFAS analysis based on unit specific "P_{REF}" values and to reflect conditions at 20 % power.

23. Pages 143 through 169 – Added Section 4.5 to perform the setpoint analysis for Kewaunee's Reactor Protection System (LCO 3.3.1) to support the Setpoint Control Program.

24. Pages 170 through 185 – Added Section 4.6 to perform the setpoint analysis for Kewaunee's Engineered Safety Features Actuation System (LCO 3.3.2) to support the Setpoint Control Program.

25. Pages 186 through 190 – Added Section 4.7 to perform the setpoint analysis for Kewaunee's Loss of Offsite Power (LOOP) Diesel Generator (DG) Start Instrumentation (LCO 3.3.5), Containment Purge and Vent Isolation Instrumentation (LCO 3.3.6), and Control Room Post Accident Recirculation (CRPAR) Actuation Instrumentation (LCO 3.3.7) to support the Setpoint Control Program.

26. Pages 191 through 199 – Updated references for North Anna and Surry and added references for Kewaunee to support the analyses performed in Sections 4.5 through 4.7.

Rev. 6

1. General Change – Deleted Reference 5.2 from all analyzed RPS/RTS and ESFAS functions for North Anna and Surry in Sections 4.1 through 4.4.

2. Updated Section 4.3.7 to note that the Pressurizer Low Pressure Reactor Trip Allowable Value and Nominal Trip Setpoint was changed based on Reference 5.139.

3. Updated Section 4.3.18 to note that the Permissive P-7, Block Low Power Trips Allowable Value and Nominal Trip Setpoint was changed based on Reference 5.139.

4. Updated Section 4.4.4 to note that the Pressurizer Pressure Low-Low ESFAS Function Allowable Value and Nominal Trip Setpoint was changed based on Reference 5.139.

5. Revised Section 4.5.3 to change the analysis for the Power Range Neutron Flux High Positive Rate Reactor Trip to allow the currently installed Nominal Trip Setpoint and Rate Lag Derivative Time Constant to remain in place for the ITS conversion.

6. Revised Section 4.5.4 to change the analysis for the Power Range Neutron Flux High Negative Rate Reactor Trip to allow the currently installed Nominal Trip Setpoint and Rate Lag Derivative Time Constant to remain in place for the ITS conversion.

7. Revised Section 4.5.6 to base the Source Range Neutron Flux High Reactor Trip analysis on a process range of 0 to 5.301 Decades versus 0 to 6 Decades.

8. Revised Section 4.6.6 High Steam Flow Coincident with Safety Injection and Coincident with T_{AVG} Low-Low to allow the Nominal Trip Set point to be changed from $0.494 * 10^6$ lbs/hr to $0.75 * 10^6$ lbs/hr.

9. Added Section 4.7.7 to address the inclusion of the Turbine Building Service Water Header Isolation Function in ITS Table 3.3.2-1.

10. Added References 5.136 through 5.142 to support the some of the changes described above.

Rev. 7

1. Changed the title in Sections 4.5.15 and 4.6.10 to Steam Generator Low Low Level Reactor Trip / Auxiliary Feedwater Initiation.

2. Added Section 4.5.18 to address the inclusion of the Turbine Trip Low Fluid Oil Pressure function in ITS Table 3.3.1-1.

3. Re-numbered Sections 4.5.18 through 4.5.23.

4. Added Reference 5.144 to support the changes associated with Section 4.5.18.

Rev. 8

1. Revised Section 4.6.9 and Figure 4.6.9 to reflect the Analytical Limit for Kewaunee's Steam Line Pressure Low ESFAS Initiation based on Technical Report NE-0994, Rev. 17 and Engineering Technical Evaluation ETE-NAF-20100075-0-0.

2. Added Reference 5.145 to support the revision to Section 4.6.9.

3. The 50.59/72.48 Screen for the changes that have been made to Section 4.6.9 is contained in ETE-NAF-20100075-0-0 (Reference 5.145). Any required document and/or program updates based on this revision will also be addressed in ETE-NAF-20100075-0-0.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide a comprehensive and controlled reference which details the design basis for the Allowable Values that appear in North Anna Power Station Improved Technical Specifications (ITS), Kewaunee Power Station Setpoint Control Program, and the LSSS/Setting Limit Values that appear in Surry Power Station Custom Technical Specifications (CTS).

1.2 Scope

- This document provides the basis for the Allowable Values to be used in North Anna Power Station Improved Technical Specifications, Table 3.3.1-1, Reactor Trip System Instrumentation (NAPS).

- This document provides the basis for the Allowable Values to be used in North Anna Power Station Improved Technical Specifications, Table 3.3.2-1, Engineered Safety Feature Actuation System Instrumentation (NAPS).

- This document provides the basis for the Limiting Safety System Settings (LSSS) to be used in Surry Power Station Custom Technical Specifications, Section 2.3, Limiting Safety System Settings, Protective Instrumentation.

- This document provides the basis for the Setting Limit Values to be used in Surry Power Station Custom Technical Specifications, Table 3.7-4, Engineered Safety Feature System Initiation Limits Instrument Setting and Table 3.7-2, Engineered Safeguards Action Instrument Operating Conditions.

- This document provides the basis for the Reactor Protection System (RPS) Instrumentation (LCO 3.3.1) Limiting Trip Setpoints, Nominal Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances to be used in Kewaunee Power Station's Setpoint Control Program to support the conversion to Improved Technical Specifications.

- This document provides the basis for the Engineered Safety Features Actuation System (ESFAS) Instrumentation Functions (LCO 3.3.2) Limiting Trip Setpoints, Nominal Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances to be used in Kewaunee Power Station's Setpoint Control Program to support the conversion to Improved Technical Specifications.

- This document provides the basis for the Loss of Offsite Power (LOOP) Diesel Generator (DG) Start Instrumentation (LCO 3.3.5) Limiting Trip Setpoints, Nominal Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances to be used in Kewaunee Power Station's Setpoint Control Program to support the conversion to Improved Technical Specifications.

- This document provides the basis for the Containment Purge and Vent Isolation Instrumentation (LCO 3.3.6) and the Control Room Post Accident Recirculation (CRPAR) Actuation Instrumentation (LCO 3.3.7) As Found and As Left Tolerances to be used in Kewaunee Power Station's Setpoint Control Program to support the conversion to Improved Technical Specifications.

2.0 OVERVIEW

2.1 Definitions

Accuracy - A degree of conformity of an indicated value to a recognized, accepted standard value or ideal value.

Allowable Value (AV) - is the threshold value used to determine channel operability during the performance of channel functional tests and channel calibrations. The AV is the limiting as found setting for the channel trip setpoint that accounts for all of the NON-COT error components from the CSA Calculation in accordance with Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994.

Analytical Limit (AL) - The setpoint value assumed in the Safety Analysis. In the context of this document, the Analytical Limit is the same as the Safety Analysis Limit (SAL).

As Found Tolerance (AFT) – For Surry and North Anna, the As Found Tolerance is equal to the Allowable Value or Limiting Safety System Setting (LSSS)/Setting Limit listed in Technical Specifications. For Kewaunee, the As Found Tolerance is equal to the statistical combination of the rack error components and rack drift.

As Left Tolerance (ALT) – is not applicable for Surry and North Anna. For Kewaunee the As Left Tolerance is equal to the statistical combination of the rack error components minus the rack drift.

Calibrated Range – The calibration span of the sensor/transmitter as it applies to the indicated process range of the loop/system.

Channel Statistical Allowance (CSA) - The total instrument loop uncertainty (usually expressed in percent of instrument span) where non-interactive error components are combined statistically and interactive error components are summed arithmetically in accordance with Dominion Standard STD-EEN-0304 (Ref. 5.5). The generic CSA equation and a summary of error terms are provided below in Table 2.1.

Channel Operational Test (COT) - A COT shall be the injection of a simulated or actual signal into the channel as close to the sensor as practicable to verify OPERABILITY of all devices in the channel required for channel OPERABILITY. The COT shall include adjustments, as necessary, of the required alarm, interlock, and trip setpoints required for channel OPERABILITY such that the setpoints are within the necessary range and accuracy. The COT may be performed by means of any series of sequential, overlapping, or total channel steps. In the context of this document, the Channel Operational Test is the same as a Channel Periodic Test or Channel Functional Test.

Instrument Loop - An arrangement or chain of modules or components as required to generate one or more protective/control signals and/or provide indication and recording functions. An Instrument Loop normally includes the following five elements; the process, a transmitter/sensor, process electronics, indications and/or automatic control elements.

Limiting Safety System Setting (LSSS) – The LSSS is a term used in the Surry Power Station CTS to define the threshold value used to determine channel operability during the performance of channel functional tests and channel calibrations. In the context of this document, the CTS LSSS or Setting Limit used for Surry Power Station is equivalent to the ITS Allowable Value used for North Anna Power Station and the As Found Tolerance for Kewaunee.

Limiting Trip Setpoint (LTSP) – Based on RIS 2006-17 and TSTF-493, Rev. 4, the LTSP is the limiting setting for the channel trip setpoint considering all credible instrument errors associated with the instrument channel (Refs. 5.99 and 5.100).

Margin - The resultant value when the Channel Statistical Allowance (CSA) value is subtracted from the Total Allowance Value (usually expressed in percent of span or the process/signal values corresponding to these).

Module - A generic term for a Westinghouse Nuclear Instrumentation Module, Westinghouse 7300 Series PC Card, Foxboro Module, NUS Module, or a Westinghouse/Hagan 7100 Electronic Module.

Nominal Trip Setpoint (NTSP) - The desired setpoint for the variable. Initial calibration and subsequent re-calibrations should be made at the Nominal Trip Setpoint value specified in approved plant documentation. According to RIS 2006-17 and TSTF-493, Rev. 4 (Refs. 5.99 and 5.100), the NTSP is the Limiting Trip Setpoint with margin added. The NTSP is always equal to or more conservative than the LTSP.

Operating Margin - The difference between the nominal operating value for the process parameter and the most limiting trip/alarm setpoint/control limit (usually expressed in percent of span or the process/signal values corresponding to these).

Process Range - The upper and lower limits of the operating region for a device, e.g., for a Pressurizer Pressure Transmitter, 0 to 3000 PSIG, for Steam Generator Level, 0 to 100 % Level. This is not necessarily the calibrated range of the device, e.g., for the Pressurizer Pressure Transmitter, the typical calibrated range is 1700 to 2500 PSIG.

Rack Error Components - These are the error terms associated with the process modules that are used to develop a Channel Statistical Allowance (CSA) value for a particular trip/alarm function. These rack error components are the calibration tolerances associated with the process modules for a module calibration (M1, M2 ... Mn) or (RCA & RCSA) for string calibration and an uncertainty value to account for Rack Drift (RD). These rack error components are combined statistically to determine the maximum allowable error which, ideally, should be used to determine the Allowable Value/LSSS/Setting Limit.

Safety Analysis Limit (SAL) - The setpoint value assumed in the Safety Analysis. In the context of this document, the Safety Analysis Limit is equivalent to the Analytical Limit (AL).

Span - The difference between the upper and lower range values of a process parameter or the signal values corresponding to these.

Tolerance - The allowable deviation from an ideal calculated value.

Total Allowance - The difference between the Nominal Trip Setpoint and the Safety Analysis Limit (usually expressed in percent of span or the process/signal values corresponding to these).

Total Loop Uncertainty (TLU) – In the context of this document, the TLU is equivalent to the Channel Statistical Allowance (CSA). A summary of TLU/CSA error terms is provided in Table 2.1 below.

Table 2.1: Channel Statistical Allowance (CSA) Equation and Error Term Definitions	
$$CSA = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + (M1+M1MTE)^2 + (M2+M2MTE)^2 + \ldots + (Mn+MnMTE)^2 + RD^2 + RTE^2 + RRA^2]^{1/2}$$	
Systematic Error (SE) (NON-COT)	Systematic Error is treated as a bias (unidirectional) and is always placed outside of the radical. Examples of Systematic Error are transmitter reference leg heatup, uncorrected Sensor Pressure Effects (SPE) and the SG Mid Deck Plate bias.
Environmental Allowance (EA) (NON-COT)	Environmental Allowance is normally associated with instrument loop sensors and equipment that is subjected to a HARSH environment during DBE and/or PDBE conditions. EA is made up of Insulation Resistance (IR) Effects, Radiation Effects (RE), Steam Pressure Temperature Effects (SPTE) and Seismic Mounting Effects (SME).
Process Measurement Accuracy (PMA) (NON-COT)	Process Measurement Accuracy is an allowance for non-instrument related effects that directly influence the accuracy of the instrument loop. Examples of PMA are fluid stratification effects on temperature measurement and the effects of fluid density changes on level measurement.
Primary Element Accuracy (PEA) (NON-COT)	Primary Element Accuracy is an allowance for the inaccuracies of the system element that quantitatively converts the measured variable energy into a form suitable for measurement.
Sensor Calibration Accuracy (SCA) (NON-COT)	Sensor Calibration Accuracy is a number or quantity that defines a limit that errors will not exceed when a sensor is used under specified operating conditions, i.e., the calibration accuracy of the sensor.
Sensor Measuring & Test Equipment (SMTE) (NON-COT)	Sensor Measuring & Test Equipment is associated with the accuracy of the Measuring and Test Equipment (M&TE) used to calibrate the loop sensor(s). Examples of SMTE are Test Gauges and Digital Multimeters (DMM).
Sensor Drift (SD) (NON-COT)	Sensor Drift is an allowance for the change in the input versus output relationship of the sensor over a period of time under specified reference operating conditions.
Sensor Pressure Effects (SPE) (NON-COT)	Sensor Pressure Effects are allowances for the steady-state pressure applied to a device. Normally, SPE applies only for differential pressure devices and is associated with the change in input-output relationship due to a change in static pressure. SPE is divided into two terms, Static Pressure Zero Effect (SPZE) and Static Pressure Span Effect (SPSE).
Sensor Temperature Effects (STE) (NON-COT)	Sensor Temperature Effect is an allowance for the effects of changes in the ambient temperature surrounding the sensor.
Sensor Power Supply Effect (SPSE) (NON-COT)	Sensor Power Supply Effect is an allowance for the effects of changes in the power supply voltage applied to the sensor.
Module Calibration Accuracy (M1 through Mn) (COT)	Module M1 to Mn is an Allowance for the accuracy of an assembly of interconnected components that constitute an identifiable device, instrument, or piece of equipment. A module can be disconnected, removed as a unit and replaced with a spare. It has definable performance characteristics that permit it to be tested as a unit.
Module Measuring & Test Equipment (MnMTE) (NON-COT)	Module Measuring & Test Equipment is associated with the accuracy of the Measuring and Test Equipment (M&TE) used to calibrate the loop module(s). Examples of MnMTE are Decade Boxes, Digital Multimeters (DMM), Test Point Resistors (TPR), Oscilloscopes and Recorders.
Rack Drift (RD) (COT)	Rack Drift is an allowance for the change in the input versus output relationship of the Rack Modules (M1 through Mn) over a period of time under specified reference operating conditions.
Rack Temperature Effect (RTE) (NON-COT)	Sensor Temperature Effect is an allowance for the effects of changes in the ambient temperature surrounding the Process Racks.
Rack Readability Allowance (RRA) (N/A)	Rack Readability Allowance is an allowance for the inability to read analog indicators because of parallax distortion.

2.2 The Significance of the Allowable Value

2.2.1 Background

Historically, for plants that have used Westinghouse Standardized Technical Specifications (STS) such as North Anna, two values have been provided for each Reactor Trip System (RTS) and Engineered Safety Features Actuation System (ESFAS) trip function; they are referred to as the "Nominal Trip Setpoint" and the "Allowable Value" (in the context of this document, the Allowable Value, Limiting Safety System Setting "LSSS" and the Setting Limit are the same). The difference in percent of span between the Nominal Trip Setpoint and the Allowable Value was calculated, in most cases, based on a summation of the errors associated with the rack components and rack drift. For linear, non-complex trip functions, this value normally worked out to be between 1.0 % and 2.0 % of span. For complex trip functions or functions that had limited margin with respect to the Safety Analysis Limit, other calculational methods were used to determine the difference between the Nominal Trip Setpoint and the Allowable Value. For plants that do not use the Westinghouse STS version of Technical Specifications such as Surry, normally only one setpoint value (assumed to be the Limiting Safety System Setting "LSSS" or the Setting Limit at Surry) is provided in the text with no guidance as to how to set the actual "Nominal" Trip Setpoint in the plant.

Based on the early versions of the Westinghouse STS, the original definition of the LSSS (i.e., the Allowable Value) was stated as follows:

"A setting chosen to prevent exceeding a Safety Analysis Limit".

This Allowable Value was intended to be used during monthly or quarterly Functional Testing as a "flag" such that if a bistable (comparator) Trip Setpoint exceeded this value, the protection channel would be declared inoperable and plant staff would be required to initiate corrective action. The intended significance of this value is that it is the point where if the value is exceeded, the implication is that the actual rack electronics and/or associated rack error components have exceeded the values assumed in the Channel Statistical Allowance (CSA) Calculation and consequently, the margin with respect to the Safety Analysis Limit has been reduced.

The Allowable Value takes on added significance when there is little or no retained/available margin with respect to the Safety Analysis Limit and conversely takes on reduced significance in proportion to the amount of retained/available margin.

2.2.2 Addressing Recent NRC Concerns Associated with Allowable Values

Dominion Corporate I&C Engineering attended a meeting with the Nuclear Regulatory Commission (NRC) and Nuclear Energy Institute (NEI) in Rockville, MD on October 8, 2003 to evaluate NRC concerns associated with the "Allowable Values" used in Technical Specifications. The "Allowable Values" of interest are those associated with Reactor Protection System (RPS) (e.g., also known as the Reactor Trip System "RTS") and Engineered Safety Features Actuation System (ESFAS) Functions that are credited in the Plant Specific Safety Analysis. The NRC expressed a basic concern at the meeting where they have identified various plants that use a method to calculate "Allowable Values" for RTS and ESFAS functions that will reduce or eliminate margin to the Analytical Limit (AL), i.e., also known as the Safety Analysis

Limit (SAL). In the worst case scenario, the margin may be determined to be negative such that the protection function is operating outside of the analyzed region.

On August 13, 2003, NRC Staff met with members of the ISA 67.04 committee and other industry groups in Rockville, MD to discuss instrument setpoint methodology and lay out their position. The major area of discussion focused on the instrument setpoint methodology recommended in ISA Standard S67.04 used by many licensees for determining protection system instrumentation setpoints. Part II of the standard, not endorsed by the NRC Staff, includes three methods for calculating "Allowable Values" which represent the "Limiting Safety System Settings" (LSSS) as described in 10CFR50.36. As stated by the NRC, Methods 1 and 2 determine "Allowable Values" that are sufficiently conservative and are acceptable to the NRC Staff. According to the NRC, Method 3 does not appear to provide an acceptable degree of conservatism and is of concern to the NRC Staff. In addition, there is also a disagreement between the NRC Staff and NEI/ISA/Some Industry Groups as to the meaning/intent of the LSSS. These items will be addressed in this document as they apply to Surry and North Anna.

As of August 2002 North Anna adopted Improved Technical Specifications (ITS). Within the North Anna ITS and ITS Bases, Allowable Values are explicitly defined and are uniquely associated with each RTS and ESFAS function, to include Backup Trips and Permissives. The Allowable Values specified in North Anna's ITS as described in this Technical Report are based on Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994.

Surry Power Station has not adopted ITS and has decided to continue using their Custom Technical Specifications (CTS). For plants licensed before 1974, prior to the introduction of Standardized Technical Specifications (STS), the setpoints (i.e., Technical Specification Limits) included in CTS for RPS and ESFAS instrumentation were based on the plant specific setpoint study and/or based on settings provided in the Westinghouse Precautions, Limitations and Setpoints (PLS) document. The RPS and ESFAS trip setpoints specified in CTS did not include allowances for instrument uncertainties associated with channel functional testing (i.e., the COT). These allowances were left up to the licensee to deal with and justify. At the present time, this applies to Surry. In many cases, the original CTS setpoints for RPS and ESFAS instrumentation have been determined to be unacceptable based on today's standards and setpoint methodologies. To address this discrepancy, Technical Specification Change Request (TSCR) No. 318 was prepared to revise 16 Limiting Safety System Settings for the Reactor Protection System and 11 Setting Limits for the Engineered Safety Features Actuation System. The revised Limiting Safety System Settings and Setting Limits were calculated in accordance with Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994. TSCR No. 318 was approved by the USNRC via Surry Technical Specifications Amendments 261/261 dated September 23, 2008 (Serial # 080594). The revised Limiting Safety System Settings, Setting Limits, and four setpoint changes were implemented for Surry Units 1 and 2 in November of 2008.

At the present time, Kewaunee Power Station is also using Custom Technical Specifications (CTS). Kewaunee's CTS is very similar to the CTS used at Surry Power Station. Dominion has decided that Kewaunee will convert to Improved Technical Specifications (ITS) in the near future. As part of the ITS conversion, Kewaunee will remove their Reactor Protection System LSSSs, ESFAS Setting Limits (known as Allowable Values in ITS), Diesel Generator (LOOP), Containment Purge and Vent Isolation, and Control Room Post Accident Recirculation Actuation from Technical Specifications and maintain control of these and other critical limits in a Setpoint Control Program as allowed by Option B of TSTF-493, Revision 4 (Ref. 5.99). The Setpoint Control Program will be administered as defined in ITS, Section 5.5.16 “Setpoint Control Program”. Like North Anna and Surry, the Allowable Values for RPS and ESFAS Instrumentation, as administered by the Setpoint Control Program will be calculated in accordance with Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994. The Kewaunee Diesel Generator (LOOP), Containment Purge and Vent Isolation, and Control Room Post Accident Recirculation Actuation instrumentation will be handled using Methods 1 and 2 as applicable.

The following subsections will focus on the meaning/intent of the Limiting Safety System Setting (LSSS) and the Allowable Value (AV) as understood by the NRC, ISA/NEI/Various Industry Groups and Dominion.

2.2.3 The NRC Staff Position Concerning the LSSS and AV

The following LSSS information is based on information from the NRC presentation to the ISA 67.04 Committee on August 13, 2003.

10CFR50.36(C)(1)(ii)(A) defines the Limiting Safety System Setting (LSSS) as the setting that must be chosen so that the automatic protective action will correct the abnormal situation before a safety limit is exceeded.

New Improved TS Bases defines allowable value (AV) to be equivalent to LSSS and defines that a channel is operable if the trip setpoint is found not to exceed the AV during the Channel Operational Test (COT).

Prior to the issuance of NRC Regulatory Issue Summary (RIS) 2006-17, the NRC Staff believed that the Allowable Value (AV) is equivalent to the Limiting Safety System Setting (LSSS). Since the issuance of RIS 2006-17 (Ref. 5.100), the NRC’s staff position is that the Limiting Trip Setpoint (LSP) protects the Safety Limit (SL) and relationship between the Allowable Value and the LSSS has been expanded upon as discussed in Section 2.2.6.(1)

2.2.4 The ISA/NEI/Various Industry Groups Position Concerning the LSSS and AV

The following information is based on the ISA 67.04 Subcommittee handout from August 13, 2003.

<u>Position Statements</u>

- The difference between the Allowable Value (AV) and the Analytical Limit (AL) is not a direct defense of the AL.
- The Trip Setpoint (TSP) protects the AL.
- The AV confirms the TSP.

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(1) There is a difference in the terminology and abbreviations used in TSTF-493, Rev. 4 versus RIS 2006-17 with respect to the Limiting Trip Setpoint and the Safety Limit.

<u>Summary</u>

- Reg Guide 1.105 endorses the calculation of the TSP using statistical methods.
- The AV, based on a portion of the errors, does not invalidate the TSP.
- The TSP protects the AL.
- The AV validates an error contribution assumption via periodic surveillance testing.
- As long as the AV is not exceeded, the channel is OPERABLE.
- During Surveillance Testing, the AV serves as the LSSS.
- The errors between the AV and the AL are not part of the LSSS as defined by 10CFR50.36.

In summary, ISA/NEI/Various Industry Groups believe that the Allowable Value (AV) is equivalent to the Limiting Safety System Setting (LSSS). However, their position is that the TSP is used to protect the Analytical Limit (AL). All of the items listed above are true, with the exception of "The TSP protects the AL". This is the statement that is under dispute.

Since August of 2003, the Industry has been developing Technical Specification Task Force Improved Standard Technical Specifications Change Traveler TSTF-493. This document addresses the agreement made between the USNRC and the industry concerning the issues listed above. Dominion's implementation of the requirements set forth in TSTF-493, Revision 4 (Ref. 5.99) as they apply to Kewaunee Power Station will be addressed in Sections 2.2.6 and 3.5.

2.2.5 The Dominion Position Concerning the LSSS and AV for North Anna and Surry

The following definition of the Allowable Value is taken from North Anna Power Station ITS Bases, Page B.3.3.1-2, Revision 0.

Use of the Trip Setpoint to define "as found" OPERABILITY and its designation as the LSSS under the expected circumstances described above would result in actions required by both the rule and technical specifications that are clearly not warranted. However, there is also some point beyond which the device would have not been able to perform its function due, for example, to greater than expected drift. This value needs to be specified in the technical specifications in order to define OPERABILITY of the devices and is designated as the Allowable Value which, as stated above, is the same as the LSSS.

The following definition of the Allowable Value is taken from the North Anna ITS Bases, Page B.3.3.1-3, Revision 0.

The Allowable Value specified in Table 3.3.1-1 serves as the LSSS such that a channel is OPERABLE if the trip setpoint is found not to exceed the Allowable Value during the CHANNEL OPERATIONAL TEST (COT). As such, the Allowable Value differs from the Trip Setpoint by an amount primarily equal to the expected instrument loop uncertainties, such as drift, during the surveillance interval. In this manner, the actual setting of the device will still meet the LSSS definition and ensure that a Safety Limit is not exceeded at any given point of time as long as the device has not drifted beyond that expected during the surveillance interval. If the actual setting of the device is found to have exceeded the Allowable Value the device would be considered inoperable for a technical specification perspective. This requires corrective action including those actions required by 10CFR50.36 when automatic protective devices do not function as required. Note that, although the channel is "OPERABLE" under *these circumstances, the trip setpoint should be left adjusted to a value within the established trip setpoint calibration tolerance band, in accordance with uncertainty assumptions stated in the referenced setpoint methodology (as-left criteria), and confirmed to be operating within the statistical allowances of the uncertainty terms assigned.*

As can be seen, the ITS Bases definition of the LSSS and the AV is consistent with the NRC Staff position. Because the AV is the only value provided in ITS and thus the Operating License, it is the only value the NRC has available to use when evaluating plant submittals. It is also the only value that we use to determine the OPERABILITY of RTS and ESFAS channels during the COT. Therefore, it is Dominion's position that the Analytical Limit will be protected if:

1. the distance between the Trip Setpoint and the Analytical Limit is equal to or greater than the Total Loop Uncertainty for that channel and

2. the distance between the Allowable Value and the Analytical Limit is equal to or greater than the NON-COT error components of the Total Loop Uncertainty and

3. the distance between the Trip Setpoint and the Allowable Value is equal to the COT error components of the Total Loop Uncertainty. The Allowable Value for certain functions may be rounded to a whole number that remains bounded by the available Safety Margin.

Both the Trip Setpoint and the Allowable Value must be properly established in order to adequately protect the Analytical Limit.

2.2.6 The Dominion Position Concerning the LSSS and AV for Kewaunee

Dominion has decided to adopt Improved Technical Specifications (ITS) for Kewaunee. As part of the ITS conversion, Dominion has chosen to implement Option B of TSTF-493, Revision 4 (Ref. 5.99). TSTF-493, Revision 4, Option B allows for the relocation of Reactor Protection System "RPS" (also known as the Reactor Trip System "RTS") and Engineered Safety Features Actuation System – "ESFAS" (also known as Engineered Safety Features – "ESF") Allowable Values (also known as the Limiting Safety System Settings – "LSSSs" or Setting Limits) from Section 3.3 of Technical Specifications to a Licensee controlled program as defined in ITS Section 5.5.16. In addition, the Diesel Generator (LOOP), Containment Purge and Vent Isolation, and Control Room Post Accident Recirculation Actuation instrumentation will also be relocated to the Licensee controlled program as defined in ITS Section 5.5.16. To implement TSTF-493, Option B, Dominion will incorporate the relevant positions taken by the industry as detailed in TSTF-493, Revision 4 and those taken by the USNRC as detailed in NRC Regulatory Issue Summary 2006-17, Dated September 19, 2006 (Refs. 5.99 and 5.100) into the Setpoint Control Program in accordance with ITS Section 5.5.16.

New and/or revised terminology and requirements have been incorporated into TSTF-493 and NRC Regulatory Issue Summary (RIS) 2006-17 that are to be used for the determination of RPS and ESFAS Setpoints. The new terminology and requirements detailed in TSTF-493, Revision 4 and RIS 2006-17 will be incorporated into Kewaunee's Setpoint Control Program as described in ITS Section 5.5.16. In addition to the new terminology and requirements, the USNRC has taken the position that the Limiting Trip Setpoint (LTSP) protects the Safety Limit (SL) (Ref. 5.100). This revised position is a change from the historical definition of the Allowable Value as delineated in Standardized Technical Specifications

(STS), i.e., "A setting chosen to prevent exceeding a Safety Analysis Limit" (Ref. 5.3). Since the Limiting Trip Setpoint (LTSP) accounts for all credible instrument errors associated with the instrument channel, it is a more conservative setting than the associated Allowable Value as defined in Section 3.5. With respect to Kewaunee's conversion to ITS, Dominion agrees with this revised position based on explanations and guidance provided in TSTF-493, Revision 4 and RIS 2006-17.

Like North Anna and Surry, Kewaunee's Setpoint Methodology is based on Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994. Using Methods 1 or 2 will ensure that the Allowable Value (equivalent to the Minimum or Maximum Allowable Value for Surry and North Anna) will account for all credible instrument and process errors that are not tested or quantified during the performance of the Channel Operational Test (COT). This Setpoint Methodology addresses the basic NRC concern brought up back in 2003 that Method 3 (used by some Licensees to determine Allowable Values) as described in ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994 may yield Allowable Values that will not protect the Safety Limit under all postulated conditions. In addition to using Methods 1 or 2, Kewaunee's Setpoint Methodology will incorporate the revised terminology and additional requirements imposed by TSTF-493, Revision 4 and RIS 2006-17. A detailed discussion of Kewaunee's Setpoint Methodology incorporating the revised terminology and requirements from TSTF-493 and RIS 2006-17 is provided in Section 3.5.

3.0 METHODOLOGY

3.1 Introduction

Many Westinghouse Plants continue to use Westinghouse or other Engineering Firms to perform some or all of their Safety Analysis Functions. In addition, Westinghouse has also performed the RPS (RTS) and ESFAS Setpoint Study for many of their plants. Typically, the Setpoint Study for these plants included the development of Channel Statistical Allowance (CSA) Calculations for Primary and some of the Backup RTS and ESFAS Trip Functions. Derived from these Setpoint Studies and CSA Calculations are the Allowable Values that appear in various versions of Standardized Technical Specifications (STS). For the Westinghouse Plants that use Custom Technical Specifications (CTS), the setpoint values specified for RPS and ESFAS Trip Functions are not defined as Allowable Values and typically, they are the same setpoint values as those found in the original Precautions, Limitations and Setpoints (PLS) Document for that particular plant. This was the case for Surry's Custom Technical Specifications until the implementation of Technical Specifications Change Request No. 318 ultimately resulting in TS Amendments 261/261 for Units 1 and 2, respectively (Ref. 5.119).

Dominion is unique in the fact that a majority of the UFSAR Chapter 14 (Surry and Kewaunee) and Chapter 15 (North Anna) Safety Analysis is performed in house by the Corporate Nuclear Analysis & Fuels Department. In addition, Channel Statistical Allowance Calculations for Primary and Backup RPS (RTS) and ESFAS Trip Functions are performed in house by the Corporate Electrical/I&C/Computers Department. Because Dominion performs their own Safety Analysis and CSA Calculations, the methodology used to determine Improved Technical Specifications (NUREG-1431 "ITS") Allowable Values for North Anna, As Found Tolerances for Kewaunee, and LSSS/Setting Limits for Surry Custom Technical Specifications will be similar and in some cases more conservative than that used by Westinghouse in the past to determine Allowable Values for later versions of Standardized Technical Specifications. In addition, the methods used in this Technical Report to calculate the limiting values for North Anna, Kewaunee, and Surry will be consistent with the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref 5.43).

3.2 Functional Groups for RPS (RTS) and ESFAS Instrumentation.

Based on Dominion Technical Report NE-0994 (Ref. 5.1), the Reactor Protection System (RPS)/Reactor Trip System (RTS) and the Engineered Safety Features Actuation System (ESFAS) Instrumentation at North Anna, Kewaunee, and Surry can be divided into two major categories, i.e., Primary Trip Functions and Backup Trip Functions. Primary Trip Functions are credited in the Plant Safety Analysis and have an associated Analytical Limit (i.e., Safety Analysis Limit or Safety Limit). Backup Trip Functions are not credited in the Plant Safety Analysis but are included in the Reactor Protection System and the Engineered Safety Features Actuation System to enhance the overall effectiveness of the system.

Primary Trip Functions include the following:

- Primary Reactor Trip Functions
- Primary Reactor Trip Permissives
- Primary ESFAS Actuation Functions
- Primary ESFAS Permissives

Backup Trip Functions include the following:

- Backup Reactor Trip Functions
- Backup Reactor Trip Permissives
- Backup ESFAS Permissives

In addition to the above, there are three basic functional groups of Westinghouse Nuclear Instrumentation System (NIS), Foxboro H-Line, NUS Replacement Modules, Westinghouse/Hagan 7100, and Westinghouse 7300 Instrumentation that develop the majority of the RPS/RTS and ESFAS trips. These basic functional groups are divided into the three categories listed below:

1. Single parameter protection function
2. Dual parameter protection function
3. Multiple parameter protection function (i.e., more than two process parameters)

Different methods are used to calculate or validate the Allowable Values for North Anna, As Found Tolerances for Kewaunee, and LSSS/Setting Limits for Surry depending on whether the function is considered to be Primary or Backup. In addition, the functional group category will also effect how the Allowable Value, As Found Tolerance or LSSS/Setting Limit is calculated. Some examples of functional groups are given below.

Single Parameter Protection Functions

- Power Range Neutron Flux High and Low Reactor Trips
- Pressurizer High and Low Pressure Reactor Trips
- Low Reactor Coolant Flow Reactor Trip
- Containment Hi-1, Hi-2 and Hi-3 (North Anna only) Pressure ESFAS initiation
- Compensated Low Steam Line Pressure ESFAS initiation
- Steam Generator Lo-2 Level ESFAS initiation

Dual Parameter Protection Functions

- Surry High Steam Flow in 2/3 Lines ESFAS initiation
- Surry High ΔP Steam Line vs. Steam Header ESFAS initiation
- North Anna High ΔP Steam Line vs. Steam Line ESFAS initiation

Multiple Parameter Protection Functions

- Steam Flow Feed Flow Mismatch Reactor Trip
- Overpower ΔT Reactor Trip
- Overtemperature ΔT Reactor Trip

Single Parameter Protection Functions

North Anna

The Nuclear Steam Supply System (NSSS) Protection and Control System at North Anna is made up of the Westinghouse Nuclear Instrumentation System (NIS) and the Westinghouse 7300 Series Process Control System. Most of the RTS and ESFAS trips generated from these systems are single parameter protection functions. Figures 3.2-1 and 3.2-2 illustrate the configuration of the Westinghouse NIS and the 7300 Process Control System.

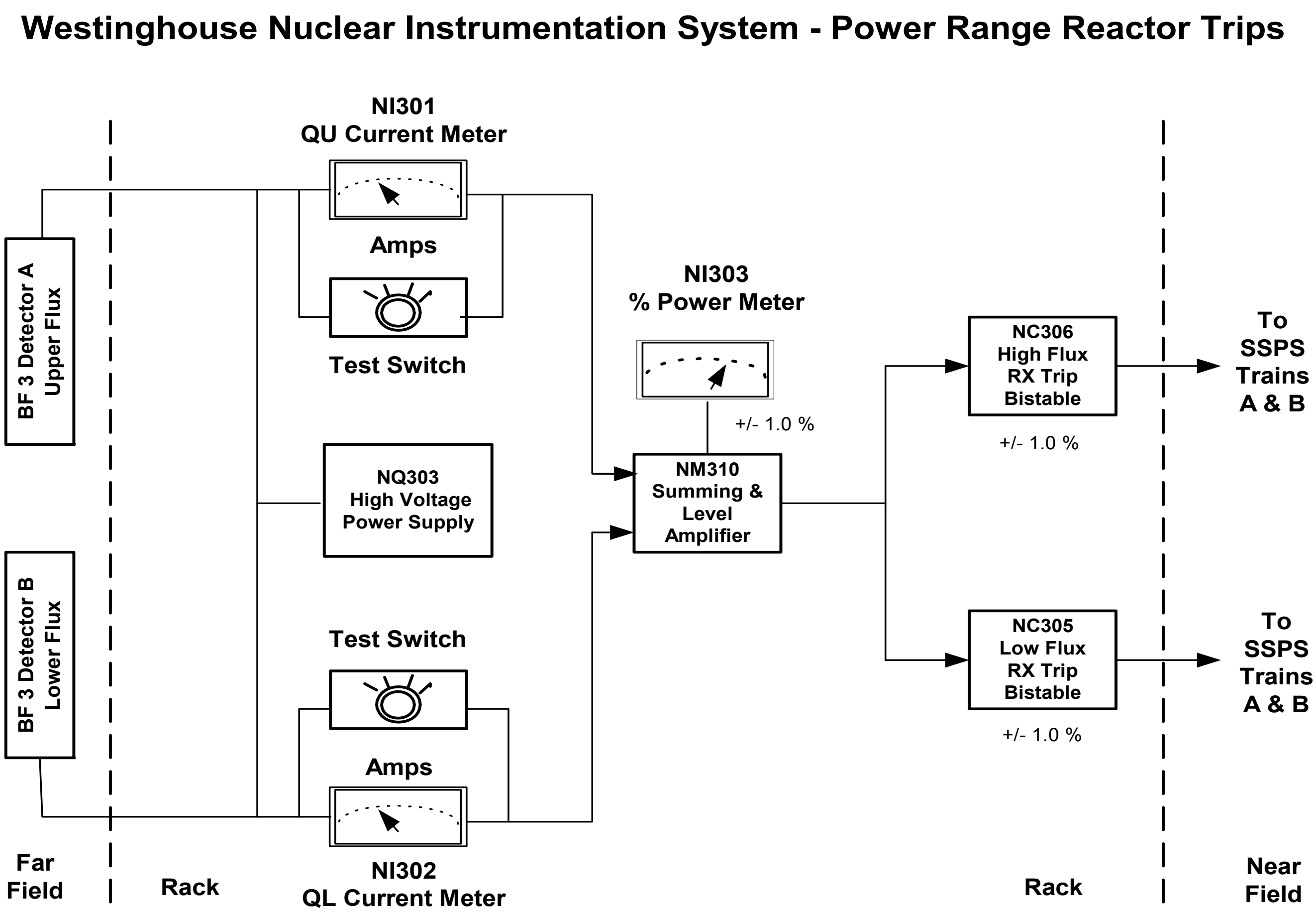


Figure 3.2-1

Refer to Figure 3.2-1 :

CSA Calculations performed for Reactor Trips generated by NIS typically include rack error terms associated with the meter indications (i.e., Amps, % Full Power, Counts per Second, etc.) and the bistables that generate the trip.

In the case of the Power Range High Flux Reactor Trip as shown on Figure 3.2-1, the rack error terms as defined in CSA Calculation EE-0063 (Ref. 5.15) are :

(M1 + M1TE) + (M5 + M5MTE) + RD + RTE

Where:
M1 = Module 1 Summing and Level Amplifier = $\pm$ 0.100 %
M1MTE = Module 1 Measuring and Test Equipment = $\pm$ 0.110 %
M5 = Module 5 Bistable Relay Driver = $\pm$ 0.833 %
M5MTE = Module 5 Measuring and Test Equipment = $\pm$ 0.943 %
RD = Rack Drift = $\pm$ 1.000 %
RTE = Rack Temperature Effects = $\pm$ 0.500 %

Westinghouse 7300 Process Control System
Low Reactor Coolant Flow Reactor Trip

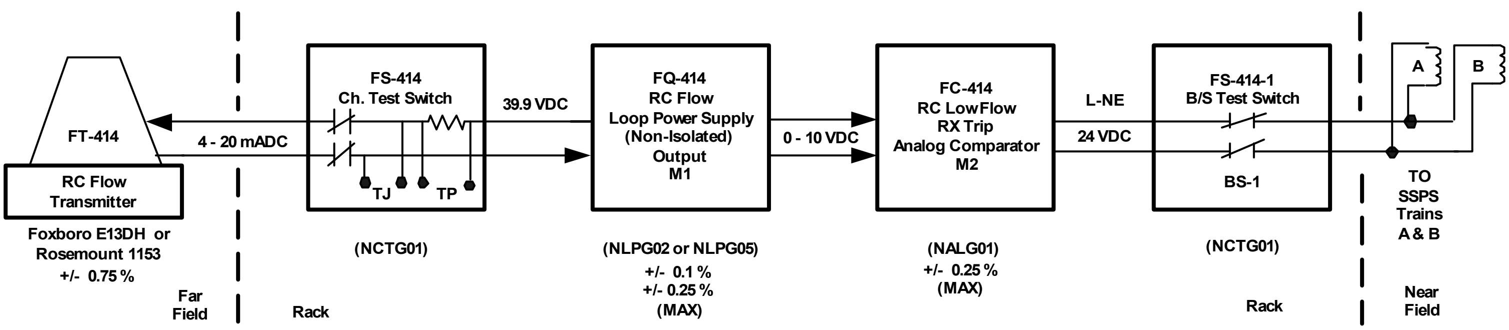


Figure 3.2-2

Refer to Figure 3.2-2 :

CSA Calculations performed for Reactor Trips generated by the Westinghouse 7300 Process Control System include rack error terms associated with the PC Cards that perform signal modification and the bistables that generate the trip.

In the case of the Low Reactor Coolant Flow Reactor Trip as shown on Figure 3.2-2, the rack error terms as defined in CSA Calculation EE-0060 (Ref. 5.21) are :

(M1 + M1MTE) + (M2 + M2MTE) + RD + RTE

Where:	M1	= Module 1 Loop Power Supply = ± 0.100 %
	M1MTE	= Module 1 Measuring and Test Equipment = ± 0.153 %
	M2	= Module 2 Analog Comparator "Bistable" = ± 0.250 %
	M2MTE	= Module 2 Measuring and Test Equipment = ± 0.030 %
	RD	= Rack Drift = ± 1.000 %
	RTE	= Rack Temperature Effects = ± 0.500 %

These rack error terms along with other error terms from the CSA Calculation will be used to validate the existing Allowable Values at North Anna or to calculate revised Allowable Values, if necessary.

Surry

The NSSS Protection and Control System at Surry uses the same Westinghouse Nuclear Instrumentation System (NIS) as North Anna. However, a majority of NSSS Protection and Control is developed from the Westinghouse/Hagan 7100 Series Process Control System (using NUS Replacement Modules for some functions). Like North Anna, most of the RPS and ESFAS trips generated from these systems are single parameter protection functions. For the Westinghouse NIS, Figure 3.2-1 is also applicable for Surry. Figure 3.2-3 illustrates the configuration of the Westinghouse/Hagan 7100 Process Control System for a single input protection function.

Westinghouse 7100 Process Control System
Low Reactor Coolant Flow Reactor Trip

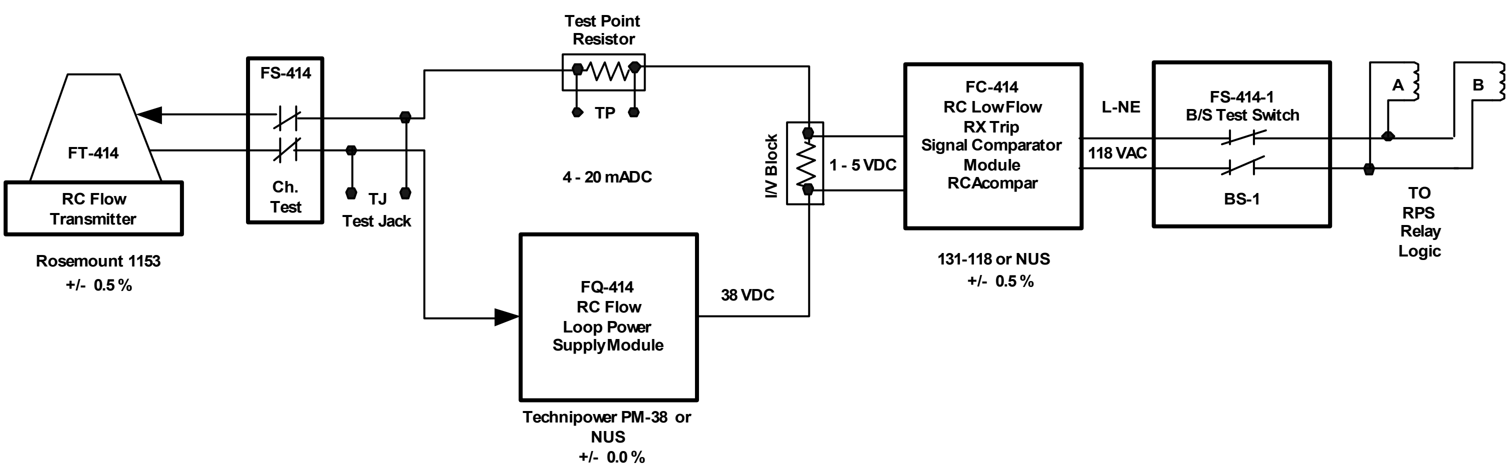


Figure 3.2-3

Refer to Figure 3.2-3 :

CSA Calculations performed for Reactor Trips generated by the Westinghouse/Hagan 7100 Process Control System also include rack error terms associated with the modules that perform signal modification and the bistables that generate the trip. The Westinghouse 7100 Process Control System mainly operates using current loops where the power supplies are not used as signal converters. In many cases, for a single parameter protection function, the only rack module that will have a tolerance associated with it will be the Signal Comparator (i.e., the Bistable). In the case of Surry's Low Reactor Coolant Flow Reactor Trip as shown in Figure 3.2-3, the rack error terms from CSA Calculation EE-0183 (Ref. 5.34) are :

(M5 + M5MTE) + RD + RTE

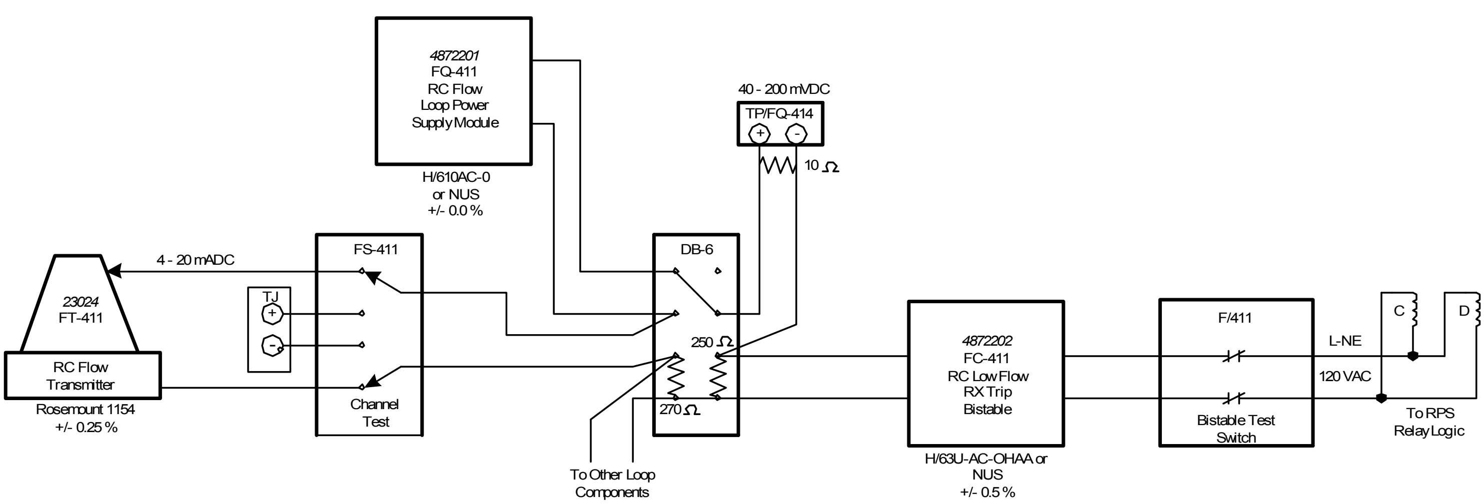
Where:	M5	= Rack Comparator Setting Accuracy = $\pm$ 0.50 %
	M5MTE	= Rack Measuring and Test Equipment = $\pm$ 0.15 %
	RD	= Rack Drift = $\pm$ 1.00 %
	RTE	= Rack Temperature Effects = $\pm$ 0.50 %

Note the difference between North Anna's rack error terms compared with the rack error terms listed above for Surry. The error terms for the Loop Power Supply are not included in Surry's CSA Calculation because it is not used as a signal converter.

Kewaunee

The NSSS Protection and Control System at Kewaunee uses the same Westinghouse Nuclear Instrumentation System (NIS) as does North Anna and Surry for Power Range. Most of the NSSS Protection and Control is developed from the Foxboro H-Line Process Control System (using NUS Replacement Modules for some functions). Like North Anna and Surry, most of the RPS and ESFAS trips generated from these systems are single parameter protection functions. For the Westinghouse Power Range NIS, Figure 3.2-1 is also applicable for Kewaunee. Figure 3.2-4 illustrates the configuration of the Foxboro H-Line Process Control System for a single input protection function.

Foxboro H-Line Process Control System
Low Reactor Coolant Flow Reactor Trip



<u>**Figure 3.2-4**</u>

Refer to Figure 3.2-4 :

CSA Calculations performed for Reactor Trips generated by the Foxboro H-Line Control System also include rack error terms associated with the modules that perform signal modification and the bistables that generate the trip. The Foxboro H-Line Process Control System mainly operates using current loops where the power supplies are not used as signal converters. In many cases, for a single parameter protection function, the only rack module that will have a tolerance associated with it will be the Bistable Module.

In the case of Kewaunee's Low Reactor Coolant Flow Reactor Trip as shown in Figure 3.2-4, the rack error terms from CSA Calculation C10819 (Ref. 5.96) are :

$$(M2_{BISTABLE} + M2MTE) + RD + RTE$$

Where:

$M2_{BISTABLE}$	= Rack Bistable Setting Accuracy = $\pm$ 0.50 %
M2MTE	= Rack Measuring and Test Equipment = $\pm$ 0.20 %
RD	= Rack Drift = $\pm$ 1.00 %
RTE	= Rack Temperature Effects = $\pm$ 0.50 %

Note the difference between North Anna's rack error terms compared with the rack error terms listed above for Kewaunee. The error terms for the Loop Power Supply are not included in Kewaunee's CSA Calculation because it is not used as a signal converter.

Dual Parameter Protection Functions

Westinghouse 7300 Process Control System
High Steam Flow in 2/3 Lines ESFAS - Channel 3

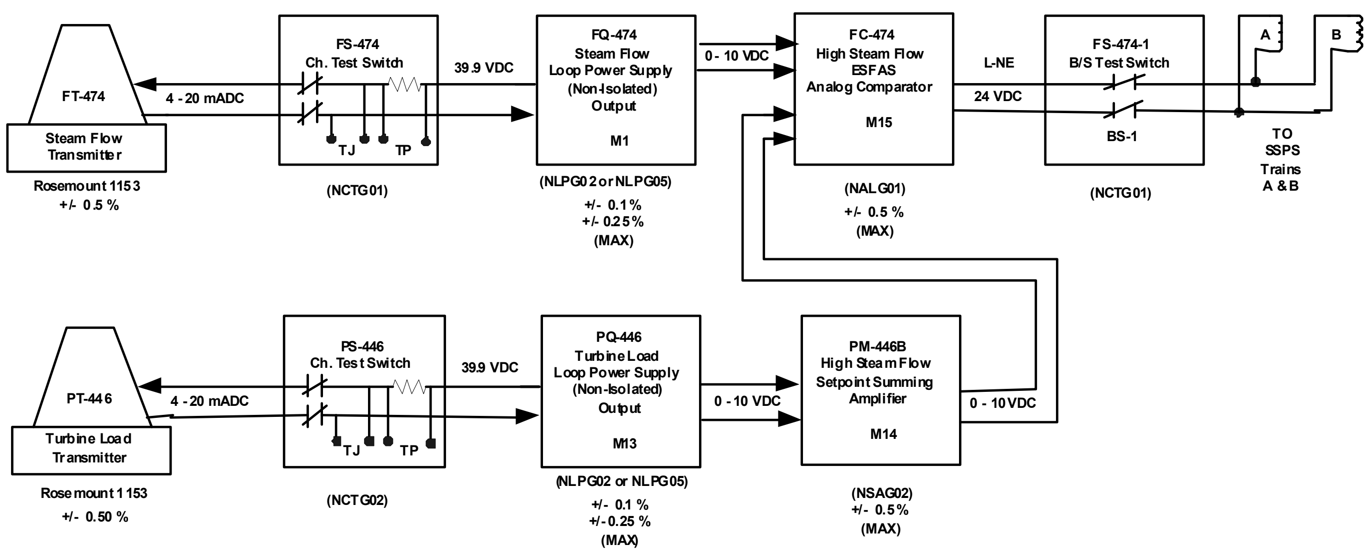


Figure 3.2-5

Figure 3.2-5 illustrates a typical dual input protection function for North Anna. Channel Statistical Allowance Calculations for dual parameter protection functions are different than single parameter functions. For example, there are more rack error terms associated with the development of the trip than a single parameter function. The rack error terms associated with North Anna's High Steam Flow in 2/3 Lines ESFAS trip based on Calculation EE-0736 (Ref. 5.23) are given below :

$$(M1 + M1MTE) + (M13 + M13MTE) + (M14 + M14MTE) + (M15 + M15MTE) + RD + RTE$$

Where:		
	M1	= Steam Flow Loop Power Supply Accuracy = $\pm$ 0.10 %
	M1MTE	= Module M1 Measuring and Test Equipment = $\pm$ 0.153 %
	M13	= Turbine Load Loop Power Supply Accuracy = $\pm$ 0.10 %
	M13MTE	= Module M13 Measuring and Test Equipment = $\pm$ 0.153 %
	M14	= High Steam Flow Setpoint Summator Accuracy = $\pm$ 0.50 %
	M14MTE	= Module M14 Measuring and Test Equipment = $\pm$ 0.042 %
	M15	= High Steam Flow Comparator Setting Accuracy = $\pm$ 0.50 %
	M15MTE	= Module M15 Measuring and Test Equipment = $\pm$ 0.042 %
	RD	= Rack Drift = $\pm$ 1.00 %
	RTE	= Rack Temperature Effects = $\pm$ 0.50 %

The rack error terms described in the example above along with other error terms from the CSA Calculation will be used to validate the existing Allowable Values at North Anna or to calculate revised Allowable Values, if necessary. The configuration of dual parameter protection functions at Surry is similar to North Anna's. The major differences between the rack error components for both plants are based on the process control equipment as illustrated above for single input protection functions.

Multiple Parameter Protection Functions

Kewaunee

There are three multiple parameter protection functions at North Anna and Kewaunee, and four multiple parameter functions at Surry. Figure 3.2-6 is a block diagram that illustrates Kewaunee's Overtemperature ΔT Reactor Trip configuration (note that Overpower ΔT and Low T_{AVG} are also shown on the drawing). The configuration of North Anna's and Surry's Overtemperature ΔT Reactor Trip is similar, noting that the process control equipment is different.

As can be seen from Figure 3.2-6, Kewaunee's Overtemperature ΔT Reactor Trip function is derived from five process parameters, they are :

- T_{HOT}
- T_{COLD}
- Pressurizer Pressure
- Function of Delta Flux (FΔI) made up of Upper Flux (Q_U) and Lower Flux (Q_L)

Kewaunee Power Station Overtemperature ΔT Reactor Trip

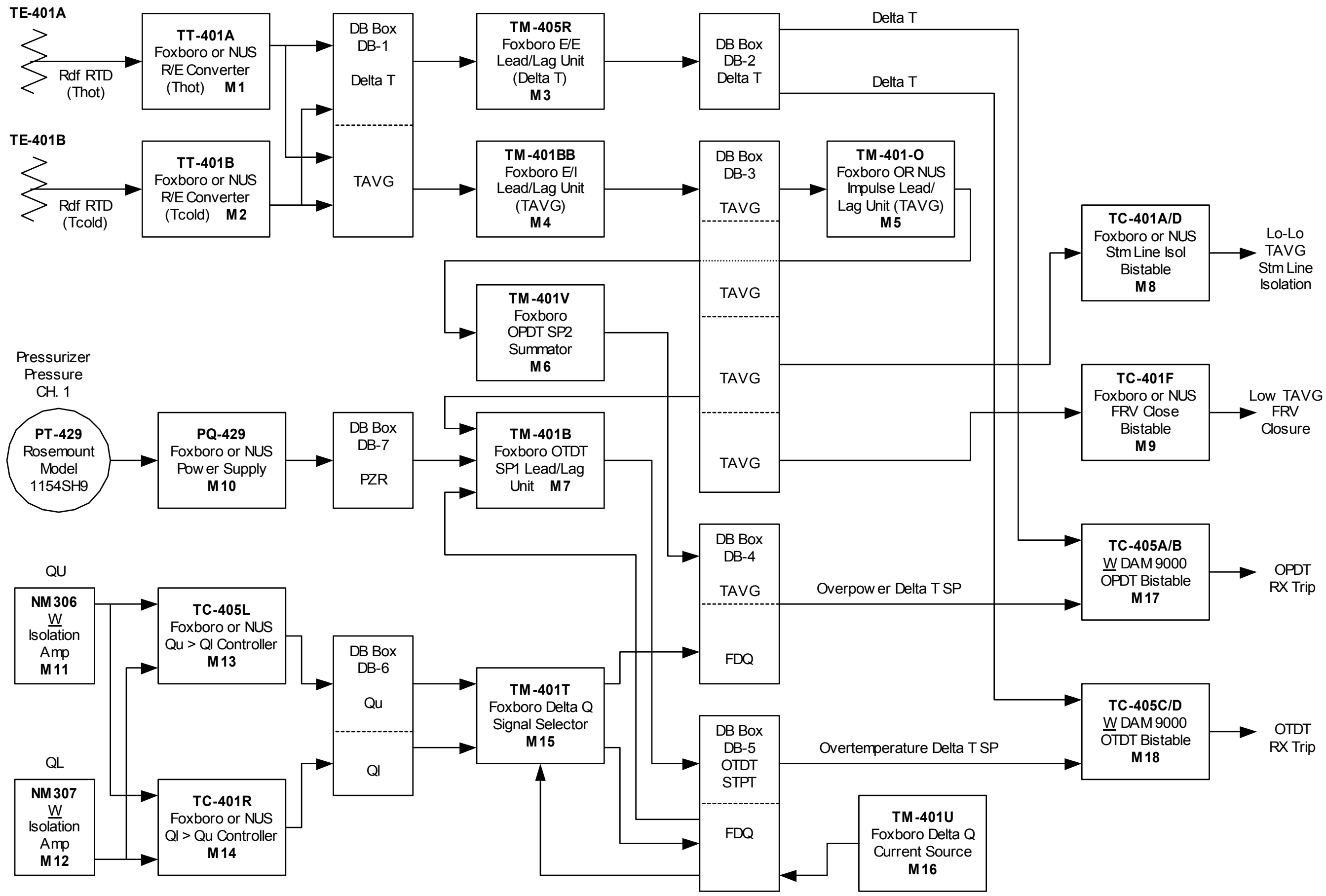


Figure 3.2-6

The Overtemperature ΔT Reactor Trip function is further broken down into channels as defined below :

- ΔT Channel, made up of T_{HOT} and T_{COLD}
- T_{AVG} Channel, made up of T_{HOT} and T_{COLD}
- Pressurizer Pressure Channel
- Function of Delta Flux (FΔI), made up of Q_U and Q_L

Because there are five inputs to Kewaunee's Overtemperature ΔT function, the rack error components will be grouped as channel inputs versus a string of modules as shown above for the Dual Parameter Function example. This type of assessment will yield a conservative and valid Allowable Value (for Kewaunee, the Allowable Value will be the As Found Tolerance) using the four step method described in Sections 3.4 and 3.5 (Section 3.5 is Kewaunee specific). CSA Calculation C11865 (Ref. 5.94) was performed using a module calibration method, which for a multiple-parameter function will result in a very conservative CSA value. However, using a module calibration method for a complex, multiple-parameter function will result in an Allowable Value, LSSS/Setting Limit, or As Found Tolerance that is non-conservative. The rack error components for each Overtemperature ΔT input channel are given below.

$$\Delta T \text{ Channel} = (RCA_1 + RMTE_1) + RD_1 + RTE_1$$

$$T_{AVG} \text{ Channel} = (RCA_2 + RMTE_2) + RD_2 + RTE_2$$

$$\text{Pressurizer Pressure Channel} = (RCA_3 + RMTE_3) + RD_3 + RTE_3$$

$$F\Delta I \text{ Channel} = (RCA_4 + RMTE_4) + RD_4 + RTE_4$$

$$OT\Delta T \text{ Setpoint} = (RCA_5 + RMTE_5)$$

$$OT\Delta T \text{ Bistable} = (RCSA + RMTE_6)$$

Where:

RCA_1	= ΔT Channel Calibration Accuracy = ± 0.707 % (M3)
$RMTE_1$	= ΔT Channel Rack Measuring and Test Equipment = ± 0.173 % (M3MTE)
RD_1	= ΔT Channel Rack Drift = ± 1.00 %
RTE_1	= ΔT Channel Rack Temperature Effect = ± 0.50 %
RCA_2	= T_{AVG} Channel Calibration Accuracy = ± 0.707 % (M4)
$RMTE_2$	= T_{AVG} Channel Rack Measuring and Test Equipment = ± 0.245 % (M4MTE)
RD_2	= T_{AVG} Channel Rack Drift = ± 1.00 %
RTE_2	= T_{AVG} Channel Rack Temperature Effect = ± 0.50 %
RCA_3	= Pressurizer Pressure Channel Calibration Accuracy = ± 0.00 %
$RMTE_3$	= Pressurizer Pressure Channel Rack Measuring and Test Equipment = ± 0.0 %
RD_3	= Pressurizer Pressure Channel Rack Drift = ± 0.00 %
RTE_3	= Pressurizer Pressure Channel Rack Temperature Effect = ± 0.00 %
RCA_4	= FΔI Channel Calibration Accuracy = ± 0.50 % (M15)
$RMTE_4$	= FΔI Channel Rack Measuring and Test Equipment = ± 0.346 % (M15MTE)
RD_4	= FΔI Channel Rack Drift = ± 1.00 %
RTE_4	= FΔI Channel Rack Temperature Effect = ± 0.50 %
RCA_5	= OTΔT Setpoint Summator Calibration Accuracy = ± 0.50 % (M7)
$RMTE_5$	= OTΔT Setpoint Summator Rack Measuring and Test Equipment = ± 0.374 % (M7MTE)
RCSA	= OTΔT Reactor Trip Bistable = ± 0.50 % (M18)
$RMTE_6$	= OTΔT Reactor Trip Bistable Rack Measuring and Test Equipment = ± 0.224 % (M18MTE)

Some of the error terms listed above will be used to determine the Allowable Value (i.e., the As Found Tolerance) for Kewaunee's Overtemperature ΔT Reactor Trip. Similar error terms will be used throughout this document to evaluate the other multiple parameter protection functions at both plants.

3.3 The Instrumentation, Systems and Automation Society (ISA) Methodologies Used to Calculate Allowable Values

The following base line parameters will be used to illustrate how the Allowable Value is calculated using Methods 1, 2 and 3 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994.

Analytical Limit (AL)	= 6.00 PSIG
Total Instrument Loop Uncertainty (TLU)	= 1.39 PSIG
Calculated Instrument Uncertainties used for COT (COT)	= 1.10 PSIG
Calculated Instrument Uncertainties not used for COT (NON-COT)	= 0.85 PSIG

Notes:

1. In the context of this document, the Analytical Limit (AL), Safety Limit (SL), and the Safety Analysis Limit (SAL) have the same meaning.

2. In the context of this document, Total Instrument Loop Uncertainty (TLU) and the Channel Statistical Allowance (CSA) have the same meaning.

3. COT means Channel Operational Test.

4. COT Instrument Uncertainties are made up of the portion of the loop that is tested during the COT. For Surry, Kewaunee, and North Anna, these error components are:

   - Rack or Module Calibration Accuracy (RCA or M1, M2 ... Mn)
   - Rack Comparator Setting Accuracy or Comparator Module Calibration Accuracy (RCSA or Mn)
   - Rack Drift (RD)

5. NON-COT Instrument Uncertainties are made up of the portion of the loop that is not tested during the COT. For Surry, Kewaunee, and North Anna, these error components may include:

   - Systematic Error (SE)
   - Environmental Allowance (EA)
   - Process Measurement Accuracy (PMA)
   - Primary Element Accuracy (PEA)
   - Sensor Calibration Accuracy and Sensor Measuring and Test Equipment (SCA + SMTE)
   - Sensor Drift (SD)
   - Sensor Pressure Effect(s) (SPE)
   - Sensor Temperature Effect (STE)
   - Sensor Power Supply Effect (SPSE)
   - Rack Measuring and Test Equipment (RMTE or M1MTE, M2MTE ... MnMTE)
   - Rack Temperature Effect (RTE)

3.3.1 Method 1

Method 1 has been evaluated by the NRC Staff and was found to be an acceptable method to be used to calculate Allowable Values. Method 1 uses a TLU equal to 1.39 PSIG. The TLU was arrived at statistically using the Square Root Sum of the Squares (SRSS) method of combining channel error components. This is an accepted industry standard and is used here at Dominion Virginia Power. The channel error components used for the COT are equal to 1.10 PSIG and the error components used for the NON-COT are equal to 0.85. With a TLU equal to 1.39 PSIG and NON-COT errors equal 0.85 PSIG, then statistically, the COT error would be equal to 1.10 PSIG as shown below.

$$[(0.85)^2 + (1.10)^2]^{1/2} = 1.39 \quad \text{or} \quad [(1.39)^2 - (0.85)^2]^{1/2} = 1.10$$

If the COT error allowance were to be removed from the TLU, the statistical combination of the NON-COT error allowances would be equal to 0.85 PSIG. This means that the LSSS would have to be set such that the margin of 0.85 PSIG is maintained between the AV and the AL. To accomplish this using a COT error allowance of 1.10 PSIG, a determinant assessment must be used such that the COT allowance can only be equal to the TLU minus the NON-COT allowance, i.e., COT = 1.39 PSIG – 0.85 PSIG = 0.54 PSIG. In Method 1, the user decides that for the Channel Operational Test, the full COT allowance of 1.10 PSIG is to be retained. To maintain the full COT error allowance, the actual trip setpoint (ACT SP) is set below the calculated trip setpoint (CAL SP). Note that the difference between the CAL SP and the Allowable Value (AV) is 0.54 PSIG. The remainder of the desired COT allowance of 1.10 PSIG is obtained by lowering the ACT SP below the CAL SP by 0.56 PSIG to yield the ACT SP value of 4.05 PSIG. Method 1 ensures that the full NON-COT allowance of 0.85 PSIG is available under all conditions for the non-tested channel error components.

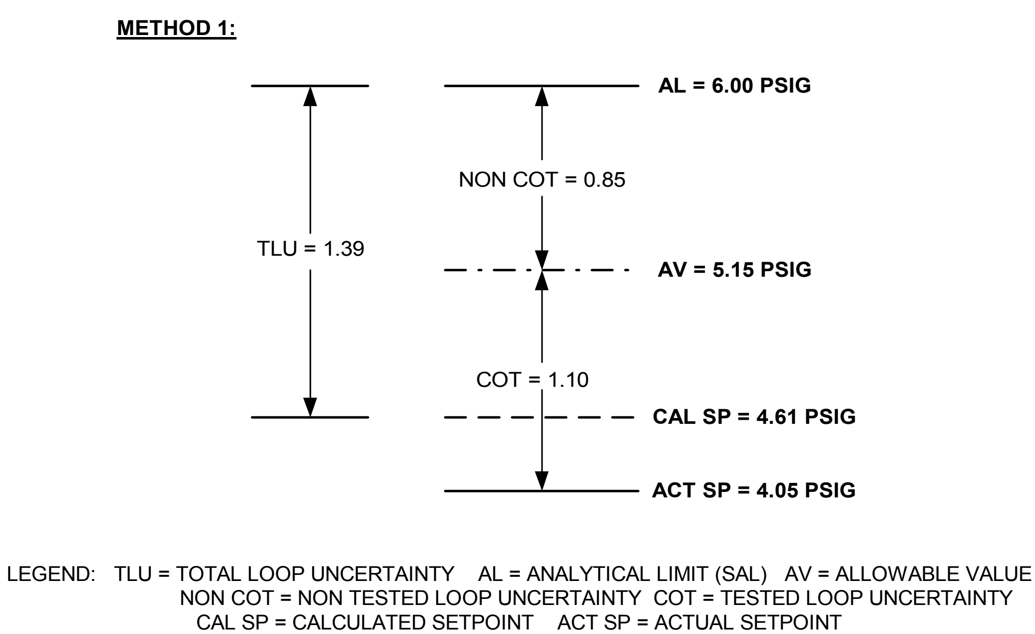


Figure 3.3-1

3.3.2 Method 2

Method 2 has been evaluated by the NRC Staff and was found to be an acceptable method to be used to calculate Allowable Values. Method 2 is essentially the same as Method 1 with the exception that the ACT SP is set equal to the CAL SP (i.e., 4.61 PSIG). This method does not allow for the full value of the COT error components as determined in the TLU (i.e., CSA Calculation). In some cases, this could cause the plant to find the AS FOUND Trip Setpoint outside of the AV more often than would be the case using Method 1. Like Method 1, Method 2 ensures that the statistical combination of the NON-COT error allowances (equal to 0.85 PSIG) is maintained between the AV and the AL under all conditions.

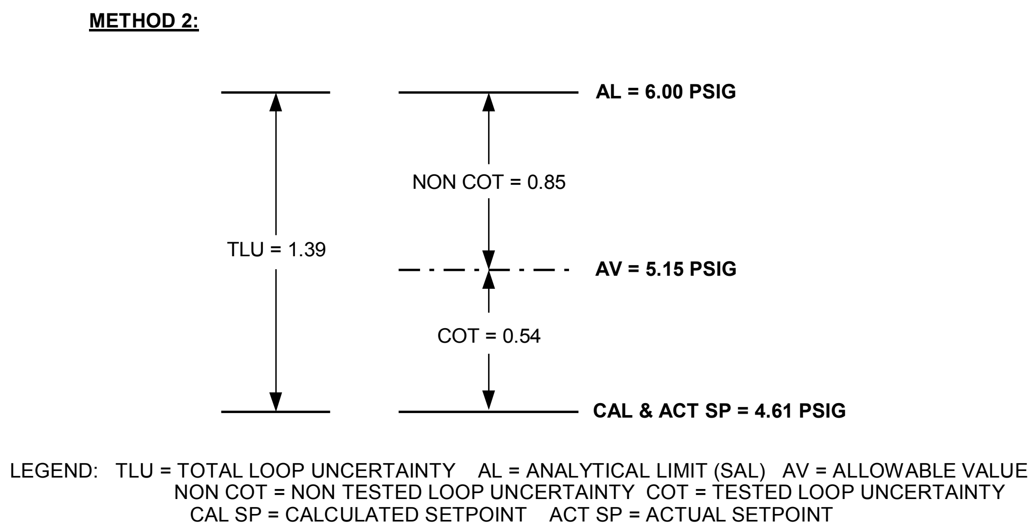


Figure 3.3-2

3.3.3 Method 3

Method 3 has been evaluated by the NRC Staff and was found to be an unacceptable method to be used to calculate Allowable Values. Method 3 has been used to calculate the Allowable Value in many Westinghouse Plants that used early versions of Standardized Technical Specifications (STS) as discussed above in Section 3.1. Using a determinant assessment, Method 3 does not ensure that the full NON-COT uncertainty allowance is maintained between the AV and the AL. To ensure that the NON-COT uncertainty allowance is maintained under all conditions, the AV must be set for ≤ 5.15 PSIG. As can be seen from the illustration below, the AV using Method 3 is set for 5.71 PSIG, i.e., CAL SP/ACT SP + COT = 5.71 PSIG. If the rack error components are allowed an offset of 1.10 PSIG before the channel is declared INOPERABLE, then the allowance for the NON-COT uncertainty is decreased to 0.29 PSIG. If the AS FOUND COT error was found to be (+) 1.05 PSIG and the AS FOUND NON-COT error was determined to be (+) 0.85 PSIG, then the channel trip function would have exceeded the Analytical Limit (i.e., SAL) and should be declared INOPERABLE. However, in accordance with Technical Specifications, the channel does not have to be declared INOPERABLE until the AS FOUND Trip Setpoint exceeds the Allowable Value. This is the concern that the NRC Staff has with Method 3. In the case of Method 3 using a determinant assessment, the AV does not protect the AL and does not identify an inoperable channel under all operating conditions.

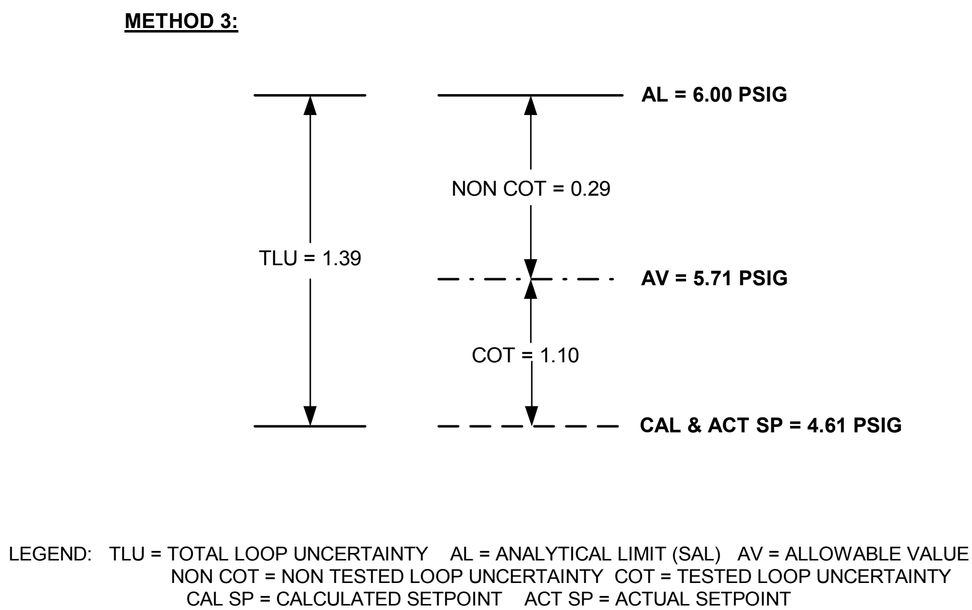
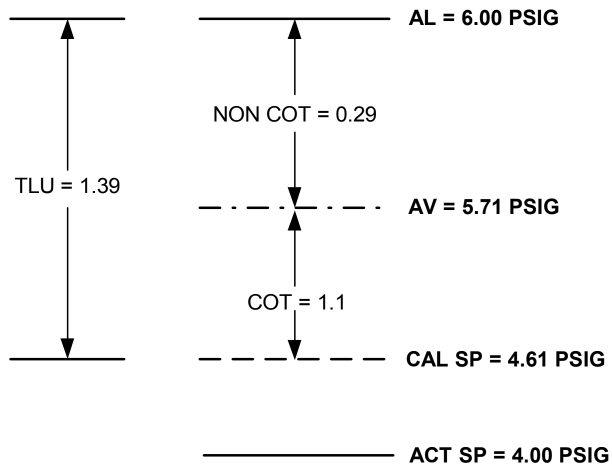


Figure 3.3-3

3.3.4 Method 3 with Additional Margin

Method 3 using additional margin for the ACT SP has been evaluated by the NRC Staff and was found to be an unacceptable method to be used to calculate Allowable Values. Method 3 with additional margin is identical to Method 3 with the exception that the ACT SP is set below the CAL SP. In the case used for this illustration, the ACT SP is set for 4.00 PSIG which provides a margin of 0.61 PSIG to the CAL SP and 1.71 PSIG to the AV. This method actually yields less conservative results than Method 3 for two reasons. First, the AV is still set for 5.71 PSIG yielding a NON-COT allowance of 0.29 PSIG. As discussed above, using a determinant assessment, the NON-COT allowance of 0.29 PSIG does not fully account for the statistical combination of the non-tested loop error components. Second, the calculated COT allowance was determined to be 1.10 PSIG. Allowing an error of 1.71 PSIG between the ACT SP and the AV is beyond the assumptions used to develop the TLU (i.e., CSA Calculation). Allowing an error of 1.71 PSIG for the Trip Setpoint before the channel is declared INOPERABLE is inconsistent with the applicable TLU assumptions and will not ensure that the rack components are operating within the assumptions of the CSA Calculation and/or the manufacturer specifications. Also note that the difference between the ACT SP and the AV is larger than the calculated TLU for the entire channel.

METHOD 3 WITH ADDITIONAL MARGIN:



LEGEND: TLU = TOTAL LOOP UNCERTAINTY AL = ANALYTICAL LIMIT (SAL) AV = ALLOWABLE VALUE
NON COT = NON TESTED LOOP UNCERTAINTY COT = TESTED LOOP UNCERTAINTY
CAL SP = CALCULATED SETPOINT ACT SP = ACTUAL SETPOINT

Figure 3.3-4

3.4 Methodology for Determining North Anna "Allowable Values" and Surry "LSSS/Setting Limits"

3.4.1 Primary RTS and ESFAS Trips and Permissives Credited in the Safety Analysis

A four step process is used to determine Allowable Values, Limiting Safety System Settings (LSSS), or Setting Limits for Primary RTS and ESFAS Trip Functions and Permissives at North Anna and Surry Power Stations that are credited in the Safety Analysis. This four step process is based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref 5.43). In the order of operation, the four steps are described below and they are illustrated in Figure 3.4-1

1. Determine the Minimum (decreasing trip) or Maximum (increasing trip) Trip Setpoint (MTS). The Maximum Trip Setpoint is arrived at by subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL). The Minimum Trip Setpoint is arrived at by adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL).

2. Determine the Minimum (decreasing trip) or Maximum (increasing trip) Allowable Value/LSSS/Setting Limit (MAV). This Minimum Allowable Value/LSSS/Setting Limit is arrived at by adding the statistical combination (i.e., Square Root of the Sum of the Squares "SRRS") of the NON COT Loop Error Components (i.e., the loop error terms that are not tested or quantified during the Channel Operational Test "COT") to the Analytical Limit (AL). The Maximum Allowable Value/LSSS/Setting Limit is arrived at by subtracting the statistical combination of the NON COT Loop Error Components from the Analytical Limit (AL).

3. Determine the Actual Trip Setpoint (ATS). After the MTS is determined in step 1, the current Nominal Trip Setpoint for the function can be evaluated for acceptability. It may be desirable to move the current Nominal Trip Setpoint in a more conservative direction to obtain additional margin to the Analytical Limit and/or to allow for the full COT error allowance between the Actual Trip Setpoint and the Actual Allowable Value. Conversely, the current Nominal Trip Setpoint may be overly conservative resulting in reduced operating margin. If there is sufficient margin to the Analytical Limit, then it may be desirable to move the existing Nominal Trip Setpoint in the non-conservative direction to obtain additional operating margin. In all cases, the ATS must be set equal to or, preferably, conservative with respect to the MTS.

4. Determine the Actual Allowable Value (AV). After MAV is determined in step 2, the Actual Allowable Value can be determined based on the ATS. The AV for an increasing trip function is arrived at by adding the statistical combination (i.e., Square Root of the Sum of the Squares "SRRS") of the COT Loop Error Components (i.e., the loop error terms that are tested or quantified during the Channel Operational Test "COT") to the Actual Trip Setpoint (ATS). The AV for a decreasing trip function is arrived at by subtracting the statistical combination of the COT Loop Error Components from the Actual Trip Setpoint (ATS). In all cases, the AV must be set equal to or, preferably, conservative with respect to the MAV.

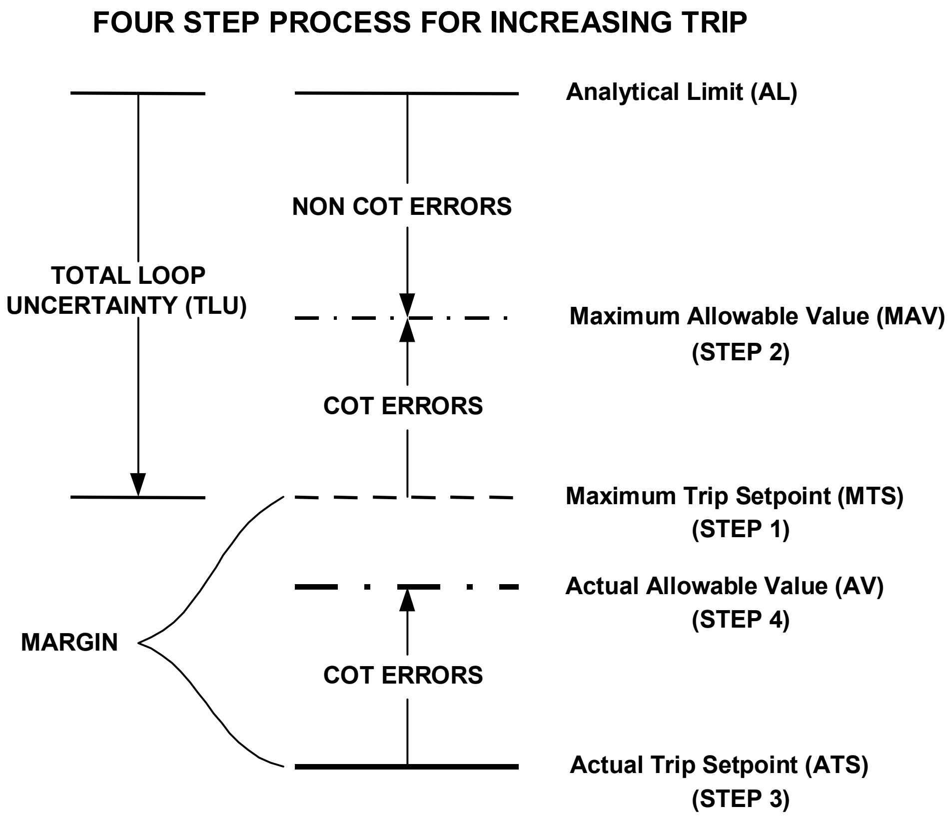


Figure 3.4-1

3.4.2 Backup RTS and ESFAS Trips and Permissives Not Credited in the Safety Analysis

A two step process is used to determine Allowable Values, LSSS, or Setting Limits for Backup RTS and ESFAS Functions at North Anna and Surry Power Stations that are not credited in the Safety Analysis. Backup RTS and ESFAS Trip Functions do not have a documented Analytical Limit; therefore, Minimum/Maximum Trip Setpoints and Allowable Values do not need to be calculated. In some cases for Backup Trips, a TLU (i.e., CSA Calculation) may not be available to perform the process described below. In such a case, the process is subjective and should be based on the best available information. The two step process is described below.

1. Determine the Actual Trip Setpoint (ATS). The current Nominal Trip Setpoint for the function should be evaluated for acceptability. It may be desirable to move the current Nominal Trip Setpoint in a more conservative direction to obtain additional margin to ensure the function will support the associated Primary Trip, if applicable. Conversely, the current Nominal Trip Setpoint may be overly conservative resulting in reduced operating margin. If there is sufficient margin with respect to the associated Primary Trip Analytical Limit (if applicable), then it may be desirable to move the existing Nominal Trip Setpoint in the non-conservative direction to obtain additional operating margin.

2. Determine the Actual Allowable Value (AV). The AV for an increasing trip function is arrived at by adding the statistical combination (i.e., Square Root of the Sum of the Squares “SRRS”) of the COT Loop Error Components (i.e., the loop error terms that are tested or quantified during the Channel Operational Test “COT”) to the Actual Trip Setpoint (ATS). The AV for a decreasing trip function is arrived at by subtracting the statistical combination of the COT Loop Error Components from the Actual Trip Setpoint (ATS).

3.4.3 Calculating Actual Allowable Values for North Anna and LSSS/Setting Limits for Surry

The existing Allowable Values for North Anna and LSSS/Setting Limit Values for Surry will be evaluated to determine if they are acceptable based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref 5.43). Examples of the methodology used for North Anna and Surry are provided below.

North Anna

The current Allowable Value for North Anna’s Pressurizer High Water Level Reactor Trip that appears in Improved Technical Specifications (Ref 5.8) will be evaluated based on the four step method described in Section 3.4.1 to ensure that it is bounded by the CSA Calculation of record and by the Safety Analysis assumptions documented in Technical Report NE-0994 (Ref. 5.1).

Given Information:

Analytical Limit/Safety Analysis Limit = 100.0 % Narrow Range Level (Ref. 5.1)

Current Allowable Value = ≤ 93.0 % Narrow Range Level (Ref. 5.8)

Current Trip Setpoint = 92.0 % Narrow Range Level (Refs. 5.2 & 5.54)

Total Loop Uncertainty/Channel Statistical Allowance = ± 6.887 % Narrow Range Level (Ref. 5.20)

Type of Trip = Increasing Trip, Normally Energized (Ref. 5.54)

Functional Group = Primary Trip, Single Parameter Protection Function (Refs. 5.1, 5.2 & 5.54)

Step 1 - Determine the Maximum (increasing trip) Trip Setpoint (MTS)

The Maximum Trip Setpoint (MTS) is equal to the Analytical Limit (AL) minus the Total Loop Uncertainty (TLU). Thus, the MTS is equal to:

$$MTS = 100.0\ \% - 6.887\ \%$$

$$MTS = 93.113\ \%\ \text{Narrow Range Level}$$

Step 2 - Determine the Maximum Allowable Value (MAV)

The Maximum Allowable Value (MAV) is equal to the Analytical Limit (AL) minus the NON-COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The NON-COT loop error components from CSA Calculation EE-0058, (Ref. 5.20) are detailed below:

Process Measurement Accuracy (PMA) = ± 2.000 % of span
Primary Element Accuracy (PEA) = ± 0.000 % of span
Sensor Calibration Accuracy + Sensor Measuring & Test Equipment (SCA+SMTE) = ± 0.744 % of span
Sensor Drift (SD) = ± 0.788 % of span
Sensor Pressure Effects (SPE) ± 5.917 % of span
Sensor Temperature Effects (STE) = ± 2.418 % of span
Sensor Power Supply Effect (SPSE) = ± 0.000 % of span
Module 1 Measuring and Test Equipment (M1MTE) = ± 0.153 % of span
Module 2 Measuring and Test Equipment (M2MTE) = ± 0.03 % of span
Rack Temperature Effect (RTE) = ± 0.500 % of span

Combining the NON-COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following NON-COT total error:

$$\text{NON-COT}_{\text{error}} = \pm [\text{PMA}^2 + \text{PEA}^2 + (\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{SPSE}^2 + \text{M1MTE}^2 + \text{M2MTE}^2 + \text{RTE}^2]^{1/2}$$

$$\text{NON-COT}_{\text{error}} = \pm [2.0^2 + 0.0^2 + (0.5+0.244)^2 + 0.788^2 + 5.917^2 + 2.418^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$$

$$\text{NON-COT}_{\text{error}} = \pm 6.805 \text{ \% Narrow Range Level}$$

The Maximum Allowable Value (MAV) for an increasing trip based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref. 5.43) is determined by subtracting the total NON-COT error from the Analytical Limit as shown below.

$$\text{MAV} = 100.0 \text{ \%} - 6.805 \text{ \%}$$

$$\text{MAV} = 93.195 \text{ \% Narrow Range Level}$$

Step 3 - Determine the Actual Trip Setpoint (ATS)

As determined in Step 1, the Maximum Trip Setpoint is equal to 93.113 % Narrow Range Level. The current Nominal Trip Setpoint for this function is 92.0 % Narrow Range Level. The current setpoint is conservative with respect to the Maximum Trip Setpoint. The nominal operating band for pressurizer level at 100 % power is 64.5 % Level ± 5.0 % Level. Subtracting the worst case normal operating level of 69.5 % from the Nominal Trip Setpoint of 92.0 % yields an operating margin of 22.5 % level. This operating margin encompasses the entire Total Loop Uncertainty and should allow for stable operation. Therefore, the current Nominal Trip Setpoint of 92.0 % Narrow Range Level will be retained.

Step 4 - Determine the Actual Allowable Value (AV)

For a single input protection function, the Allowable Value will be determined based on the following rack error components :

- Rack Calibration Accuracy (RCA)
- Rack Comparator Setting Accuracy (RCSA)
- Rack Drift (RD)

Note : The RCA and RCSA terms used above are typically defined in Dominion CSA Calculations as Module Tolerances and are designated as M_1, M_2 … M_n. For the purposes of this report, the Terms RCA_1, RCA_2, RCA_n and RCSA are the same as M_1, M_2 and M_n as used in the CSA Calculations.

There are two rack error terms that are not included in the calculation of the Allowable Value, Rack Measuring and Test Equipment (RMTE) and Rack Temperature Effect (RTE). These rack error terms are not included because they cannot be evaluated/quantified during the performance of the COT. Normally, M&TE is checked on a periodic basis (i.e., every quarter, six months or year). Rack Temperature Effects are not really ever checked or quantified. The Emergency Switchgear Room (the Relay Room at Kewaunee) is designed to maintain a relatively constant temperature. If the temperature changes by more than a nominal amount, the effects on the process instrumentation are normally not evaluated unless a loop or loops are deviating from their nominal process value(s) as indicated in the control room. In addition, by not using these error components, the calculated Allowable Value will be more conservative and easily quantified during or immediately subsequent to functional testing.

The methodology used to calculate the Allowable Value will be based on the Square Root Sum of the Squares (SRSS) of the three rack error terms listed above, noting that each rack error term will be treated as an independent variable. This method will yield a Rack Allowance and thus an Allowable Value that will be consistent with the assumptions of the CSA Calculation of record. Note the example below using the North Anna Pressurizer High Water Level Reactor Trip.

As determined in Step 2, the Maximum Allowable Value is equal to 93.195 % Narrow Range Level. The current ITS Allowable Value for this function is $\leq$ 93.0 % Narrow Range Level. The current ITS Allowable Value is conservative with respect to the Maximum Allowable Value (MAV) and is also conservative with respect to the calculated Allowable Value if it were based on the COT error components taken from Calculation EE-0058 (Ref. 5.20) as shown below.

The Actual Allowable Value (AV) is equal to the Actual Trip Setpoint plus the COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The COT loop error components from CSA Calculation EE-0058, (Ref. 5.20) are detailed below:

Module 1 – Westinghouse NLPG02 or NLPG05 Card (M1) = $\pm$ 0.10 % of span
Module 2 - Westinghouse NALG02 Card (M2) = $\pm$ 0.25 % of span
Rack Drift (RD) = $\pm$ 1.0 % of span

Combining the COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following COT total error:

$COT_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.10^2 + 0.25^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.036 % Narrow Range Level

As described in Step 4 above, the Actual Allowable Value (AV) for an increasing trip is determined by adding the total COT error to the Actual Trip Setpoint as shown below.

AV = 92.0 % + 1.036 %

AV = 93.036 % Narrow Range Level

The calculated Actual Allowable Value of 93.036 % Narrow Range Level will be rounded back to 93.0 % Narrow Range Level which is consistent with the current ITS Allowable Value for this function. Thus, the Actual Allowable Value for North Anna Pressurizer High Water Level Reactor Trip is:

AV = $\leq$ 93.0 % Narrow Range Level

Steps 1 through 4 as they apply for North Anna's Pressurizer High Water Level Reactor Trip are illustrated below in Figure 3.4-3a.

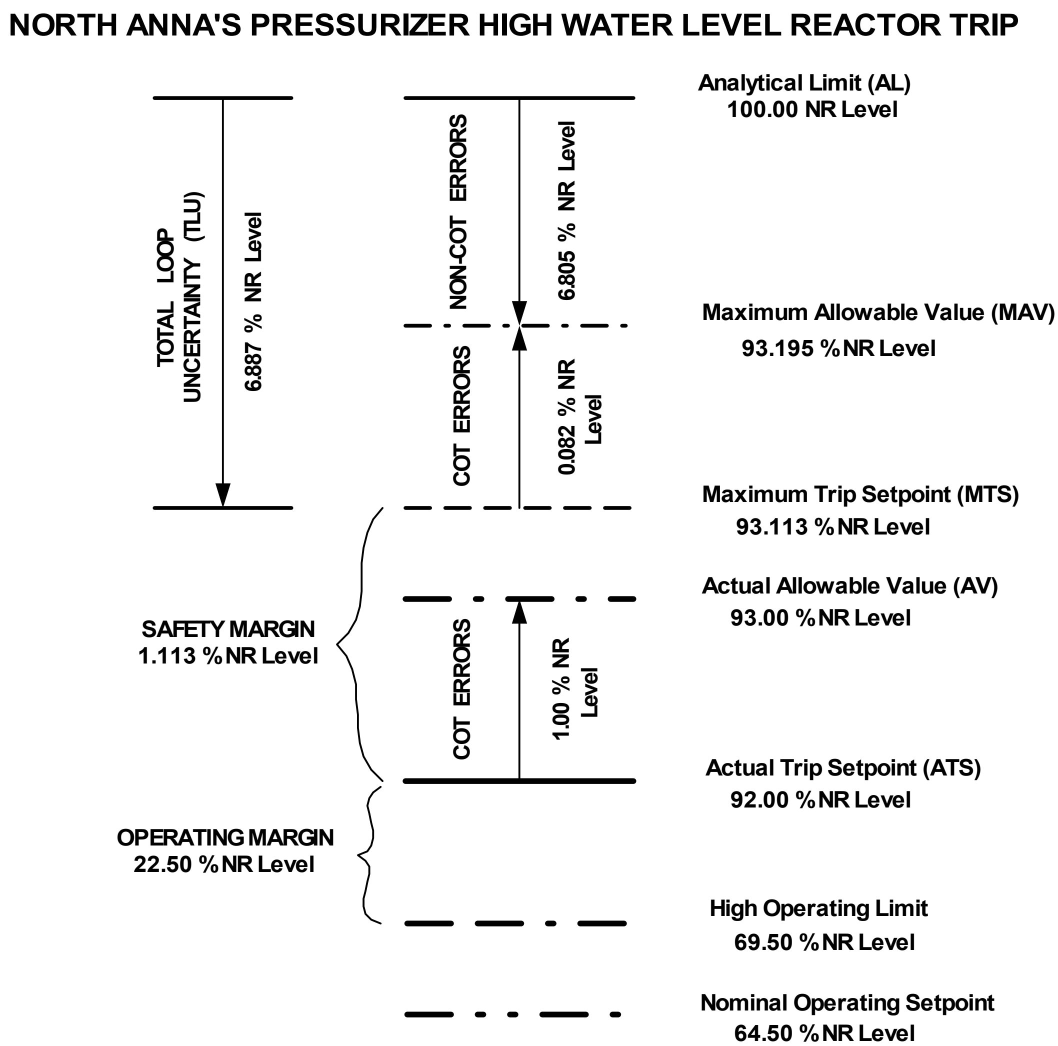


Figure 3.4-3a

Surry

The current Limiting Safety System Setting (LSSS) for Surry's Pressurizer High Water Level Reactor Trip that appears in Custom Technical Specifications (Ref. 5.7) will be evaluated based on the four step method described in Section 3.4.1 to ensure that it is bounded by the CSA Calculation of record and by the Safety Analysis assumptions documented in Technical Report NE-0994 (Ref. 5.1).

Given Information:

Analytical Limit/Safety Analysis Limit = 100.0 % Narrow Range Level (Ref. 5.1)

Current Allowable Value (i.e., LSSS) = ≤ 92.0 % Narrow Range Level (Ref. 5.7)

Current Trip Setpoint = 88.0 % Narrow Range Level (Refs. 5.2 & 5.67)

Total Loop Uncertainty/Channel Statistical Allowance = ± 7.894 % Narrow Range Level (Ref. 5.33)

Type of Trip = Increasing Trip, Normally Energized (Ref. 5.67)

Functional Group = Primary Trip, Single Parameter Protection Function (Refs. 5.1, 5.2 & 5.67)

Step 1 - Determine the Maximum (increasing trip) Trip Setpoint (MTS)

The Maximum Trip Setpoint (MTS) is equal to the Analytical Limit (AL) minus the Total Loop Uncertainty (TLU). Thus, the MTS is equal to:

$$MTS = 100.0\ \% - 7.894\ \%$$

$$MTS = 92.106\ \%\ \text{Narrow Range Level}$$

Step 2 - Determine the Maximum Allowable Value (MAV)

The Maximum Allowable Value (MAV) is equal to the Analytical Limit (AL) minus the NON-COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The NON-COT loop error components from CSA Calculation EE-0458 (Ref. 5.33) are detailed below:

Process Measurement Accuracy (PMA) = ± 2.000 % of span
Primary Element Accuracy (PEA) = ± 0.000 % of span
Sensor Calibration Accuracy + Sensor Measuring & Test Equipment (SCA+SMTE) = ± 0.817 % of span
Sensor Drift (SD) = ± 0.838 % of span
Sensor Pressure Effects (SPE) ± 6.984 % of span
Sensor Temperature Effects (STE) = ± 2.550 % of span
Sensor Power Supply Effect (SPSE) = ± 0.000 % of span
Module 1 Measuring and Test Equipment (M1MTE) = ± 0.00 % of span
Module 4 Measuring and Test Equipment (M4MTE) = ± 0.150 % of span
Rack Temperature Effect (RTE) = ± 0.500 % of span

Combining the NON-COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following NON-COT total error:

$$NON\ COT_{error} = \pm [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + RTE^2]^{1/2}$$

$$NON\ COT_{error} = \pm [2.0^2 + 0.0^2 + (0.5+0.317)^2 + 0.838^2 + 6.984^2 + 2.550^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

$$NON\ COT_{error} = \pm 7.805\ \%\ \text{Narrow Range Level}$$

The Maximum Allowable Value (MAV) for an increasing trip based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref. 5.43) is determined by subtracting the total NON-COT error from the Analytical Limit as shown below.

$$MAV = 100.0\ \% - 7.805\ \%$$

$$MAV = 92.195\ \%\ \text{Narrow Range Level}$$

Step 3 - Determine the Actual Trip Setpoint (ATS)

As determined in Step 1, the Maximum Trip Setpoint is equal to 92.106 % Narrow Range Level. The current Nominal Trip Setpoint for this function at Surry is 88.0 % Narrow Range Level. The current setpoint is conservative with respect to the Maximum Trip Setpoint. The nominal operating band for pressurizer level at 100 % power is 53.7 % Level $\pm$ 5.0 % Level. Subtracting the worst case normal operating level of 58.7 % from the Nominal Trip Setpoint of 88.0 % yields an operating margin of 29.3 % level. This operating margin encompasses the entire Total Loop Uncertainty and should allow for stable operation. Therefore, the current Nominal Trip Setpoint of 88.0 % Narrow Range Level will be retained.

Step 4 - Determine the Actual Allowable Value (AV)

As determined in Step 2, the Maximum Allowable Value is equal to 92.195 % Narrow Range Level. The current LSSS value for this function is $\leq$ 92.0 % Narrow Range Level. The current LSSS value is conservative with respect to the Maximum Allowable Value (MAV) however; it is non-conservative with respect to the calculated Allowable Value if it were based on the COT error components taken from Calculation EE-0458 (Ref. 5.33) as shown below.

The Actual Allowable Value (i.e., LSSS) is equal to the Actual Trip Setpoint plus the COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The COT loop error components from CSA Calculation EE-0458 (Ref. 5.33) are detailed below:

Module 1 – Technipower PM-38 or NUS LPS801 Loop Power Supply (M1) = $\pm$ 0.00 % of span
Module 4 – Hagan Model 139-118 or NUS SAM/DAM 801 Module (M4) = $\pm$ 0.50 % of span
Rack Drift (RD) = $\pm$ 1.0 % of span

Combining the COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following COT total error:

$$COT_{error} = \pm\ (M1^2 + M4^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm\ (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

$$COT_{error} = \pm\ 1.12\ \%\ \text{Narrow Range Level}$$

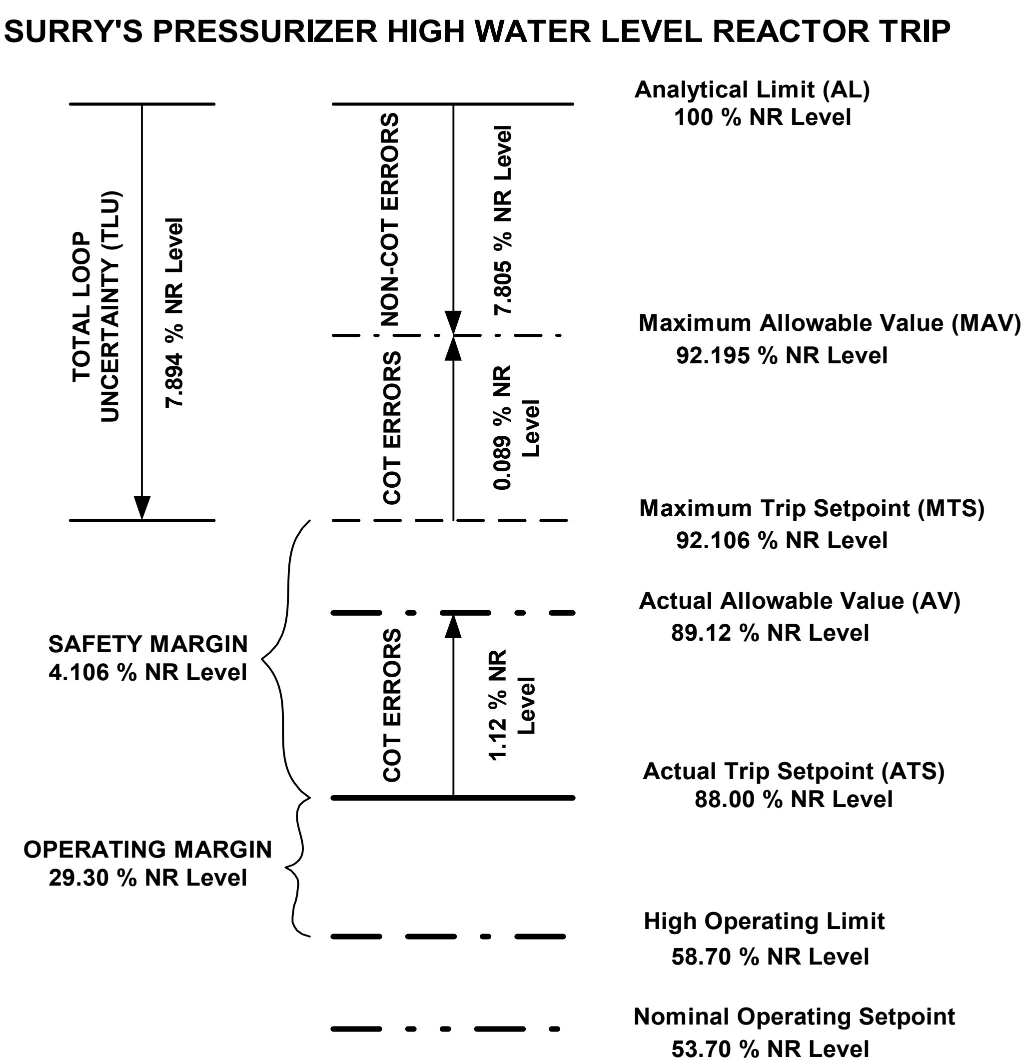
As described in Step 4 above, the Actual Allowable Value (AV) for an increasing trip is determined by adding the total COT error to the Actual Trip Setpoint as shown below.

AV = 88.00 % + 1.12 % = 89.12 % Narrow Range Level

The current CTS LSSS of ≤ 92.0 % Narrow Range Level will be changed to ≤ 89.12 % Narrow Range Level as shown above.

AV (i.e., LSSS) = ≤ 89.12 % Narrow Range Level

Steps 1 through 4 as they apply for Surry's Pressurizer High Water Level Reactor Trip are illustrated below in Figure 3.4-3b.



<u>**Figure 3.4-3b**</u>

3.5 Methodology for Determining Kewaunee's "Allowable Value" and "Limiting Trip Setpoint" Based on TSTF-493 and RIS 2006-17

Kewaunee's setpoint methodology is identical to that of Surry and North Anna noting that the requirements and revised terminology imposed by TSTF-493 and RIS 2006-17 (Refs. 5.99 and 5.100) will be incorporated into the methodology as appropriate. Kewaunee Power Station has chosen to implement TSTF-493, Revision 4, Option B as part of the conversion to Improved Technical Specifications. As stated above in Section 2.2.6, TSTF-493, Revision 4, Option B allows for the relocation of the Allowable Values associated with LCO's 3.3.1, 3.3.2, 3.3.5, 3.3.6, and 3.3.7 from Section 3.3 of Technical Specifications to a Licensee controlled program as defined in ITS Section 5.5.16. The Licensee controlled program is defined in ITS Section 5.5.16 as the "Setpoint Control Program".

The Setpoint Control Program establishes the requirements for ensuring that setpoints for automatic protective devices are initially within and remain within the Technical Specification requirements. The Setpoint Control Program will govern the process for implementing changes to instrumentation setpoints and will describe the setpoint methodology used to ensure that setpoints are established in accordance with the requirements of Methods 1 or 2 from ISA-RP67.04.02-2000 and ISA-RP67.04-Part II-1994, TSTF-493, Revision 4, Option B, and RIS 2006-17. The automatic protective devices related to variables that perform a significant safety function at Kewaunee Power Station as delineated by 10 CFR 50.36(c)(1)(ii)(A) are described in detail in Sections 4.5, 4.6, and 4.7.

3.5.1 Primary RPS and ESFAS Trips, Permissives, and Other LCO's Credited in the Kewaunee Safety Analysis

A four step process is used to determine the Allowable Value (AV), Limiting Trip Setpoint (LTSP), Nominal Trip Setpoint (NTSP), and the As Found Tolerance (AFT) for Trip Functions, Permissives, and other LCO's at Kewaunee Power Station that are credited in the Safety Analysis. This four step process is based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref 5.43) and the revised terminology described in TSTF-493, Revision 4, and RIS 2006-17. In the order of operation, the four steps are described below and they are illustrated in Figure 3.5-1

1. Determine the Minimum (decreasing trip) or Maximum (increasing trip) Limiting Trip Setpoint (LTSP). The Maximum Limiting Trip Setpoint is arrived at by subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) (also known as the Safety Analysis Limit). The Minimum Limiting Trip Setpoint is arrived at by adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL).

2. Determine the Minimum (decreasing trip) or Maximum (increasing trip) Allowable Value (AV). This Maximum Allowable Value is arrived at by subtracting the statistical combination (i.e., Square Root of the Sum of the Squares "SRRS") of the NON COT Loop Error Components (i.e., the loop error terms that are not tested or quantified during the Channel Operational Test "COT") from the Analytical Limit (AL). The Minimum Allowable Value is arrived at by adding the statistical combination of the NON COT Loop Error Components to the Analytical Limit (AL).

3. Determine the Nominal Trip Setpoint (NTSP). After the LTSP is determined in step 1, the current Nominal Trip Setpoint for the function can be evaluated for acceptability. It may be desirable to move the current Nominal Trip Setpoint in a more conservative direction to obtain additional margin to the Analytical Limit and/or to allow for the full COT error allowance between the Nominal Trip Setpoint and the As Found Tolerance (AFT). Conversely, the current Nominal Trip Setpoint may be overly conservative resulting in reduced operating margin. If there is sufficient margin to the Analytical Limit, then it may be desirable to move the existing Nominal Trip Setpoint in the non-conservative direction to obtain additional operating margin. In all cases, the NTSP must be set equal to or, preferably, conservative with respect to the LTSP.

4. Determine the As Found Tolerance (AFT). Note that the As Found Tolerance for Kewaunee is equivalent to the Allowable Values/Limiting Safety System Settings/Setting Limits used for North Anna and Surry. After the AV is determined in step 2, the As Found Tolerance can be determined based on the NTSP. The AFT for an increasing trip function is arrived at by adding the statistical combination (i.e., Square Root of the Sum of the Squares “SRRS”) of the COT Loop Error Components (i.e., the loop error terms that are tested or quantified during the Channel Operational Test “COT”) to the Nominal Trip Setpoint (NTSP). The AFT for a decreasing trip function is arrived at by subtracting the statistical combination of the COT Loop Error Components from the Nominal Trip Setpoint. In all cases, the As Found Tolerance must be set equal to or, preferably, conservative with respect to the Allowable Value.

Kewaunee's Four Step Process

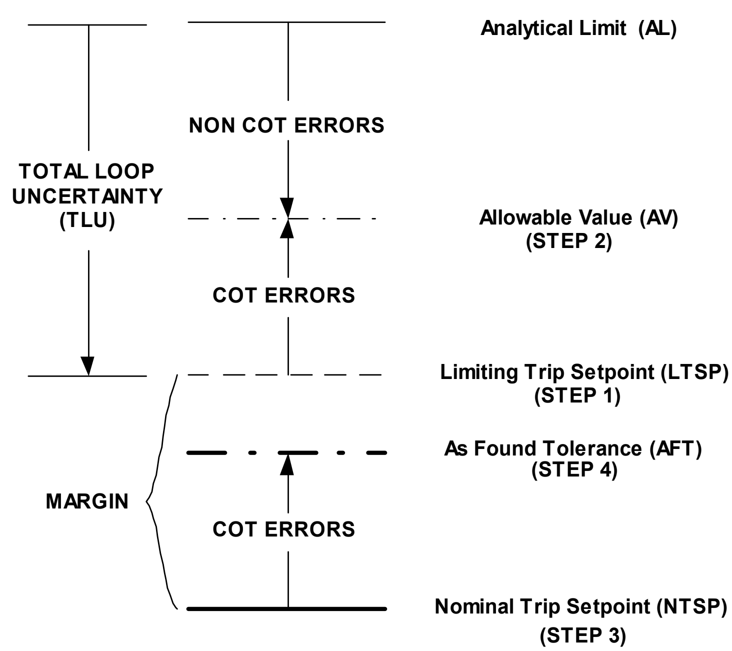


Figure 3.5-1

3.5.2 Backup RPS and ESFAS Trips, Permissives, and Other LCO's Not Credited in the Kewaunee Safety Analysis

A two step process is used to determine the As Found Tolerance for Backup RPS and ESFAS Functions at Kewaunee Power Station that are not credited in the Safety Analysis. Backup RPS/ ESFAS and other LCO's Trip Functions do not have a documented Safety Limit; therefore, Limiting Trip Setpoints and Allowable Values do not need to be calculated. In some cases for Backup Trips, a TLU (i.e., CSA Calculation) may not be available to perform the process described below. In such a case, the process is subjective and should be based on the best available information. The two step process is described below.

1. Determine the Nominal Trip Setpoint (NTSP). The current Nominal Trip Setpoint for the function should be evaluated for acceptability. It may be desirable to move the current Nominal Trip Setpoint in a more conservative direction to obtain additional margin to ensure the function will support the associated Primary Trip, if applicable. Conversely, the current Nominal Trip Setpoint may be overly conservative resulting in reduced operating margin. If there is sufficient margin with respect to the associated Primary Trip Analytical Limit (if applicable), then it may be desirable to move the existing Nominal Trip Setpoint in the non-conservative direction to obtain additional operating margin.

2. Determine the As Found Tolerance (AFT). The AFT for an increasing trip function is arrived at by adding the statistical combination (i.e., Square Root of the Sum of the Squares "SRRS") of the COT Loop Error Components (i.e., the loop error terms that are tested or quantified during the Channel Operational Test "COT") to the Nominal Trip Setpoint (NTSP). The AFT for a decreasing trip function is arrived at by subtracting the statistical combination of the COT Loop Error Components from the Nominal Trip Setpoint (NTSP).

3.5.3 Calculating Limiting Trip Setpoints, Allowable Values, and As Found Tolerances for Kewaunee Power Station

Kewaunee's Steam Generator Water Level High - High

Currently, Kewaunee's Custom Technical Specifications (Ref. 5.90) does not specify a Setting Limit for the Steam Generator High-High Water Level ESFAS Trip. This function will be included in the Setpoint Control Program in accordance with ITS Table 3.3.2.1, item 5.b. Based on the requirements of ITS Section 5.5.16, this function will be evaluated based on the four step method described in Section 3.5.1 to ensure that it is bounded by the CSA Calculation of record and by the Safety Analysis assumptions documented in Technical Report NE-0994 (Ref. 5.1). The example given below will be adjusted to include the revised terminology and requirements specified in TSTF-493, Revision 4 and RIS 2006-17 to support the conversion to ITS and the implementation of the Kewaunee Setpoint Control Program.

Given Information:

Analytical Limit = 100.0 % Narrow Range Level (Ref. 5.1)

Current CTS Setting Limit = not specified

Current Nominal Trip Setpoint = 66.5 % Narrow Range Level (Ref. 5.112)

Total Loop Uncertainty/Channel Statistical Allowance = (+) 3.967 to (+) 7.923 % Narrow Range Level (only the most positive value is used for the analysis) (Ref. 5.97)

Type of Trip = Increasing Trip, Normally Energized (Ref. 5.112)

Functional Group = Primary Trip, Single Parameter Protection Function (Refs. 5.1 and 5.112)

Step 1 - Determine the Limiting Trip Setpoint (LTSP)

The Limiting Trip Setpoint (LTSP) is equal to the Analytical Limit (AL) minus the Total Loop Uncertainty (TLU). Thus, the LTSP is equal to:

$$LTSP = 100.0\ \% - 7.923\ \%$$

$$LTSP = 92.077\ \%\ \text{Narrow Range Level}$$

Step 2 - Determine the Allowable Value (AV)

The Allowable Value (AV) is equal to the Analytical Limit (AL) minus the NON-COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The NON-COT loop error components from Kewaunee CSA Calculation C11116 (Ref. 5.97) are detailed below:

Systematic Error (SE) = ± 0.000 % of span
Process Measurement Accuracy (PMA_3) = ± 5.945 % of span
Primary Element Accuracy (PEA) = ± 0.000 % of span
Sensor Calibration Accuracy + Sensor Measuring & Test Equipment (SCA+SMTE) = ± 0.467 % of span
Sensor Drift (SD) = ± 0.280 % of span
Sensor Pressure Effects (SPE) ± 0.577 % of span
Sensor Temperature Effects (STE) = ± 1.241 % of span
Sensor Power Supply Effect (SPSE) = ± 0.060 % of span
Module 1 Measuring and Test Equipment (M1MTE) = ± 0.000 % of span
Module 3 Measuring and Test Equipment (M3MTE) = ± 0.200 % of span
Rack Temperature Effect (RTE) = ± 0.500 % of span

Combining the NON-COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following NON-COT total error:

$$\text{NON COT}_{error} = SE + PMA_3 \pm [PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.0 + 5.945 \pm [0.0^2 + (0.25+0.217)^2 + 0.280^2 + 0.577^2 + 1.241^2 + 0.060^2 + 0.0^2 + 0.20^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = 7.514 \text{ \% Narrow Range Level}$$

The Allowable Value (AV) for an increasing trip based on the requirements of Methods 1 or 2 as described in ISA-RP67.04.02-2000 (Ref. 5.43) is determined by subtracting the total NON-COT error from the Analytical Limit as shown below.

$$AV = 100.0 \text{ \%} - 7.514 \text{ \%}$$

$$AV = 92.486 \text{ \% Narrow Range Level}$$

Step 3 - Determine the Nominal Trip Setpoint (NTSP)

As determined in Step 1, the Limiting Trip Setpoint is equal to 92.077 % Narrow Range Level. The current Nominal Trip Setpoint for this function at Kewaunee is 66.5 % Narrow Range Level. The Nominal Trip Setpoint is conservative with respect to the Limiting Trip Setpoint. The nominal operating band for Steam Generator Level at 100 % power is 44.0 % Level ± 5.0 % Level (Refs. 5.134 and 5.135). Subtracting the worst case normal operating level of 49.0 % from the Nominal Trip Setpoint of 66.5 % yields an operating margin of 17.5 % level. This operating margin encompasses the entire Total Loop Uncertainty and should allow for stable operation. Therefore, the current Nominal Trip Setpoint of 66.5 % Narrow Range Level will be retained.

Step 4 - Determine the As Found Tolerance (AFT)

As determined in Step 2, the Allowable Value (AV) is equal to 92.486 % Narrow Range Level. The As Found Tolerance will be based on the COT error components taken from Calculation C11116 (Ref. 5.97) as shown below.

The As Found Tolerance is equal to the Nominal Trip Setpoint plus the COT loop error components taken from the Total Loop Uncertainty (TLU) calculation. The COT loop error components from CSA Calculation C11116 are detailed below:

Module 1 – Foxboro or NUS Loop Power Supply (M1) = $\pm$ 0.00 % of span
Module 3 – Foxboro or NUS Bistable Module (M3) = $\pm$ 0.50 % of span
Rack Drift (RD) = $\pm$ 1.0 % of span

Combining the COT loop error components using the Square Root of the Sum of the Squares (SRSS) method as described in Dominion Standard STD-EEN-0304 (Ref. 5.5), we have the following COT total error:

$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.12 % Narrow Range Level

As described in Step 4 above, the As Found Tolerance (AFT) for an increasing trip is determined by adding the total COT error to the Nominal Trip Setpoint as shown below.

AFT = 66.5 % + 1.12 % = 67.62 % Narrow Range Level

This As Found Tolerance of 67.62 % Narrow Range Level will be included in the Setpoint Control Program to support Kewaunee's conversion to ITS, noting the Nominal Trip Setpoint is equal to 66.5 % Narrow Range Level. The Nominal Trip Setpoint and the As Found Tolerance are both set below the Allowable Value of 92.486 % Narrow Range Level and the Limiting Trip Setpoint of 92.077 % Narrow Range Level.

As Found Tolerance (AFT) = 66.5 % Narrow Range Level $\pm$ 1.12 % Narrow Range Level
As Left Tolerance (ALT) = 66.5 % Narrow Range Level $\pm$ 0.50 % Narrow Range Level[(1)]

Steps 1 through 4 as they apply for Kewaunee's Steam Generator High-High Water Level Reactor Trip are illustrated below in Figure 3.5-2.

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(1) ALT = COT error minus Rack Drift (RD) = $\pm (0.0^2 + 0.5^2)^{1/2} = \pm$ 0.5 % of span = $\pm$ 0.5 % NR Level

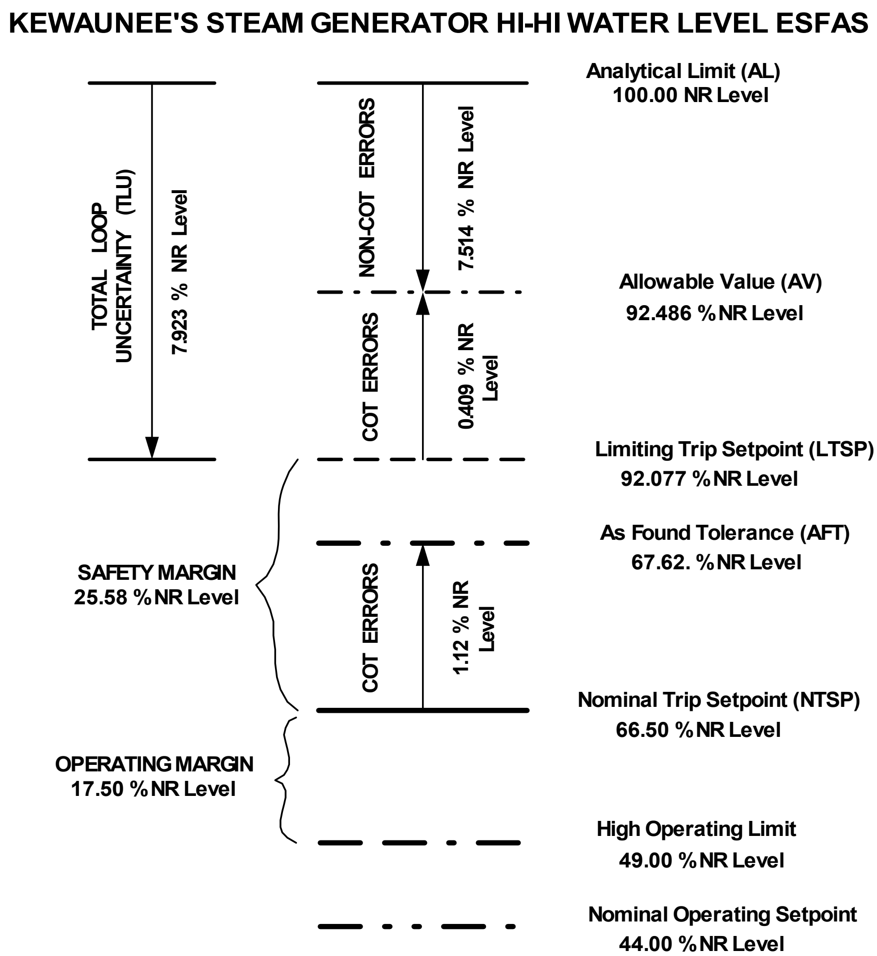


Figure 3.5-2

In addition to the above, TSTF-493, Revision 4 and RIS 2006-17 also stipulate that the As Left Tolerance be specified as part of the Setpoint Control Program. The As Left Tolerances will be specified for Kewaunee's RPS instrumentation, ESFAS instrumentation, and other instrumentation associated with LCO's 3.3.5, 3.3.6, and 3.3.7 in Sections 4.5, 4.6, and 4.7, respectively. In general, for single input parameters, the As Left Tolerance will be equal to the calibration accuracy of the module or the SRSS of calibration accuracies of the modules used to develop the trip function. For multiple input parameters, the As Left Tolerance will be developed as described in Sections 4.5, 4.6, and 4.7.

4.0 RESULTS

4.1 Allowable Values for North Anna ITS Table 3.3.1-1 (RTS Instrumentation)

Reactor Trips

4.1.1 Manual Reactor Trip

Allowable Value = N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

4.1.2 Power Range Neutron Flux High Setpoint Reactor Trip

Allowable Value : $\leq$ 110.0 % RTP (Refs. 5.1, 5.8, 5.15 & 5.46)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 111.702 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 112.113 % RTP. The Actual Nominal Trip Setpoint of 109.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 110.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 110.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 109.0 % RTP.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0063 (Ref. 5.15) are given below. The COT and NON COT error components are used in Figure 4.1.2 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + PMA_3^2 + M1MTE^2 + M5MTE^2 + RTE^2)^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm (1.667^2 + 4.167^2 + 1.667^2 + 0.110^2 + 0.943^2 + 0.5^2)^{1/2}$$

$$\text{NON COT}_{error} = \pm 4.906 \text{ \% of span} = \pm 5.887 \text{ \% RTP}$$

$$\text{COT}_{error} = \pm (M1^2 + M5^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.1^2 + 0.833^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.305 \text{ \% of span} = \pm 1.566 \text{ \% RTP}$$

See Figure 4.1.2 for specific details.

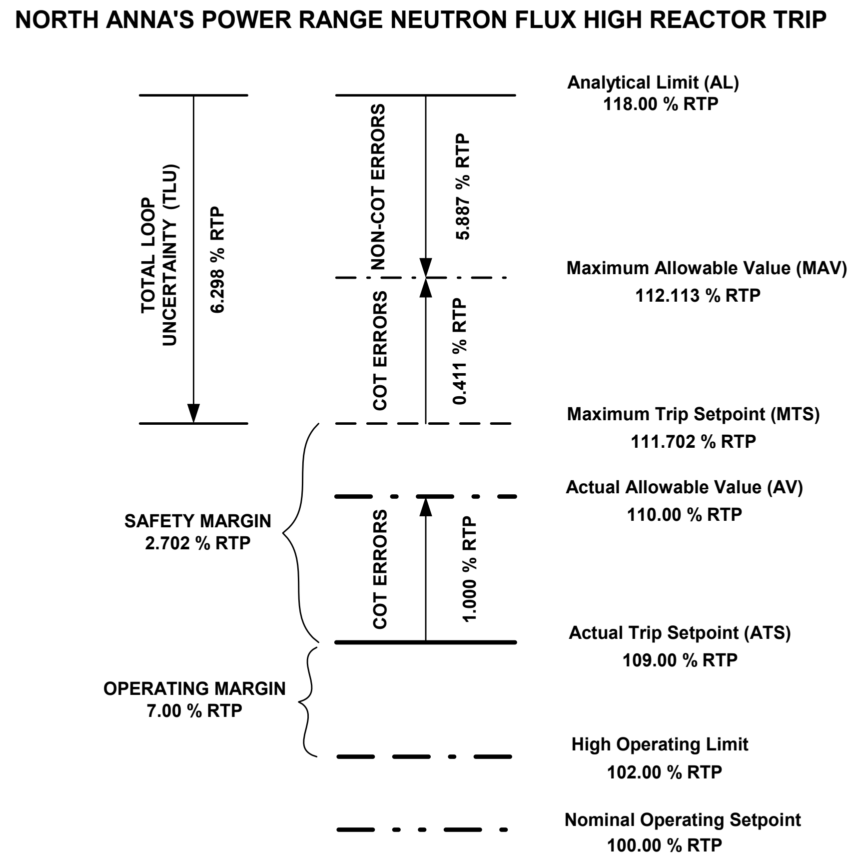


Figure 4.1.2

4.1.3 Power Range Neutron Flux Low Setpoint Reactor Trip

Allowable Value : $\leq$ 26.0 % RTP (Refs. 5.1, 5.8, 5.15 & 5.46)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 28.702 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 29.113 % RTP. The Actual Nominal Trip Setpoint of 25.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 26.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 26.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 25.0 % RTP.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0063 (Ref. 5.15) are given below. The COT and NON COT error components are used in Figure 4.1.3 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + PMA_3^2 + M1MTE^2 + M6MTE^2 + RTE^2)^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm (1.667^2 + 4.167^2 + 1.667^2 + 0.110^2 + 0.943^2 + 0.5^2)^{1/2}$$

NON $COT_{error} = \underline{+}$ 4.906 % of span = $\underline{+}$ 5.887 % RTP

$COT_{error} = \underline{+} (M1^2 + M6^2 + RD^2)^{1/2}$

$COT_{error} = \underline{+} (0.1^2 + 0.833^2 + 1.0^2)^{1/2}$

$COT_{error} = \underline{+}$ 1.305 % of span = $\underline{+}$ 1.566 % RTP

See Figure 4.1.3 for specific details.

NORTH ANNA'S POWER RANGE NEUTRON FLUX LOW SETPOINT REACTOR TRIP

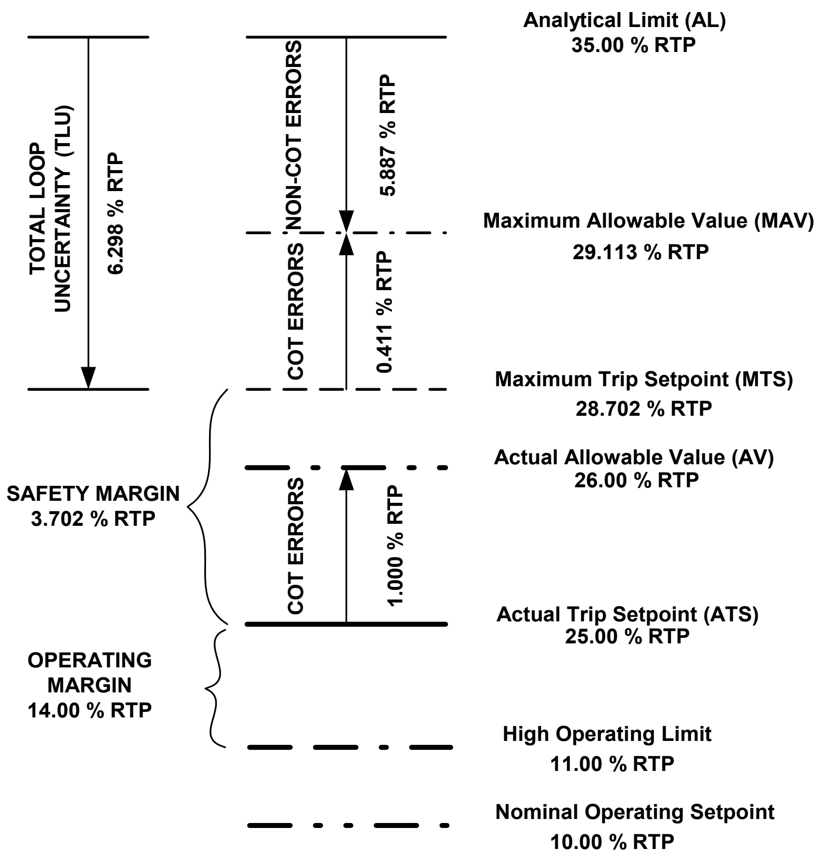


Figure 4.1.3

4.1.4 Power Range Neutron Flux High Positive Rate Reactor Trip

Allowable Value : $\leq$ 5.5 % RTP @ $\geq$ 2 Seconds (Refs. 5.1, 5.8 & 5.46)

This Allowable Value of $\leq$ 5.5 % RTP @ $\geq$ 2.0 Seconds is based on maintaining a Nominal Trip Setpoint value of 5.0 % RTP @ 2.25 Seconds. The distance in percent of span between the Nominal Trip Setpoint and the Allowable Value is based on the time constant tolerance of $\pm$ 10.0 % for the NIS Rate Lag Derivative Amplifier. This Allowable Value is calculated based on the dynamics involved with the trip and does not conform to the static methodologies described in Section 3.0.

Note : This trip function is not credited in the UFSAR Chapter 15 Safety Analysis. A CSA Calculation has not been performed for this function.

4.1.5 Power Range Neutron Flux High Negative Rate Reactor Trip

Allowable Value : $\leq$ 5.5 % RTP @ $\geq$ 2 Seconds (Refs. 5.1, 5.8 & 5.46)

This Allowable Value of $\leq$ 5.5 % RTP @ $\geq$ 2.0 Seconds is based on maintaining a Nominal Trip Setpoint value of (-) 5.0 % RTP @ 2.25 Seconds. The distance in percent of span between the Nominal Trip Setpoint and the Allowable Value is based on the time constant tolerance of $\pm$ 10.0 % for the NIS Rate Lag Derivative Amplifier. This Allowable Value is calculated based on the dynamics involved with the trip and does not conform to the static methodologies described in Section 3.0.

Note : This trip function is not credited in the UFSAR Chapter 15 Safety Analysis. A CSA Calculation has not been performed for this function.

4.1.6 Intermediate Range Neutron Flux High Reactor Trip

Allowable Value : $\leq$ 40.0 % RTP (Refs. 5.1, 5.8, 5.16 & 5.57)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 85.66 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 88.217 % RTP. The Actual Nominal Trip Setpoint of 35.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 40.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 40.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 35.0 % RTP. See Figure 4.1.6 for specific details.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0738 (Ref. 5.16) are given below. The COT and NON COT error components are used in Figure 4.1.6 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm (EA^2 + PMA^2 + PEA^2 + SCA^2 + SD^2 + SPE^2 + M4MTE^2 + RTE^2 + RRA^2)^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm (0.0^2 + 8.5^2 + 0.0^2 + 0.5^2 + 1.0^2 + 0.0^2 + 4.654^2 + 0.5^2 + 1.0^2)^{1/2}$$

NON $COT_{error} = \pm$ 9.819 % of span = $\pm$ 11.783 % RTP

$COT_{error} = \pm (M4^2 + RD^2)^{1/2}$

$COT_{error} = \pm (3.530^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 3.669 % of span = $\pm$ 4.403 % RTP

See Figure 4.1.6 for specific details.

NORTH ANNA'S INTERMEDIATE RANGE HIGH FLUX REACTOR TRIP

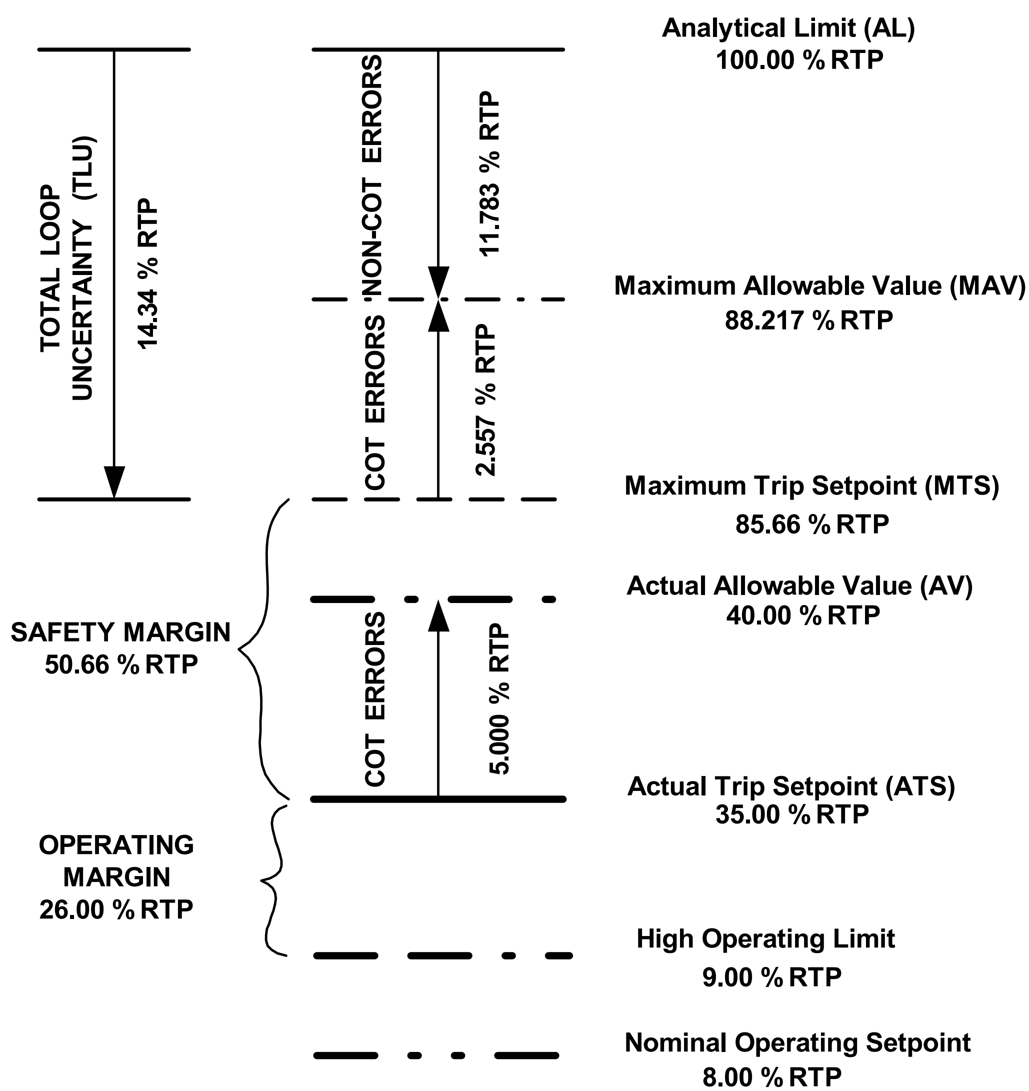


Figure 4.1.6

4.1.7 Source Range Neutron Flux High Reactor Trip

Allowable Value : $\leq$ 1.3 * 10^5 CPS (Refs. 5.1, 5.8, 5.17 & 5.51)

Subtracting the Total Loop Uncertainty (TLU = + 0.84 * 10^5 and - 0.46 * 10^5) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 1.76 * 10^5 Counts Per Second [(1)]. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 2.36 * 10^5 Counts Per Second (CPS). The Actual Nominal Trip Setpoint of 1.0 * 10^5 CPS is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 1.3 * 10^5 CPS is conservative with respect to the Maximum Allowable Value. The current Allowable Value of 1.3 * 10^5 CPS is more conservative than the calculated COT error and will be retained.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0710 (Ref. 5.17) are given below. The COT and NON COT error components are used in Figure 4.1.7 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2 + RRA^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + (0.0+0.0)^2 + 0.0^2 + 0.0^2 + 0.0^2 + 1.065^2 + 1.0^2 + 0.5^2 + 0.0^2]^{1/2}$

$\text{NON COT}_{error} = \pm$ 1.554 % of linear span

= + 0.24*10^5 CPS and – 0.19*10^5 CPS (Based on the Nominal Trip setpoint of 1.0*10^5 CPS)

= 0.24*10^5 CPS [(2)]

$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (1.617^2 + 1.9^2 + 1.9^2)^{1/2}$

$\text{COT}_{error} = \pm$ 3.136 % of linear span

= + 0.54*10^5 CPS and – 0.35*10^5 CPS (Based on the Nominal Trip Setpoint of 1.0*10^5 CPS)

= 0.35*10^5 CPS [(2)]

---

(1) Nominal Trip Setpoint = 1.0 * 10^5 CPS ⇒ log 1.0 * 10^5 = 5.0 (on a 0 to 6 Decade scale)
Analytical Limit = 2.6 * 10^5 CPS ⇒ log 2.6 * 10^5 = 5.41497 (on a 0 to 6 Decade scale)
Full CSA = $\pm$ 4.412 % of linear span ⇒ (4.412 %/100 %) * 6 Decades = $\pm$ 0.26472 Decade
High Trip Setpoint = 5.0 + 0.26472 = 5.26472 ⇒ antilog 5.26472 = 1.84 * 10^5
Low Trip Setpoint = 5.0 - 0.26472 = 4.73528 ⇒ antilog 4.73528 = 0.54 * 10^5
CSA(+) = 1.84 * 10^5 – 1.0 * 10^5 = 0.84 * 10^5 and CSA(-) = 1.0 * 10^5 – 0.54 * 10^5 = 0.46 * 10^5
Full CSA = (+) 0.84 * 10^5 CPS and (-) 0.46 * 10^5 CPS

(2) The most conservative value is used regardless of sign.

NORTH ANNA'S SOURCE RANGE NEUTRON FLUX HIGH REACTOR TRIP

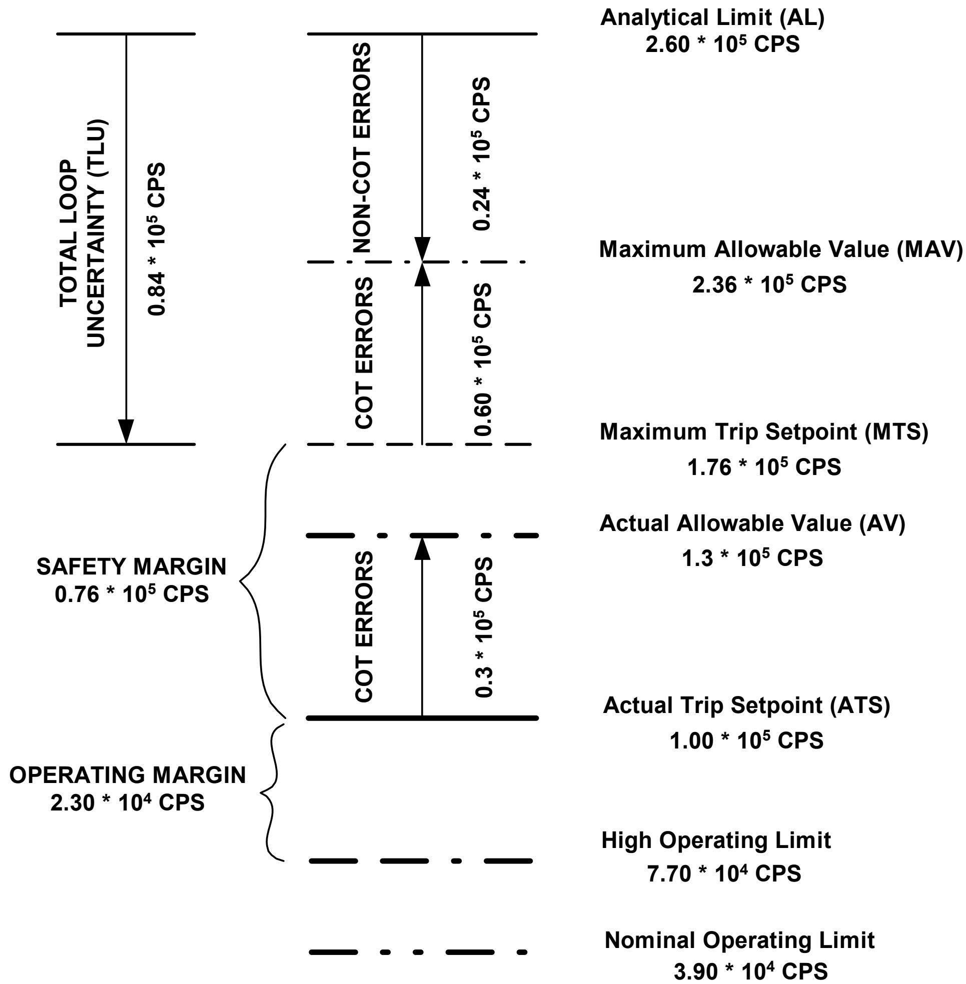


Figure 4.1.7

4.1.8 Overtemperature ΔT Reactor Trip

Allowable Value : See below (Refs. 5.1, 5.8, 5.18 & 5.47)

" The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 2.0 % of the ΔT span " (Note that 2.0 % of the ΔT span is equal to 3.0 % ΔT Power)

The Overtemperature ΔT (OTΔT) Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. Further, the OTΔT Reactor Trip will be analyzed for the following three conditions:

- OTΔT Reactor Trip with no FΔI
- OTΔT Reactor Trip with (+) FΔI
- OTΔT Reactor Trip with (-) FΔI

Note: FΔI is the Delta Flux Penalty generated from the Upper and Lower Power Range Neutron Flux Detectors (i.e., Q_U and Q_L).

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields the following Maximum Trip Setpoints (MTS) for the three OTΔT Reactor Trip conditions described above:

- MTS for OTΔT Reactor Trip with no FΔI = 139.0 % - 6.716 % = 132.28 % ΔT Power
- MTS for OTΔT Reactor Trip with (+) FΔI = 145.0 % - 9.005 % = 135.99 % ΔT Power
- MTS for OTΔT Reactor Trip with (-) FΔI = 144.0 % - 8.378 % = 135.62 % ΔT Power

Subtracting the NON COT error components from the Analytical Limit yields the following Maximum Allowable Values (MAV) for the three OTΔT Reactor Trip conditions described above:

- MAV for OTΔT Reactor Trip with no FΔI = 139.0 % - 5.214 % = 133.79 % ΔT Power
- MAV for OTΔT Reactor Trip with (+) FΔI = 145.0 % - 7.949 % = 137.05 % ΔT Power
- MAV for OTΔT Reactor Trip with (-) FΔI = 144.0 % - 7.230 % = 136.77 % ΔT Power

For the most limiting condition (i.e., OTΔT Reactor Trip with no FΔI) the Actual Nominal Trip Setpoint of 126.4 % ΔT Power (e.g., based on T_{AVG} = 586.8 ^{o}F) is conservative with respect to the Maximum Trip Setpoint of 132.28 % ΔT Power and the Actual Allowable Value of 129.4 % ΔT Power is conservative with respect to the Maximum Allowable Value of 133.79 % ΔT Power. This Allowable Value of ≤ 129.4 % ΔT Power is based on maintaining a Nominal Trip Setpoint value of 126.4 % ΔT Power. Note that this analysis is based on static conditions such that dynamic components are not considered.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0434 (Ref. 5.18) with the appropriate modifications described in Section 3.2 for the OTΔT Reactor Trip are given below. The COT and NON COT error components are used in Figure 4.1.8 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV) for the most limiting condition.

OTΔT Reactor Trip with no FΔI

NON COT_{error} = $[EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_1^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$

Where the following RMTE Terms are taken from Calculation EE-0434 (Ref. 5.18) :

$RMTE_1$ = ΔT Channel Measuring and Test Equipment = $(M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M6MTE^2 + M15MTE^2)^{1/2}$

$RMTE_1 = (0.23^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.12^2 + 0.09^2 + 0.06^2)^{1/2} = 0.488$ % of span

$RMTE_2$ = T_{AVG} Channel Measuring and Test Equipment = $(M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M7MTE^2 + M20MTE^2 + M35MTE^2)^{1/2}$

$RMTE_2 = (0.23^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.12^2 + 0.09^2 + 0.06^2 + 0.06^2)^{1/2} = 0.491$ % of span

$RMTE_3$ = Pressurizer Pressure Channel Measuring and Test Equipment = $(M36MTE^2 + M37MTE^2)^{1/2}$

$RMTE_3 = (0.08^2 + 0.06^2)^{1/2} = 0.100$ % of span

$RMTE_4$ = FΔI Channel Measuring and Test Equipment = $(M38MTE^2 + M39MTE^2 + M40MTE^2 + M41MTE^2)^{1/2}$

$RMTE_4 = (0.06^2 + 0.06^2 + 0.09^2 + 0.06^2)^{1/2} = 0.137$ % of span

$RMTE_5$ = OTΔT Setpoint Summator Measuring and Test Equipment = M42MTE

$RMTE_5 = 0.120$ % of span

$RMTE_6$ = OTΔT Reactor Trip Bistable Measuring and Test Equipment = M47MTE

$RMTE_6 = 0.060$ % of span

Thus, the NON COT_{error} is equal to:

NON COT_{error} = $[0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.425)^2 + 0.45^2 + 2.013^2 + 0.00^2 + 0.488^2 + 0.491^2 + 0.100^2 + 0.137^2 + 0.120^2 + 0.060^2 + 0.500^2]^{1/2}$

NON COT_{error} = $\pm$ 3.476 % of span = $\pm$ 5.214 % ΔT Power

$COT_{error} = \pm (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$

$COT_{error} = \underline{+} (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$

$COT_{error} = \underline{+}$ 1.871 % of span = $\underline{+}$ 2.806 % ΔT Power

<u>OTΔT Reactor Trip with (+) FΔI</u>

$NON\ COT_{error} =]EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_2^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = [0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.425)^2 + 0.45^2 + 2.013^2 + 4.00^2 + 0.488^2 + 0.491^2 + 0.100^2 + 0.137^2 + 0.120^2 + 0.060^2 + 0.500^2]^{1/2}$

$NON\ COT_{error} = \underline{+}$ 5.299 % of span = $\underline{+}$ 7.949 % ΔT Power

$COT_{error} = \underline{+} (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$

$COT_{error} = \underline{+} (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$

$COT_{error} = \underline{+}$ 1.871 % of span = $\underline{+}$ 2.806 % ΔT Power

<u>OTΔT Reactor Trip with (-) FΔI</u>

$NON\ COT_{error} = [EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_2^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = [0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.425)^2 + 0.45^2 + 2.013^2 + 3.34^2 + 0.488^2 + 0.491^2 + 0.100^2 + 0.137^2 + 0.120^2 + 0.060^2 + 0.500^2]^{1/2}$

$NON\ COT_{error} = \underline{+}$ 4.820 % of span = $\underline{+}$ 7.230 % ΔT Power

$COT_{error} = \underline{+} (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$

$COT_{error} = \underline{+} (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$

$COT_{error} = \underline{+}$ 1.871 % of span = $\underline{+}$ 2.806 % ΔT Power

See Figure 4.1.8 for specific details associated with the OTΔT Reactor Trip with no FΔI.

NORTH ANNA'S OVERTEMPERATURE DELTA T REACTOR TRIP

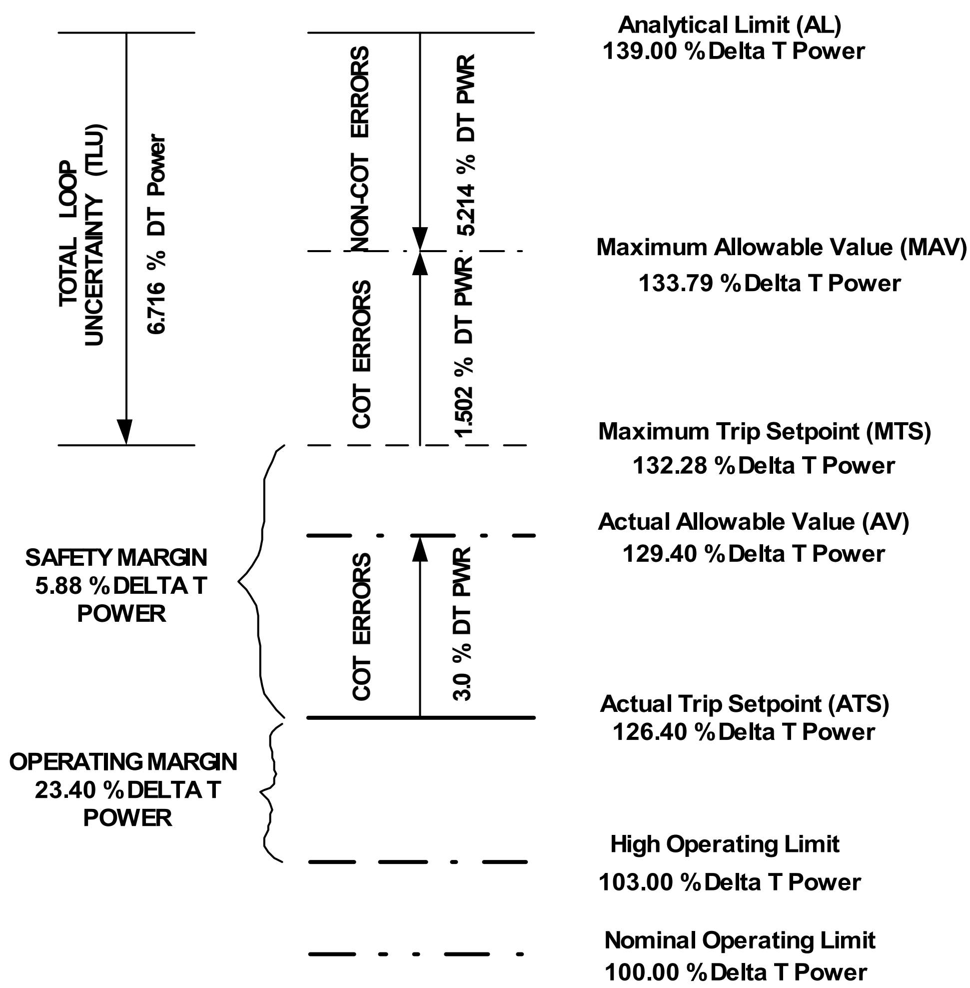


Figure 4.1.8

4.1.9 Overpower ΔT Reactor Trip

Allowable Value : See below (Refs. 5.1, 5.8, 5.18 & 5.47)

" The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 2.0 % of the ΔT span " (Note that 2.0 % of the ΔT span is equal to 3.0 % ΔT Power)

The Overpower ΔT Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. The Overpower ΔT Reactor Trip is a backup reactor trip function and is not credited in the UFSAR Chapter 15 Safety Analysis. The Allowable Value of 2.0 % of the ΔT span is consistent with the original design basis for this function and is conservative with respect to the CSA Calculation assumptions (Ref. 5.18).

4.1.10 Pressurizer Low Pressure Reactor Trip

Allowable Value : $\geq$ 1860 PSIG (Refs. 5.1, 5.8, 5.19 & 5.44)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 1851.58 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 1849.41 PSIG. The Actual Nominal Trip Setpoint of 1870 PSIG is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of 1860 PSIG is conservative with respect to the Minimum Allowable Value. This Allowable Value of $\geq$ 1860 PSIG is based on maintaining a Nominal Trip Setpoint value of 1870 PSIG.

In this case, the current Allowable Value of $\geq$ 1860 PSIG will be retained because it is sufficiently close enough to the calculated value using the CSA rack error terms from Calculation EE-0069 (Ref 5.19). The calculated Allowable Value for this function is $\geq$ 1860.8 PSIG. The 0.8 PSIG offset is accommodated in the 18.42 PSIG Safety Margin for this trip as illustrated in Figure 4.1.10.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0069 (Ref. 5.19) are given below. The COT and NON COT error components are used in Figure 4.1.10 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm [EA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M2MTE^2 + RCSAMTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + (0.500+0.404)^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.153^2 + 0.0^2 + 0.03^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = \pm 2.389 \text{ \% of span} = \pm 19.11 \text{ PSIG}$$

$$\text{COT}_{error} = \pm (M1^2 + M2^2 + RCSA^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.1^2 + 0.5^2 + 0.25^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.150 \text{ \% of span} = \pm 9.2 \text{ PSIG}$$

See Figure 4.1.10 for specific details.

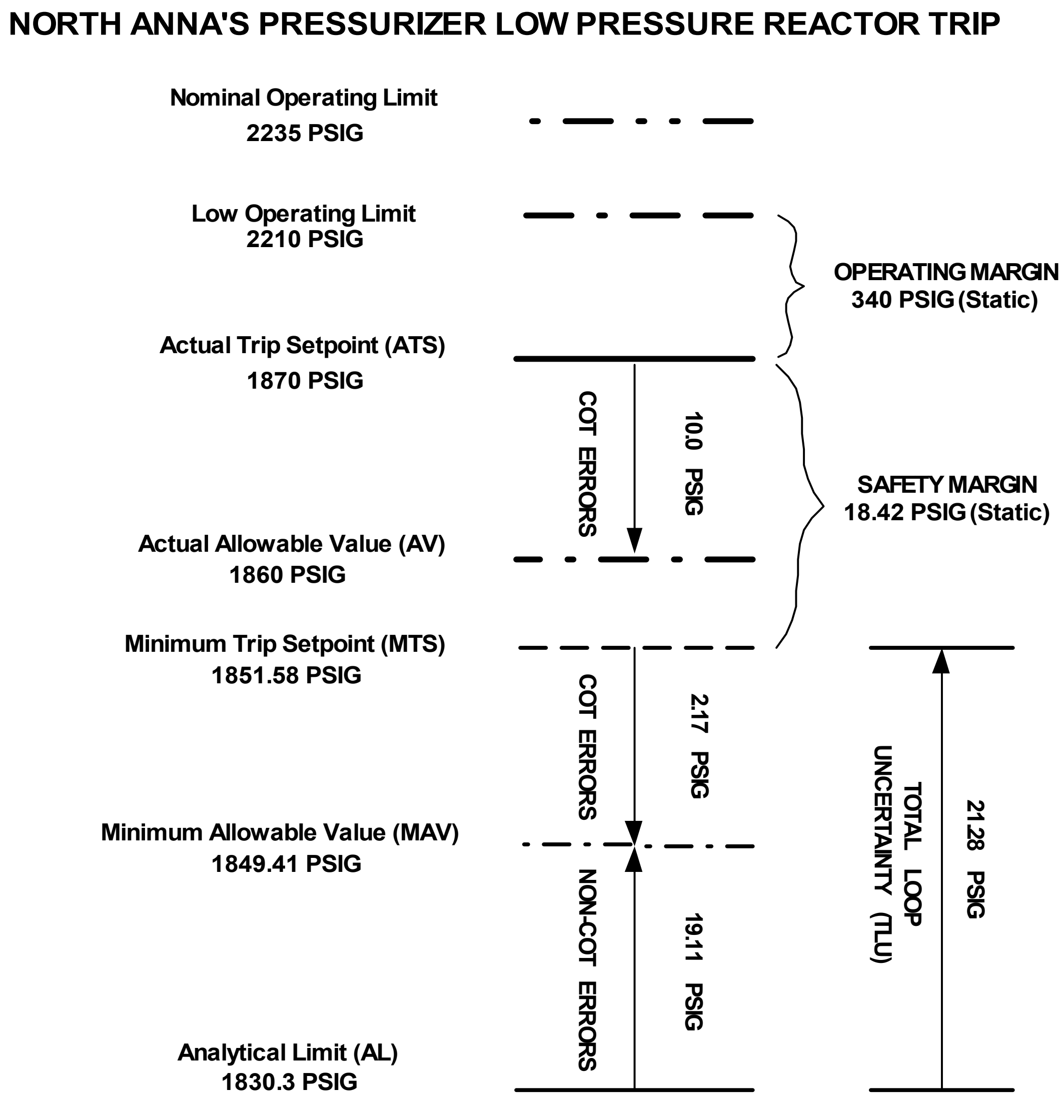


Figure 4.1.10

4.1.11 Pressurizer High Pressure Reactor Trip

Allowable Value : $\leq$ 2370 PSIG (Refs. 5.1, 5.8, 5.19, 5.44 & 5.88)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 2370.4 PSIG. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 2372.19 PSIG. The Actual Nominal Trip Setpoint of 2360 PSIG is conservative with respect to the Maximum Trip Setpoint. The current Actual Allowable Value of 2370 PSIG is conservative with respect to the Maximum Allowable Value. The Nominal Trip Setpoint value of 2360 PSIG allows a 10 PSIG margin to be used for the COT error components. This leaves a margin of 2.19 PSIG from the Actual Allowable Value to the Maximum Allowable Value as illustrated in Figure 4.1.11.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0069 (Ref. 5.19) are given below. The COT and NON COT error components are used in Figure 4.1.11 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm [EA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M2MTE^2 + RCSAMTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + (0.500+0.404)^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.153^2 + 0.0^2 + 0.03^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = \pm 2.389$ % of span $= \pm 19.11$ PSIG

$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm 1.036$ % of span $= \pm 8.29$ PSIG

See Figure 4.1.11 for specific details.

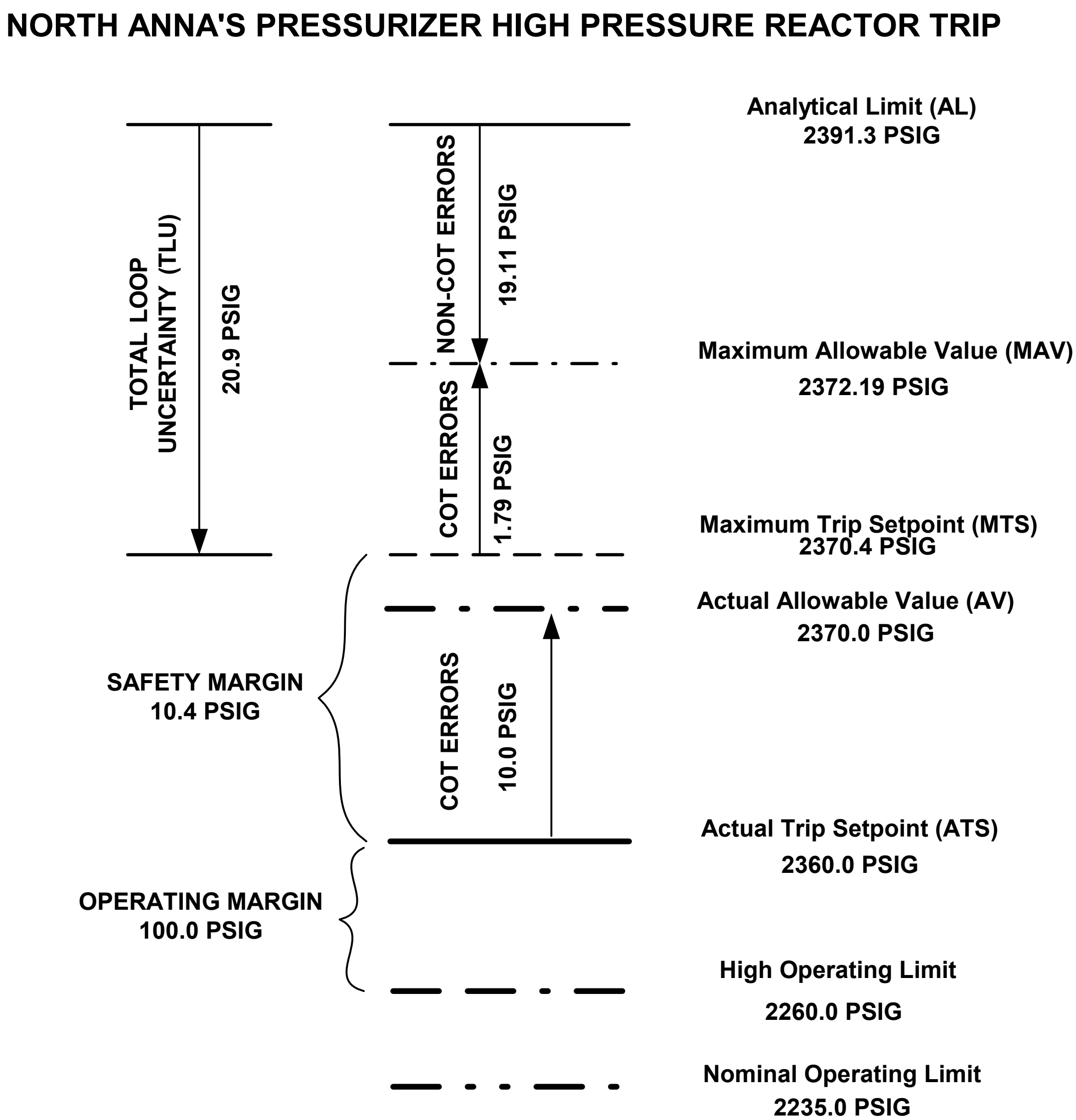


Figure 4.1.11

4.1.12 Pressurizer High Level Reactor Trip

Allowable Value : ≤ 93.0 % Level (Hot) (Refs. 5.1, 5.8, 5.20 & 5.54)

The analysis for North Anna's Pressurizer High Level Reactor Trip was performed in Section 3.4.3 and the specific details are illustrated in Figure 3.4.3.a.

4.1.13 Reactor Coolant Flow Low Reactor Trip

Allowable Value : $\geq$ 89.0 % Flow (Normalized) (Refs. 5.1, 5.8, 5.21, 5.53 & 5.84)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 89.338 % Flow. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 88.986 % Flow. The current Nominal Trip Setpoint of 90.0 % Flow is conservative with respect to the Minimum Trip Setpoint. The current Allowable Value of $\geq$ 89.0 % Flow is conservative with respect to the Minimum Allowable Value. The Nominal Trip Setpoint value of 90.0 % Flow will allow a 1.0 % Flow margin to be used for the COT error components. The Allowable Value of $\geq$ 89.0 % Flow is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0060 (Ref 5.21).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0060 (Ref. 5.21) are given below. The COT and NON COT error components are used in Figure 4.1.13 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$NON\ COT_{error}$ (ΔP span) = $[(SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M2MTE^2]^{1/2}$

$NON\ COT_{error}$ (ΔP span) = $[(0.000 + 0.000)^2 + 0.375^2 + 0.0^2 + 0.000^2 + 0.153^2 + 0.030^2]^{1/2}$

$NON\ COT_{error}$ (ΔP span) = $\pm$ 0.406 % of ΔP span = $\pm$ 0.271 % of Flow span @ 90 % Flow$^{(1)}$

$NON\ COT_{error}$ (Flow span) = $(PMA^2 + PEA^2 + RTE^2)^{1/2}$

$NON\ COT_{error}$ (Flow span) = $(1.512^2 + 0.360^2 + 0.5^2)^{1/2}$

$NON\ COT_{error}$ (Flow span) = 1.633 % of Flow span

TOTAL $NON\ COT_{error}$ (Flow span) = $(1.633^2 + 0.271^2)^{1/2}$ = 1.655 % of Flow span = 1.986 % Flow @ 90.0 % Flow$^{(2)}$.

COT_{error} (ΔP span) = $\pm$ $(M1^2 + M2^2)^{1/2}$

COT_{error} (ΔP span) = $\pm$ $(0.1^2 + 0.25^2)^{1/2}$

COT_{error} (ΔP span) = $\pm$ 0.269 % of ΔP span = $\pm$ 0.179 % of Flow span @ 90 % Flow

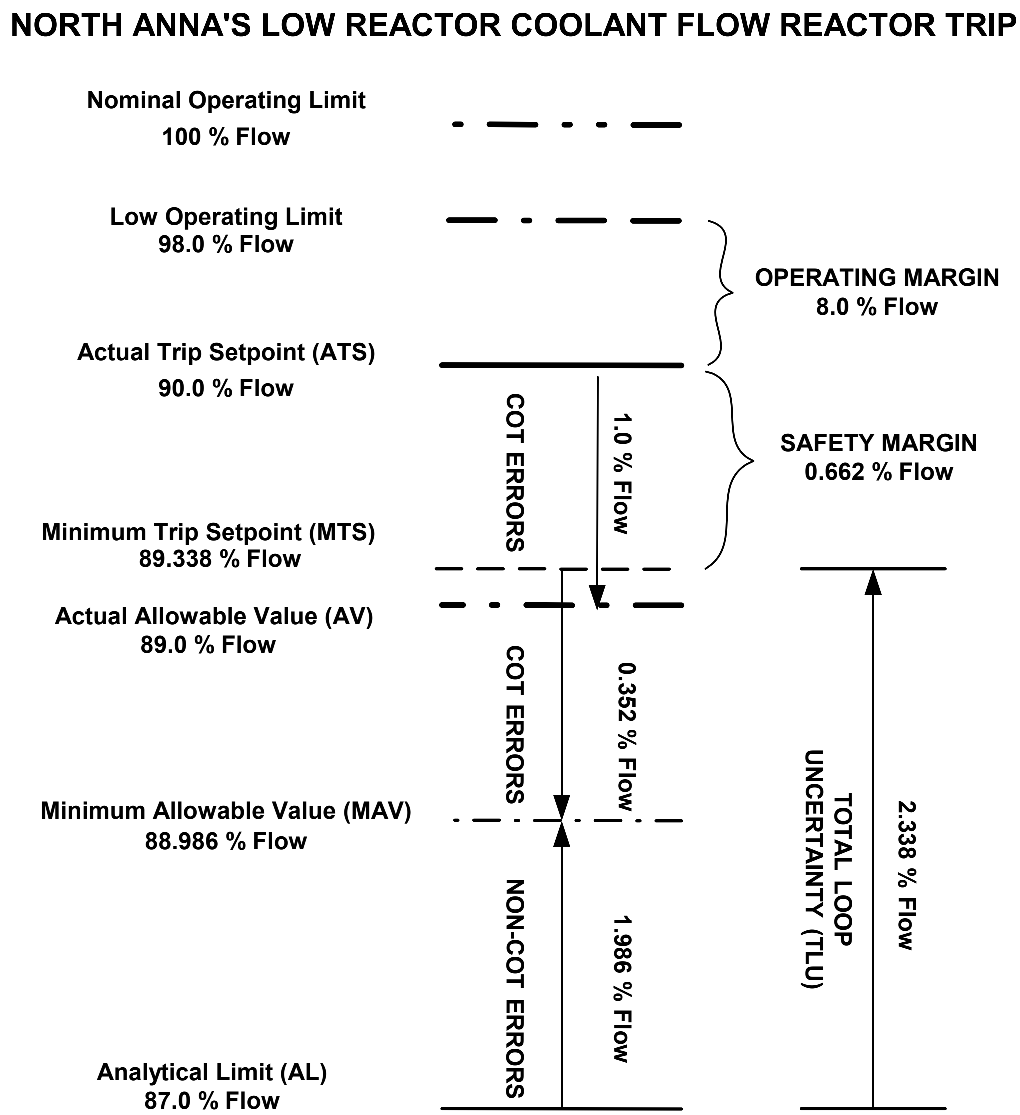
COT_{error} (Flow span) = RD = 1.0 % of Flow span
TOTAL COT_{error} (Flow span) = $(0.179^2 + 1.0^2)^{1/2}$ = 1.016 % of Flow span = 1.219 % Flow @ 90.0 % Flow.

(1) % Flow Span = (ΔP uncertainty) * 0.5 * ($Flow_{max}/Flow_{nom}$)

0.271 = (0.406)*0.5*(120/90) (Refs. 5.23 and 5.120)

(2) % Flow = (% Flow Span / 100) * 120

See Figure 4.1.13 for specific details.



(1) The TLU is based on the 90% trip setpoint in CSA Calculation EE-0060 (Ref. 5.21)

Figure 4.1.13

4.1.14 Reactor Coolant Pump Breaker Position

Allowable Value : N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

4.1.15 Reactor Coolant Pump Undervoltage

Allowable Value : This Allowable Value will be provided by Corporate Electrical EE Power.

4.1.16 Reactor Coolant Pump Underfrequency

Allowable Value : This Allowable Value will be provided by Corporate Electrical EE Power.

4.1.17 Steam Generator Water Level Low Low Reactor Trip/SI

Allowable Value : $\geq$ 17.0 % Narrow Range (NR) Level (Refs. 5.1, 5.8, 5.22 & 5.48)

The analysis for Steam Generator Water Level Low Low Reactor Trip will be based on HARSH/DBE Conditions which will bound both the Reactor Trip and ESFAS Initiation Functions. Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 14.955 % NR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 14.645 % NR Level. The Actual Nominal Trip Setpoint of 18.0 % NR Level is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of $\geq$ 17.0 % NR Level is conservative with respect to the Minimum Allowable Value. In this case, the current Allowable Value of $\geq$ 17.0 % NR Level will be retained because it meets the requirements of Methods 1 and 2 as discussed in Sections 3.3.1 and 3.3.2. In addition, the current Allowable Value is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0492 (Ref 5.22). This Allowable Value of $\geq$ 17.0 % NR Level is based on maintaining a Nominal Trip Setpoint value of 18.0 % NR Level.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0492 (Ref. 5.22) are given below. The COT and NON COT error components are used in Figure 4.1.17 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{error} = PMA_{DBE} + IR + SPTE + RE_{DBE} \pm]PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 8.4 + 0.960 + 3.619 + 0.0 \pm [0.0^2 + (0.5+0.383)^2 + 0.289^2 + 0.635^2 + 1.110^2 + 0.158^2 + 0.05^2 + 0.5^2]^{1/2}$

NON COT_{error} = + 14.645 % of span = + 14.645 % NR Level (worst case).

$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

COT_{error} = $\pm$ 1.036 % of span = $\pm$ 1.036 % NR level

See Figure 4.1.17 for specific details.

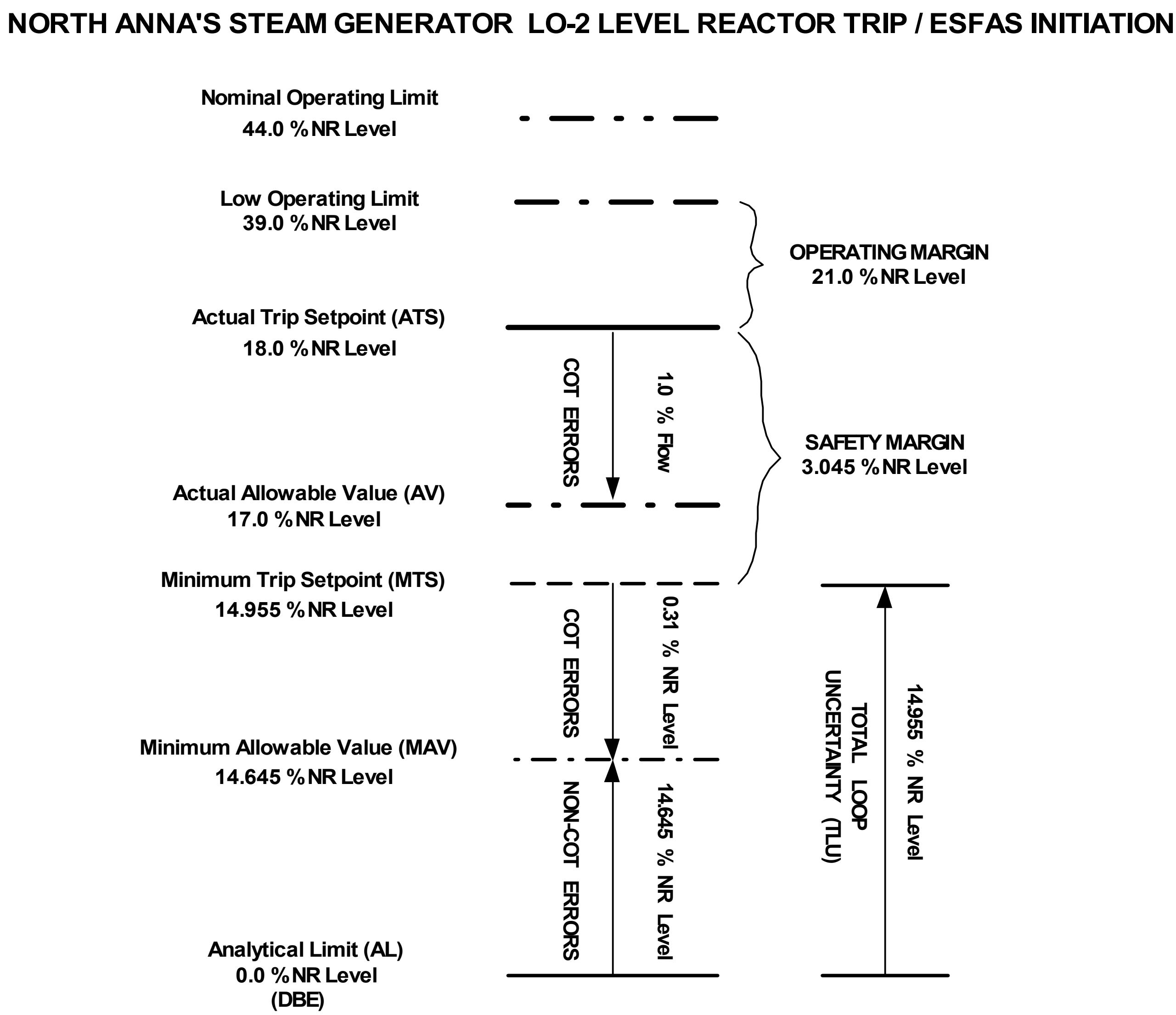


Figure 4.1.17

4.1.18 Steam Generator Water Level Low Coincident Reactor Trip

Allowable Value : $\geq$ 24.0 % Narrow Range (NR) Level (Refs. 5.1, 5.8, 5.22 & 5.48)

This Allowable Value of $\geq$ 24.0 % NR Level is based on maintaining a Nominal Trip Setpoint value of 25.0 % Level. In this case, the current value of $\geq$ 24.0 % NR Level will be retained because it is conservative with respect to the calculated value the CSA rack error terms from Calculation EE-0492 (Ref 5.22). The Steam Generator Water Level Low Coincident Reactor Trip is a backup reactor trip function and no specific setpoint is assumed.

4.1.19 Steam Flow Feed Flow Mismatch Coincident Reactor Trip

Allowable Value : ≤ 42.5 % of F_{nom} (i.e., nominal Feedwater Flow at RTP) (Refs. 5.1, 5.8, 5.23 & 5.49)

This Allowable Value of ≤ 42.5 % of F_{nom} is based on maintaining a Nominal Trip Setpoint value of 40.0 % of F_{nom}. In this case, the current Allowable Value of ≤ 42.5 % of F_{nom} will be retained because it is conservative with respect to the calculated value based on the CSA rack error terms from Calculation EE-0736 (Ref 5.23). The Steam Flow Feed Flow Mismatch Coincident Reactor Trip is a backup reactor trip function and is not credited in the UFSAR Chapter 15 Safety Analysis.

4.1.20 Turbine Trip – Low Auto Stop Oil Pressure

Allowable Value : ≥ 40.0 PSIG (Refs. 5.1, 5.8 & 5.45)

This Allowable Value of ≥ 40.0 PSIG is based on maintaining a Nominal Trip Setpoint value of 45.0 PSIG. In this case, the current Allowable Value of ≥ 40.0 PSIG will be retained because it is sufficiently close enough to the calculated value. The calculated Allowable Value is based on adding the uncertainty values associated with the pressure switch calibration accuracy and drift / repeatability (i.e., 1.3 PSIG + 2.6 PSIG = 3.9 PSIG). In this case the current and historical Allowable Value of ≥ 40.0 PSIG will be retained because this trip is not credited in the UFSAR Chapter 15 Safety Analysis and a CSA Calculation has not been performed for this function, thus no Safety or Design Basis analysis is adversely affected.

4.1.21 Turbine Stop Valve Closure

Allowable Value : ≥ 0.0 % Open (Refs. 5.1, 5.8 & 5.70)

The Turbine Stop Valve Closure function is not credited in the UFSAR Chapter 15 Safety Analysis and therefore no Safety Analysis Limit is specified in References 5.1 and 5.2 for this function. In addition, a CSA Calculation has not been performed for this function. The current Trip Setpoint at North Anna for the Turbine Stop Valve Closure function is ≥ 1.0 % Open and the Allowable Value is ≥ 0.0 % Open (Ref 5.2). The basis for retaining the current Allowable Value for the Turbine Stop Valve Closure function is given below :

1. There is no Safety Analysis Limit or implied Design Basis Limit for this function that has been documented in Technical Specifications, UFSAR or the DBD. In addition, no CSA Calculation has been performed for this function at North Anna.

2. The proposed 1.0 % delta between the Trip Setpoint and the Allowable Value is consistent with North Anna's current values and has been used since the initial startup of the plant (Ref 5.3).

3. The proposed Allowable Value is also consistent with value given in the "Westinghouse Reactor Protection System / Engineered Safety Features Actuation System Setpoint Methodology provided to Dominion Virginia Power under S/N 541, Dockets 50-338 and 50-339 (Ref 5.3).

4.1.22 Safety Injection (SI) Input from Engineered Safety Features Actuation System (ESFAS)

Allowable Value : N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

Reactor Trip Permissives

4.1.23 Permissive P-6, Intermediate Range Neutron Flux

Allowable Value : $\geq 3 * 10^{-11}$ Amps (Refs. 5.1, 5.8, 5.16 & 5.57)

This Allowable Value of $\geq 3 * 10^{-11}$ Amps is based on maintaining a Nominal Trip Setpoint value of 5 $* 10^{-11}$ Amps. In this case, the current Allowable Value of $\geq 3 * 10^{-11}$ Amps will be retained because it is equal to the calibration accuracy of the device. Note that this function is assumed to be available in the UFSAR Chapter 15 Safety Analysis but no specific setpoint is assumed (Refs 5.1 & 5.2).

4.1.24 Permissive P-7, Block Low Power Reactor Trips

Allowable Value : N/A (Refs. 5.1 & 5.8)

Permissive P-7 is made up of Permissives P-10 and P-13.

4.1.25 Permissive P-8, Power Range Neutron Flux

Allowable Value : $\leq$ 31.0 % RTP (Refs. 5.1, 5.8, 5.15 & 5.46)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 33.702 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 34.113 % RTP. The Actual Nominal Trip Setpoint of 30.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 31.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 31.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 30.0 % RTP.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0063 (Ref. 5.15) are given below. The COT and NON COT error components are used in Figure 4.1.25 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + PMA_3^2 + M1MTE^2 + M7MTE^2 + RTE^2)^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm (1.667^2 + 4.167^2 + 1.667^2 + 0.110^2 + 0.943^2 + 0.5^2)^{1/2}$$

$$\text{NON COT}_{error} = \pm 4.906 \text{ \% of span} = \pm 5.887 \text{ \% RTP}$$

$$\text{COT}_{error} = \pm (M1^2 + M7^2 + RD^2)^{½}$$

$COT_{error} = \underline{+} (0.1^2 + 0.833^2 + 1.0^2)^{1/2}$

$COT_{error} = + 1.305$ % of span = $\underline{+}$ 1.566 % RTP

See Figure 4.1.25 for specific details.

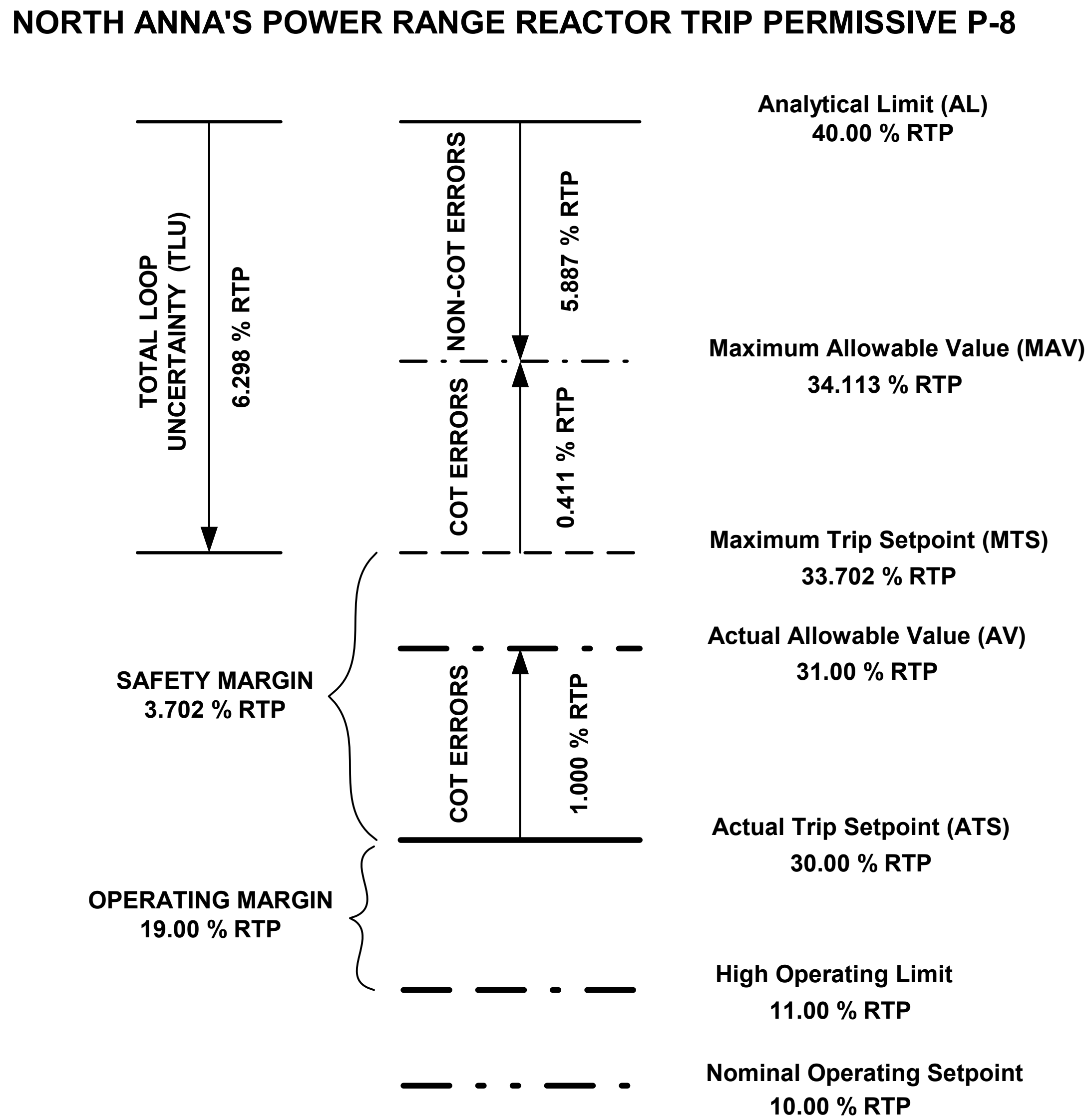


Figure 4.1.25

4.1.26 Permissive P-10, Power Range Neutron Flux

Allowable Values : ≥ 7.0 % RTP AND ≤ 11.0 % RTP (Refs. 5.1, 5.8, 5.15 & 5.46)

These Allowable Values of ≥ 7.0 % RTP and ≤ 11.0 % RTP are based on maintaining a Nominal Trip Setpoint value of 10.0 % RTP and a Nominal Reset value of 8.0 % RTP. In this case, the current Allowable Values will be retained because they are conservative with respect to the calculated values using the CSA rack error terms from Calculation EE-0063 (Ref 5.15). Note that this function is assumed to be available in the UFSAR Chapter 15 Safety Analysis but no specific setpoint is assumed (Refs 5.1 & 5.2).

4.1.27 Permissive P-13, Turbine Impulse Pressure

Allowable Value : ≤ 11.0 % RTP (Refs. 5.1, 5.8 & 5.56)

This Allowable Value of ≤ 11.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 10.0 % RTP. In this case, the current Allowable Value of ≤ 11.0 % RTP will be retained because it is conservative based on the methodologies described in Section 3.4.2. Note that this function is assumed to be available in the UFSAR Chapter 15 Safety Analysis but no specific setpoint is assumed (Refs 5.1 & 5.2).

4.1.28 Reactor Trip Breakers

Allowable Value : N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

4.1.29 Reactor Trip Breaker Undervoltage and Shunt Trip Mechanism

Allowable Value : N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

4.1.30 Automatic Trip Logic

Allowable Value : N/A (Ref. 5.8)

There is no specific RTS Trip Setpoint associated with this function.

4.2 Allowable Values for North Anna ITS Table 3.3.2-1 (ESFAS Instrumentation)

Safety Injection

4.2.1 Safety Injection, Manual Initiation

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.2 Safety Injection Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.3 Containment Pressure – High

Allowable Value : $\leq$ 17.7 PSIA (Refs. 5.1, 5.8, 5.25 & 5.55)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 18.52 PSIA. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 18.74 PSIA. The Actual Nominal Trip Setpoint of 17.0 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 17.7 PSIA is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 17.7 PSIA is based on maintaining a Nominal Trip Setpoint value of 17.0 PSIA. The current ITS Allowable Value of $\leq$ 17.7 PSIA is approximately equal to the calculated COT_{error} shown below.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0052 (Ref. 5.25) are given below. The COT and NON COT error components are used in Figure 4.2.3 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.18)^2 + 0.308^2 + 0.0^2 + 1.158^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = \pm 1.474 \text{ \% of span} = \pm 0.958 \text{ PSIA}$$

$$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$$

$$COT_{error} = \pm 1.036 \text{ \% of span} = \pm 0.673 \text{ PSIA}$$

See Figure 4.2.3 for specific details.

NORTH ANNA'S CONTAINMENT PRESSURE HI-1 ESFAS INITIATION

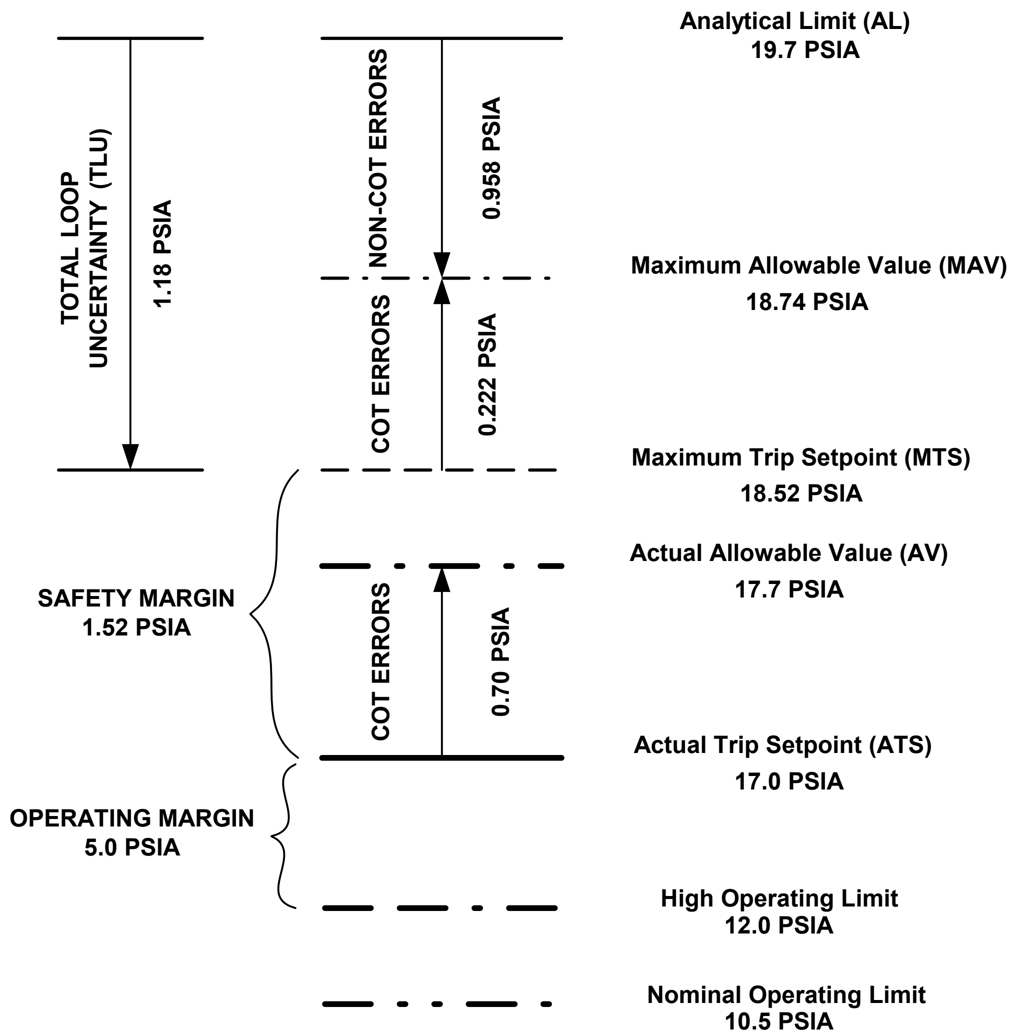


Figure 4.2.3

4.2.4 Pressurizer Pressure Low-Low

Allowable Value : $\geq$ 1770 PSIG (Refs. 5.1, 5.8, 5.19 & 5.44)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 1768.22 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 1766.45 PSIG. The Actual Nominal Trip Setpoint of 1780 PSIG is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of 1770 PSIG is conservative with respect to the Minimum Allowable Value. This Allowable Value of $\geq$ 1770 PSIG is based on maintaining a Nominal Trip Setpoint value of 1780 PSIG.

In this case, the current Allowable Value of $\geq$ 1770 PSIG will be retained because it is sufficiently close enough to the calculated value using the CSA rack error terms from Calculation EE-0069 (Ref 5.19). The calculated Allowable Value for this function is $\geq$ 1771.71 PSIG. The 1.71 PSIG offset is accommodated in the 11.78 PSIG Safety Margin for this trip as illustrated in Figure 4.2.4.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0069 (Ref. 5.19) are given below. The COT and NON COT error components are used in Figure 4.2.4 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{\text{error}} = \text{SE} \pm \text{EA} + [(\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{M1MTE}^2 + \text{RCSAMTE}^2 + \text{RTE}^2]^{1/2}$

$\text{NON COT}_{\text{error}} = 1.88 + 4.00 \pm [0.904^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{\text{error}} = \pm 8.269$ % of span = + 66.152 PSIG (worst case)

$\text{COT}_{\text{error}} = \pm (\text{M1}^2 + \text{RCSA}^2 + \text{RD}^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm 1.036$ % of span = $\pm$ 8.29 PSIG

See Figure 4.2.4 for specific details.

NORTH ANNA'S PRESSURIZER LO-2 PRESSURE ESFAS INITIATION

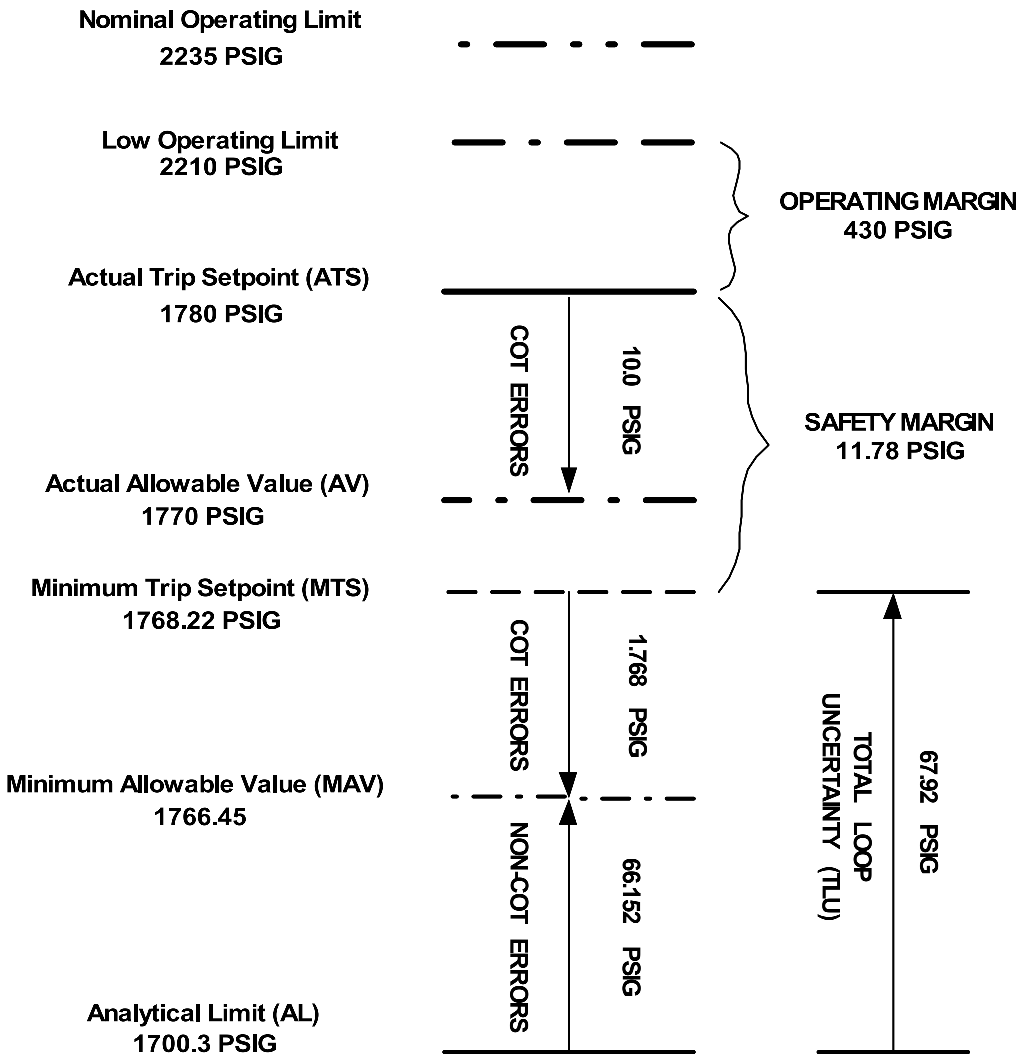


Figure 4.2.4

4.2.5 <u>High Differential Pressure Between Steam Lines</u>

Allowable Value : **$\leq$ 112.0 PSID** **(Refs. 5.1, 5.8, 5.26 & 5.50)**

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 111.9 PSID. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 115.66 PSID. The Actual Nominal Trip Setpoint of 100.0 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 112.0 PSID is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 112.0 PSID is based on maintaining a Nominal Trip Setpoint value of 100.0 PSID. The current ITS Allowable Value of $\leq$ 112.0 PSID is conservative with respect to the calculated COT_{error} shown below. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0121 (Ref. 5.26) are given below. The COT and NON COT error components are used in Figure 4.2.5 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$NON\ COT_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M6MTE^2 + RTE^2]^{1/2}$$

$$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (1.0+0.0)^2 + 0.607^2 + 0.0^2 + 2.086^2 + 0.216^2 + 0.042^2 + 0.5^2]^{1/2}$$

$$NON\ COT_{error} = \pm 2.453\ \%\ of\ span = \pm 34.34\ PSID$$

$$COT_{error} = \pm (M1^2 + M6^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.141^2 + 0.5^2 + 1.0^2)^{1/2}$$

$$COT_{error} = \pm 1.127\ \%\ of\ span = \pm 15.78\ PSID$$

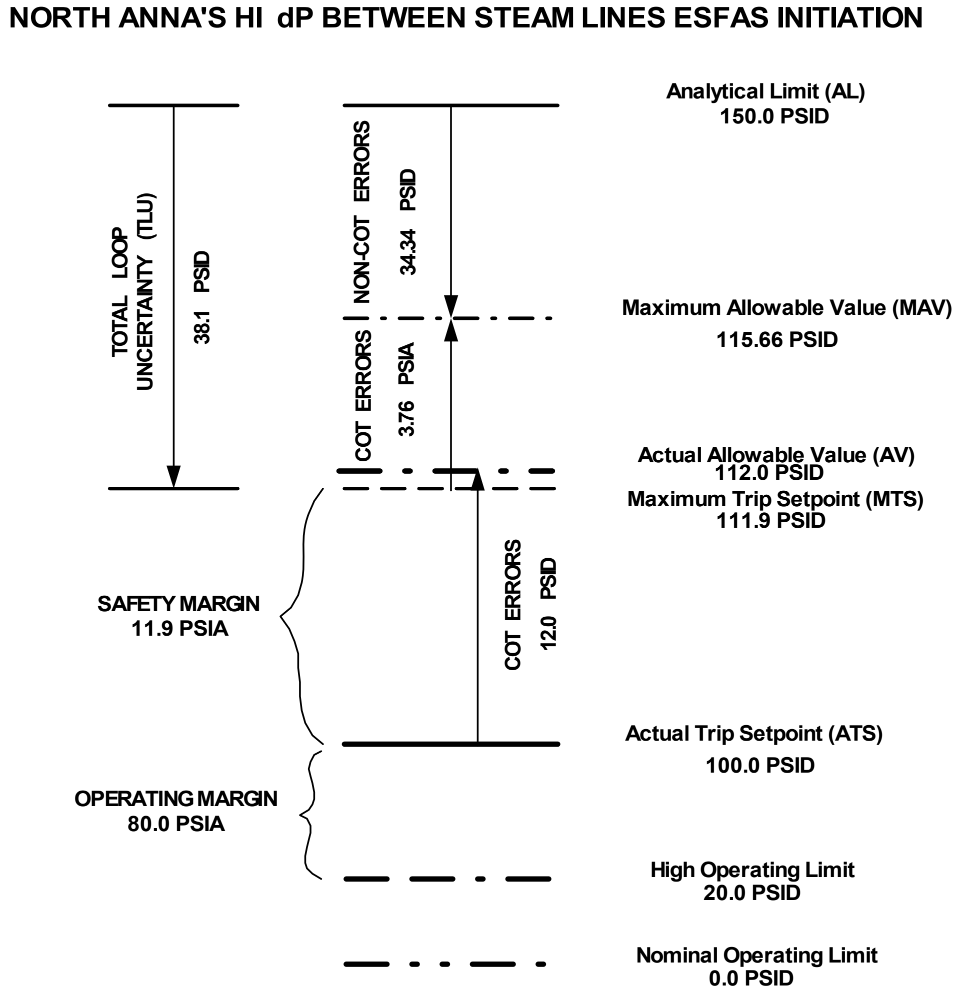


Figure 4.2.5

4.2.6 High Steam Flow in Two Steam Lines

Allowable Value : **≤ 42.0 % of $Flow_{nom}$ from 0 to 20 % Power, increasing linearly to ≤ 111.0 % of $Flow_{nom}$ at 100 % Power. (Refs. 5.1, 5.8, 5.23 & 5.49)**

Subtracting the Total Loop Uncertainty (TLU = 2.436 % of ΔP span) from the Analytical Limit (AL = 20.715 % of ΔP span from 0 % to 20 % power, the most limiting condition) yields a Maximum Trip Setpoint (MTS) of 18.279 % of ΔP span. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 18.414 % of ΔP span. The Actual Nominal Trip Setpoint of 9.39 % of ΔP span (from 0 % to 20 % power, the most limiting condition) is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of ≤ 10.19 % of ΔP span is conservative with respect to the Maximum Allowable Value. This Allowable Value of ≤ 10.19 % of ΔP span is based on maintaining a Nominal Trip Setpoint value of 9.39 % of ΔP span. See Figure 4.2.6 for specific details.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0736 (Ref. 5.23) are given below. The COT and NON COT error components are modified below to reflect 20 % power conditions. These error components are used in Figure 4.2.6 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$CSA_6NON\ COT_{error} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPSE^2 + STE^2 + SPE^2 + M1MTE^2 + RTE^2]^{1/2}$

$CSA_6NON\ COT_{error} = [0.0^2 + 1.037^2 + 0.0^2 + (0.5+0.189)^2 + 0.353^2 + 0.0^2 + 1.277^2 + 0.409^2 + 0.153^2 + 0.173^2]^{1/2}$

$CSA_6NON\ COT_{error} = \underline{+}\ 1.878$ % of ΔP span (The PMA and RTE terms were converted from % Flow to % ΔP for 20 % power conditions. See Note 1)

$CSA_7NON\ COT_{error} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPSE^2 + STE^2 + SPE^2 + M13MTE^2 + M14MTE^2 + M15MTE^2]^{1/2}$

$CSA_7NON\ COT_{error} = [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.205)^2 + 0.278^2 + 0.0^2 + 1.079^2 + 0.0^2 + 0.153^2 + 0.042^2 + 0.042^2]^{1/2}$

$CSA_7NON\ COT_{error} = \underline{+}\ 1.329$ % of ΔP span

$TOTAL\ NON\ COT_{error} = \underline{+}\ (1.878^2 + 1.329^2)^{1/2} = \underline{+}\ 2.301$ % of ΔP span

$CSA_{6\ \&\ 7}COT_{error}\ \Delta P\ span = \underline{+}\ (M1^2 + M13^2 + M14^2 + M15^2 + RD^2)^{1/2}$

$CSA_{6\&7}COT_{error} = \underline{+}\ (0.1^2 + 0.1^2 + 0.5^2 + 0.5^2 + 0.346^2)^{1/2}$

$CSA_{6\&7}COT_{error} = \underline{+}\ 0.800$ % of ΔP span (The RD term was converted from % Flow to % ΔP for 20 % power conditions. See Note 1)

The Total Loop Uncertainty (TLU) for 20 % power used in Figure 4.2.6 is equal to :

$TLU = (TOTAL\ NON\ COTerror^2 + CSA_{6\&7}COTerror^2)^{1/2} = (2.301^2 + 0.800^2)^{1/2} = 2.436$ % ΔP span

---

Note 1: Calculation EE-0736 specifies a 3.0 % of flow span PMA value, a 0.5 % of flow span RTE value, and a 1.0 % of flow span RD value. Equation 03 from EE-0736 is used to convert from % of Flow span to % of ΔP span. Equation 03 modified for a generic conversion from % of Flow span to % ΔP of span is % ΔP span = [% Flow span / 0.5] / [Flowmax / Flow x]. Flowmax is the maximum indicated flowrate (i.e., $5 * 10^6$ PPH) and Flow x is the flowrate of interest. At 20 % power, Flow x = 20 % Flow, noting that the nominal flowrate at 100 % power is equal to $4.247 * 10^6$ PPH. To bound this analysis for the MUR uprate on both units at North Anna, the nominal flow rate will be increased by 1.7 %, i.e., $4.247 * 10^6$ PPH * 1.017 = $4.319 * 10^6$ PPH. Flow x = 0.2 * $4.319 * 10^6$ PPH = $0.8638 * 10^6$ PPH.

% ΔP span(PMA) = [3.0 / 0.5] / [5.0 / 0.8638] = 1.037 % ΔP span
% ΔP span(RTE) = [0.5 / 0.5] / [5.0 / 0.8638] = 0.173 % ΔP span
% ΔP span(RD) = [1.0 / 0.5] / [5.0 / 0.8638] = 0.346 % ΔP span

NORTH ANNA'S HI STEAM FLOW IN TWO STEAM LINES ESFAS INITIATION

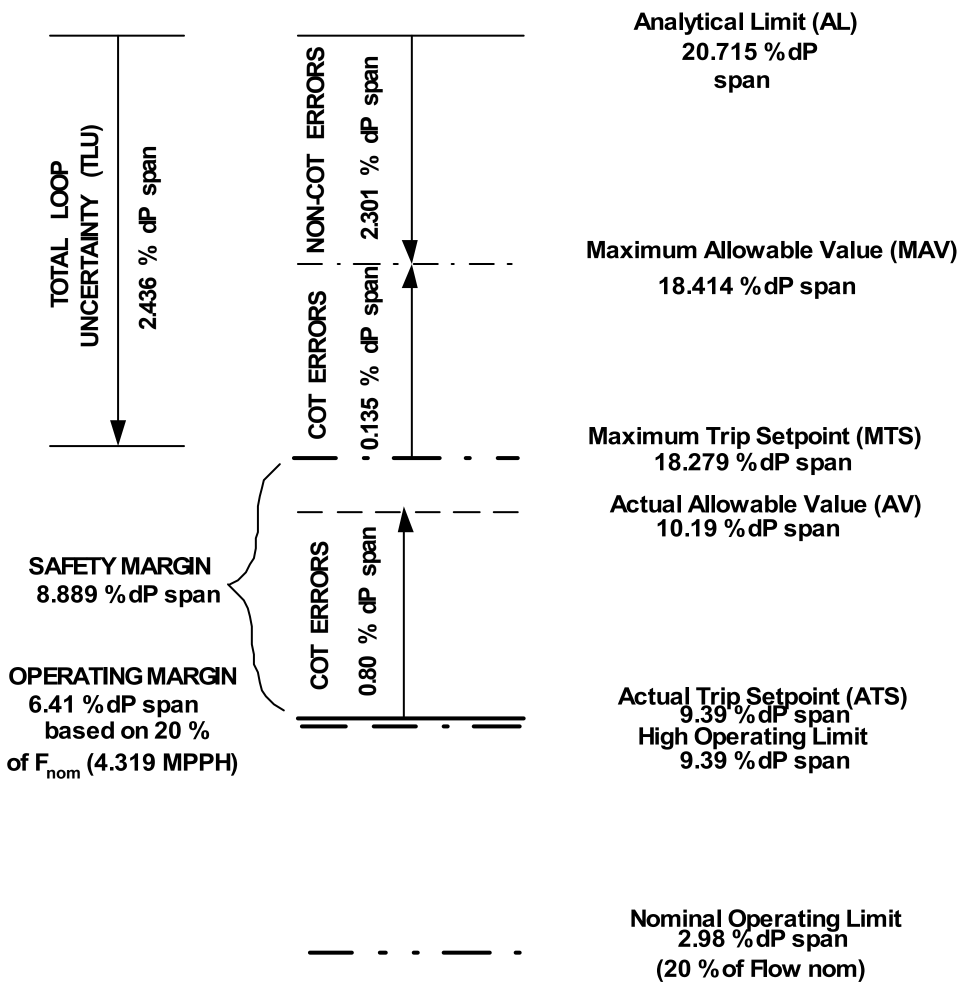


Figure 4.2.6

Notes:

1. $Flow_{max}$ = 5.0 MPPH and Pre-MUR $Flow_{nom}$ = 4.247 MPPH. Based on Technical Report EE-0085, Appendix 18-5 (Ref. 5.13), the equation used to convert from % $Flow_{nom}$ to % ΔP span is : % ΔP span (Unit 1) = $((\% Flow_{nom} / Flow_{max})^2 / 1.25060)) * 100$. % ΔP span (Unit 2) = $((\% Flow_{nom} / Flow_{max})^2 / 1.25383)) * 100$. See the example below for the conversion of the Analytical Limit of 60 % of $Flow_{nom}$ to % ΔP span:

$$\text{Unit 1} = ((0.6 * 4.247) / 5.0)^2 / 1.25060)) * 100 = 20.77 \% \Delta P \text{ span}$$
$$\text{Unit 2} = ((0.6 * 4.247) / 5.0)^2 / 1.25383)) * 100 = 20.715 \% \Delta P \text{ span (Bounding value used above)}$$

2. $Flow_{max}$ = 5.0 MPPH and Post-MUR $Flow_{nom}$ = 4.247 MPPH * 1.7 % = 4.319 MPPH. Based on Technical Report EE-0085, Appendix 18-5 (Ref. 5.13), the equation used to convert from % $Flow_{nom}$ to % ΔP span is : % ΔP span (Unit 1) = $((\% Flow_{nom} / Flow_{max})^2 / 1.25528)) * 100$. % ΔP span (Unit 2) = $((\% Flow_{nom} / Flow_{max})^2 / 1.25863)) * 100$. See the example below for the conversion of the Analytical Limit of 60 % of $Flow_{nom}$ to % ΔP span:

$$\text{Unit 1 (Post MUR Pref(est)} = 814.2 \text{ psig)} = ((0.6 * 4.319) / 5.0)^2 / 1.25528)) * 100 = 21.399 \% \Delta P \text{ span}$$
$$\text{Unit 2 (Post MUR Pref(est)} = 812.15 \text{ psig)} = ((0.6 * 4.319) / 5.0)^2 / 1.25863)) * 100 = 21.342 \% \Delta P \text{ span}$$

4.2.7 T_{AVG} Low-Low

Allowable Value : **$\geq$ 542.0 ^{o}F** **(Refs. 5.1, 5.8, 5.18 & 5.47)**

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 541.474 ^{o}F. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 540.45 ^{o}F. The Actual Nominal Trip Setpoint of 543.0 ^{o}F is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of $\geq$ 542.0 ^{o}F is conservative with respect to the Minimum Allowable Value. This Allowable Value of $\geq$ 542.0 ^{o}F is based on maintaining a Nominal Trip Setpoint value of 543.0 ^{o}F.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0434 (Ref. 5.18) are given below. The COT and NON COT error components are used in Figure 4.2.7 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$CSA_{13}NON\ COT_{error} = [EA^2 + PEA^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (4 * SD_{RTD}{}^2) + STE_{RTD}{}^2 + M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M7MTE^2 + M20MTE^2 + M26MTE^2 + RTE^2]^{1/2}$

$CSA_{13}NON\ COT_{error} = [0.0^2 + 0.0^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.0^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.12^2 + 0.09^2 + 0.06^2 + 0.03^2 + 0.5^2]^{1/2}$

$CSA_{13}NON\ COT_{error} = \pm$ 1.450 % of span = $\pm$ 1.450 ^{o}F

$CSA_{13}COT_{error} = \pm (M1^2 + M2^2 + M3^2 + M4^2 + M5^2 + M7^2 + M20^2 + M26^2 + RD^2)^{1/2}$

$CSA_{13}COT_{error} = \pm (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.25^2 + 1.0^2)^{1/2}$

$CSA_{13}COT_{error} = \pm$ 1.677 % of span = $\pm$ 1.677 ^{o}F

See Figure 4.2.7 for specific details.

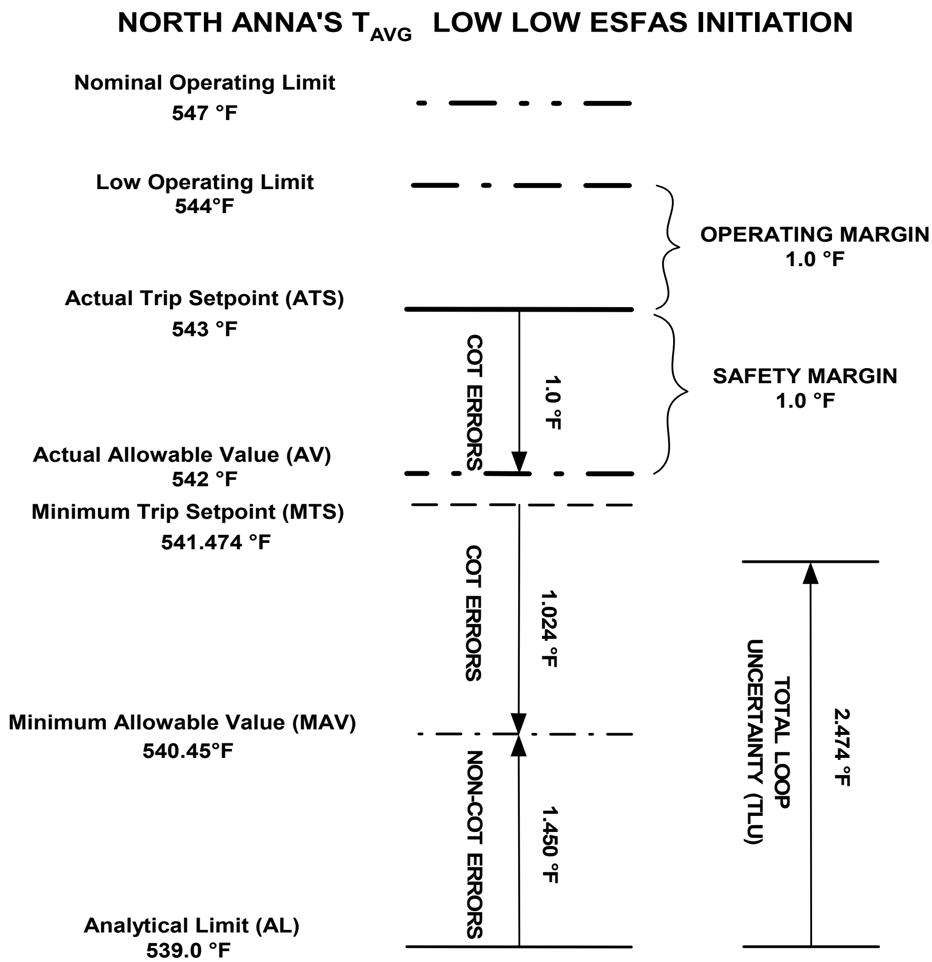


Figure 4.2.7

4.2.8 Steam Line Pressure - Low

Allowable Value : **≥ 585.0 PSIG** **(Refs. 5.1, 5.8, 5.26 & 5.50)**

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 474.1 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 469.09 PSIG. The Actual Nominal Trip Setpoint of 600 PSIG is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of ≥ 585 PSIG is conservative with respect to the Minimum Allowable Value. This Allowable Value of ≥ 585 PSIG is based on maintaining a Nominal Trip Setpoint value of 600 PSIG. Also note that this function is dynamically compensated.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0121 (Ref. 5.26) are given below. The COT and NON COT error components are used in Figure 4.2.8 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$NON\ COT_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M4MTE^2 + M5MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.207)^2 + 0.429^2 + 0.0^2 + 1.475^2 + 0.153^2 + 0.042^2 + 0.03^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 1.771 % of span = $\pm$ 24.79 PSIG

$COT_{error} = \pm (M1^2 + M4^2 + + M5^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.1^2 + 0.5^2 + 0.25^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.15 % of span = $\pm$ 16.1 PSIG

See Figure 4.2.8 for specific details.

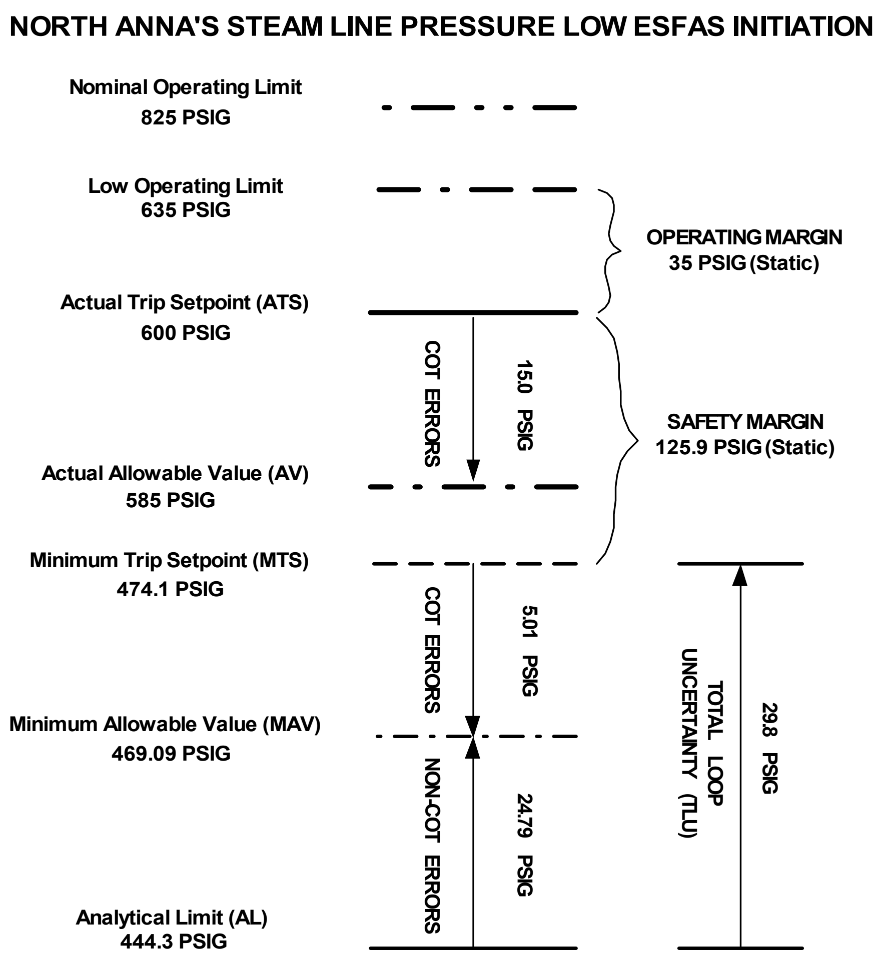


Figure 4.2.8

Containment Spray

4.2.9 Containment Spray, Manual Initiation

Allowable Value : N/A (Refs. 5.1 & 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.10 Containment Spray Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Refs. 5.1 & 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.11 Containment Pressure High - High

Allowable Value : $\leq$ 28.45 PSIA (Refs. 5.1, 5.8, 5.25 & 5.55)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 28.82 PSIA. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 29.04 PSIA. The Actual Nominal Trip Setpoint of 27.75 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 28.45 PSIA is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 28.45 PSIA is based on maintaining a Nominal Trip Setpoint value of 27.75 PSIA. The current ITS Allowable Value of $\leq$ 28.45 PSIA is slightly greater than the calculated COT_{error} shown below but the offset is accommodated in the Safety Margin illustrated in Figure 4.2.11.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0052 (Ref. 5.25) are given below. The COT and NON COT error components are used in Figure 4.2.11 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON } COT_{error} = [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON } COT_{error} = [0.0^2 + 0.0^2 + (0.5+0.18)^2 + 0.308^2 + 0.0^2 + 1.158^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$$

$$\text{NON } COT_{error} = \pm 1.474 \text{ \% of span} = \pm 0.958 \text{ PSIA}$$

$$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$$

$$COT_{error} = \pm 1.036 \text{ \% of span} = \pm 0.673 \text{ PSIA}$$

See Figure 4.2.11 for specific details.

NORTH ANNA'S CONTAINMENT PRESSURE HI-3 ESFAS INITIATION

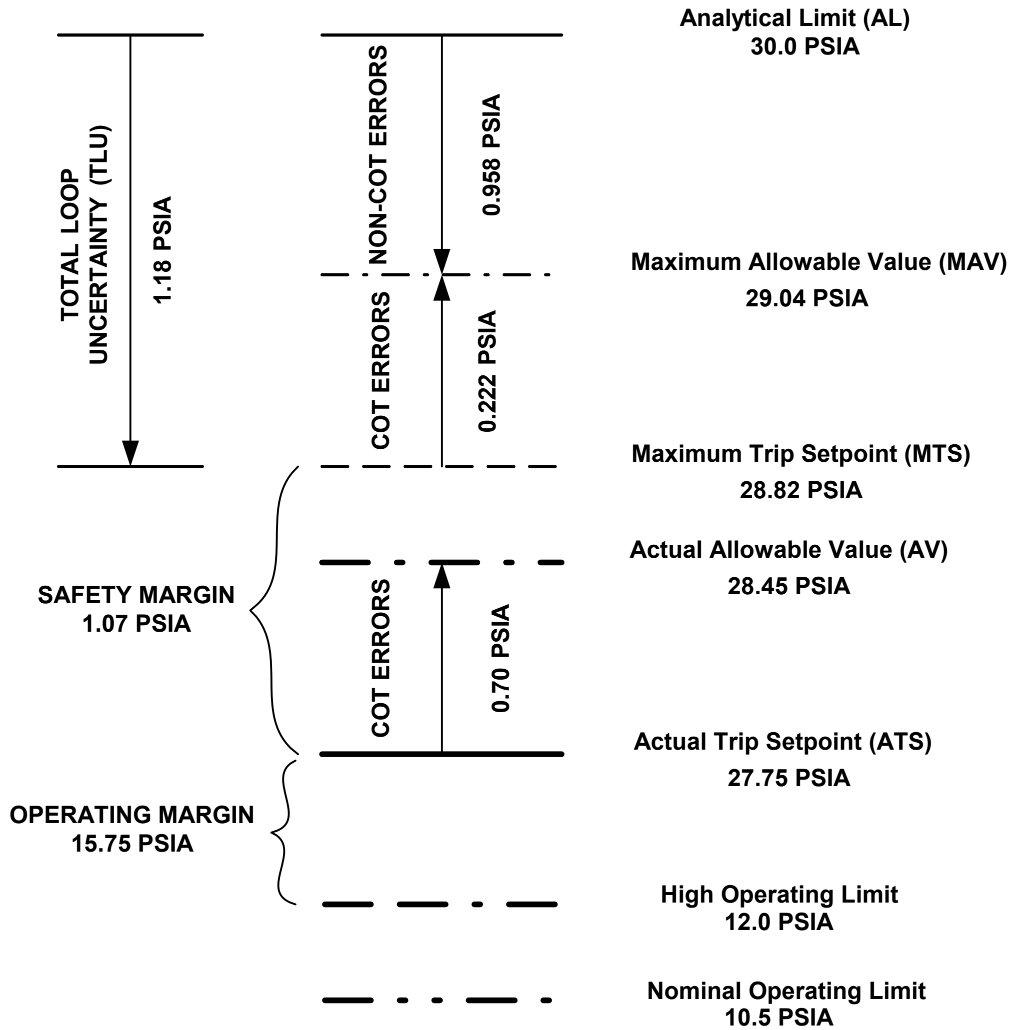


Figure 4.2.11

Containment Isolation – Phase A

4.2.12 Containment Isolation – Phase A, Manual Initiation

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.13 Containment Isolation – Phase A, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.14 Safety Injection

Allowable Value : N/A (Ref. 5.8)

See Items 4.2.1 through 4.2.8.

Containment Isolation – Phase B

4.2.15 Containment Isolation – Phase B, Manual Initiation

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.16 Containment Isolation – Phase B, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.17 Containment Pressure High - High

Allowable Value : See Item 4.2.11

Steam Line Isolation

4.2.18 Steam Line Isolation, Manual Initiation

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.19 Steam Line Isolation, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.20 Containment Pressure Intermediate High - High

Allowable Value : $\leq$ 18.5 PSIA (Refs. 5.1, 5.8, 5.25 & 5.55)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 18.82 PSIA. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 19.04 PSIA. The Actual Nominal Trip Setpoint of 17.8 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 18.5 PSIA is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 18.5 PSIA is based on maintaining a Nominal Trip Setpoint value of 17.8 PSIA. The current ITS Allowable Value of $\leq$ 18.5 PSIA is slightly greater than the calculated COT_{error} shown below but the offset is accommodated in the Safety Margin illustrated in Figure 4.2.20.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0052 (Ref. 5.25) are given below. The COT and NON COT error components are used in Figure 4.2.20 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.18)^2 + 0.308^2 + 0.0^2 + 1.158^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = \pm$ 1.474 % of span = $\pm$ 0.958 PSIA

$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.036 % of span = $\pm$ 0.673 PSIA

See Figure 4.2.20 for specific details.

NORTH ANNA'S CONTAINMENT PRESSURE HI-2 ESFAS INITIATION

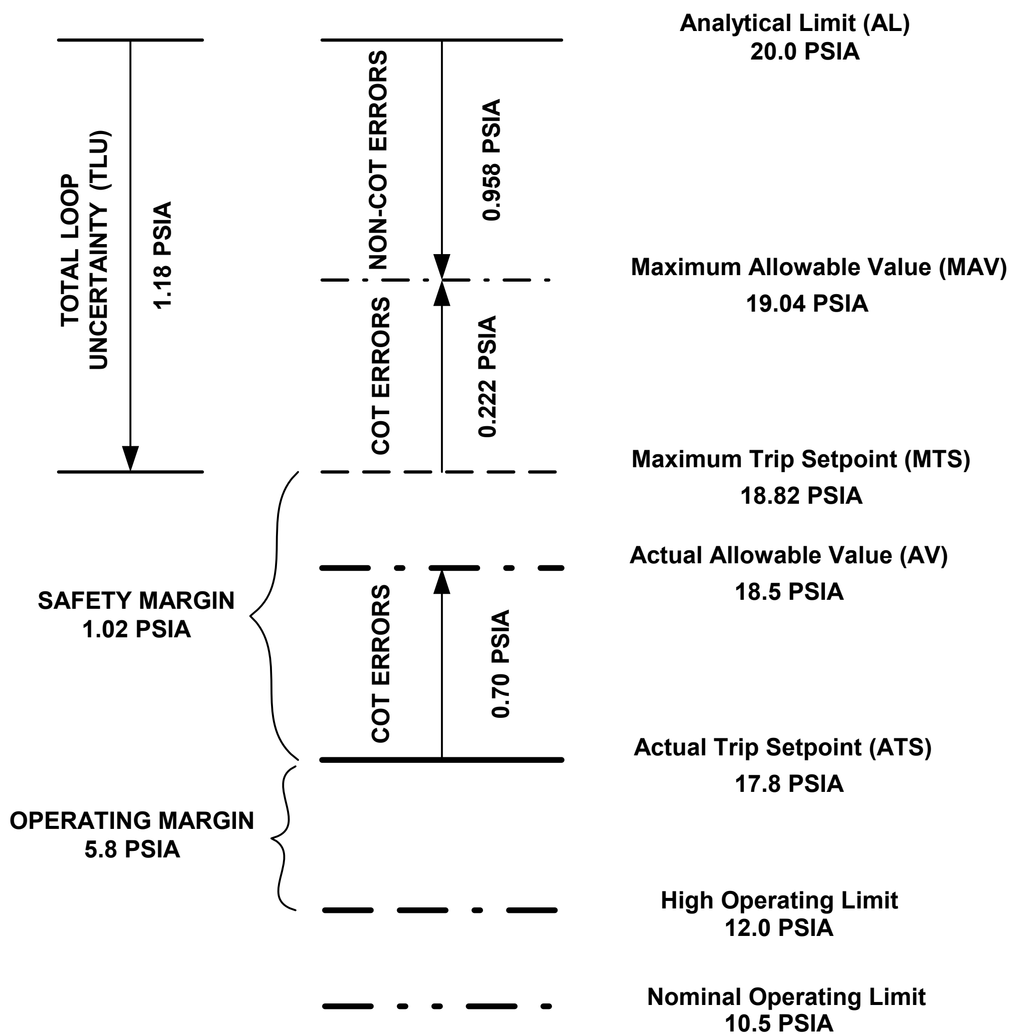


Figure 4.2.20

4.2.21 High Steam Flow in Two Steam Lines

Allowable Value : See Item 4.2.6

4.2.22 T_{AVG} Low-Low

Allowable Value : See Item 4.2.7.

4.2.23 Steam Line Pressure - Low

Allowable Value : See Item 4.2.8

Turbine Trip and Feedwater Isolation

4.2.24 Turbine Trip and Feedwater Isolation, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Set point associated with this function.

4.2.25 SG Water Level - High High (P-14)

Allowable Value : $\leq$ 76.0 % Narrow Range (NR) Level (Refs. 5.1, 5.8, 5.22 & 5.48)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 98.024 % NR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 98.334 % NR Level. The Actual Nominal Trip Setpoint of 75.0 % NR Level is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 76.0 % NR Level is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 76.0 NR Level is based on maintaining a Nominal Trip Setpoint value of 75.0 % NR Level.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0492 (Ref. 5.22) are given below. The COT and NON COT error components are used in Figure 4.2.25 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$NON\ COT_{error} = SE + PMA_2 + [PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.0 + 0.0 + [0.0^2 + (0.5+0.383)^2 + 0.289^2 + 0.635^2 + 1.110^2 + 0.158^2 + 0.05^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 1.666 % of span = $\pm$ 1.666 % NR Level

$COT_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.036 % of span = $\pm$ 1.036 % NR Level

See Figure 4.2.25 for specific details.

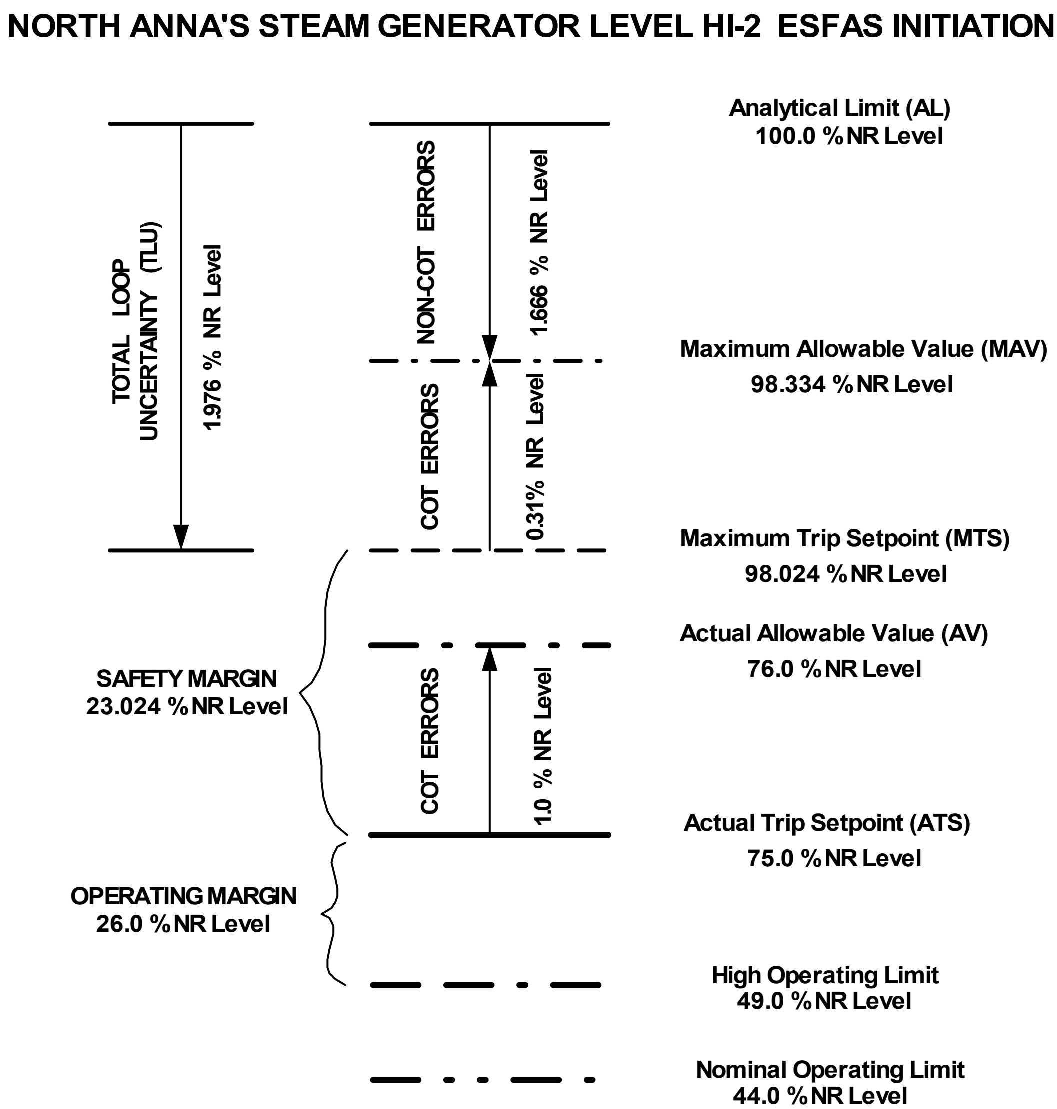


Figure 4.2.25

4.2.26 Safety Injection

Allowable Value : **N/A**

See Items 4.2.1 through 4.2.8.

Auxiliary Feedwater

4.2.27 Auxiliary Feedwater, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.28 SG Water Level - Low Low

Allowable Value : See item 4.1.17.

4.2.29 Safety Injection

Allowable Value : N/A

See items 4.2.1 through 4.2.8.

4.2.30 Loss of Offsite Power

Allowable Value : This Allowable Value will be provided by Corporate Electrical EE Power.

4.2.31 Trip of all Main Feedwater Pumps

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

Automatic Switch Over to Containment Sump

4.2.32 Containment Sump Auto Switch Over, Automatic Actuation Logic and Actuation Relays

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.33 Refueling Water Storage Tank Level – Low Low (Auto-Switchover to Containment Sump)

Allowable Values : $\geq$ 15.0 % Wide Range (WR) Level and $\leq$ 17.0 % Wide Range (WR) Level

(Refs. 5.1, 5.8, 5.27, 5.52 & 5.86)

There are two Analytical Limits and thus two Allowable Values associated with this function. The Analytical Limits are $\geq$ 13.5 % WR Level and $\leq$ 18.5 % WR Level. The corresponding Allowable Values are $\geq$ 15.0 % WR Level and $\leq$ 17.0 WR Level. Both Allowable Values will be analyzed below.

Analysis for $\geq$ 15.0 % Wide Range (WR) Level

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL = 13.5 % WR Level) yields a Minimum Trip Setpoint (MTS) of 15.243 % WR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 14.868 % WR Level. The Actual Nominal Trip Setpoint of 16.0 % WR Level is conservative with respect to the Minimum Trip Setpoint. The Actual Allowable Value of $\geq$ 15.0 % WR Level is conservative with respect to the Minimum Allowable Value. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0092 (Ref. 5.27) are given below. The COT and NON COT error components are used in Figure 4.2.33 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{\text{error}} = \text{SE} \pm [\text{EA}^2 + \text{PMA}^2 + \text{PEA}^2 + (\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{SPSE}^2 + \text{M1MTE}^2 + \text{M2MTE}^2 + \text{RTE}^2]^{1/2}$

$\text{NON COT}_{\text{error}} = 0.064 \pm [0.0^2 + 0.022^2 + 0.0^2 + (0.5+0.211)^2 + 0.222^2 + 0.0^2 + 0.933^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{\text{error}}$ = + 1.368 % of span and – 1.24 % of span

$\text{COT}_{\text{error}} = \pm (\text{M1}^2 + \text{M2}^2 + \text{RD}^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm$ 1.036 % of span

Analysis for $\leq$ 17.0 % Wide Range (WR) Level

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL = 18.5 % WR Level) yields a Maximum Trip Setpoint (MTS) of 16.885 % WR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 17.26 % WR Level. The Actual Nominal Trip Setpoint of 16.0 % WR Level is conservative with respect to the Maximum Trip Setpoint. The Actual Allowable Value of $\leq$ 17.0 % WR Level is slightly conservative with respect to the Maximum Allowable Value. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0092 (Ref. 5.27) are given below. The COT and NON

COT error components are used in Figure 4.2.33 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$NON\ COT_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.064 \pm [0.0^2 + 0.022^2 + 0.0^2 + (0.5+0.211)^2 + 0.222^2 + 0.0^2 + 0.933^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$

$NON\ COT_{error}$ = + 1.368 % of span and – 1.24 % of span

$COT_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.036 % of span

See Figures 4.2.33 for specific details.

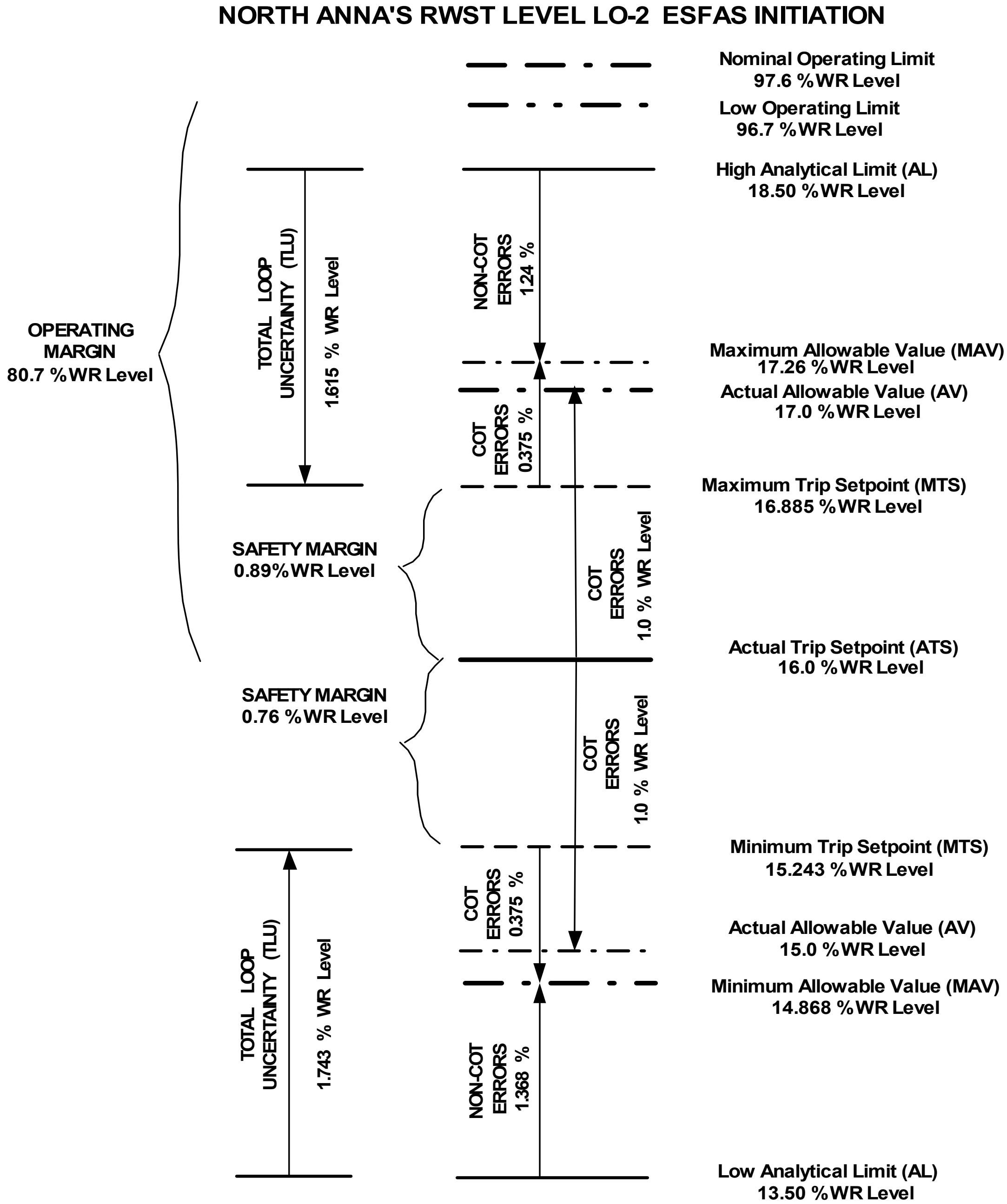

NORTH ANNA'S RWST LEVEL LO-2 ESFAS INITIATION
Nominal Operating Limit
97.6 %WR Level
Low Operating Limit
96.7 %WR Level
High Analytical Limit (AL)
18.50 %WR Level
NON-COT ERRORS 1.24 %
TOTAL LOOP UNCERTAINTY (TLU)
1.615 % WR Level
OPERATING MARGIN
80.7 %WR Level
Maximum Allowable Value (MAV)
17.26 %WR Level
Actual Allowable Value (AV)
17.0 %WR Level
COT ERRORS 0.375 %
Maximum Trip Setpoint (MTS)
16.885 %WR Level
SAFETY MARGIN
0.89%WR Level
COT ERRORS 1.0 % WR Level
Actual Trip Setpoint (ATS)
16.0 %WR Level
SAFETY MARGIN
0.76 %WR Level
COT ERRORS 1.0 % WR Level
Minimum Trip Setpoint (MTS)
15.243 %WR Level
COT ERRORS 0.375 %
Actual Allowable Value (AV)
15.0 %WR Level
Minimum Allowable Value (MAV)
14.868 %WR Level
TOTAL LOOP UNCERTAINTY (TLU)
1.743 % WR Level
NON-COT ERRORS 1.368 %
Low Analytical Limit (AL)
13.50 %WR Level

Figure 4.2.33

4.2.34 Refueling Water Storage Tank Low Level – RS Pump Start

Allowable Values : $\geq$ 59.0 % Wide Range (WR) Level and $\leq$ 61.0 % Wide Range (WR) Level

(Refs. 5.1, 5.8, 5.27, 5.52 & 5.86)

There are two Analytical Limits and thus two Allowable Values associated with this new function. The Analytical Limits are based on Technical Report NE-0994 (Ref. 5.1). The Analytical Limits are $\geq$ 57.50 % WR Level and $\leq$ 62.50 % WR Level. The corresponding Allowable Values to be used in Technical Specifications are $\geq$ 59.00 % WR Level and $\leq$ 61.00 % WR Level. Both Allowable Values will be analyzed below.

Analysis for $\geq$ 59.00 % Wide Range (WR) Level

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 59.24 % WR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 58.868 % WR Level. The Actual Nominal Trip Setpoint of 60.00 % WR Level is conservative with respect to the Minimum Trip Setpoint. The Actual Allowable Value of $\geq$ 59.00 % WR Level is conservative with respect to the Minimum Allowable Value. This Allowable Value of $\geq$ 59.00 % WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00 % WR Level. The proposed Allowable Value of $\geq$ 59.00 % WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms) from Dominion Channel Statistical Allowance (CSA) Calculation EE-0092 (Reference 5.27).

Analysis for $\leq$ 61.00 % Wide Range (WR) Level

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 60.885 % WR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 61.26 % WR Level. The Actual Nominal Trip Setpoint of 60.00 % WR Level is conservative with respect to the Maximum Trip Setpoint. The Actual Allowable Value of $\leq$ 61.00 % WR Level is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 61.00 % WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00 % WR Level. The proposed Allowable Value of $\leq$ 61.00 % WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms) from Dominion Channel Statistical Allowance (CSA) Calculation EE-0092 (Ref. 5.27).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0092 (Ref. 5.27) are given below. The COT and NON COT error components are used in Figure 4.2.34 to determine the Minimum/Maximum Trip Setpoints (MTS) and the Minimum/Maximum Allowable Values (MAV).

$$\text{NON COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.064 \pm [0.0^2 + 0.022^2 + 0.0^2 + (0.5+0.211)^2 + 0.222^2 + 0.0^2 + 0.933^2 + 0.0^2 + 0.153^2 + 0.03^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = +1.368 \text{ \% of span and } -1.24 \text{ \% of span}$$

$$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.1^2 + 0.25^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.036 \text{ \% of span}$$

See Figure 4.2.34 for specific details.

NORTH ANNA'S RWST LEVEL LO ESFAS INITIATION

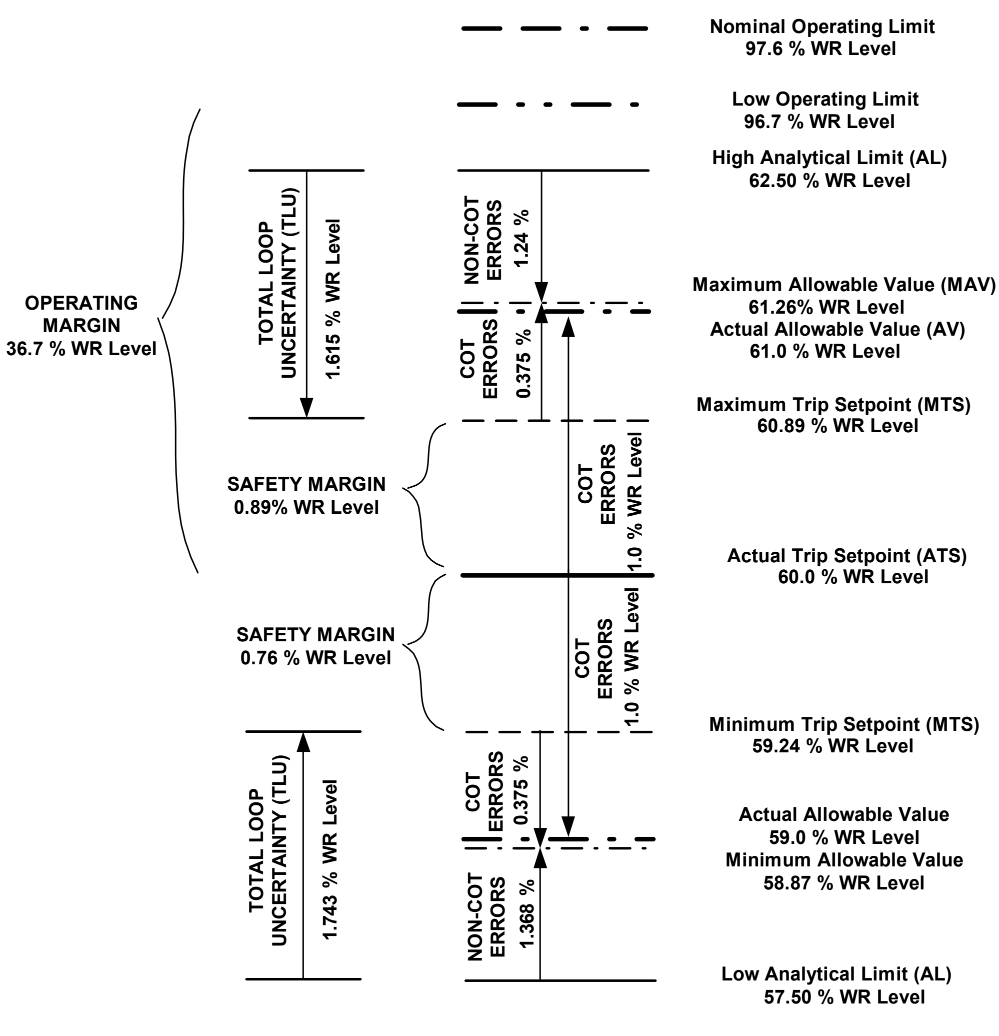


Figure 4.2.34

Note: The COT errors are based on the Minimum Trip Setpoint value minus the Minimum Allowable value and the Actual Trip Setpoint value minus the Actual Allowable Value

4.2.35 Safety Injection

Allowable Value : N/A

See Items 4.2.1 through 4.2.8.

ESFAS Permissives

4.2.36 Reactor Trip, P-4

Allowable Value : N/A (Ref. 5.8)

There is no specific ESFAS Trip Setpoint associated with this function.

4.2.37 Pressurizer Pressure, P-11

Allowable Value : $\leq$ 2010 PSIG (Refs. 5.1, 5.8, 5.19, 5.44)

For North Anna's ITS, only one Allowable Value will be provided for the P-11 function. The automatic disabling of the manual block of safety injection on increasing pressure is the portion of this function that is important to safety. The Allowable Value of $\leq$ 2010 PSIG is based on maintaining a Nominal Trip Setpoint value of 2000 PSIG. In this case, the current value of $\leq$ 2010 PSIG will be retained because it is sufficiently close enough to the calculated value using the methodologies described in Section 3.3 and the CSA rack error terms from Calculation EE-0069 (Ref 5.19). The calculated Allowable Value for this function is $\leq$ 2008.3 PSIG. Note that this function is assumed to be available in the Safety Analysis but no specific setpoint is assumed and thus the margin of safety is not affected.

4.2.38 T_{AVG}, P-12

Allowable Value : $\leq$ 545.0 ^oF (Refs. 5.1, 5.8, 5.18, 5.47)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 544.526 ^oF. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 545.55 ^oF. The Actual Nominal Trip Setpoint of 544.0 ^oF is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 545.0 ^oF is conservative with respect to the Maximum Allowable Value.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0434 (Ref. 5.18) are given below. The COT and NON COT error components are used in Figure 4.2.38 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$$CSA_{13}NON\ COT_{error} = [EA^2 + PEA^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (4 * SD_{RTD}{}^2) + STE_{RTD}{}^2 + M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M7MTE^2 + M20MTE^2 + M26MTE^2 + RTE^2]^{1/2}$$

$CSA_{13}NON\ COT_{error} = [0.0^2 + 0.0^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.0^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.23^2 + 0.12^2 + 0.09^2 + 0.06^2 + 0.03^2 + 0.5^2]^{½}$

$CSA_{13}NON\ COT_{error} = \pm\ 1.450$ % of span = $\pm\ 1.450\ ^oF$

$CSA_{13}COT_{error} = \pm\ (M1^2 + M2^2 + M3^2 + M4^2 + M5^2 + M7^2 + M20^2 + M26^2 + RD^2)^{1/2}$

$CSA_{13}COT_{error} = \pm\ (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.25^2 + 1.0^2)^{1/2}$

$CSA_{13}COT_{error} = \pm\ 1.677$ % of span = $\pm\ 1.677\ ^oF$

See Figure 4.2.38 for specific details.

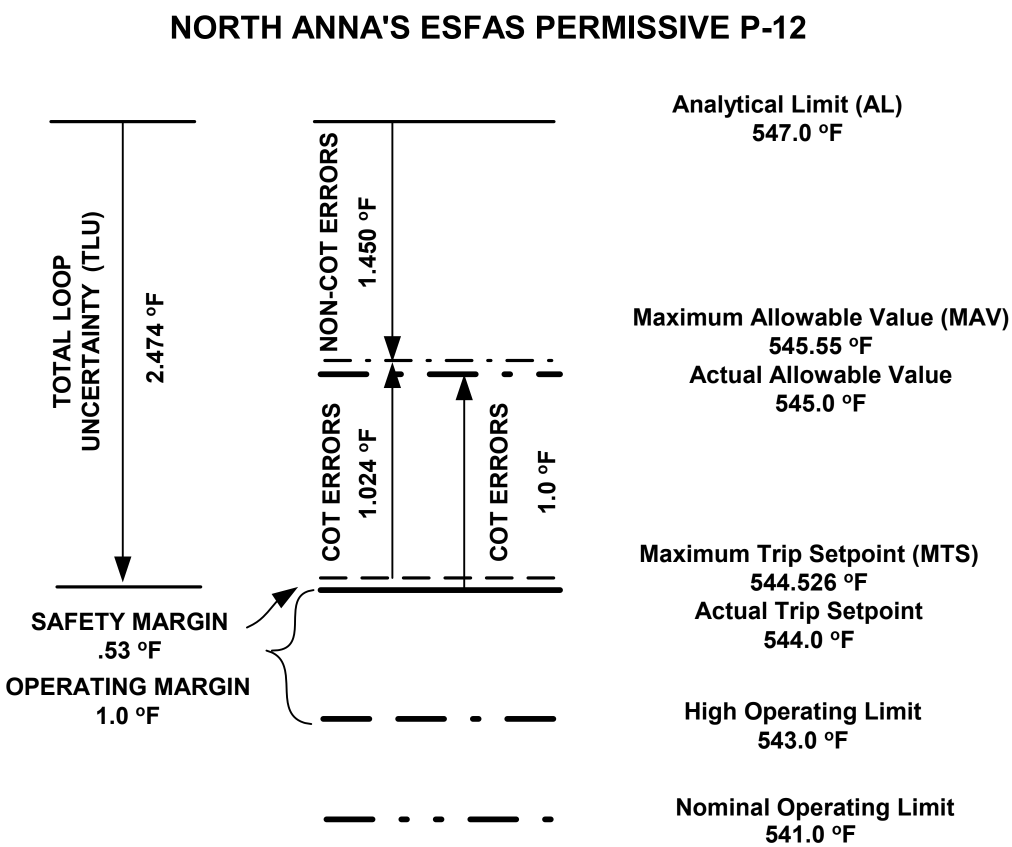


Figure 4.2.38

4.3 Limiting Safety System Settings (LSSS) for Surry Power Station Custom Technical Specifications, Section 2.3, Limiting Safety System Settings, Protective Instrumentation and Protective Instrumentation Settings for Reactor Trip Interlocks.

Note: In the context of this document, the terms Allowable Value and Setting Limit and Limiting Safety System Setting (LSSS) have the same meaning and intent.

Reactor Trips

4.3.1 Power Range Neutron Flux High Setpoint Reactor Trip

Allowable Value : $\leq$ 109.0 % RTP (Refs. 5.1, 5.7, 5.28 & 5.81)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 110.48 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 111.08 % RTP. The Actual Nominal Trip Setpoint of 107.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 109.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 109.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 107.0 % RTP.

The calculated Allowable Value for this function is $\leq$ 108.697 % RTP. The 0.303 % RTP offset is accommodated in the 3.48 % RTP Safety Margin for this trip as illustrated in Figure 4.3.1.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0198 (Ref. 5.28) are given below. The COT and NON COT error components are used in Figure 4.3.1 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + RMTE^2 + RTE^2)^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm (2.000^2 + 5.000^2 + 2.000^2 + 0.5^2)^{1/2}$

$\text{NON COT}_{error} = \pm$ 5.766 % of span = $\pm$ 6.920 % RTP

$\text{COT}_{error} = \pm (RCA^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (1.0^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.414 % of span = $\pm$ 1.697 % RTP

See Figure 4.3.1 for specific details.

SURRY'S POWER RANGE NEUTRON FLUX HIGH REACTOR TRIP

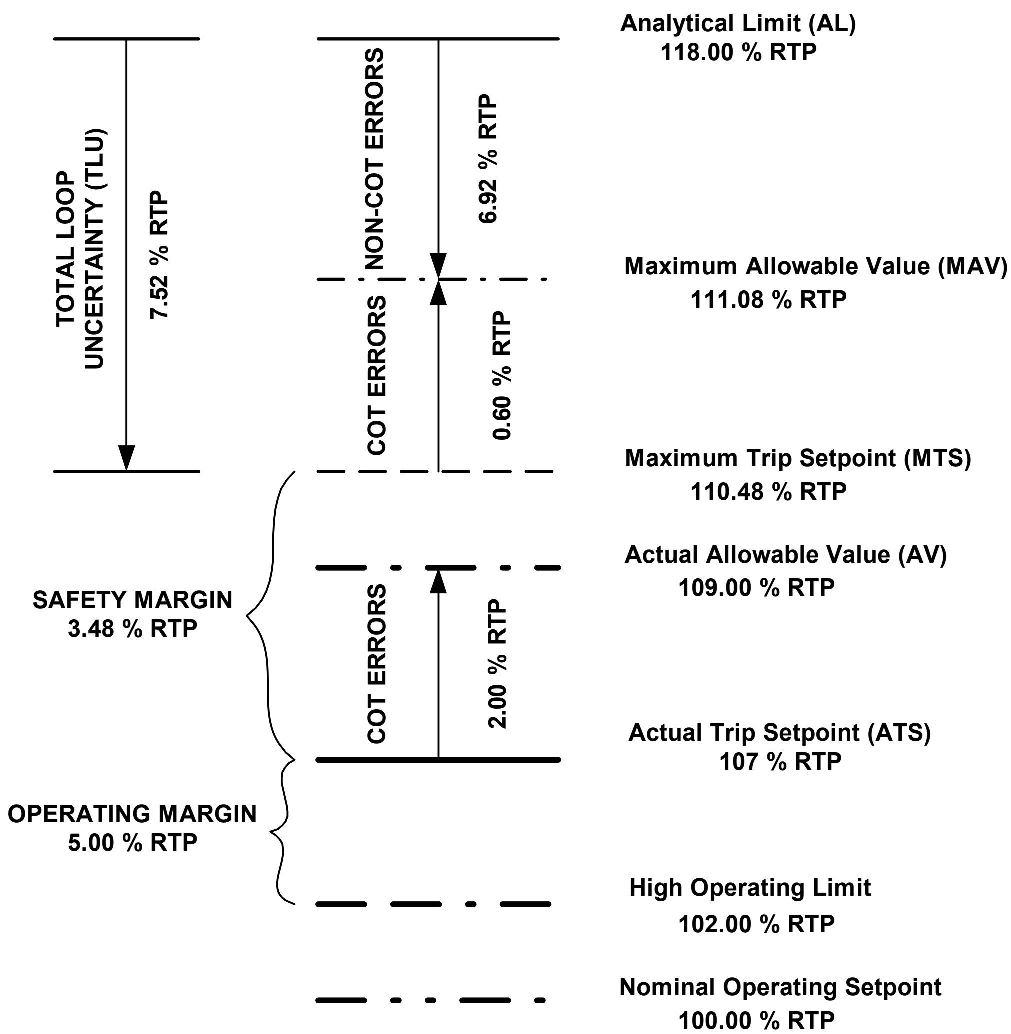


Figure 4.3.1

4.3.2 Power Range Neutron Flux Low Setpoint Reactor Trip

Allowable Value : $\leq$ 25.0 % RTP (Refs. 5.1, 5.7, 5.28 & 5.81)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 27.48 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 28.08 % RTP. The Actual Nominal Trip Setpoint of 23.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 25.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 25.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 23.0 % RTP.

The calculated Allowable Value for this function is $\leq$ 24.70 % RTP. The 0.30 % RTP offset is accommodated in the 4.48 % RTP Safety Margin for this trip as illustrated in Figure 4.3.2.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0198 (Ref. 5.28) are given below. The COT and NON COT error components are used in Figure 4.3.2 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + RMTE^2 + RTE^2)^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm (2.000^2 + 5.000^2 + 2.000^2 + 0.5^2)^{½}$

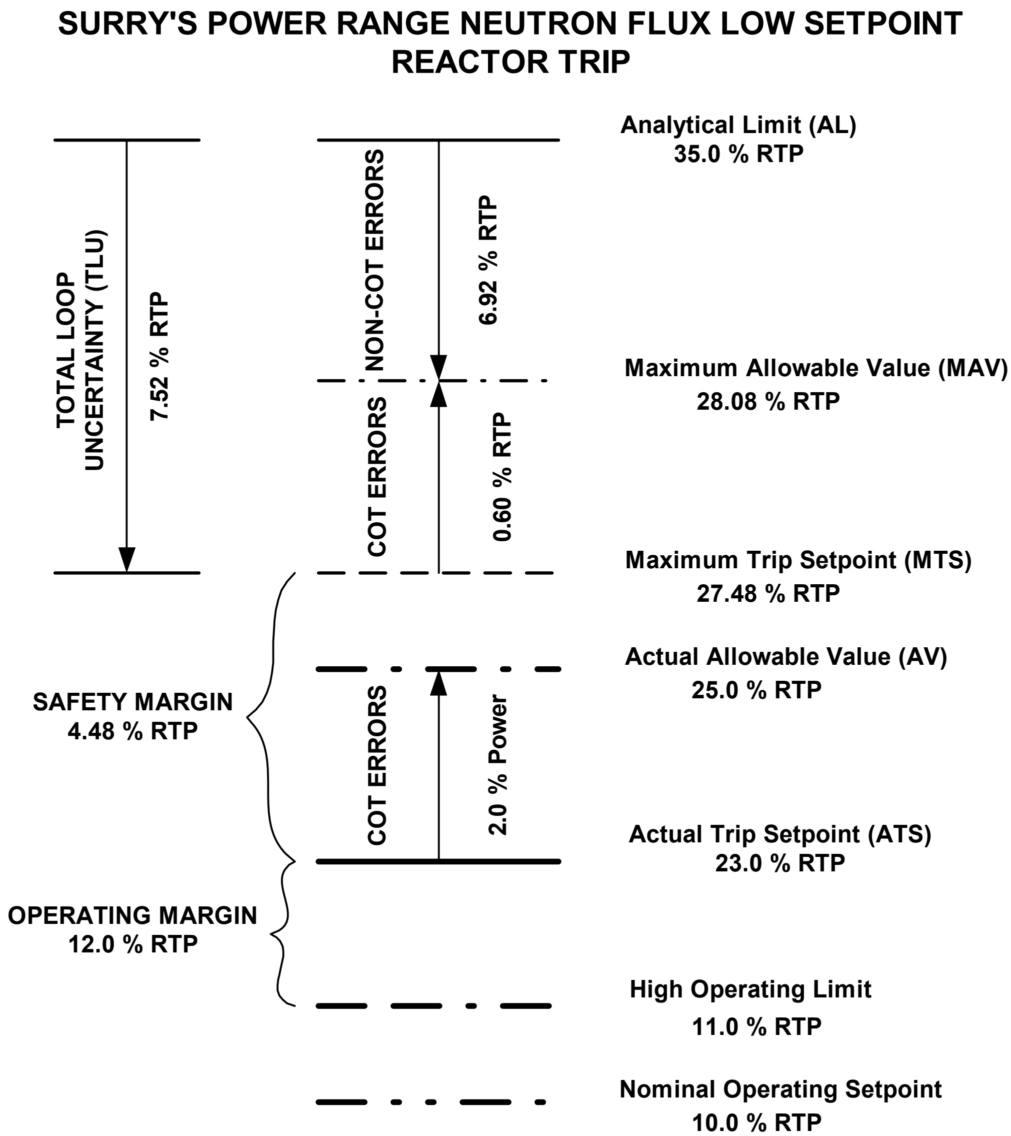
$\text{NON COT}_{error} = \pm$ 5.766 % of span = $\pm$ 6.920 % RTP

$\text{COT}_{error} = \pm (M1^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (1.0^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.414 % of span = $\pm$ 1.697 % RTP

See Figure 4.3.2 for specific details.



<u>Figure 4.3.2</u>

4.3.3 Intermediate Range Neutron Flux High Reactor Trip

Allowable Value : **$\leq$ 40.0 % RTP** **(Refs. 5.1, 5.7, 5.29 & 5.82)**

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 88.18 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 89.627 % RTP. The Actual Nominal Trip Setpoint of 35.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of 40.0 % RTP is conservative with respect to the Maximum Allowable Value. This Allowable Value of $\leq$ 40.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 35.0 % RTP.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0722 (Ref. 5.29) are given below. The COT and NON COT error components are used in Figure 4.3.3 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm (EA^2 + PMA^2 + PEA^2 + SCA^2 + SD^2 + SPE^2 + RTE^2 + RRA^2)^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm (0.0^2 + 8.498^2 + 0.0^2 + 0.5^2 + 1.0^2 + 0.0^2 + 0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{NON COT}_{error} = \pm$ 8.644 % of span = $\pm$ 10.373 % RTP

$\text{COT}_{error} = \pm [(M4 + M4MTE)^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm [(1.003 + 3.622)^2 + 1.00^2]^{1/2}$

$\text{COT}_{error} = \pm$ 4.732 % of span = $\pm$ 5.678 % RTP

Note: The M4MTE was included in the COT_{error} formula due to the meter being used for the adjustment of the bistable.

See Figure 4.3.3 for specific details.

SURRY'S INTERMEDIATE RANGE HIGH FLUX REACTOR TRIP

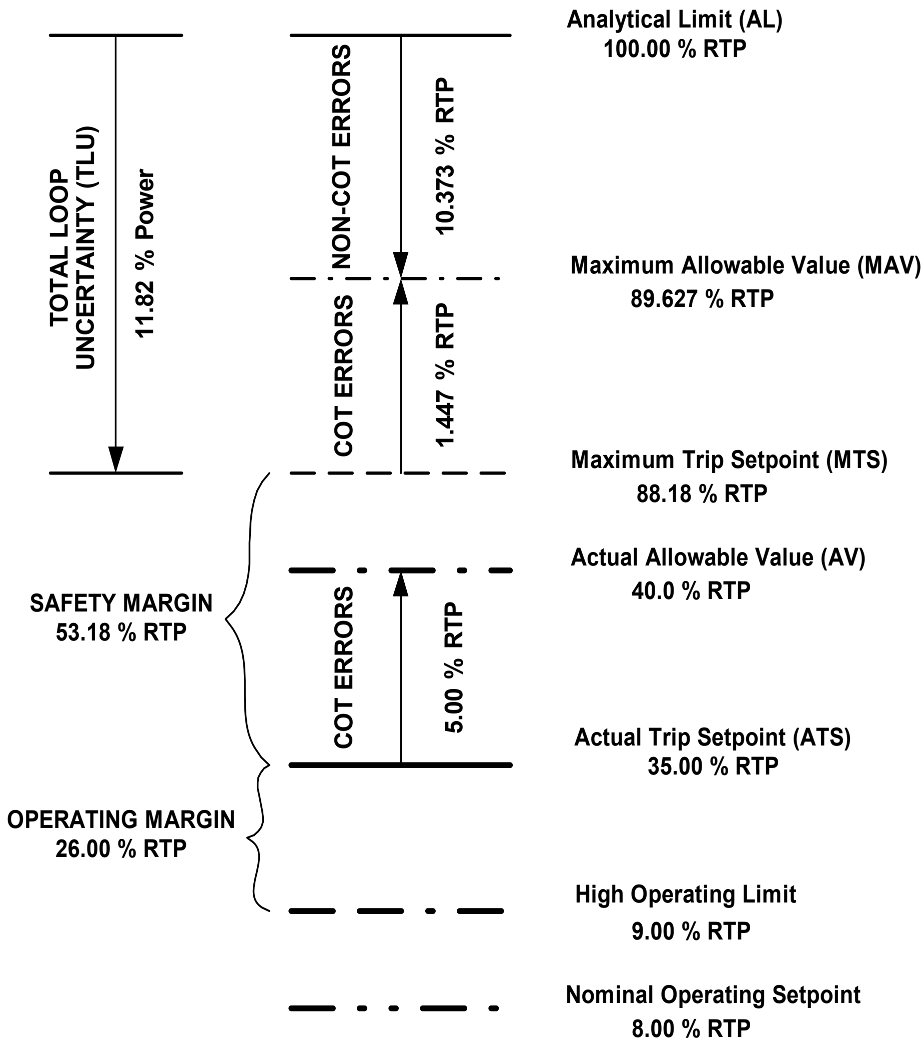


Figure 4.3.3

4.3.4 Source Range Neutron Flux High Reactor Trip

Allowable Value : **$\leq$ 1.51 * 10^5 CPS** **(Refs. 5.1, 5.7, 5.30, 5.82)**

Subtracting the Total Loop Uncertainty (TLU = + 0.93 * 10^5 and – 0.48 * 10^5) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 1.21 * 10^6 Counts Per Second (CPS). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 1.27 * 10^6 CPS. The Actual Nominal Trip Setpoint of 1.0 * 10^5 CPS is conservative with respect to the Maximum Trip Setpoint. The current Allowable Value of $\leq$ 1.00 * 10^6 CPS is conservative with respect to the Maximum Allowable Value. The current Allowable Value $\leq$ 1.00 * 10^6 is not consistent with the calculated Allowable Values using the COT errors shown below. The Allowable Value will be changed from $\leq$ 1.00 * 10^6 to $\leq$ 1.51 * 10^5 CPS to conform to the methodology described in Sections 3.3.1 and 3.3.2.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0719 (Ref. 5.30) are given below. The COT and NON COT error components are used in Figure 4.3.4 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$NON\ COT_{error} = SE \pm (PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2 + RRA^2)^{1/2}$

$NON\ COT_{error} = 0.0 \pm (0.0^2 + 0.0^2 + (0.0+0.0)^2 + 0.0^2 + 0.0^2 + 0.0^2 + 1.817^2 + 1.0^2 + 0.5^2 + 0.0^2)^{1/2}$

$NON\ COT_{error} = \pm$ 2.133 % of linear span

= + 0.34*10^5 CPS and – 0.25*10^5 CPS (Based on Trip Setpoint of 1.0*10^5 CPS)
= 0.34*10^5 CPS(1)

$COT_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$COT_{error} = \pm (1.617^2 + 1.617^2 + 1.9^2)^{1/2}$

$COT_{error} = \pm$ 2.973 % of linear span

= + 0.51*10^5 CPS and – 0.34*10^5 CPS (Based on the Nominal Trip Setpoint of 1.0*10^5 CPS)

= 0.51*10^5 CPS(2)

---

(1) Nominal Trip Setpoint = 1.0 * 10^5 CPS $\Rightarrow$ log 1.0 * 10^5 = 5.0 (on a 0 to 6 Decade scale)
Analytical Limit = 1.3 * 10^6 CPS $\Rightarrow$ log 1.3 * 10^6 = 6.11394 (on a 0 to 6 Decade scale)
Full CSA = $\pm$ 4.744 % of linear span $\Rightarrow$ (4.744 %/100 %) * 6 Decades = $\pm$ 0.28464 Decade
High Trip Setpoint = 5.0 + 0.28464 = 5.28464 $\Rightarrow$ antilog 5.28464 = 1.93 * 10^5
Low Trip Setpoint = 5.0 - 0.28464 = 4.71536 $\Rightarrow$ antilog 4.71536 = 0.52 * 10^5
CSA(+) = 1.93 * 10^5 – 1.0 * 10^5 = 0.93 * 10^5 and CSA(-) = 1.0 * 10^5 – 0.52 * 10^5 = 0.48 * 10^5
Full CSA = (+) 0.93 * 10^5 CPS and (-) 0.48 * 10^5 CPS

(2) The most conservative value is used regardless of sign.

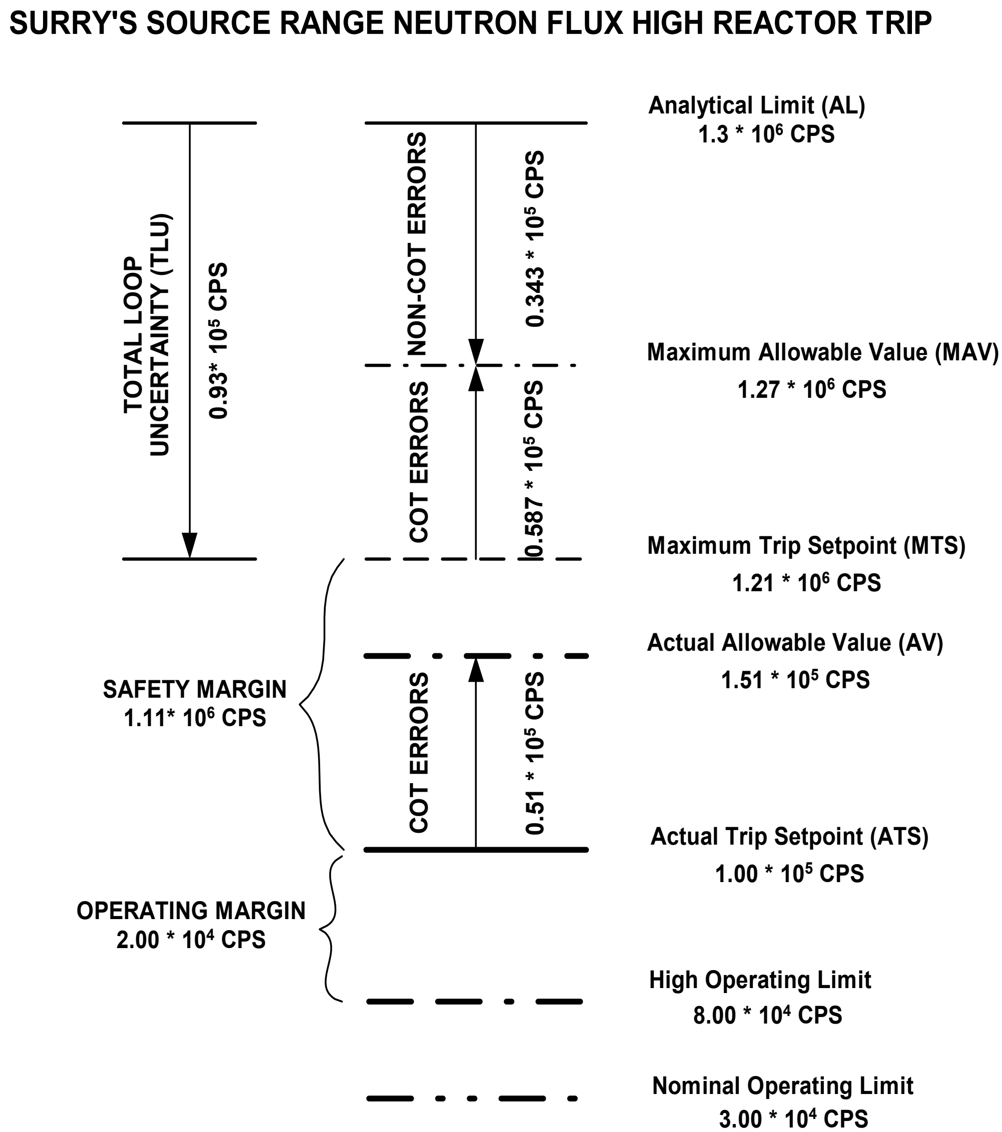

SURRY'S SOURCE RANGE NEUTRON FLUX HIGH REACTOR TRIP
Analytical Limit (AL)
1.3 * 10^6 CPS
TOTAL LOOP UNCERTAINTY (TLU)
0.93* 10^5 CPS
NON-COT ERRORS
0.343 * 10^5 CPS
Maximum Allowable Value (MAV)
1.27 * 10^6 CPS
COT ERRORS
0.587 * 10^5 CPS
Maximum Trip Setpoint (MTS)
1.21 * 10^6 CPS
SAFETY MARGIN
1.11* 10^6 CPS
Actual Allowable Value (AV)
1.51 * 10^5 CPS
COT ERRORS
0.51 * 10^5 CPS
Actual Trip Setpoint (ATS)
1.00 * 10^5 CPS
OPERATING MARGIN
2.00 * 10^4 CPS
High Operating Limit
8.00 * 10^4 CPS
Nominal Operating Limit
3.00 * 10^4 CPS

Figure 4.3.4

4.3.5 <u>Overtemperature ΔT Reactor Trip</u>

Allowable Value : See below (Refs. 5.1, 5.7, 5.31, 5.69, 5.71, 5.72, 5.73 & 5.74)

" The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 2.0 % of the ΔT span " (Note that 2.0 % of the ΔT span is equal to 3.0 % ΔT Power)

The Overtemperature ΔT (OTΔT) Reactor Trip Setpoint equation in terms of process units is:

$$OT\Delta T_{SP} \leq \Delta T_o [K_1 - K_2 * (\frac{1+\tau_1 s}{1+\tau_2 s}) * (T - T') + K_3 * (P - P') - F(\Delta Q)]$$

Where: **(Equation 4.3.5)**

ΔT_0 = Indicated ΔT at rated thermal power, ^oF
T = Average coolant temperature, ^oF
T' = 573.0 ^oF
P = Pressurizer pressure, psig
P' = 2235 psig
K_1 = 1.135
K_2 = 0.01072
K_3 = 0.000566
ΔI = $q_t - q_b$, where q_t and q_b are percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of rated power.
f(ΔI) = function of ΔI, percent of rated core power as shown in Surry TS Figure 2.3-1.
τ_1 $\geq$ 29.7 seconds
τ_2 $\leq$ 4.4 seconds

The Overtemperature ΔT (OTΔT) Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. Further, the OTΔT Reactor Trip will be analyzed for the following three conditions:

- OTΔT Reactor Trip with no FΔI
- OTΔT Reactor Trip with (+) FΔI
- OTΔT Reactor Trip with (-) FΔI

Note: FΔI is the Delta Flux Penalty generated from the Upper and Lower Power Range Neutron Flux Detectors (i.e., Q_U and Q_L).

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields the following Maximum Trip Setpoints (MTS) for the three OTΔT Reactor Trip conditions described above:

- MTS for OTΔT Reactor Trip with no FΔI = 123.2 % - 7.956 % = 115.24 % ΔT Power
- MTS for OTΔT Reactor Trip with (+) FΔI = 128.9 % - 9.788 % = 119.11 % ΔT Power
- MTS for OTΔT Reactor Trip with (-) FΔI = 131.3 % - 11.355 % = 119.95 % ΔT Power

Subtracting the NON COT error components from the Analytical Limit yields the following Maximum Allowable Values (MAV) for the three OTΔT Reactor Trip conditions described above:

- MAV for OTΔT Reactor Trip with no FΔI = 123.2 % - 5.676 % = 117.52 % ΔT Power
- MAV for OTΔT Reactor Trip with (+) FΔI = 128.9 % - 8.045 % = 120.855 % ΔT Power
- MAV for OTΔT Reactor Trip with (-) FΔI = 131.3 % - 9.891 % = 121.409 % ΔT Power

For the most limiting condition (i.e., OTΔT Reactor Trip with no FΔI) the Actual Nominal Trip Setpoint of 111.5 % ΔT Power (e.g., based on T_{AVG} = 573.0 ^oF) is conservative with respect to the Maximum Trip Setpoint of 115.24 % ΔT Power and the Actual Allowable Value of 114.5 % ΔT Power is conservative with respect to the Maximum Allowable Value of 117.52 % ΔT Power. This Allowable Value of $\leq$ 114.5 % ΔT Power is based on maintaining a Nominal Trip Setpoint value of 111.5 % ΔT Power. Note that this analysis is based on static conditions such that dynamic components are not considered.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0415 (Ref. 5.31) with the appropriate modifications described in Section 3.2 for the OTΔT Reactor Trip are given below. The COT and NON COT error components are used in Figure 4.3.5b to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV) for the most limiting condition.

<u>OTΔT Reactor Trip with no FΔI</u>

$$NON\ COT_{error} = [EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_1^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$$

Where the following RMTE Terms are taken from Calculation EE-0415 (Ref. 5.31):

$RMTE_1^2$ = ΔT Channel Measuring and Test Equipment = $(M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M6MTE^2)^{1/2}$

$RMTE_1^2 = (0.248^2 + 0.248^2 + 0.248^2 + 0.244^2 + 0.30^2 + 0.26^2)^{1/2}$ = 0.634 % of span

$RMTE_2^2$ = T_{AVG} Channel Measuring and Test Equipment = $(M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M7MTE^2 + M30MTE^2 + M31MTE^2)^{1/2}$

$RMTE_2^2 = (0.248^2 + 0.248^2 + 0.248^2 + 0.244^2 + 0.30^2 + 0.26^2 + 0.212^2 + 0.212^2)^{1/2}$ = 0.701 % of span

$RMTE_3^2$ = Pressurizer Pressure Channel Measuring and Test Equipment = $M45MTE^2$

$RMTE_3^2$ = 0.212 % of span

$RMTE_4^2$ = FΔI Channel Measuring and Test Equipment = $(M49MTE^2 + M52MTE^2)^{1/2}$

$RMTE_4^2 = (0.0^2 + 0.212^2)^{1/2} = 0.212$ % of span
$RMTE_5^2$ = OTΔT Setpoint Summator Measuring and Test Equipment = M32MTE

$RMTE_5^2 = 0.30$ % of span

$RMTE_6^2$ = OTΔT Reactor Trip Bistable Measuring and Test Equipment = M33MTE

$RMTE_6^2 = 0.212$ % of span

Thus, the NON COT_{error} is equal to:

$$NON\ COT_{error} = [0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.404)^2 + 0.75^2 + 2.319^2 + 0.00^2 + 0.634^2 + 0.701^2 + 0.212^2 + 0.212^2 + 0.300^2 + 0.212^2 + 0.500^2]^{1/2}$$

NON $COT_{error} = \pm 3.784$ % of span = ± 5.676 % ΔT Power

$$COT_{error} = \pm (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$$

$$COT_{error} = \pm (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$$

$COT_{error} = \pm 1.871$ % of span = ± 2.806 % ΔT Power

<u>OTΔT Reactor Trip with (+) FΔI</u>

$$NON\ COT_{error} = [EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_2^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$$

$$NON\ COT_{error} = [0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.404)^2 + 0.75^2 + 2.319^2 + 3.80^2 + 0.634^2 + 0.701^2 + 0.212^2 + 0.212^2 + 0.300^2 + 0.212^2 + 0.500^2]^{1/2}$$

NON $COT_{error} = \pm 5.363$ % of span = ± 8.045 % ΔT Power

$$COT_{error} = \pm (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$$

$$COT_{error} = \pm (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$$

$COT_{error} = \pm 1.871$ % of span = ± 2.806 % ΔT Power

OTΔT Reactor Trip with (-) FΔI

$NON\ COT_{error} = [EA_{non}^2 + PMA_{TAVG}^2 + PMA_{\Delta T}^2 + PEA^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (SCA_{RTD} + SMTE_{RTD})^2 + (4 * SD_{RTD}^2) + STE_{RTD}^2 + PMA_{XMTR}^2 + (SCA_{XMTR} + SMTE_{XMTR})^2 + SD_{XMTR}^2 + STE_{XMTR}^2 + FLUX_3^2 + RMTE_1^2 + RMTE_2^2 + RMTE_3^2 + RMTE_4^2 + RMTE_5^2 + RMTE_6^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = [0.00^2 + 1.70^2 + 1.30^2 + 0.00^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.00^2 + 0.00^2 + (0.50+0.404)^2 + 0.75^2 + 2.319^2 + 5.40^2 + 0.634^2 + 0.701^2 + 0.212^2 + 0.212^2 + 0.300^2 + 0.212^2 + 0.500^2]^{1/2}$

$NON\ COT_{error} = \pm$ 6.594 % of span = $\pm$ 9.891 % ΔT Power

$COT_{error} = \pm (RCA_1^2 + RCA_2^2 + RCA_3^2 + RCA_4^2 + RCA_5^2 + RCA_6^2 + RD_{TAVG}^2 + RD_{\Delta T}^2)^{1/2}$

$COT_{error} = \pm (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.871 % of span = $\pm$ 2.806 % ΔT Power

See Figure 4.3.5b for specific details associated with the OTΔT Reactor Trip with no FΔI.

Revised Time Constants for Equation 4.3.5, Overtemperature ΔT Reactor Trip Equation

The installed "nominal" Lead (τ_1) and Lag (τ_2) Time Constants used for the dynamic compensation associated with T_{AVG} (T) as detailed in Equation 4.3.5 are set for 33 seconds and 4 seconds, respectively. As stated in Reference 5.71, a lead time constant of 33 seconds and lag time constant of 4 seconds is more conservative than the current Technical Specifications settings of 25 seconds and 3 seconds for τ_1 and τ_2, respectively. The actual "nominal" lead/lag ratio of 33/4 installed in the plant on both units has been shown analytically to provide a faster response (i.e., will cause a reactor trip earlier) than the current Technical Specifications lead/lag ratio of 25/3 for all postulated ramp rates used in the Safety Analysis for the Overtemperature ΔT Reactor Trip Function. The revised Technical Specification limits for τ_1 and τ_2 are based on the installed lead and lag settings in the plant, noting the $\pm$ 10 % of the desired Time Constant tolerance as given by the manufacturer and the Instrument Calibration Procedure (Refs. 5.69 and 5.73). Thus, the revised Technical Specification limit for τ_1 is 29.7 Seconds (i.e., 33 seconds – 3.3 seconds) and the revised Technical Specification limit for τ_2 is 4.4 seconds (i.e., 4 seconds + 0.4 seconds). Figure 4.3.5a compares the ramp response of a 29.7/4.4 lead/lag setting versus the current Technical Specifications lead/lag setting of 25/3. The T_{AVG} ramp rate used in Figure 4.3.5a (i.e., + 10 °F / Minute) approximates the Surry T_{AVG} response for an Uncontrolled Rod Withdrawal from Full Power terminated by the OTΔT Reactor Trip for a 0.8 pcm/sec insertion rate as shown in NA&F Calculation SM-932, Figure 14.2-4 (Ref. 5.74). As shown in Figure 4.3.5a, for ramp time $\leq$ 7 seconds (i.e., time ≈ 2 lag time constants), the ramp response of the current Technical Specification lead/lag setting of 25/3 is slightly more conservative than the revised setting of 29.7/4.4. However, after two lag time constants, the output response of the revised Technical Specification lead/lag settings is more conservative and will cause the OTΔT Reactor Trip to come in sooner than the current settings. Also note that based on

Reference 5.74, there are no Safety Analysis cases that credit the OTΔT Reactor Trip for event termination times less than 20 seconds.

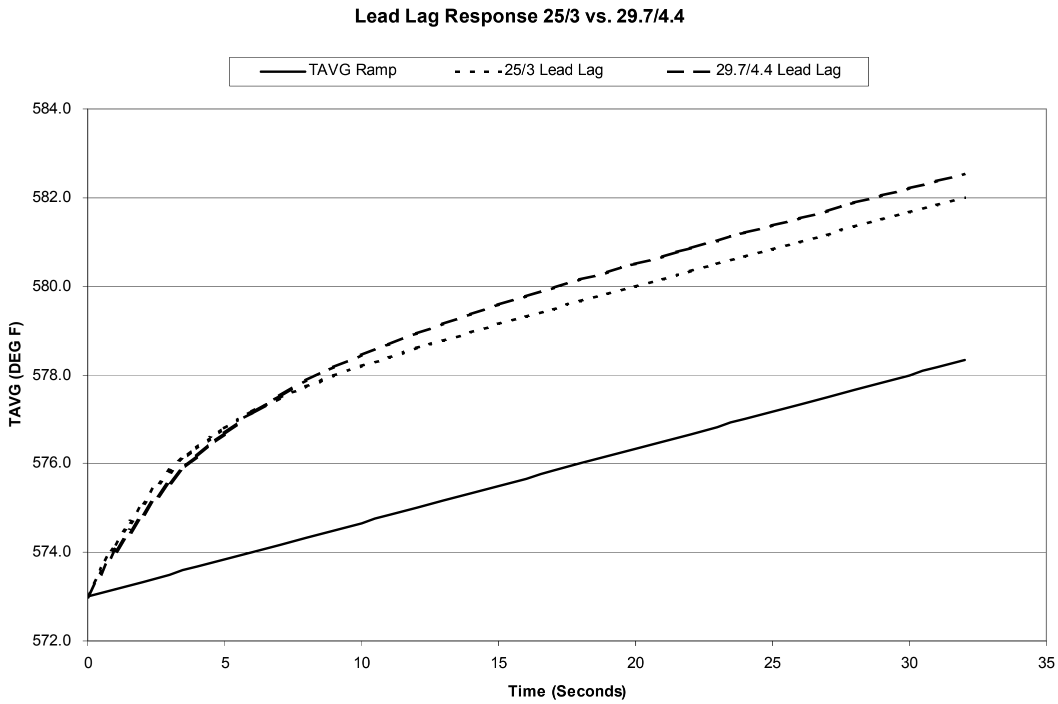


Figure 4.3.5a

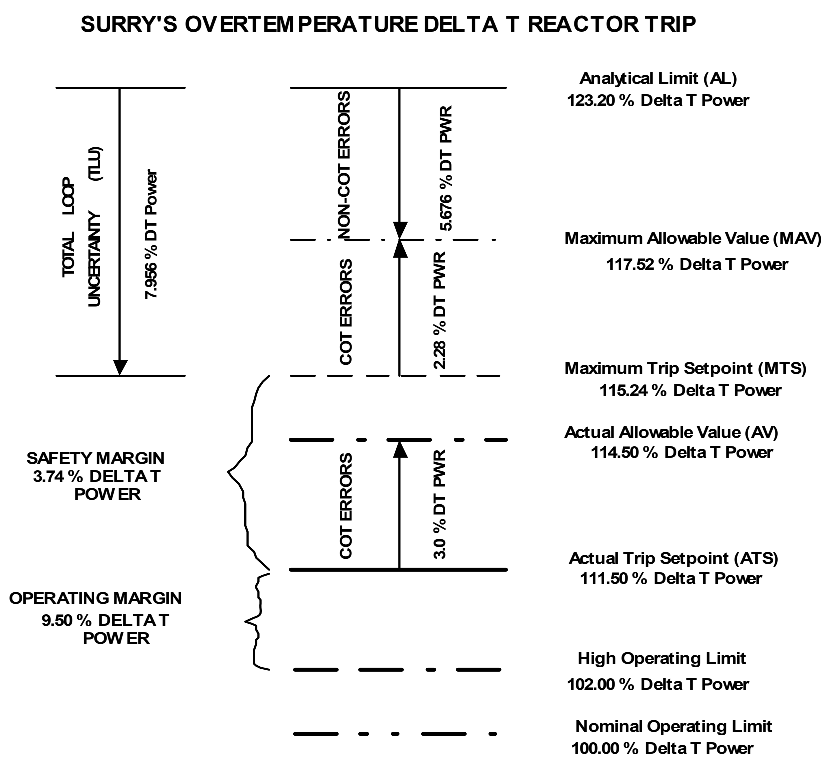


Figure 4.3.5b

4.3.6 <u>Overpower ΔT Reactor Trip</u>

Allowable Value : See below (Refs. 5.1, 5.7, 5.31, 5.69, 5.73, 5.75 & 5.76)

" The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 2.0 % of the ΔT span " (Note that 2.0 % of the ΔT span is equal to 3.0 % ΔT Power)

The Overpower ΔT (OPΔT) Reactor Trip Setpoint equation in terms of process units is:

$$\Delta T \leq \Delta T_0 \left[K_4 - K_5 * \left(\frac{t_3^{s}}{1 + t_3^{s}} \right) T - K_6 (T - T') - f(\Delta I) \right]$$

(Equation 4.3.6)

Where:

ΔT_0 = Indicated ΔT at rated thermal power, ^{o}F
T = Average coolant temperature, ^{o}F
T' = Average coolant temperature measured at nominal conditions and rated power, ^{o}F
K_4 = A constant = 1.089
K_5 = 0 for decreasing average temperature
A constant, for increasing average temperature 0.02/ ^{o}F
K_6 = 0 for $T \leq T'$
0.001086 for $T \geq T'$
f(ΔI) = function of ΔI, percent of rated core power as shown in Surry TS Figure 2.3-1.
τ_3 $\geq$ 9.0 seconds

The Overpower ΔT Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. The Overpower ΔT Reactor Trip is a backup reactor trip function and is not credited in the Surry UFSAR Chapter 14 Safety Analysis. However, the FΔI portion of the Overpower ΔT Reactor Trip is credited in NA&F Calculation SM-0933 (Ref. 5.75) and NA&F Technical Report NE-680 (Ref. 5.76). The FΔI reset function is used to reduce the Overpower ΔT Reactor Trip setpoint (Surry) and Overtemperature ΔT Reactor Trip setpoint (North Anna and Surry) to compensate for axial power distribution effects. This compensating term, which is a function of ΔI, the axial flux difference, is derived on the basis of a set of bounding non-symmetric axial power distributions. Finally, the time constant for the Overpower ΔT T_{AVG} rate penalty (i.e., τ_3) is not credited in the Chapter 14 Safety Analysis, Calculation SM-0933 or Technical Report NE-680.

The Allowable Value of 2.0 % of the ΔT span is consistent with the original design basis for this function and is conservative with respect to the CSA Calculation assumptions (Ref. 5.31). The revised Technical Specification Limit for τ_3 as described in Equation 4.3.6 above will be changed from 10 Seconds to $\geq$ 9.0 Seconds. The reduction of 1 second from the original τ_3 time constant of 10 seconds takes into account the $\pm$ 10 % of the desired Time Constant tolerance as given by the manufacturer and the Instrument Calibration Procedure (Ref. 5.69).

4.3.7 Pressurizer Low Pressure Reactor Trip

Allowable Value : $\geq$ 1875 PSIG (Refs. 5.1, 5.7, 5.32 & 5.68)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 1872.37 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 1869.48 PSIG. The Actual Nominal Trip Setpoint of 1885 PSIG is conservative with respect to the Minimum Trip Setpoint. The current Allowable Value of $\geq$ 1875 PSIG is conservative with respect to the Minimum Allowable Value. The Nominal Trip Setpoint value of 1885 PSIG allows a 10.00 PSIG margin to be used for the COT error components. The Allowable Value of $\geq$ 1875 PSIG is approximately equal to the calculated value using the CSA rack error terms from Calculation EE-0514.

The calculated Allowable Value for this function is $\geq$ 1875.20 PSIG is based on a setpoint of 1885 PSIG using the COT error components. The 0.20 PSIG offset is accommodated in the 12.63 PSIG Safety Margin for this trip as illustrated in Figure 4.3.7.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0514 (Ref. 5.32) are given below. The COT and NON COT error components are used in Figure 4.3.7 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$NON\ COT_{error} = SE \pm [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + M5MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.904^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.212^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 2.398 % of span = $\pm$ 19.184 PSIG

$COT_{error} = \pm (M1^2 + M4^2 + M5^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.225 % of span = $\pm$ 9.800 PSIG

See Figure 4.3.7 for specific details.

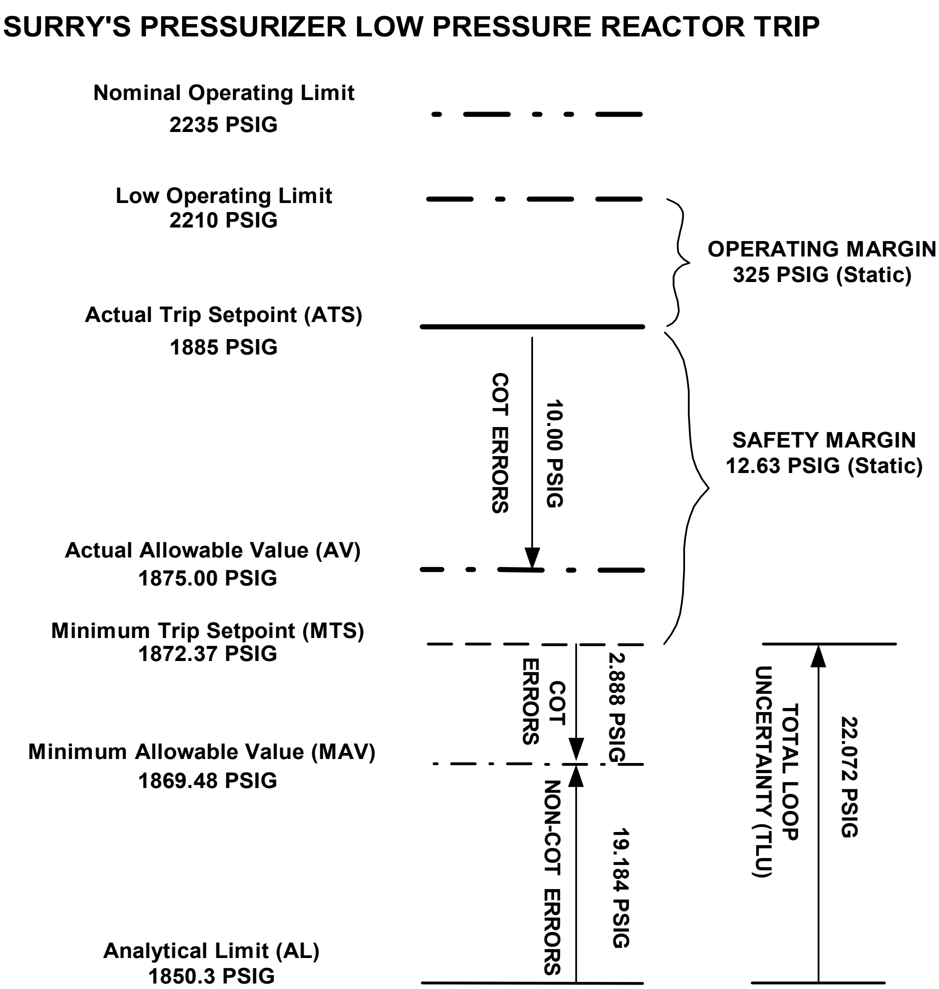


Figure 4.3.7

4.3.8 Pressurizer High Pressure Reactor Trip

Allowable Value : $\leq$ 2380 PSIG (Refs. 5.1, 5.7, 5.32 & 5.68)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 2388.98 PSIG. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 2391.20 PSIG. The Actual Nominal Trip Setpoint of 2370 PSIG is conservative with respect to the Maximum Trip Setpoint. The current Actual Allowable Value of $\leq$ 2385 PSIG is conservative with respect to the Maximum Allowable Value. The current Allowable Value $\leq$ 2385 PSIG will be changed to $\leq$ 2380 PSIG to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. This is based on the Nominal Trip Setpoint value of 2370.0 PSIG. The Nominal Trip Setpoint value of 2370 PSIG will allow a 10.0 PSIG margin to be used for the COT error components. The Allowable Value of $\leq$ 2380 PSIG is sufficiently close enough to the calculated value using the CSA rack error terms from Calculation EE-0514 (Ref 5.32).

The calculated Allowable Value for this function is $\leq$ 2378.94 PSIG. The 1.06 PSIG offset is accommodated in the 18.98 PSIG Safety Margin for this trip as illustrated in Figure 4.3.8.

In this case, the current Allowable Value of $\leq$ 2385.0 PSIG will be changed to $\leq$ 2380.0.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0514 (Ref. 5.32) are given below. The COT and NON COT error components are used in Figure 4.3.8 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.904^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.0^2 + 0.0^2 + 0.15^2 + 0.5^2 +]^{1/2}$

$\text{NON COT}_{error} = \pm$ 2.388 % of span = $\pm$ 19.104 PSIG

$\text{COT}_{error} = \pm (M1^2 + M4^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.118 % of span = $\pm$ 8.944 PSIG

See Figure 4.3.8 for specific details.

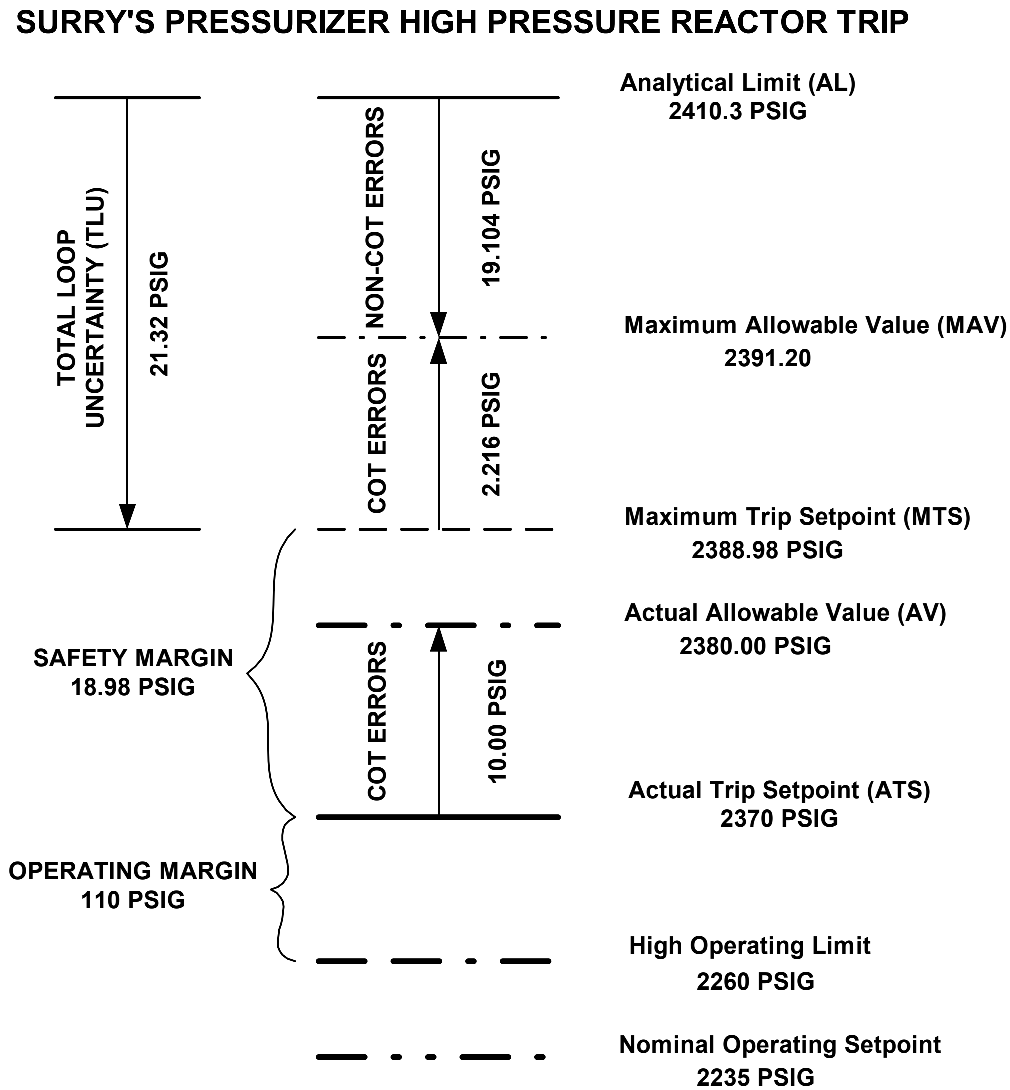

SURRY'S PRESSURIZER HIGH PRESSURE REACTOR TRIP
TOTAL LOOP UNCERTAINTY (TLU)
21.32 PSIG
NON-COT ERRORS
19.104 PSIG
COT ERRORS
2.216 PSIG
Analytical Limit (AL)
2410.3 PSIG
Maximum Allowable Value (MAV)
2391.20
Maximum Trip Setpoint (MTS)
2388.98 PSIG
SAFETY MARGIN
18.98 PSIG
Actual Allowable Value (AV)
2380.00 PSIG
COT ERRORS
10.00 PSIG
Actual Trip Setpoint (ATS)
2370 PSIG
OPERATING MARGIN
110 PSIG
High Operating Limit
2260 PSIG
Nominal Operating Setpoint
2235 PSIG

Figure 4.3.8

4.3.9 Reactor Coolant Flow Low Reactor Trip

Allowable Value : $\geq$ 91.0 % Flow (Normalized) (Refs. 5.1, 5.7, 5.34 & 5.66)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 89.93 % Flow. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 89.63 % Flow. The current Nominal Trip Setpoint of 92.0 % Flow is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of $\geq$ 90.0 % Flow is conservative with respect to the Minimum Allowable Value. The current Allowable Value of $\geq$ 90.0 % Flow is non-conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0183 (Ref 5.34). The current Allowable Value of $\geq$ 90.0 % Flow will be changed to $\geq$ 91.0 % Flow to conform to the methodology described in Sections 3.3.1 and 3.3.2.

The calculated Allowable Value for this function is $\geq$ 90.738 % Flow. The 0.262 % Flow offset is accommodated in the 2.067 % Flow Safety Margin for this trip as illustrated in Figure 4.3.9.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0183 (Ref. 5.34) are given below. The COT and NON COT error components are used in Figure 4.3.9 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

NON COT_{error} (ΔP span) = $[(SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M6MTE^2]^{1/2}$

NON COT_{error} (ΔP span) = $[(0.50+0.169)^2 + 0.357^2 + 0.0^2 + 1.288^2 + 0.114^2]^{1/2}$

NON COT_{error} (ΔP span) = $\pm$ 1.499 % of ΔP span = $\pm$ 0.978 % of Flow span @ 92 % Flow

NON COT_{error} (Flow span) = $(PMA^2 + PEA^2 + RTE^2)^{1/2}$

NON COT_{error} (Flow span) = $(1.900^2 + 0.0^2 + 0.5^2)^{1/2}$

NON COT_{error} (Flow span) = 1.965 % of Flow span

TOTAL NON COT_{error} (Flow span) = $(1.965^2 + 0.978^2)^{1/2}$ = 2.195 % of Flow span = 2.634 % Flow @ 92.0 % Flow (e.g., the Nominal Trip Setpoint).

COT_{error} (ΔP span) = $\pm$ $(M6^2)^{1/2}$

COT_{error} (ΔP span) = $\pm$ $(0.5^2)^{1/2}$

COT_{error} (ΔP span) = $\pm$ 0.50 % of ΔP span = $\pm$ 0.326 % of Flow span @ 92 % Flow

COT_{error} (Flow span) = RD = 1.0 % of Flow span

TOTAL COT_{error} (Flow span) = $(0.326^2 + 1.0^2)^{1/2}$ = 1.052 % of Flow span = 1.262 % Flow @ 92.0 % Flow (e.g., the Nominal trip Setpoint).

See Figure 4.3.9 for specific details.

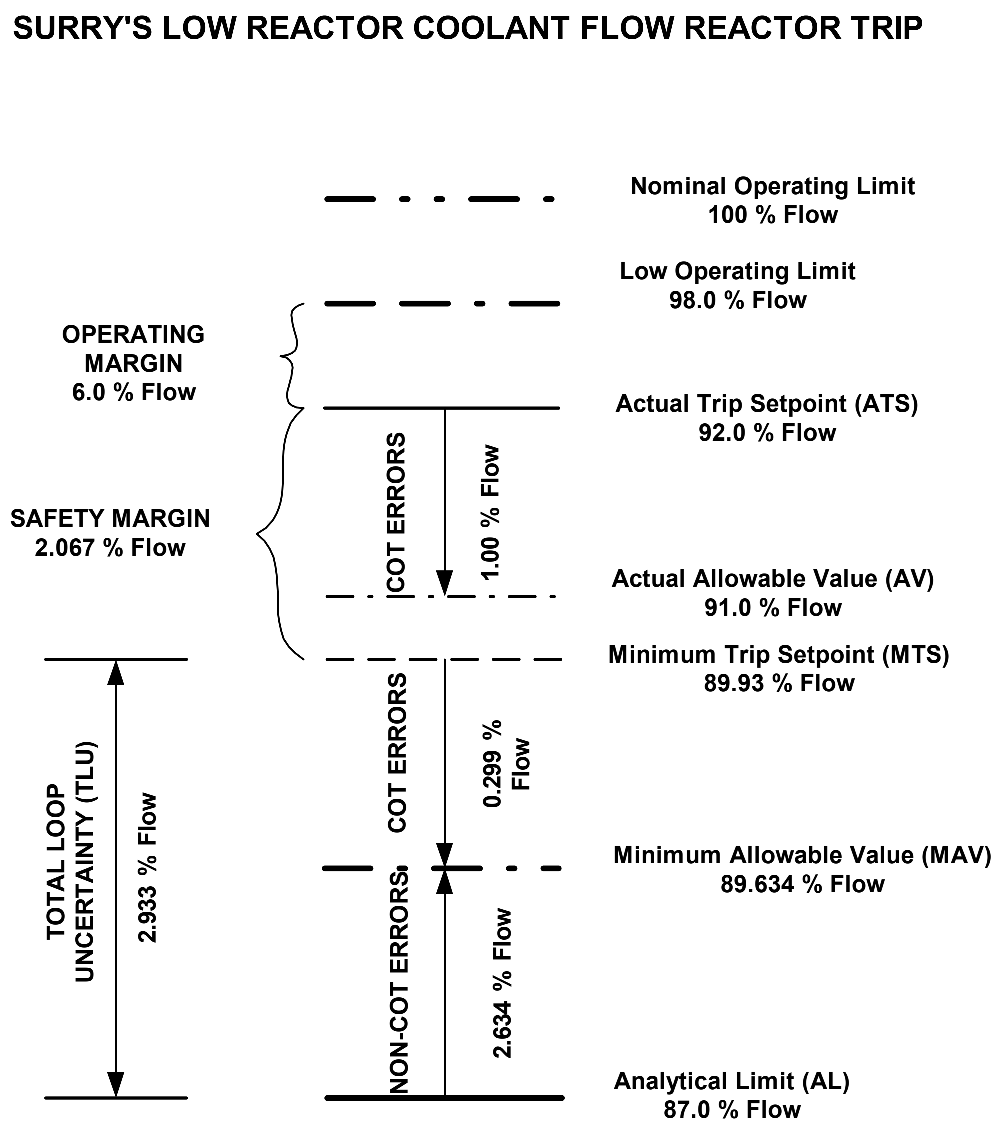


Figure 4.3.9

4.3.10 Reactor Coolant Pump Undervoltage

Allowable Value : This Allowable Value will be provided by Corporate Electrical EE Power.

4.3.11 Reactor Coolant Pump Underfrequency

Allowable Value : This Allowable Value will be provided by Corporate Electrical EE Power.

4.3.12 Pressurizer High Level Reactor Trip

Allowable Value : $\leq$ 89.12 % Level (Hot) (Refs. 5.1, 5.7, 5.33, 5.67 & 5.87)

The analysis for Surry's Pressurizer High Level Reactor Trip was performed in Section 3.4.3 and the specific details are illustrated in Figure 3.4.3.b.

Note: According to Technical Specification 2.3 Basis, 1154 ft^3 is equal to 92 % of level span. The revised LSSS is equal to 89.12 % of level span. According to Technical Report NE-1381, Revision 0, Page 12, 1.0 % level in the Pressurizer is equal to 74.0 gallons and 1 gallon is equal to 0.13368 ft^3. Then 92 % - 89.12 % = 2.88 % level span. So 2.88 % level span * 74 gallons per % span = 213.12 gallons, taking 213.12 gallons * 0.13368 ft^3 per gallon = 28.49 ft^3. Subtracting this volume of 28.49 ft^3 from the original volume of 1154 ft^3 yields a new volume of 1125.5 ft^3 at 89.12 % level.

4.3.13 Steam Generator Water Level Low Low Reactor Trip/SI

Allowable Value : $\geq$ 16.0 % Narrow Range (NR) Level (Refs. 5.1, 5.7, 5.35 & 5.60)

The analysis for Steam Generator Water Level Low Low Reactor Trip will be based on HARSH/DBE Conditions which will bound both the Reactor Trip and ESFAS Initiation Functions. Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 14.764 % NR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 14.426 % NR Level. The Actual Nominal Trip Setpoint of 17.0 % NR Level is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of $\geq$ 14.5 % NR Level is non-conservative with respect to the Minimum Allowable Value. In this case, the current Allowable Value of $\geq$ 14.5 % NR Level will be changed to $\geq$ 16.0 % NR Level to meet the requirements of Methods 1 and 2 as discussed in Sections 3.3.1 and 3.3.2. In addition, the new Allowable Value is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0432 (Ref 5.35). This Allowable Value of $\geq$ 16.0 % NR Level is based on maintaining a Nominal Trip Setpoint value of 17.0 % NR Level.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0432 (Ref. 5.35) are given below. The COT and NON COT error components are used in Figure 4.3.13 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$$\text{NON COT}_{error} = PMA_{DBE} + IR + SPTE + RE_{DBE} \pm (PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M3MTE^2 + RTE^2)^{1/2}$$

$$\text{NON COT}_{error} = 8.75 + 0.265 + 3.510 + 0.0 \pm [0.0^2 + (0.5+0.361)^2 + 0.281^2 + 1.158^2 + 1.087^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

NON COT_{error} = + 14.426 % of span = + 14.426 % NR Level (worst case).

$$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

COT_{error} = $\pm$ 1.118 % of span = $\pm$ 1.118 % NR level

See Figure 4.3.13 for specific details.

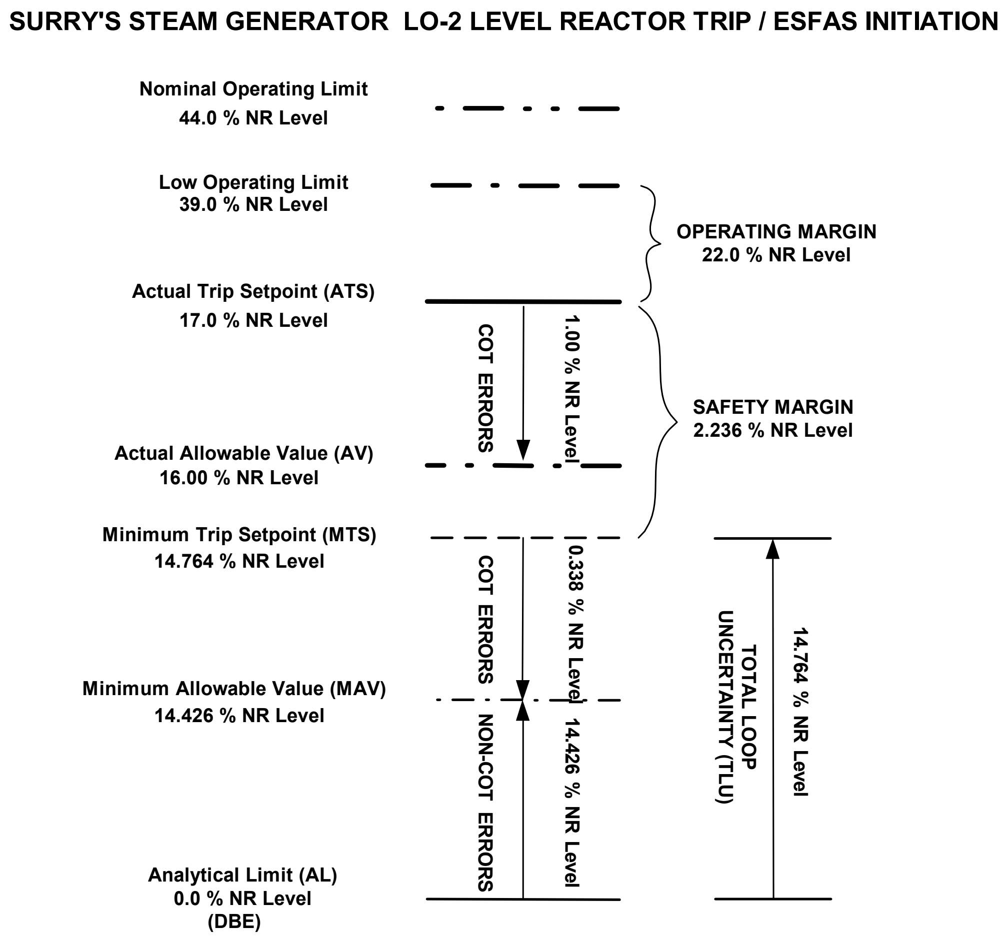


Figure 4.3.13

4.3.14 Steam Generator Water Level Low Coincident Reactor Trip

Allowable Value : $\geq$ 19.0 % Narrow Range (NR) Level (Refs. 5.1, 5.7, 5.35 & 5.60)

In this case, the current value of $\geq$ 15.0 % NR Level will be changed to $\geq$ 19.0 % to ensure it is conservative with respect to the calculated value of the CSA rack error terms from Calculation EE-0432 (Ref 5.35). The Steam Generator Water Level Low Coincident Reactor Trip is a backup reactor trip function and is not credited in the UFSAR Chapter 14 Safety Analysis.

The current Allowable Value $\geq$ 15.0 % NR Level will be changed to $\geq$ 19.0 % NR Level to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. This Allowable Value of $\geq$ 19.0 % NR Level is based on maintaining a Nominal Trip Setpoint value of 20.0 % Level.

4.3.15 Steam Flow Feed Flow Mismatch Coincident Reactor Trip

Allowable Value : **$\leq$ 1.0 * 10^6 lbs/hr (i.e., nominal steam flow at RTP = 3.7533 * 10^6 lbs/hr) (Refs. 5.1, 5.7 & 5.36)**

This Allowable Value of $\leq$ 1.0 * 10^6 lbs/hr is based on maintaining a Nominal Trip Setpoint value of 0.709 * 10^6 lbs/hr. In this case, the current Allowable Value of $\leq$ 1.0 * 10^6 lbs/hr is equal to 26.64 % of nominal steam flow at RTP (i.e., $Flow_{nom}$). The current Allowable Value will be retained because it is conservative with respect to the calculated value based on the CSA rack error terms from Calculation EE-0355 (Ref 5.36). In addition, the current Allowable Value is conservative with respect to the nominal value used in later versions of Technical Specifications (i.e., ≈ 40.0 % of nominal flow at RTP). The Steam Flow Feed Flow Mismatch Coincident Reactor Trip is a backup reactor trip function and is not credited in the Surry UFSAR Chapter 14 Safety Analysis.

4.3.16 Safety Injection (SI) Input from Engineered Safety Features Actuation System (ESFAS)

See Section 4.4.

Reactor Trip Permissives

Note: In the context of this document, the terms Allowable Value and Setting Limit and Limiting Safety System Setting (LSSS) have the same meaning and intent.

4.3.17 Permissive P-6, Intermediate Range Neutron Flux

Allowable Value : **The source range high flux, high setpoint trip shall be unblocked prior to or when the intermediate range nuclear flux decreases to 5 *10^{-11} Amps (Refs. 5.1, 5.7, 5.29 & 5.57)**

This Allowable Value of 5 *10^{-11} Amps is based on maintaining a Nominal Trip Setpoint of 1 *10^{-10} Amps [(1)]. In this case, the current Allowable Value of 5 *10^{-11} Amps will be retained because it is equal to the calibration accuracy of the device. Note that this function is assumed to be available in the UFSAR Chapter 14 Safety Analysis but no specific setpoint is assumed (Ref 5.1).

(1) The inequality signs have been removed from the text in order to clarify the actual operation of the "unblock" portion of the permissive function.

4.3.18 Permissive P-7, Block Low Power Reactor Trips

Allowable Value : **The reactor trip on low pressurizer pressure, high pressurizer level, turbine trip, and low reactor coolant flow for two or more loops shall be unblocked prior to or when power increases to 11 % of rated power. (Refs. 5.1, 5.8, 5.28, 5.38 & 5.139)**

Permissive P-7 is made up of input signals from Turbine First Stage Pressure and NIS Power Range. Signals to the P-7 and P-10 permissives are supplied from the same bistables in the NIS Power Range drawers. P-7 and P-10 will both enable and block functions from the "trip" and "reset" points of these bistables. The calibration procedures for the NIS Power Range bistables set the nominal trip setpoints associated with the two permissives such that they will trip whenever the measured reactor power level reaches 10 % power (increasing). The P-7 input from Turbine First Stage Pressure is currently set to trip at 10.0 % Turbine Load (increasing). When two out of four of the NIS Power Range channels trip or if one of the two Turbine First Stage Pressure channels trip the following occurs:

- Permissive P-7 allows reactor trip on the following: low flow, reactor coolant pump breakers open in more than one loop, undervoltage (RCP busses), underfrequency (RCP) busses, turbine trip, pressurizer low pressure, and pressurizer high level.

- Permissive P-10 allows manual block of intermediate range reactor trip, allows manual block of power range (low setpoint) reactor trip, allows manual block of intermediate range rod stop (P-1), and automatically blocks source range reactor trip (P-6) and provides an input to P-7.

The "trip" and "reset" of a bistable cannot be the same point. It is physically not possible. There must be a deadband between the "trip" and "reset" points. The calibration procedures for the NIS Power Range bistables set the nominal reset points for the two permissives such that they reset whenever the measured reactor power level reaches 8% power (decreasing). The P-7 input from Turbine First Stage Pressure is set to reset at 10 % Turbine Load (decreasing). When three out of four of the NIS Power Range channels reset and if two out of the two Turbine First Stage Pressure channels reset the following occurs:

- Permissive P-7 blocks reactor trip on the following: low flow, reactor coolant pump breakers open in more than one loop, undervoltage, underfrequency, turbine trip, pressurizer low pressure, and pressurizer high level.

There is no specific Safety Analysis Limit associated with Permissive P-7. However, Permissive P-7 is "Assumed Available" by Nuclear Analysis and Fuel. Since P-7 is a permissive for functions with Safety Analysis Limits, for conservatism, it will be treated as if it had a Limiting Safety System Setting. In order to account for instrumentation (COT) errors, 1% of reactor power will be added to the P-7 safety function. This results in a Limiting Safety System Setting for the P-7 enable interlock of 11% of reactor power (i.e., Turbine Load). The Trip Setpoint for the Turbine First Stage Pressure Inputs to Permissive P-7 has been changed to 10.0 % Turbine Load (increasing) and the Reset Setpoint will be changed to 8.8 % Turbine Load (decreasing) (Ref. 5.139).

4.3.19 Permissive P-8, Power Range Neutron Flux

Allowable Value : **The single loop loss of flow reactor trip shall be unblocked prior to or when the power range nuclear flux increases to 37.0 % of rated power. (Refs. 5.1, 5.7, 5.28 & 5.82)**

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 52.48 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 53.08 % RTP. The Actual Nominal Trip Setpoint of 35.0 % RTP is conservative with respect to the Maximum Trip Setpoint and the current Allowable Value of 50.0 % RTP is conservative with respect to the Maximum Allowable Value (1). The current Allowable Value of 50.0 % RTP will be changed to 37.0 % RTP to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of 37.0 % RTP is conservative with respect to the Maximum Allowable Value but is non-conservative with respect to the calculated Allowable Value using the CSA rack error terms from Calculation EE-0198 (Ref. 5.28). The calculated Allowable Value for this function is 36.70 % RTP. The 0.3 % RTP offset is accommodated in the 17.48 % RTP Safety Margin for this trip as illustrated in Figure 4.3.19. This Allowable Value of 37.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 35.0 % RTP.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0198 (Ref. 5.28) are given below. The COT and NON COT error components are used in Figure 4.3.19 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm (PMA_1^2 + PMA_2^2 + RMTE^2 + RTE^2)^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm (2.0^2 + 5.0^2 + 2.0^2 + 0.5^2)^{1/2}$

$\text{NON COT}_{error} = \pm$ 5.766 % of span = $\pm$ 6.919 % RTP

$\text{COT}_{error} = \pm (RCA^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (1.0^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = +$ 1.414 % of span = $\pm$ 1.697 % RTP

See Figure 4.3.19 for specific details.

(1) The inequality signs have been removed from the text in order to clarify the actual operation of the “unblock” portion of the permissive function.

SURRY'S POWER RANGE REACTOR TRIP PERMISSIVE P-8

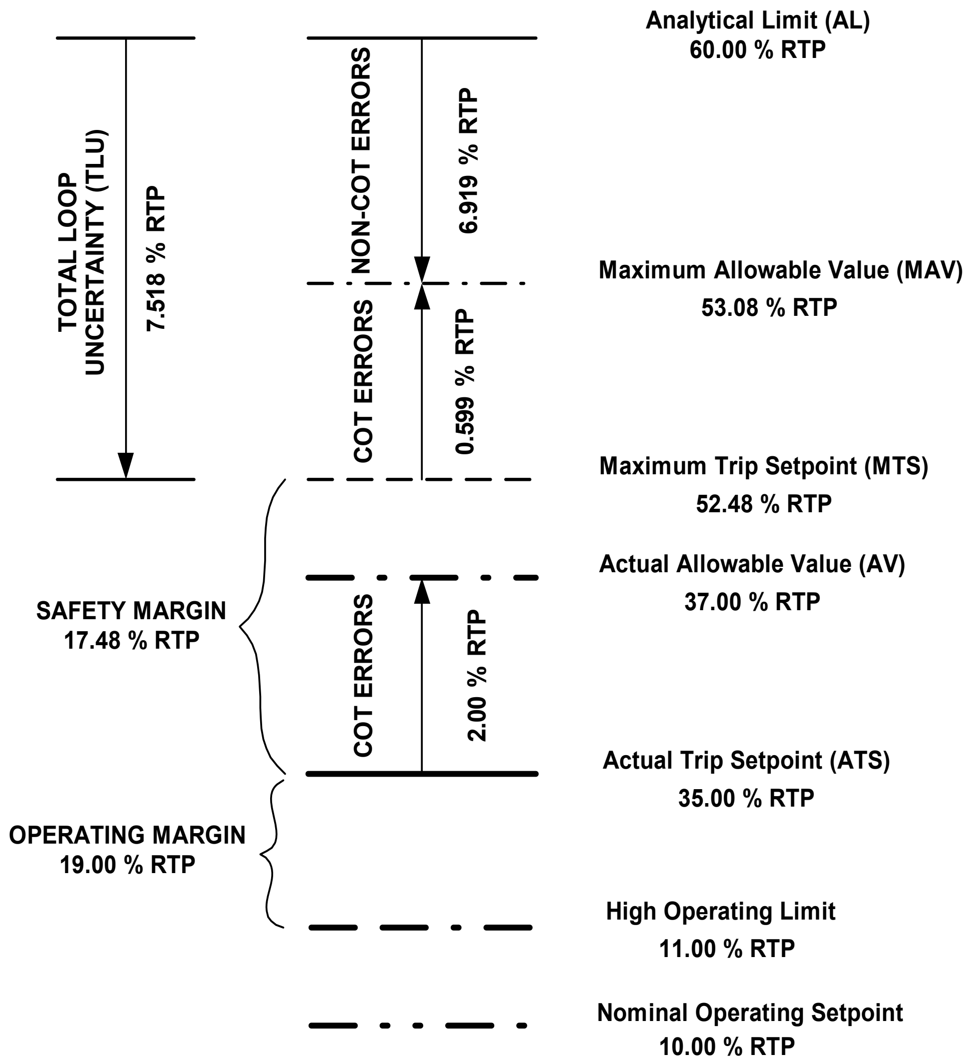


Figure 4.3.19

4.3.20 Permissive P-10, Power Range Neutron Flux

Allowable Values : The power range high flux, low setpoint trip and the intermediate range high flux, high setpoint trip shall be unblocked prior to or when power decreases to 7.0 % of rated power. (Refs. 5.1, 5.7 & 5.82)

Signals to the P-10 permissive are supplied from bistables in the NIS Power Range drawers. The P-10 permissive enables and blocks functions based on the "trip" and "reset" points of the bistable. The calibration procedures for the NIS Power Range bistables set the nominal trip setpoint such that it will trip whenever the measured reactor power level reaches 10 % power (increasing). When two out of four of these channels trip the following occurs:

- Permissive P-10: enables manual block of intermediate range reactor trip, allows manual block of power range (low setpoint) reactor trip, allows manual block of intermediate range rod stop (P-1), and automatically blocks source range reactor trip (P-6).

- These bistables also provide one of two inputs to Permissive P-7 to enable certain at power reactor trips (see section 4.3.18 for Permissive P-7).

The calibration procedures for the NIS Power Range bistables set the nominal reset point for Permissive P-10 such that it is reset whenever the measured reactor power level reaches 8 % power (decreasing). When three out of four of these channels reset the following occurs:

- Permissive P-10: defeats the manual block of the intermediate range reactor trip, defeats the manual block of power range (low setpoint) reactor trip, and defeats the manual block of intermediate range rod stop.

- These bistables also provide one of two inputs to Permissive P-7 to block certain at power trips (see section 4.3.18 for Permissive P-7)

There is no specific Safety Analysis Limit associated with Permissive P-10. However, it is "Assumed Available" by Nuclear Analysis and Fuel. Since P-10 is a permissive for functions with Safety Analysis Limits and provides an input for Permissive P-7, for conservatism, it will be treated as if it had an Allowable Value. In order to account for instrumentation (COT) errors, 1 % of reactor power is added to the P-10 safety function. The power range high flux, low setpoint trip and the intermediate range high flux, high setpoint trip shall be unblocked prior to and when power decreases to 7 % of rated power. This results in an Allowable Value for the P-10 (defeat block) interlock of 7.0 % of RTP.

This Allowable Value of 7.0 % RTP is based on maintaining a Nominal Reset value of 8.0 % RTP decreasing. The revised Allowable Value of 7.0 % RTP is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0198 (Ref 5.28).

4.4 Setting Limits for Surry Power Station Custom Technical Specifications, Table 3.7-4, Engineered Safety Features Actuation System Instrumentation Setting Limits and Table 3.7-2, Engineered Safety Features Actuation System Instrumentation Operating Conditions

Note: In the context of this document, the terms Allowable Value, Setting Limit and Limiting Safety System Setting (LSSS) have the same meaning and intent.

4.4.1 Safety Injection, Manual Initiation

Allowable Value : N/A

There is no specific ESFAS Trip Setpoint associated with this function.

4.4.2 Containment Pressure – High

Allowable Value : $\leq$ 18.5 PSIA (Refs. 5.1, 5.7, 5.39 & 5.61)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 18.463 PSIA. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 18.731 PSIA. The Actual Nominal Trip Setpoint of 17.7 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 19.0 PSIA is non-conservative with respect to the Maximum Allowable Value. The current Allowable Value of $\leq$ 19.0 PSIA will be changed to $\leq$ 18.5 PSIA to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of $\leq$ 18.5 PSIA is based on maintaining a Nominal Trip Setpoint value of 17.7 PSIA.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0131 (Ref. 5.39) are given below. The COT and NON COT error components are used in Figure 4.4.2 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + STE^2 + SPE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.215)^2 + 0.308^2 + 1.158^2 + 0.0^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = \pm 1.490 \text{ \% of span} = \pm 0.969 \text{ PSIA}$$

$$\text{COT}_{error} = \pm (M1^2 + M4^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{½}$$

$$\text{COT}_{error} = \pm 1.118 \text{ \% of span} = \pm 0.727 \text{ PSIA}$$

See Figure 4.4.2 for specific details.

SURRY'S CONTAINMENT PRESSURE HI-1 ESFAS INITIATION

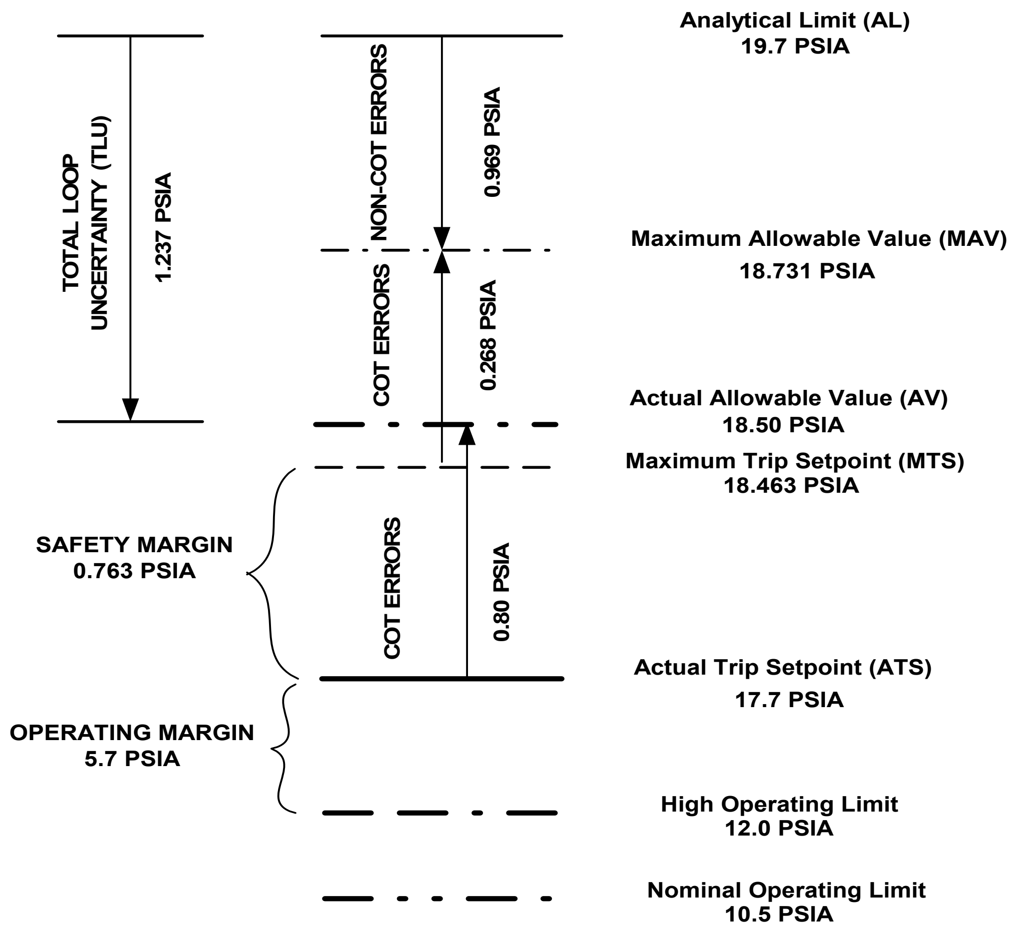


Figure 4.4.2

4.4.3 Containment Pressure High - High

Allowable Value : $\leq$ 24.00 PSIA (Refs. 5.1, 5.7, 5.39 & 5.61)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 25.763 PSIA. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 26.031 PSIA. The Actual Nominal Trip Setpoint of 23.00 PSIA is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of $\leq$ 25.00 PSIA is conservative with respect to the Maximum Allowable Value. The Allowable Value of $\leq$ 25.00 PSIA will be changed to $\leq$ 24.00 PSIA to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised allowable value of $\leq$ 24.00 PSIA is conservative with respect to the calculated Maximum Allowable Value but is non-conservative with respect to the calculated Allowable Value using the CSA rack error terms from Calculation EE-0131 (Ref. 5.39). The calculated Allowable Value for this function is $\leq$ 23.727 PSIA. The 0.273 PSIA offset is accommodated in the 2.763 PSIA Safety Margin for this function as illustrated in Figure 4.4.3. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0131 (Ref. 5.39) are given below. The COT and NON COT error components are used in Figure 4.4.3 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = (\text{PMA}^2 + \text{PEA}^2 + (\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{SPSE}^2 + \text{M1MTE}^2 + \text{M4MTE}^2 + \text{RTE}^2)^{1/2}$$

$$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.215)^2 + 0.308^2 + 1.158^2 + 0.0^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2)^{1/2}$$

$$\text{NON COT}_{error} = \pm\ 1.490\ \%\ \text{of span} = \pm\ 0.969\ \text{PSIA}$$

$$\text{COT}_{error} = \pm\ (\text{M1}^2 + \text{M4}^2 + \text{RD}^2)^{1/2}$$

$$\text{COT}_{error} = \pm\ (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm\ 1.118\ \%\ \text{of span} = \pm\ 0.727\ \text{PSIA}$$

SURRY'S CONTAINMENT PRESSURE HI-HI ESFAS INITIATION

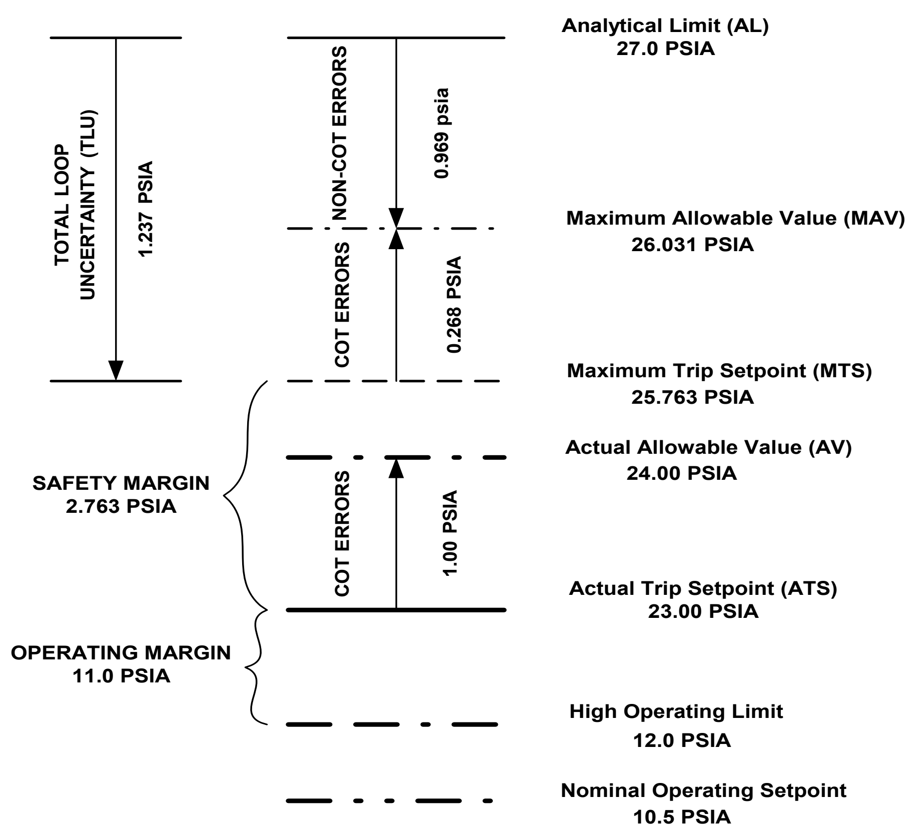


Figure 4.4.3

4.4.4 Pressurizer Pressure Low-Low

Allowable Value : $\geq$ 1770 PSIG (Refs. 5.1, 5.8, 5.32 & 5.68)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 1771.06 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 1770.40 PSIG. The Actual Nominal Trip Setpoint of 1780 PSIG is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of 1770 PSIG is conservative with respect to the Minimum Allowable Value. The Nominal Trip Setpoint value of 1780 PSIG allows a 10.00 PSIG margin to be used for the COT error components. The Allowable Value of $\geq$ 1770 PSIG is conservative with respect to the calculated Minimum Allowable Value but is non-conservative with respect to the calculated Allowable Value using the CSA rack error terms from Calculation EE-0514.

The calculated Allowable Value for this function is $\geq$ 1771.056 PSIG based on the a setpoint of 1780 PSIG using the COT error components. The 1.056 PSIG offset is accommodated in the 8.94 PSIG Safety Margin for this trip as illustrated in Figure 4.4.4.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0514 (Ref. 5.32) are given below. The COT and NON COT error components are used in Figure 4.4.4 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{error} = SE + IR \pm [PMA^2 + SPTE^2 + RE_{DBE}^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + RTE2]^{1/2}$

$\text{NON COT}_{error} = 0.0 + .245 \pm [0.0^2 + 8.0^2 + 1.688^2 + 0.0^2 + (0.5 + 0.404)^2 + 0.75^2 + 0.0^2 + 2.013^2 + 0.0^2 + 0.0^2 + 0.15^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = -\ 8.273\ \%$ or $+\ 8.763\ \%$ of span $= +\ 70.104$ PSIG (worst case)

$\text{COT}_{error} = \pm (M1^2 + M4^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm\ 1.118\ \%$ of span $= \pm\ 8.944$ PSIG

See Figure 4.4.4 for specific details.

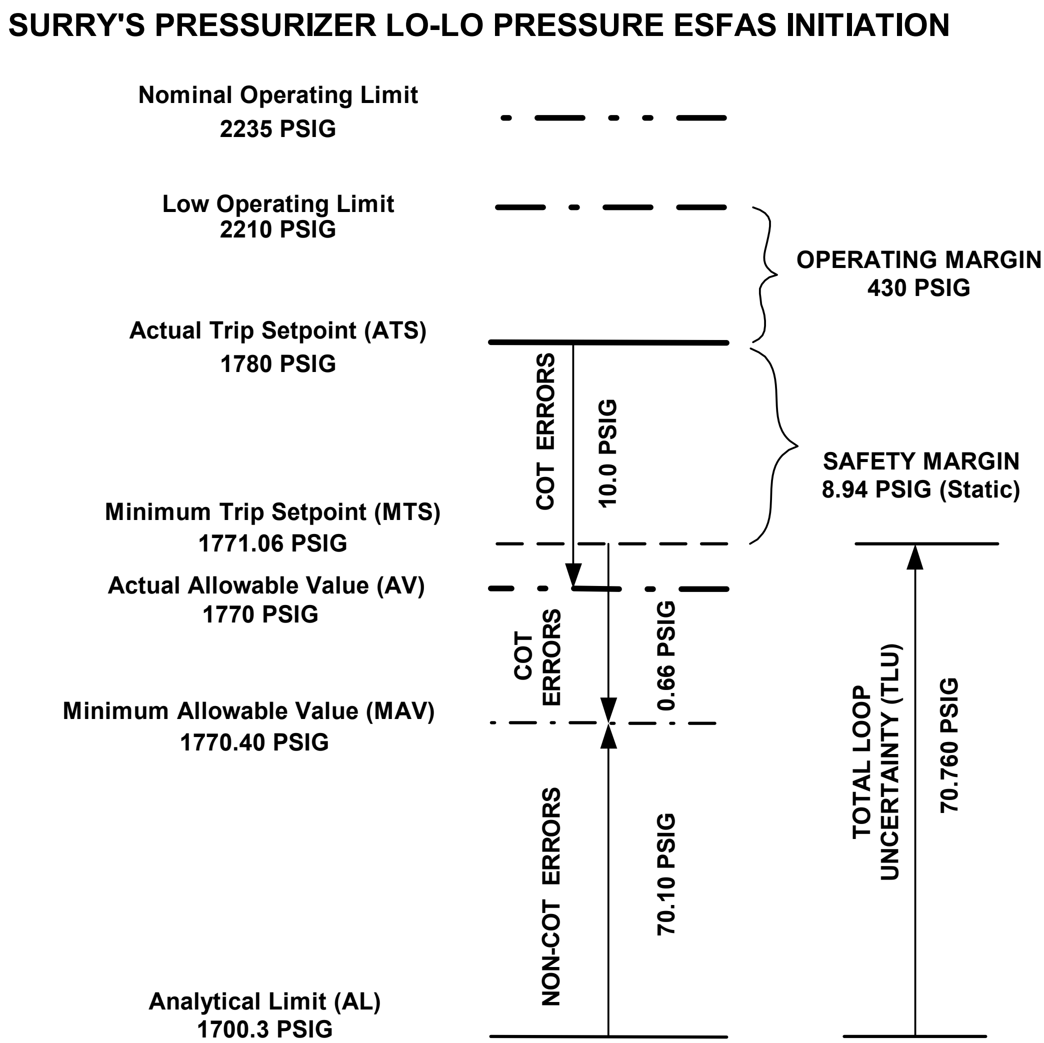


Figure 4.4.4

4.4.5 High Differential Pressure Steam Lines Versus Steam Header ESFAS Initiation

Allowable Value : ≤ 135.0 PSID (Refs. 5.1, 5.7, 5.36 & 5.65)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 130.63 PSID. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 135.60 PSID. The Actual Nominal Trip Setpoint of 120.0 PSID is conservative with respect to the Maximum Trip Setpoint. However, the current Allowable Value of ≤ 150.0 PSID is non-conservative with respect to the Maximum Allowable Value. The current Allowable Value will be changed from ≤ 150.0 PSID to ≤ 135.0 PSID in order to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of $\leq$ 135.0 PSID is based on maintaining a Nominal Trip Setpoint value of 120.0 PSID. The revised Allowable Value of $\leq$ 135.0 PSID is conservative with respect to the calculated COT_{error} shown below. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0355 (Ref. 5.36) are given below. The COT and NON COT error components are used in Figure 4.4.5 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$NON\ COT_{error\ csa\ 7} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M10MTE^2]^{1/2}$

$NON\ COT_{error\ csa7} = [0.0^2 + 0.0^2 + 0.0^2 + (0.5 + 0.207)^2 + 0.429^2 + 0.0^2 + 1.475^2 + 0.0^2 + 0.0^2]^{1/2}$

$NON\ COT_{error\ csa7} = \pm$ 1.691 % of span = $\pm$ 23.674 PSID

$NON\ COT_{error\ csa\ 14} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M17MTE^2 + M18MTE^2]^{1/2}$

$NON\ COT_{error\ csa14} = [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.207)^2 + 0.429^2 + 0.0^2 + 1.475^2 + 0.0^2 + 0.0^2 + 0.158^2]^{1/2}$

$NON\ COT_{error\ csa14} = \pm$ 1.698 % of span = $\pm$ 23.772 PSID

$NON\ COT_{error\ r4} = (M19MTE^2 + RTE^2)^{1/2}$

$NON\ COT_{error\ r4} = [0.212^2 + 0.5^2)^{1/2}$

$NON\ COT_{error\ r4} = \pm$ 0.543 % of span = $\pm$ 7.602 PSID

$TOTAL\ NON\ COT_{error} = (NON\ COT_{error\ csa7}{}^2 + NON\ COT_{error\ csa\ 14}{}^2 + NON\ COT_{error\ r4}{}^2)^{1/2}$

$TOTAL\ NON\ COT_{error} = (1.691^2 + 1.698^2 + 0.543^2)^{1/2}$

$TOTAL\ NON\ COT_{eror}$ = 2.457 % of span = $\pm$ 34.40 PSID

$COT_{error} = \pm (M10^2 + M17^2 + M18^2 + M19^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.0^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.225 % of span = $\pm$ 17.15 PSID

See Figure 4.4.5 for specific details.

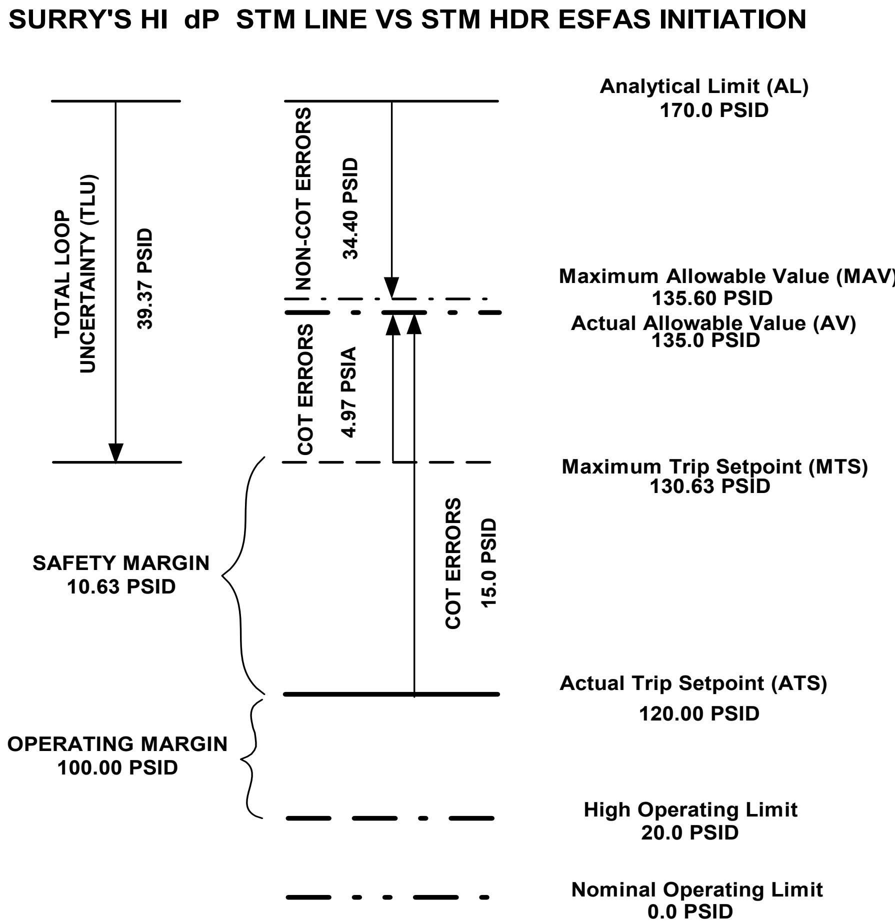

SURRY'S HI dP STM LINE VS STM HDR ESFAS INITIATION
Analytical Limit (AL)
170.0 PSID
TOTAL LOOP UNCERTAINTY (TLU)
39.37 PSID
NON-COT ERRORS
34.40 PSID
Maximum Allowable Value (MAV)
135.60 PSID
Actual Allowable Value (AV)
135.0 PSID
COT ERRORS
4.97 PSIA
Maximum Trip Setpoint (MTS)
130.63 PSID
SAFETY MARGIN
10.63 PSID
COT ERRORS
15.0 PSID
Actual Trip Setpoint (ATS)
120.00 PSID
OPERATING MARGIN
100.00 PSID
High Operating Limit
20.0 PSID
Nominal Operating Limit
0.0 PSID

Figure 4.4.5

4.4.6 High Steam Flow in 2/3 Steam Lines

Allowable Values : **$\leq$ 40.0 % of full steam flow (at zero load), $\leq$ 40.0 % of full steam flow (at 20 % load) and $\leq$ 110.0 % of full steam flow (at full load) (Refs. 5.1, 5.7, 5.12, 5.38 & 5.62)**

Subtracting the Total Loop Uncertainty (TLU = 2.933 % of ΔP span) from the Analytical Limit (AL = 20.76 % of ΔP span from 0 % to 20 % power, the most limiting condition) yields a Maximum Trip Setpoint (MTS) of 17.827 % of ΔP span. Subtracting the NON COT error components from the AL yields a Maximum Allowable Value (MAV) of 17.935 % of ΔP span. The Actual Nominal Trip Setpoint of 8.30 % of ΔP span (from 0 % to 20 % power) is conservative with respect to the Maximum Trip Setpoint (MTS). The current Allowable Value of $\leq$ 9.09 % of ΔP span (e.g., equivalent to 40 % of full steam flow at RTP) is conservative with respect to the MAV. The Allowable Value of $\leq$ 9.09 % of ΔP span is based on maintaining a Nominal Trip Setpoint value of 8.30 % of ΔP span. The statistical combination of the COT and NON COT error components from CSA Calculation EE-0457 (Ref. 5.38) are given below.

$CSA_{stm\ flow}\ NON\ COT_{error} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPSE^2 + STE^2 + SPE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$

$CSA_{stm\ flow}\ NON\ COT_{error} = [0.0^2 + 1.041^2 + 0.0^2 + (0.0+0.0)^2 + 0.490^2 + 0.0^2 + 1.638^2 + 1.331^2 + 0.0^2 + 0.212^2 + 0.174^2]^{1/2}$

$CSA_{stm\ flow}\ NON\ COT_{error} = \pm$ 2.419 % of ΔP span (The PMA and RTE terms were converted from % Flow to % ΔP for 20 % power conditions. See Note 1 below)

$CSA_{tfsp}\ NON\ COT_{error} = [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPSE^2 + STE^2 + SPE^2 + M1MTE^2 + M2MTE^2 + M5MTE^2]^{1/2}$

$CSA_{tfsp}\ NON\ COT_{error} = [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.219)^2 + 0.321^2 + 0.0^2 + 1.191^2 + 0.0^2 + 0.0^2 + 0.212^2 + 0.212^2]^{1/2}$

$CSA_{tfsp}\ NON\ COT_{error} = \pm$ 1.459 % of ΔP span

$TOTAL\ NON\ COT_{error} = \pm (2.419^2 + 1.459^2)^{1/2} = \pm$ 2.825 % of ΔP span

$CSA_{6\ \&\ 7}COT_{error} = \pm (M1^2 + M2^2 + M1^2 + M2^2 + M5^2 + RD^2)^{1/2}$

$CSA_{6\&7}COT_{error} = \pm (0.0^2 + 0.5^2 + 0.0^2 + 0.5^2 + 0.347^2)^{1/2}$

$CSA_{6\&7}COT_{error} = \pm$ 0.788 % of ΔP span (the RD term was converted from % Flow to % ΔP for 20 % power conditions. See Note 1 below)

$TLU = (TOTAL\ NON\ COTerror^2 + CSA_{6\&7}COTerror^2)^{1/2} = (2.825^2 + 0.788^2)^{1/2} = 2.933$ % ΔP span

SURRY'S HI STEAM FLOW IN TWO STEAM LINES ESFAS INITIATION

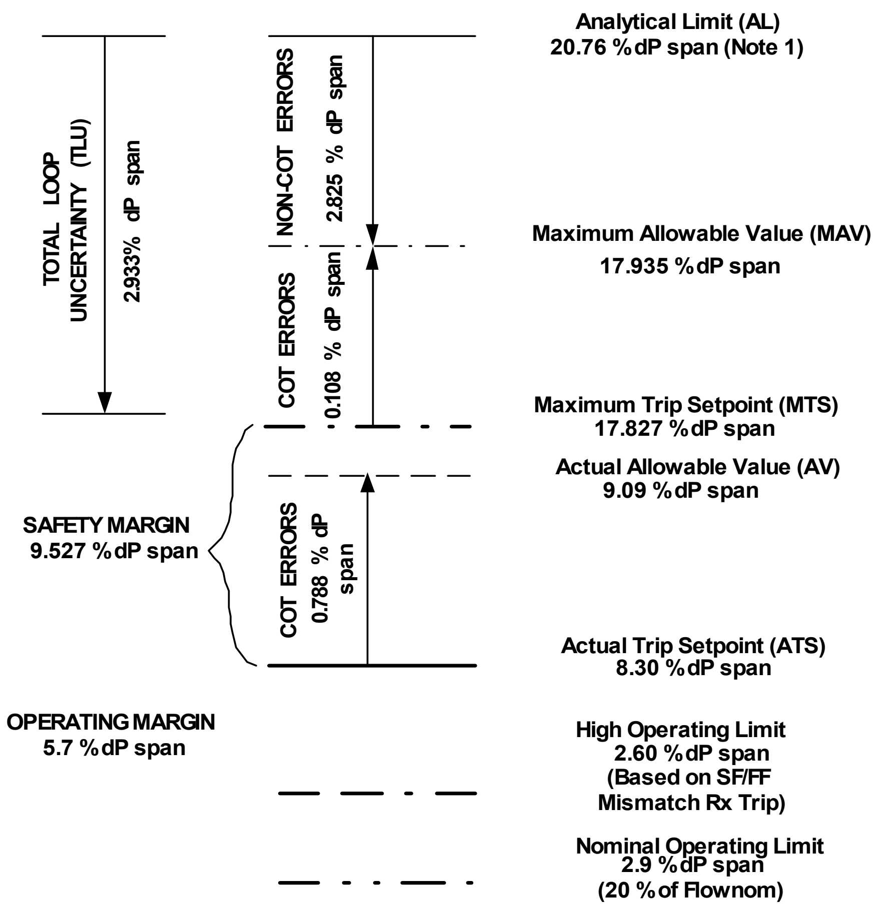


Figure 4.4.6

Note 1: Calculation EE-0457 specifies a 3.0 % of flow span PMA value, a 0.5 % of flow span RTE value, and a 0.5 % of flow span RD value. Equation 2.3 from EE-0457 is used to convert from % of Flow span to % of ΔP span. Equation 2.3 modified for a generic conversion from % of Flow span to % ΔP of span is % ΔP span = [% Flow span / 0.5] / [Flowmax / Flow x]. Flowmax is the maximum indicated flowrate (i.e., 4.4 * 10^6 PPH) and Flow x is the flowrate of interest. At 20 % power, Flow x = 20 % Flow, noting that the nominal flowrate at 100 % power is equal to 3.7533 * 10^6 PPH. To bound this analysis for the MUR uprate on both units at Surry, the nominal flow rate will be increased by 1.7 %, i.e., 3.7533 * 10^6 PPH * 1.017 = 3.817 * 10^6 PPH. Flow x = 0.2 * 3.817 * 10^6 PPH = 0.7634 * 10^6 PPH.

% ΔP span(PMA) = [3.0 / 0.5] / [4.4 / 0.7634] = 1.041 % ΔP span
% ΔP span(RTE) = [0.5 / 0.5] / [4.4 / 0.7634] = 0.174 % ΔP span
% ΔP span(RD) = [1.0 / 0.5] / [4.4 / 0.7634] = 0.347 % ΔP span

Note 2: $Flow_{max}$ = 4.4 MPPH and $Flow_{nom}$ = 3.7533 MPPH. Based on Technical Report EE-0100, Appendix 18-5 (Ref. 5.12), the equation used to convert from % $Flow_{nom}$ to % ΔP span is : % ΔP span = ((% $Flow_{nom}$ / $Flow_{max})^2$ / 1.26169)) * 100. See the example below for the conversion of the Analytical Limit of 60 % of $Flow_{nom}$ to % ΔP span for Pre and Post MUR conditions:

Pre-MUR $((0.6 * 3.7533) / 4.4)^2$ / 1.26169)) * 100 = 20.76 % ΔP span (Bounding Value)
Post-MUR $((0.6 * 3.817) / 4.4)^2$ / 1.26169)) * 100 = 21.47 % ΔP span

4.4.7 Low T_{AVG}

Allowable Value : ≥ 541.0 °F (Refs. 5.1, 5.7, 5.31 & 5.69)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 541.1 °F. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 540.276 °F. The Actual Nominal Trip Setpoint of 543.0 °F is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of ≥ 541.0 °F is conservative with respect to the Minimum Allowable Value. This Allowable Value of ≥ 541.0 °F is based on maintaining a Nominal Trip Setpoint value of 543.0 °F. The actual Allowable Value of ≥ 541.0 °F is slightly less than the calculated Allowable Value of ≥ 541.342 °F. The 0.342 °F offset is accommodated in the Safety Margin of 1.898 °F. See Figure 4.4.7 for specific details.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0415 (Ref. 5.31) are given below. The COT and NON COT error components are used in Figure 4.4.7 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$CSA_{11}NON\ COT_{error} = [PMA_{TAVG}{}^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (SCA_{RTD}+SMTE_{RTD})^2 + (4 * SD_{RTD}{}^2)+ M1MTE^2 + M2MTE^2 + M3MTE^2 + M4MTE^2 + M5MTE^2 + M7MTE^2 + M11MTE^2 + RTE^2]^{1/2}$

$CSA_{13}NON\ COT_{error} = [1.70^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (0.417+0.167)^2 + (4 * 0.25^2) + 0.248^2 + 0.248^2 + 0.248^2 + 0.244^2 + 0.3^2 + 0.260^2 + 0.150^2 + 0.5^2]^{1/2}$

$CSA_{13}NON\ COT_{error} = \pm 2.276$ % of span $= \pm 2.276$ °F

$CSA_{13}COT_{error} = \pm (M1^2 + M2^2 + M3^2 + M4^2 + M5^2 + M7^2 + M11^2 + RD^2)^{1/2}$

$CSA_{13}COT_{error} = \pm (0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$CSA_{13}COT_{error} = \pm 1.658$ % of span $= \pm 1.658$ °F

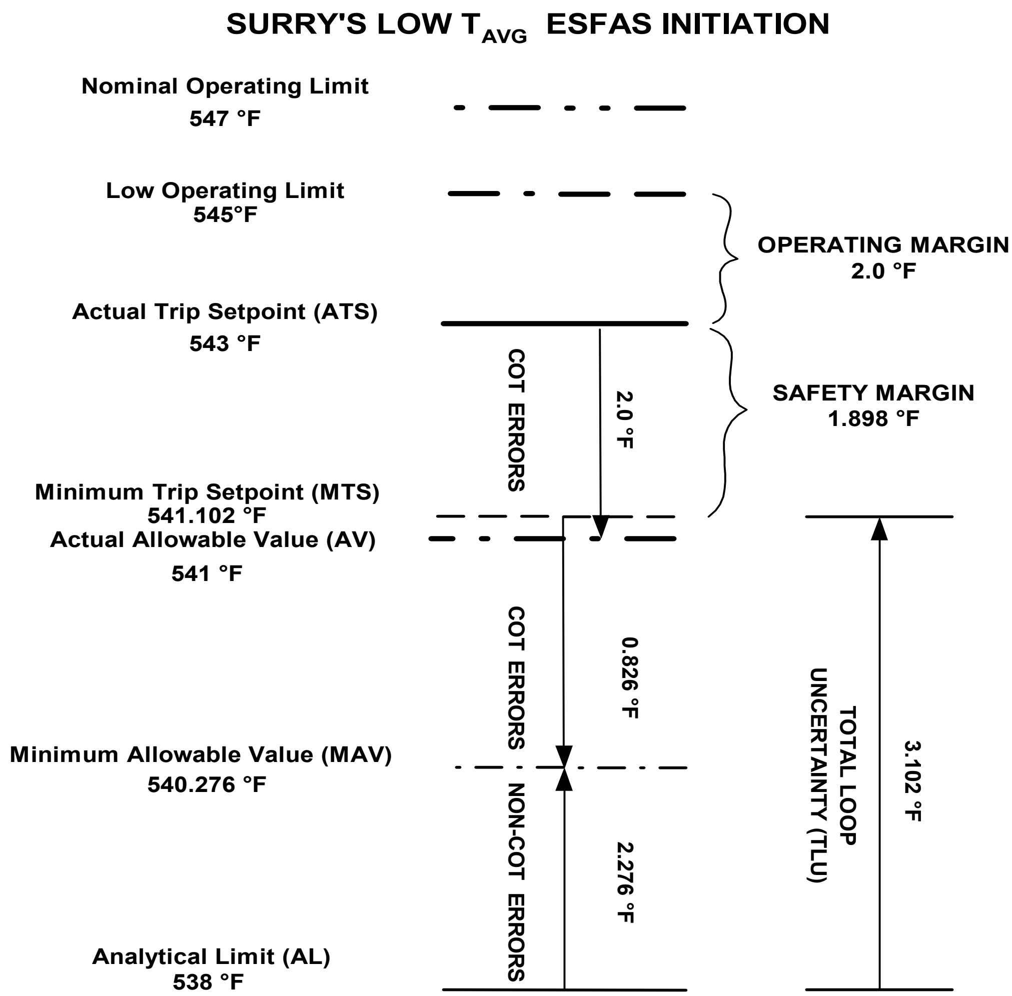


Figure 4.4.7

4.4.8 Steam Line Pressure - Low

Allowable Value : **≥ 510.0 PSIG** **(Refs. 5.1, 5.7, 5.36 & 5.65)**

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 456.11 PSIG. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 450.09 PSIG. The Actual Nominal Trip Setpoint of 525 PSIG is conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of ≥ 500 PSIG is conservative with respect to the Minimum Allowable Value. The current Allowable Value of ≥ 500 PSIG will be changed to ≥ 510 PSIG to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of ≥ 510 PSIG is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0355 (Ref.5.36). The calculated Allowable Value for this function is 507.85 PSIG.

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0355 (Ref. 5.36) are given below. The COT and NON COT error components are used in Figure 4.4.8 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$NON\ COT_{error} = \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M10MTE^2 + M11MTE^2 + M12MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.207)^2 + 0.429^2 + 0.0^2 + 1.475^2 + 0.0^2 + 0.0^2 + 0.158^2 + 0.05^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 1.771 % of span = $\pm$ 24.79 PSIG

$COT_{error} = \pm (M10^2 + M11^2 + +M12^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.225 % of span = $\pm$ 17.15 PSIG

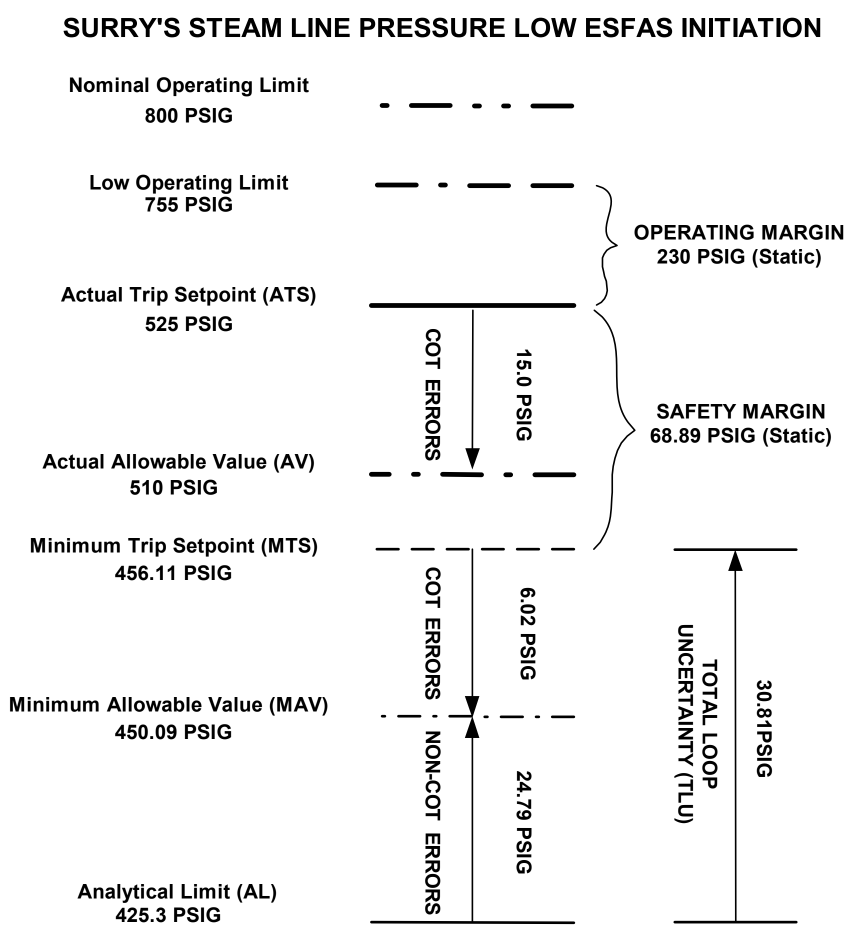


Figure 4.4.8

4.4.9 Steam Generator Water Level Low Low Reactor Trip/SI

See item 4.3.13.

4.4.10 Low Intake Canal Level

Allowable Value : 23 feet-5.85 inches (Refs. 5.1, 5.7, 5.42, 5.78, 5.79 & 5.80)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 23 feet–5.66 inches. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 23 feet-5.63 inches. The Actual Nominal Trip Setpoint of 23 feet-6 inches conservative with respect to the Minimum Trip Setpoint and the Actual Allowable Value of 23 feet-6 inches is conservative with respect to the Minimum Allowable Value. However, the current Allowable Value is set equal to the Nominal Trip Setpoint. In this case, the Allowable Value will be changed from 23 feet-6 inches to 23 feet-5.85 inches. This revised Allowable Value will allow a 0.15 inch margin to be used for the COT error components. The revised Allowable Value of 23 feet-5.85 inches is conservative with respect to the calculated value using the CSA rack error terms from Calculation EE-0724 (Ref. 5.42) and Engineering Transmittal CEE 98-005 (Ref. 5.78).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0724 (Ref. 5.42) and Engineering Transmittal CEE 98-005 (Ref. 5.78) are given below. The COT and NON COT error components are used in Figure 4.4.10 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + RCA^2 \ + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 56.43 \pm [0.0^2 + 0.0^2 + 0.0^2 + (5.53 + 0.25)^2 + 0.0^2 + 0.0^2 + 0.0^2 + 0.32^2]^{1/2}$

NON COT_{error} = 56.43 $\pm$ 5.789 seconds = 50.641 seconds to 62.22 seconds

Converting seconds to inches : Calculation ME-0318 (Ref. 5.79) and Engineering Transmittal CEE 98-005 (Ref. 5.78) indicates that with a loss of power, the drop in canal level is linear with respect to time. In 66 seconds, canal level will drop 5.972 inches. Thus, 5.972 inches/66 seconds = 0.0904848 inches/second. The Allowable Value of 23 feet- 5.85 inches calculates out to a voltage of 230 mV @ 61.568 seconds using the range of 250 mV and 75.33 seconds from EE-0724.

NON COT_{error} = 50.641 seconds * 0.0904848 inches = 4.58 inches to 62.22 seconds * 0.0904848 inches = 5.63 inches (worst case).

$\text{COT}_{error} = (RMTE^2 + RD^2)^{1/2}$

$\text{COT}_{error} = (1.70^2 + 0.64^2)^{1/2}$ = 1.816 seconds

COT_{error} = $\pm$ 1.816 seconds * 0.0904848 inches = 0.1643 inches

Figure 4.4.10 for specific details.

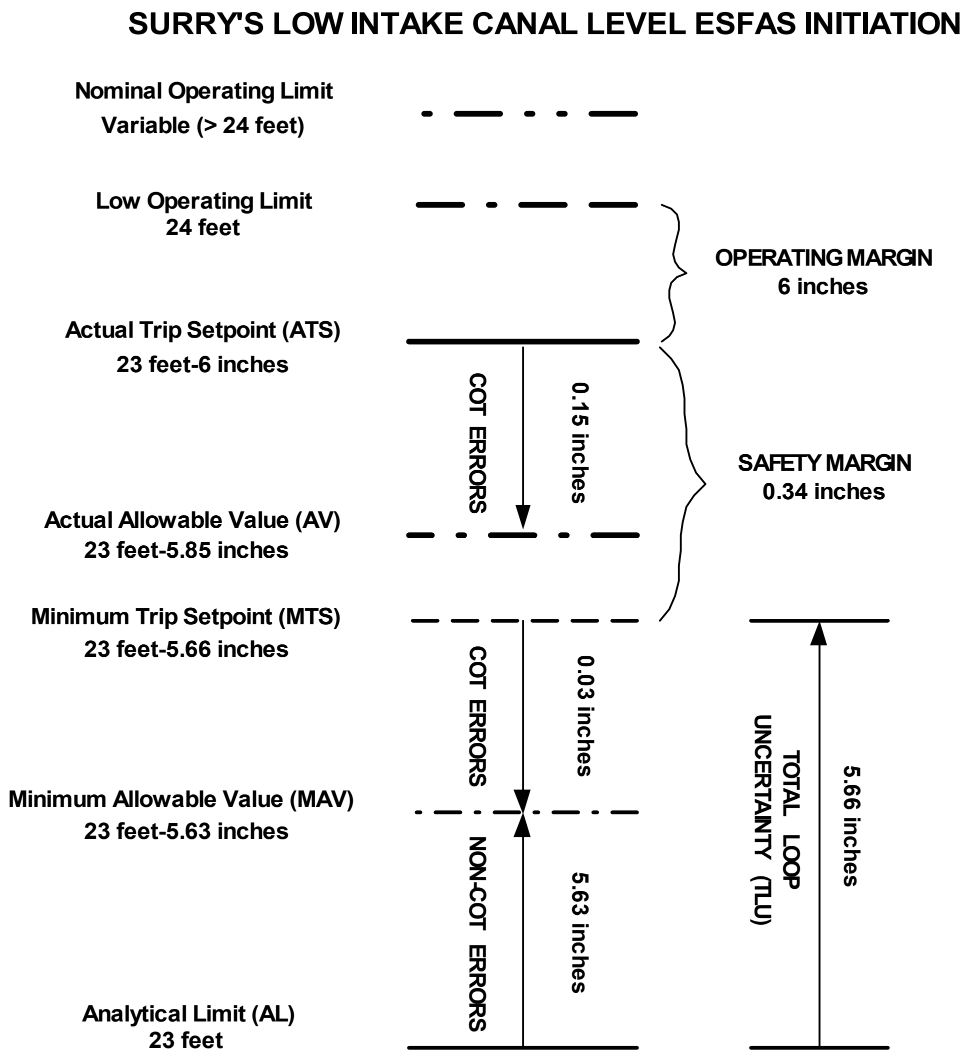


Figure 4.4.10

4.4.11 SG Water Level - High High

Allowable Value : ≤ 76.0 % Narrow Range (NR) Level (Refs. 5.1, 5.7, 5.35 & 5.60)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 85.46 % NR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 85.80 % NR Level. The Actual Nominal Trip Setpoint of 75.0 % NR Level is conservative with respect to the Maximum Trip Setpoint and the Actual Allowable Value of ≤ 80.0 % NR Level is conservative with respect to the Maximum Allowable Value. The Allowable Value of ≤ 80.0 % NR Level will be changed to ≤ 76.0 % NR Level to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised allowable value of ≤ 76.0 % NR Level is conservative with respect to the calculated value using CSA rack error terms from Calculation EE-0432 (Ref. 5.35). The statistical combination of the COT and NON COT error components from CSA Calculation EE-0432 (Ref. 5.35) are given below. The COT and NON COT error components are used in Figure 4.4.11 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$\text{NON COT}_{error} = SE + PMA_2 + [PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 + (-8.70) \pm [0.0^2 + (0.5+0.361)^2 + 0.281^2 + 1.158^2 + 1.087^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = -10.601$ % of span = - 10.601 % NR Level

$\text{COT}_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm 1.118$ % of span = $\pm$ 1.118 % NR Level

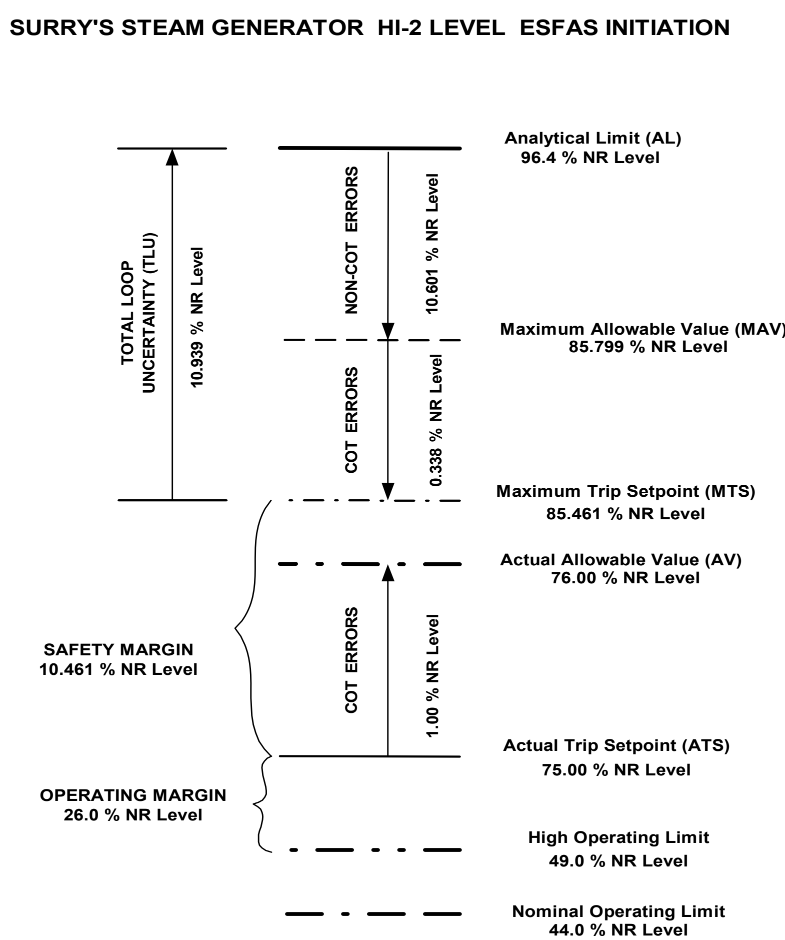


Figure 4.4.11

4.4.12 Refueling Water Storage Tank Level Low – Low RMT Initiation

Allowable Values : $\geq$ 12.7 % Wide Range (WR) Level and $\leq$ 14.3 % Wide Range (WR) Level (Refs. 5.1, 5.7, 5.41 & 5.58)

There are two Analytical Limits and thus two Allowable Values associated with this function. The Analytical Limits are $\geq$ 11.00 % WR Level and $\leq$ 16.00 % WR Level. The corresponding Allowable Values are $\geq$ 11.25 % WR Level and $\leq$ 15.75 % WR Level. Both Allowable Values will be analyzed below.

Analysis for $\geq$ 11.25 % Wide Range (WR) Level

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 12.799 % WR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 12.355 % WR Level. The Actual Nominal Trip Setpoint of 13.5 % WR Level is conservative with respect to the Minimum Trip Setpoint. The Actual Allowable Value of $\geq$ 11.25 % WR Level is non-conservative with respect to the Minimum Allowable Value. The Allowable Value of $\geq$ 11.25 % WR Level will be changed to $\geq$ 12.7 % WR Level to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of $\geq$ 12.7 % WR Level is conservative with respect to the calculated value using CSA rack error terms from Calculation EE-0112 (Ref. 5.41).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0112 (Ref. 5.41) are given below. The COT and NON COT error components are used in Figure 4.4.12 to determine the Minimum Trip Setpoint (MTS) and the Minimum Allowable Value (MAV).

$\text{NON COT}_{\text{error}} = \text{SE} \pm [\text{EA}^2 + \text{PMA}^2 + \text{PEA}^2 + (\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{SPSE}^2 + \text{M1MTE}^2 + \text{M3MTE}^2 + \text{RTE}^2]^{1/2}$

$\text{NON COT}_{\text{error}} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.234)^2 + 0.270^2 + 0.0^2 + 0.976^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{\text{error}} = + 1.355$ % of span

$\text{COT}_{\text{error}} = \pm (\text{M1}^2 + \text{M3}^2 + \text{RD}^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm 1.118$ % of span

Analysis for $\leq$ 15.75 % Wide Range (WR) Level

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 14.201 % WR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 14.645 % WR Level. The Actual Nominal Trip Setpoint of 13.5 % WR Level is conservative with respect to the Maximum Trip Setpoint. The Actual Allowable Value of $\leq$ 15.75 % WR Level is non-conservative with respect to the Maximum Allowable Value. The Allowable Value of $\leq$ 15.75 % WR Level will be changed to $\leq$ 14.3 % WR Level to conform to the requirements of Methods 1 and 2 as described in Sections 3.3.1 and 3.3.2. The revised Allowable Value of $\leq$ 14.3 % WR Level is conservative with respect to the calculated value using CSA rack error terms from Calculation EE-0112 (Ref. 5.41).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0112 (Ref. 5.41) are given below. The COT and NON COT error components are used in Figure 4.4.12 to determine the Maximum Trip Setpoint (MTS) and the Maximum Allowable Value (MAV).

$$\text{NON COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.234)^2 + 0.270^2 + 0.0^2 + 0.976^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = + 1.355 \text{ \% of span}$$

$$\text{COT}_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.118 \text{ \% of span}$$

See Figure 4.4.12 for specific details.

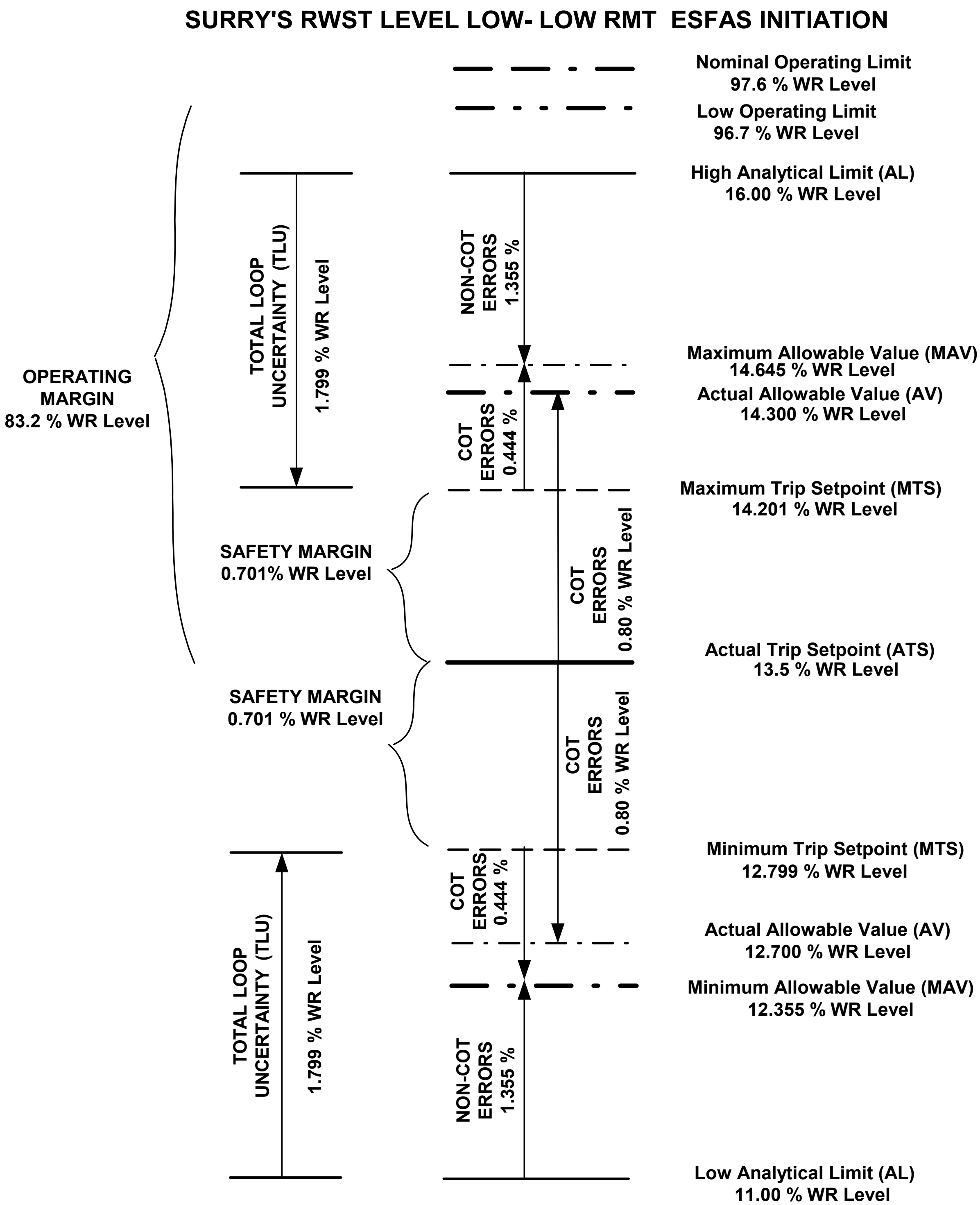

SURRY'S RWST LEVEL LOW- LOW RMT ESFAS INITIATION
Nominal Operating Limit
97.6 % WR Level
Low Operating Limit
96.7 % WR Level
High Analytical Limit (AL)
16.00 % WR Level
NON-COT ERRORS 1.355 %
TOTAL LOOP UNCERTAINTY (TLU)
1.799 % WR Level
OPERATING MARGIN
83.2 % WR Level
Maximum Allowable Value (MAV)
14.645 % WR Level
Actual Allowable Value (AV)
14.300 % WR Level
COT ERRORS 0.444 %
Maximum Trip Setpoint (MTS)
14.201 % WR Level
SAFETY MARGIN
0.701% WR Level
COT ERRORS 0.80 % WR Level
Actual Trip Setpoint (ATS)
13.5 % WR Level
SAFETY MARGIN
0.701 % WR Level
COT ERRORS 0.80 % WR Level
Minimum Trip Setpoint (MTS)
12.799 % WR Level
COT ERRORS 0.444 %
Actual Allowable Value (AV)
12.700 % WR Level
Minimum Allowable Value (MAV)
12.355 % WR Level
TOTAL LOOP UNCERTAINTY (TLU)
1.799 % WR Level
NON-COT ERRORS 1.355 %
Low Analytical Limit (AL)
11.00 % WR Level

Figure 4.4.12

4.4.13 Refueling Water Storage Tank Level – Low Inside/Outside Recirculation Spray Pump Interlock

Allowable Values : ≥ 59.0 % Wide Range (WR) Level and ≤ 61.0 % Wide Range (WR) Level (Refs. 5.1, 5.7, 5.41, 5.58 & 5.83)

There are two Analytical Limits and thus two Setting Limits associated with this new function. The Analytical Limits are based on input from the Nuclear Analysis and Fuel group and Technical Report NE-1460 (Reference 5.83). The Analytical Limits are ≥ 57.50 % WR Level and ≤ 62.50 % WR Level. The corresponding Setting Limits to be used in Technical Specifications are ≥ 59.00 % WR Level and ≤ 61.00 % WR Level. Both Setting Limits will be analyzed below.

Analysis for ≥ 59.00 % Wide Range (WR) Level

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Minimum Trip Setpoint (MTS) of 59.299 % WR Level. Adding the NON COT error components to the Analytical Limit yields a Minimum Allowable Value (MAV) of 58.855 % WR Level. The Actual Nominal Trip Setpoint of 60.00 % WR Level is conservative with respect to the Minimum Trip Setpoint. The Actual Allowable Value of ≥ 59.00 % WR Level is conservative with respect to the Minimum Allowable Value. This Allowable Value of ≥ 59.00 % WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00 % WR Level. The Allowable Value of ≥ 59.00 % WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms) from Dominion Channel Statistical Allowance (CSA) Calculation EE-0112 (Reference 5.41).

Analysis for ≤ 61.00 % Wide Range (WR) Level

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Maximum Trip Setpoint (MTS) of 60.701 % WR Level. Subtracting the NON COT error components from the Analytical Limit yields a Maximum Allowable Value (MAV) of 61.145 % WR Level. The Actual Nominal Trip Setpoint of 60.00 % WR Level is conservative with respect to the Maximum Trip Setpoint. The Actual Allowable Value of ≤ 61.00 % WR Level is conservative with respect to the Maximum Allowable Value. This Allowable Value of ≤ 61.00 % WR Level is based on maintaining a Nominal Trip Setpoint value of 60.00 % WR Level. The Allowable Value of ≤ 61.00 % WR Level is conservative with respect to the calculated value using rack error terms (i.e., COT error terms) from Dominion Channel Statistical Allowance (CSA) Calculation EE-0112 (Reference 5.41).

The statistical combination of the COT and NON COT error components from CSA Calculation EE-0112 are given below. The COT and NON COT error components are used in Figure 4.4.13 to determine the Minimum/Maximum Trip Setpoints (MTS) and the Minimum/Maximum Allowable Values (MAV).

$$\text{NON COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M3MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.5+0.234)^2 + 0.270^2 + 0.0^2 + 0.972^2 + 0.0^2 + 0.0^2 + 0.150^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = + 1.355 \text{ \% of span}$$

$$\text{COT}_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{½}$

$COT_{error} = \pm$ 1.118 % of span

See Figure 4.4.13 for specific details.

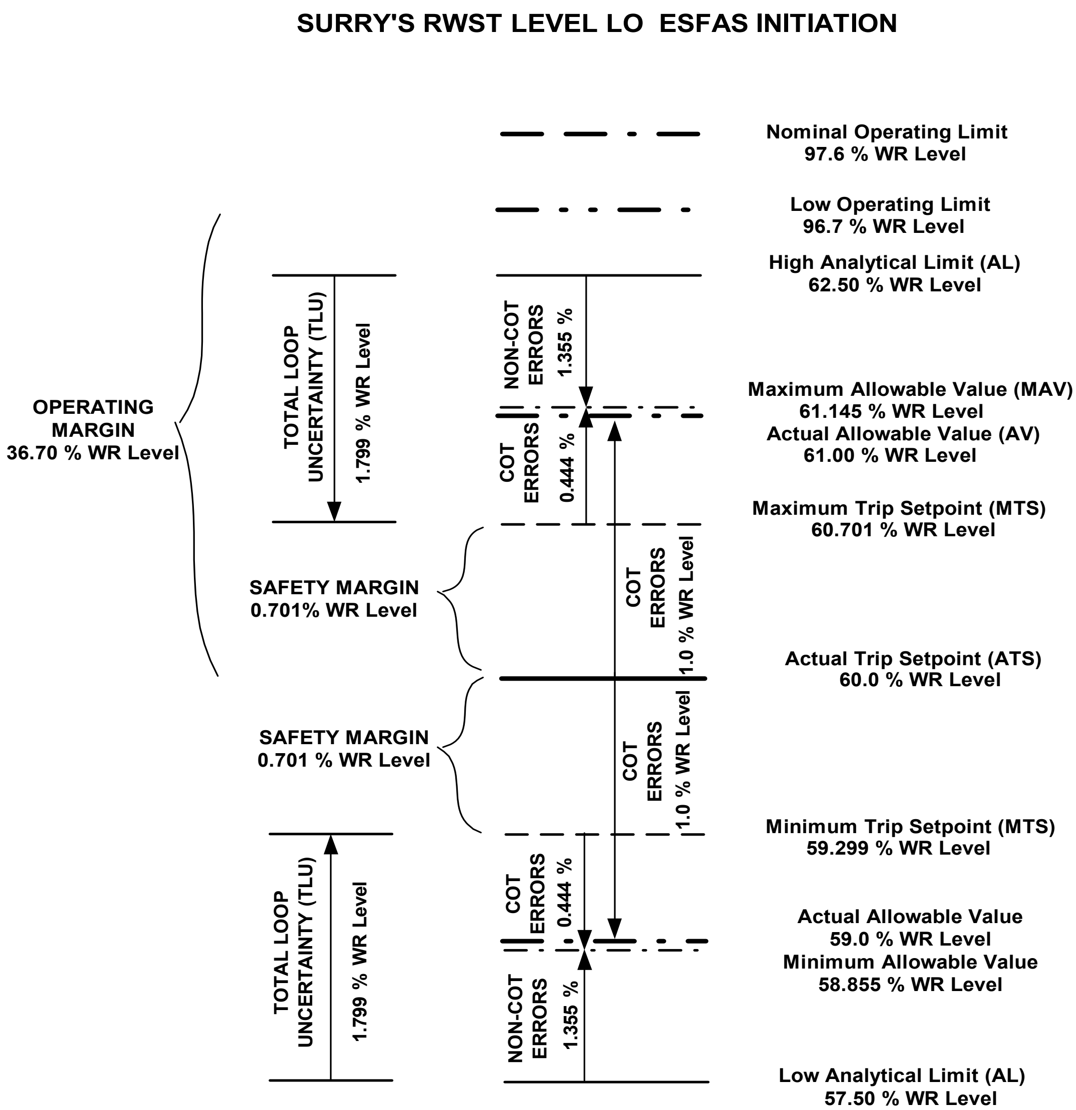


Figure 4.4.13

Note: The COT errors are based on the Minimum Trip Setpoint value minus the Minimum Allowable value and the Actual Trip Setpoint value minus the Actual Allowable Value.

ESFAS Permissives

Note: In the context of this document, the terms Allowable Value and Setting Limit and Limiting Safety System Setting (LSSS) have the same meaning and intent.

4.4.14 Pressurizer Pressure, P-11

Allowable Value : $\leq$ 2010 PSIG (Refs. 5.1, 5.7, 5.32 & 5.44)

Only one Allowable Value will be provided for the P-11 function. The automatic disabling of the manual block of safety injection on increasing pressure is the portion of this function that is important to safety. The revised Allowable Value of $\leq$ 2010 PSIG is based on maintaining a Nominal Trip Setpoint value of 2000 PSIG. In this case, the current Allowable Value of $\leq$ 2000 PSIG is set equal to the Nominal Trip Setpoint. Changing the Allowable Value to $\leq$ 2010 PSIG will take into account the tolerances associated with the CSA rack error terms from Calculation EE-0514 (Ref 5.32). The calculated Allowable Value for this function is $\leq$ 2008.9 PSIG. Note that this function is assumed to be available in the Safety Analysis but no specific setpoint is assumed. The proposed Allowable Value for Surry is the same as the Allowable Value in North Anna's Improved Technical Specifications for the automatic disabling of the manual block of safety injection.

4.4.15 T_{AVG}, P-12

Allowable Value : $\leq$ 545.0 ^{o}F (Refs. 5.1, 5.7, 5.31, 5.69)

Only one Allowable Value will be provided for the P-12 function. The automatic disabling of the manual block of the High Steam Flow in 2/3 Lines or Low Steam Pressure coincident with Low T_{AVG} on increasing temperature is the portion of this function that is important to safety. The revised Allowable Value of $\leq$ 545.0 ^{o}F is based on maintaining a Nominal Trip Setpoint value of $\leq$ 544.0 ^{o}F. In this case, the current Allowable Value of $\leq$ 543.0 ^{o}F is set equal to the Nominal Trip Setpoint of the Low T_{AVG} Interlock (see section 4.4.7). Changing the Allowable Value to $\leq$ 545.0 ^{o}F will take into account the tolerances associated with the CSA rack error terms from Calculation EE-0415 (Ref 5.31). The revised Allowable Value for this function is conservative with respect to the calculated value of $\leq$ 545.658 ^{o}F (See COT_{error} from item 4.4.7). Note that this function is assumed to be available in the Safety Analysis but no specific setpoint is assumed.

4.5 Limiting Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances for Kewaunee Reactor Protection System (RPS) Instrumentation to Support the Setpoint Control Program

Note : Only the limiting As Found Tolerance value will be addressed in analysis for each Reactor Trip Function described below.

Reactor Trips

4.5.1 Power Range Neutron Flux High Setpoint Reactor Trip

As Found Tolerance Value : 105 % RTP ± 1.5 % RTP (Refs. 5.1, 5.90, 5.91, 5.103, and 5.104)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 110.96 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 111.19 % RTP. The Nominal Trip Setpoint (NTSP) of 105.0 % RTP is conservative with respect to the Limiting Trip Setpoint and the As Found Tolerance Value of ≤ 106.5 % RTP is conservative with respect to the Allowable Value. The current Custom Technical Specification (CTS) LSSS value of ≤ 109 % RTP will be changed to an As Found Tolerance value ≤ 106.5 % RTP to conform to the requirements of TSTF-493, Rev. 4 and RIS 2006-17. The As Found Tolerance is based on a Nominal Trip Setpoint value of 105 % RTP. The Nominal Trip Setpoint value of 105 % RTP will allow a 1.5 % RTP margin to be used for the COT error components. The revised As Found Tolerance value of ≤ 106.5 % RTP is conservative with respect to the calculated value of ≤ 106.56 % RTP using the CSA rack error terms from Calculation C11705 (Ref 5.91).

The calculated As Found Tolerance value for this function is ≤ 106.562 % RTP. The 0.062 % RTP offset will be subtracted from the calculated value to arrive at a value that can be determined on the indicator. The statistical combination of the COT and NON COT error components from CSA Calculation C11705 (Ref. 5.91) are given below. The COT and NON COT error components are used in Figure 4.5.1 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$$NON\ COT_{error} = SE \pm (PMA_1^2 + PMA_3^2 + M1MTE^2 + M3MTE + RTE^2)^{1/2}$$

$$NON\ COT_{error} = 0.333 \pm (1.417^2 + 5.124^2 + 0.185^2 + 0.193^2 + 0.5^2)^{1/2}$$

$$NON\ COT_{error} = \pm 5.679\ \%\ of\ span = \pm 6.815\ \%\ RTP$$

$$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.05^2 + 0.833^2 + 1.0^2)^{1/2}$$

COT_{error} = ± 1.302 % of span = ± 1.562 % RTP (for conservatism round to ± 1.5 % RTP)

As Found Tolerance (AFT) = 105 % RTP ± 1.5 % RTP
As Left Tolerance (ALT) = 105 % RTP ± 1.0 % RTP(1)

See Figure 4.5.1 for specific details.

---

(1) As Left Tolerance = $\pm (M1^2 + M3^2)^{1/2} = \pm (0.05^2 + 0.833^2)^{1/2} = \pm 0.834$ % of span = $\pm$ 1.001 % RTP

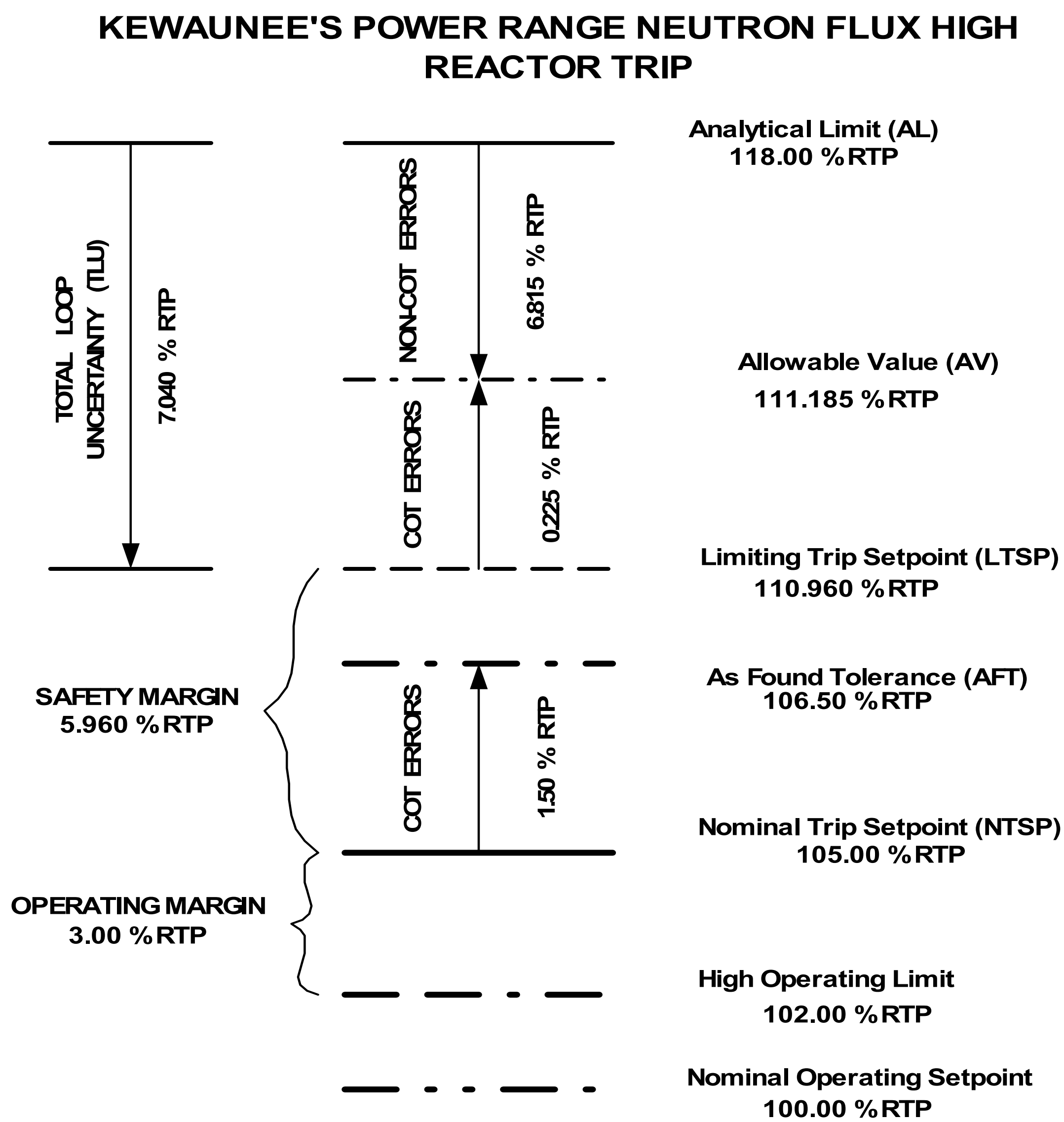


Figure 4.5.1

4.5.2 Power Range Neutron Flux Low Setpoint Reactor Trip

As Found Tolerance: 24.5 % RTP $\pm$ 1.5 % RTP (Refs. 5.1, 5.90, 5.91, 5.103, and 5.104)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 27.96 % Rated Thermal Power (RTP). Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 28.19 % RTP. The Nominal Trip Setpoint (NTSP) of 24.5 % RTP is conservative with respect to the Limiting Trip Setpoint and the As Found Tolerance Value of $\leq$ 26.062 % RTP (conservatively round to $\leq$ 26.0) is conservative with respect to the Allowable Value. The current Custom Technical Specification (CTS) LSSS value of $\leq$ 25 % RTP will be changed to an As Found Tolerance value of $\leq$ 26 % RTP to conform to the requirements of TSTF-493, Rev. 4 and RIS 2006-17. The As Found Tolerance is based on a Nominal Trip Setpoint value of 24.5 % RTP. The Nominal Trip Setpoint value of 24.5 % RTP will allow a 1.5 % RTP margin to be used for the COT error components.

The statistical combination of the COT and NON COT error components from CSA Calculation C11705 (Ref. 5.91) are given below. The COT and NON COT error components are used in Figure 4.5.2 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$\text{NON COT}_{\text{error}} = \text{SE} \pm (\text{PMA}_1^2 + \text{PMA}_3^2 + \text{M1MTE}^2 + \text{M4MTE} + \text{RTE}^2)^{1/2}$

$\text{NON COT}_{\text{error}} = 0.333 \pm (1.417^2 + 5.124^2 + 0.185^2 + 0.193^2 + 0.5^2)^{1/2}$

$\text{NON COT}_{\text{error}} = \pm$ 5.679 % of span = $\pm$ 6.815 % RTP

$\text{COT}_{\text{error}} = \pm (\text{M1}^2 + \text{M4}^2 + \text{RD}^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm (0.05^2 + 0.833^2 + 1.0^2)^{1/2}$

$\text{COT}_{\text{error}} = \pm$ 1.302 % of span = $\pm$ 1.562 % RTP (for conservatism round to $\pm$ 1.5 % RTP)

As Found Tolerance (AFT) = 24.5 % RTP $\pm$ 1.5 % RTP
As Left Tolerance (ALT) = 24.5% RTP $\pm$ 1.0 % RTP(1)

See Figure 4.5.2 for specific details.

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(2) As Left Tolerance = $\pm (\text{M1}^2 + \text{M4}^2)^{1/2} = \pm (0.05^2 + 0.833^2)^{1/2} = \pm$ 0.834 % of span = $\pm$ 1.001 % RTP

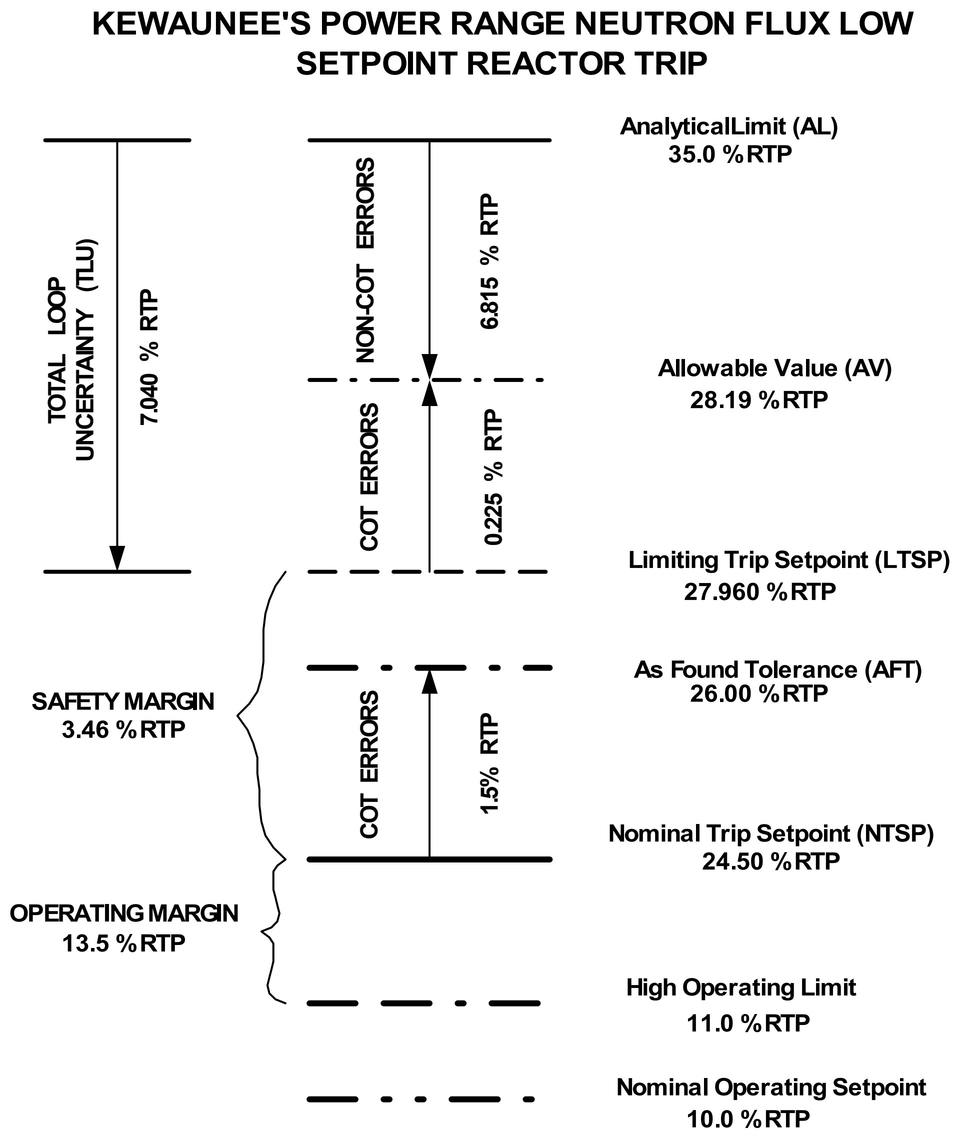
KEWAUNEE'S POWER RANGE NEUTRON FLUX LOW
SETPOINT REACTOR TRIP
TOTAL LOOP
UNCERTAINTY (TLU)
7.040 % RTP
NON-COT ERRORS
6.815 % RTP
COT ERRORS
0.225 % RTP
COT ERRORS
1.5% RTP
AnalyticalLimit (AL)
35.0 %RTP
Allowable Value (AV)
28.19 %RTP
Limiting Trip Setpoint (LTSP)
27.960 %RTP
As Found Tolerance (AFT)
26.00 %RTP
SAFETY MARGIN
3.46 %RTP
Nominal Trip Setpoint (NTSP)
24.50 %RTP
OPERATING MARGIN
13.5 %RTP
High Operating Limit
11.0 %RTP
Nominal Operating Setpoint
10.0 %RTP

Figure 4.5.2

4.5.3 Power Range Neutron Flux High Positive Rate Reactor Trip

As Found Tolerance: 5.0 % RTP ± 1.3 % RTP with a time constant of 2.3 seconds ± 0.2 seconds (Refs. 5.1, 5.11, 5.12, 5.13, 5.73, 5.90, 5.91, 5.104, 5.136, & 5.142)

The current Kewaunee Custom Technical Specifications (CTS) LSSS value for this function is 15.0 % / Δq / 5.0 seconds. The manner in which this specification is presented in Kewaunee's CTS is different than the typical presentation in Standardized Technical Specifications (STS) or in Improved Technical Specifications (ITS). The typical expression for this function in STS or ITS would be "≤ 15.0 % RTP with a time constant ≥ 5.0 Seconds." For consistency and clarity, the expression for this function will be written in the ITS format. The current static Nominal Trip Setpoint (NTSP) for this function is (+) 5.0 % RTP and the Rate Lag Derivative Time Constant associated with this function is currently set at a nominal value of 2 seconds versus the required CTS LSSS value of 5.0 seconds.

For Rate Lag Derivative functions, conservative settings are ≥ the desired/required time constant. The Power Range Neutron Flux Positive Rate Reactor Trip is developed based on a combination of the dynamic compensation from the Rate Lag Derivative Module (NM311) and the static trip setpoint installed in the Bistable Relay Driver (NC303). When Kewaunee's current settings for Rate Lag Derivative Module (i.e., nominal 2 second time constant) and the Bistable Relay Driver (i.e., nominal trip setpoint is + 5.0 % RTP) are combined, the Power Range Neutron Flux Positive Rate Reactor Trip function is set conservative when compared to the current CTS LSSS settings (i.e., + 15.0 % RTP with a time constant of 5 seconds) for all postulated conditions which include both a ramp and a step. The major contributing factor that results in this determination is based on the fact that the nominal trip setpoint is set at 5.0 % RTP versus 15.0 % RTP. The currently installed settings versus the current LSSS settings will be compared below for both a step and a ramp.

Based on References 5.12, 5.13, 5.136, and 5.137, the equation to determine the output of a Rate Lag Derivative Module for a step input is:

$$V_{OUT} = G * (e^{-t/t1} * (V_F - V_I) + B)$$

Where:

G	= Module Gain = 1.0000 V/V
e	= antilog of the natural log (e^x)
t	= time of interest (for this example use 0.1 second)
t1	= Rate Lag Derivative Time Constant = 2 or 5 Seconds
V_F	= Voltage input to the Rate Lag Derivative Module after the step change = 8.771 VDC
V_I	= Voltage input to the Rate Lag Derivative Module before the step change = 8.333 VDC
B	= Rate Lag Derivative Module Bias = 0.000 VDC

There is no pedestal voltage for the NIS Rate Lag Derivative Modules. For a step change starting at V_{OUT} = 0.000 VDC with the currently installed settings, i.e., + 5.0 % RTP = (5 %/120 %) * 10.000 VDC = + 0.417 VDC and a nominal Rate Lag Derivative Time Constant of 2 seconds, the Power Range Neutron Flux Positive Rate Reactor Trip will occur with a power change of 5.256 % RTP. This includes a conservative assumption of 0.1 seconds used for the time of interest (i.e., t) to account for on-board module lag(s) and the process lags. Therefore, the common parameters are:

Bistable Relay Driver Setpoint = 5.0 % RTP = 0.417 VDC
Rate Lag Derivative Time Constant = 2 seconds

To make the Positive Rate Bistable Relay Driver trip, we must use a step change of 0.438 VDC to account for lags in the system as discussed above. This step change voltage is calculated as:

$(1 / e^{-0.1/2}) * 0.417$ VDC = 0.438 VDC

With the currently installed settings, NM311 will output the following:

$V_{OUT(NM311)} = 1.0000 * (e^{-0.1/2} * (8.771 – 8.333) + 0.000)$
$V_{OUT(NM311)}$ = 0.417 VDC (Bistable Relay Driver TRIP), noting that actual power is equal to (0.438 VDC / 10.000 VDC) * 120 % RTP = (+) 5.256 % RTP.

Using the same input parameters and substituting Kewaunee's current LSSS settings, NM311 will output the following:

$V_{OUT(NM311)} = 1.0000 * (e^{-0.1/5} * (8.771 – 8.333) + 0.000)$
$V_{OUT(NM311)}$ = 0.429 VDC (Bistable Relay Driver RESET), noting that actual power is equal to (+) 5.256 % RTP. However, the installed setpoint for the Bistable Relay Driver would be set at (+) 15.0 % RTP = (15 % RTP / 120 % RTP) * 10.000 VDC = 1.250 VDC.

Based on References 5.12, 5.13, 5.136, and 5.137, the equation to determine the output of a Rate Lag Derivative Module for a ramp input is:

$V_{OUT} = G * V_I + t1 * RR * G * (1 - e^{-t/t1}) + B$

Where:

G = Module Gain = 1.0000 V/V
e = antilog of the natural log (e^x)
t = time of interest (for this example use 5 seconds)
t1 = Rate Lag Derivative Time Constant = 2 or 5 Seconds
V_I = Voltage input to the Rate Lag Derivative Module before the ramp starts = 8.333 VDC
RR = Ramp Rate (VDC/Second)
B = Rate Lag Derivative Module Bias = 0.000 VDC

The assumption used for this example for the Ramp Rate (RR) is a (+) 15.0 RTP power change in 5 seconds. That means the indicated power on the Full Power Meter goes from 100 % RTP to 115 % RTP in 5 seconds. So the Ramp Rate will be [(15 % RTP / 120 % RTP) * 10.000 VDC] / 5 seconds = 0.250 VDC / second = 3.0 % RTP / second. The currently installed settings versus the current Technical Specifications LSSS settings will be compared below for a ramp of (+) 3.0 % RTP / second at a time of interest (t) of 5 seconds after the ramp begins.

With the currently installed settings, the Positive Rate Trip will respond as shown below:

Nominal Trip Setpoint = (+) 5.0 % RTP = 0.417 VDC
Nominal Rate Lag Derivative Time Constant = 2 Seconds

$V_{OUT(NM311)} = 1.0000 * 0.000 + 2 * 0.250 * 1.0000 (1 - e^{-5/2}) + 0.000$
$V_{OUT(NM311)}$ = 0.459 VDC (Bistable Relay Driver TRIP)

With the current Technical Specifications LSSS settings, the Positive Rate Trip will respond as shown below:

Nominal Trip Setpoint = (+) 15.0 % RTP = 1.250 VDC
Nominal Rate Lag Derivative Time Constant = 5 Seconds

$V_{OUT(NM311)} = 1.0000 * 0.000 + 5 * 0.250 * 1.0000 (1 - e^{-5/5}) + 0.000$
$V_{OUT(NM311)}$ = 0.790 VDC (Bistable Relay Driver RESET)

As can be seen from the examples above, from a dynamic perspective, the current Technical Specifications LSSS setting for the Rate Lag Derivative Time Constant (i.e., time constant = 5 seconds) will yield the most conservative output from NM311 for both a ramp and a step. However, when the dynamics and the statics are combined for the overall function, noting that the installed static nominal trip setpoint is set conservative by 10.0 % RTP, the currently installed settings are conservative for all conditions. It should also be noted that Kewaunee's currently installed settings of (+) 5.0 % RTP with a Rate Lag Derivative Time Constant of 2 seconds are consistent with the nominal Standardized Technical Specifications (STS) values for this function and are identical to North Anna's settings for this function.

Note : This trip function is not credited in the USAR Chapter 14 Safety Analysis (Ref. 5.1). A CSA Calculation has not been performed for this function. CSA Calculation 11705 (Ref. 5.91) and Instrument Surveillance Procedure SP-48-004A (Ref. 5.104) were used to perform this analysis.

Static As Found Tolerance (AFT) = 5.0 % RTP ± 1.3 % RTP(1)
Static As Left Tolerance (ALT) = 5.0% RTP ± 0.5 % RTP(2)
Dynamic As Found Tolerance = 2.3 seconds ± 0.2 seconds(3)
Dynamic As Left Tolerance = 2.3 seconds ± 0.2 seconds(3)

---

(1) AFT = $\pm (M1^2+NM311^2+NC303^2+RD^2)^{1/2} = \pm (0.05^2+0.05^2+0.417^2+1.0^2)^{1/2}$ = ± 1.086 % span = ± 1.303 % RTP
(2) ALT = $\pm (M1^2+NM311^2+NC303^2)^{1/2} = \pm (0.05^2+0.05^2+0.417^2)^{1/2}$ = ± 0.424 % span = ± 0.508 % RTP
(3) The Dynamic Tolerance is equal to ± 10 % of the desired time constant based on Reference 5.73.

Note: the calibration accuracy of NC303 is ± 0.5 % RTP = ± (0.5 % / 120 %) * 100 % span = ± 0.417 % span

4.5.4 Power Range Neutron Flux High Negative Rate Reactor Trip

As Found Tolerance: 5.0 % RTP ± 1.3 % RTP with a time constant of 2.3 seconds ± 0.2 seconds (Refs. 5.1, 5.11, 5.12, 5.13, 5.73, 5.90, 5.91, 5.104, 5.136, & 5.142)

The current Kewaunee Custom Technical Specifications (CTS) LSSS value for this function is 10.0 % / Δq / 5.0 seconds. The manner in which this specification is presented in Kewaunee's CTS is different than the typical presentation in Standardized Technical Specifications (STS) or in Improved Technical Specifications (ITS). The typical expression for this function in STS or ITS would be "≤ 10.0 % RTP with a time constant ≥ 5.0 Seconds." For consistency and clarity, the expression for this function will be written in the ITS format. The current static Nominal Trip Setpoint (NTSP) for this function is (-) 5.0 % RTP and the Rate Lag Derivative Time Constant associated with this function is currently set at a nominal value of 2 seconds versus the required CTS LSSS value of 5.0 seconds.

For Rate Lag Derivative functions, conservative settings are ≥ the desired/required time constant. The Power Range Neutron Flux Negative Rate Reactor Trip is developed based on a combination of the dynamic compensation from the Rate Lag Derivative Module (NM311) and the static trip setpoint installed in the Bistable Relay Driver (NC301). When Kewaunee's current settings for Rate Lag Derivative Module (i.e., nominal 2 second time constant) and the Bistable Relay Driver (i.e., nominal trip setpoint is + 5 % RTP) are combined, the Power Range Neutron Flux Negative Rate Reactor Trip function is set conservative when compared to the current CTS LSSS settings (i.e., - 10 % RTP with a time constant of 5 seconds) for all postulated conditions which include both a ramp and a step. The major contributing factor that results in this determination is based on the fact that the nominal trip setpoint is set at – 5.0 % RTP versus – 10.0 % RTP. The currently installed settings versus the current LSSS settings will be compared below for both a step and a ramp.

Based on References 5.12, 5.13, 5.136, and 5.137, the equation to determine the output of a Rate Lag Derivative Module for a step input is:

$$V_{OUT} = G * (e^{-t/t1} * (V_F - V_I) + B)$$

Where:

G	= Module Gain = 1.0000 V/V
e	= antilog of the natural log (e^x)
t	= time of interest (for this example use 0.1 second)
t1	= Rate Lag Derivative Time Constant = 2 or 5 Seconds
V_F	= Voltage input to the Rate Lag Derivative Module after the step change = 7.895 VDC
V_I	= Voltage input to the Rate Lag Derivative Module before the step change = 8.333 VDC
B	= Rate Lag Derivative Module Bias = 0.000 VDC

There is no pedestal voltage for the NIS Rate Lag Derivative Modules. For a step change starting at V_{OUT} = 0.000 VDC with the currently installed settings, i.e., - 5.0 % RTP = (- 5 %/120 %) * 10.000 VDC = - 0.417 VDC and a nominal Rate Lag Derivative Time Constant of 2 seconds, the Power Range Neutron Flux Negative Rate Reactor Trip will occur with a power change of - 5.256 % RTP. This includes a conservative assumption of 0.1 seconds used for the time of interest (i.e., t) to account for on-board module lag(s) and the process lags. Therefore, the common parameters are:

Bistable Relay Driver Setpoint = - 5.0 % RTP = - 0.417 VDC
Rate Lag Derivative Time Constant = 2 seconds

To make the Negative Rate Bistable Relay Driver trip, we must use a step change of - 0.438 VDC to account for lags in the system as discussed above. This step change voltage is calculated as:

$(1 / e^{-0.1/2}) * - 0.417$ VDC = - 0.438 VDC

With the currently installed settings, NM311 will output the following:

$V_{OUT(NM311)} = 1.0000 * (e^{-0.1/2} * (7.895 – 8.333) + 0.000)$
$V_{OUT(NM311)}$ = - 0.417 VDC (Bistable Relay Driver TRIP), noting that actual power is equal to (-) 5.256 % RTP.

Using the same input parameters and substituting Kewaunee's current LSSS settings, NM311 will output the following:

$V_{OUT(NM311)} = 1.0000 * (e^{-0.1/5} * (7.895 – 8.333) + 0.000)$
$V_{OUT(NM311)}$ = - 0.429 VDC (Bistable Relay Driver RESET), noting that actual power is equal to (-) 5.256 % RTP. However, the installed setpoint for the Bistable Relay Driver would be set at (-) 10 % RTP = (-10 % RTP / 120 % RTP) * 10.000 VDC = - 0.833 VDC.

Based on References 5.12, 5.13, 5.136, and 5.137, the equation to determine the output of a Rate Lag Derivative Module for a ramp input is:

$V_{OUT} = G * V_I + t1 * RR * G * (1 - e^{-t/t1}) + B$

Where:

G = Module Gain = 1.0000 V/V
e = antilog of the natural log (e^x)
t = time of interest (for this example use 10 seconds)
t1 = Rate Lag Derivative Time Constant = 2 or 5 Seconds
V_I = Voltage input to the Rate Lag Derivative Module before the ramp starts = 8.333 VDC
RR = Ramp Rate (VDC/Second)
B = Rate Lag Derivative Module Bias = 0.000 VDC

The currently installed settings versus the current Technical Specifications LSSS settings will be compared below for the minimum ramp of (-) 3.0 % RTP / second at a time of interest (t) of 5 seconds after the ramp begins. This is the minimum ramp rate and approximate ramp time required to achieve a trip for either condition. The Ramp Rate VDC/Second = (- 3.0 % RTP/120 % RTP) * 10 VDC = (-) 0.250 VDC / Second.

With the currently installed settings, the Negative Rate Trip will respond as shown below:

Nominal Trip Setpoint = (-) 5.0 % RTP = - 0.417 VDC
Nominal Rate Lag Derivative Time Constant = 2 Seconds

$V_{OUT(NM311)}$ = 1.0000 * 0.000 + 2 * - 0.250 * 1.0000 (1 - $e^{-5/2}$) + 0.000
$V_{OUT(NM311)}$ = - 0.459 VDC (Bistable Relay Driver TRIP)

With the current Technical Specifications LSSS settings, the Negative Rate Trip will respond as shown below:

Nominal Trip Setpoint = (-) 10.0 % RTP = - 0.833 VDC
Nominal Rate Lag Derivative Time Constant = 5 Seconds

$V_{OUT(NM311)}$ = 1.0000 * 0.000 + 5 * - 0.250 * 1.0000 (1 - $e^{-5/5}$) + 0.000
$V_{OUT(NM311)}$ = - 0.790 VDC (Bistable Relay Driver RESET)

As can be seen from the examples above, from a dynamic perspective, the current Technical Specifications LSSS setting for the Rate Lag Derivative Time Constant (i.e., time constant = 5 seconds) yields the most conservative output from NM311 for both a ramp and a step. However, when the dynamics and the statics are combined for the overall function, noting that the installed static nominal trip setpoint is set conservative by 5.0 % RTP, the currently installed settings are conservative for all conditions. It should also be noted that Kewaunee's currently installed settings of (-) 5.0 % RTP with a Rate Lag Derivative Time Constant of 2 seconds are consistent with the nominal Standardized Technical Specifications (STS) values for this function and are identical to North Anna's settings for this function. Finally, Kewaunee's installed settings for this function are consistent with the requirements of WCAP-10298-A which specify nominal settings for the Power Range Negative Rate Trip of (-) 5.0 % RTP with a time constant of 2 seconds (Ref. 5.138).

Note : This trip function is not credited in the USAR Chapter 14 Safety Analysis (Ref. 5.1). A CSA Calculation has not been performed for this function. CSA Calculation 11705 (Ref. 5.91) and Instrument Surveillance Procedure SP-48-004A (Ref. 5.104) were used to perform this analysis.

Static As Found Tolerance (AFT) = 5.0 % RTP ± 1.3 % RTP(1)
Static As Left Tolerance (ALT) = 5.0% RTP ± 0.5 % RTP(2)
Dynamic As Found Tolerance = 2.3 seconds ± 0.2 seconds(3)
Dynamic As Left Tolerance = 2.3 seconds ± 0.2 seconds(3)

---

(1) AFT = $\pm (M1^2+NM311^2+NC301^2+RD^2)^{1/2} = \pm (0.05^2+0.05^2+0.417^2+1.0^2)^{1/2}$ = ± 1.086 % span = ± 1.303 % RTP
(2) ALT = $\pm (M1^2+NM311^2+NC301^2)^{1/2} = \pm (0.05^2+0.05^2+0.417^2)^{1/2}$ = ± 0.424 % span = ± 0.508 % RTP
(3) The Dynamic Tolerance is equal to ± 10 % of the desired time constant based on Reference 5.73.

Note: the calibration accuracy of NC301 is ± 0.5 % RTP = ± (0.5 % / 120 %) * 100 % span = ± 0.417 % span

4.5.5 Intermediate Range Neutron Flux High Reactor Trip

As Found Tolerance : 20.0 % RTP ± 5.0 % RTP (Refs. 5.1, 5.16, 5.29, and 5.116)

The current Custom Technical Specification (CTS) LSSS value of ≤ 40.0 % RTP is based on maintaining a Nominal Trip Setpoint value of 20.0 % RTP. The current Custom Technical Specification (CTS) LSSS value is non-conservative based on the COT error components of the Nuclear Instrumentation System. The Intermediate Range Neutron Flux High Reactor Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); therefore no Channel Statistical Allowance (CSA) Calculation has been performed for this function. The typical COT error allowance for this function is approximately 5.0 % RTP. For example, the COT error for this function at Surry is equal to ± 5.678 % RTP, the COT error at North Anna is ± 4.403 % RTP, and the typical Standardized Technical Specifications (STS) COT allowance is 5 % RTP (Refs. 5.3, 5.16, and 5.29). The As Found Tolerance will be ≤ 25.0 % RTP. The As Found Tolerance of ≤ 25.0 % RTP is based on maintaining a Nominal Trip Setpoint Value of 20.0 % RTP.

Note : This trip function is not credited in the USAR Chapter 14 Safety Analysis (Ref. 5.1). A CSA Calculation has not been performed for this function. Ref. 5.116 was used in the determination of the AFT and ALT below.

As Found Tolerance (AFT) = 20.0 % RTP ± 5.0 % RTP
As Left Tolerance (ALT) = 20.0% RTP ± 4.9 % RTP[(1)]

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(1) ALT = $\pm (CSA^2 - RD^2)^{1/2} = \pm (5.0^2 - 1.2^2)^{1/2} = \pm 4.854$ % RTP

4.5.6 Source Range Neutron Flux High Reactor Trip

As Found Tolerance: 1.0 E5 CPS + 0.466 E5 CPS, - 0.318 E5 CPS (Refs. 5.1, 5.17, 5.30, and 5.117)

The current Custom Technical Specification (CTS) LSSS for this function states "within Source Range span". The current Nominal Trip Setpoint for this function is 1.0 E5 Counts Per Second (CPS). The Source Range Neutron Flux High Reactor Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); therefore no Channel Statistical Allowance (CSA) Calculation has been performed for this function. The typical COT error allowance for this function is approximately ± 3.0 % of linear span. For example, the COT error for this function at Surry is equal to ± 2.973 % of linear span and the COT error at North Anna is ± 3.136 % of linear span (Refs. 5.17 and 5.30). To be conservative, the North Anna COT error allowance will be used in this analysis. The As Found Tolerance will be ≤ 1.466 E5 CPS[(1)]. The As Found Tolerance of ≤ 1.466 E5 CPS is based on maintaining a Nominal Trip Setpoint Value of 1.0 E5 CPS.

Note : This trip function is not credited in the USAR Chapter 14 Safety Analysis (Ref. 5.1). A CSA Calculation has not been performed for this function. References 5.17, 5.30, and 5.117 were used in the determination of the AFT and ALT below.

As Found Tolerance (AFT) = 1.0 E5 CPS + 0.466 E5 CPS, - 0.318 E5 CPS[(1)]
As Left Tolerance (ALT) = 1.0 E5 CPS + 0.358 E5 CPS, - 0.264 E5 CPS[(2)]

(1) Nominal Trip Setpoint = $1.0 * 10^5$ CPS ⇒ log $1.0 * 10^5 = 5.0$ (on a 0 to 5.301 Decade scale)
COT error = ± 3.136 % of linear span ⇒ (3.136 %/100 %) * 5.301 Decades = ± 0.166239 Decade
High Trip Setpoint = 5.0 + 0.166239 = 5.166239 ⇒ antilog 5.166239 = $1.466 * 10^5$
Low Trip Setpoint = 5.0 - 0.166239 = 4.833761 ⇒ antilog 4.833761 = $0.682 * 10^5$

(2) Nominal Trip Setpoint = $1.0 * 10^5$ CPS ⇒ log $1.0 * 10^5 = 5.0$ (on a 0 to 5.301 Decade scale)
COT error minus Rack Drift = ± 2.5 % of linear span ⇒ (2.5 %/100 %) * 5.301 Decades = ± 0.133 Decade
High Trip Setpoint = 5.0 + 0.133 = 5.133 ⇒ antilog 5.133 = $1.358 * 10^5$
Low Trip Setpoint = 5.0 - 0.133 = 4.867 ⇒ antilog 4.867 = $0.736 * 10^5$

4.5.7 Overtemperature ΔT Reactor Trip

As Found Tolerance: See below (Refs. 5.1, 5.90, 5.94, 5.105, 5.114, and 5.133)

"The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 2.0 % of the ΔT span" (Note that 2.0 % of the ΔT span is equal to 3.0 % ΔT Power)

The Overtemperature ΔT (OTΔT) Reactor Trip Setpoint equation in terms of process units is:

$$OT\Delta T_{SP} \leq \Delta T_0 \left[K_1 - K_2 * \left(\frac{1 + t_1 s}{1 + t_2 s}\right) * (T - T') + K_3 * (P - P') - f(\Delta I) \right]$$

(Equation 4.5.7)

Where :

ΔT_0 = Indicated ΔT at Rated Power, %
T = Average temperature, °F
T' = 573.0 °F
P = Pressurizer pressure, psig
P' = 2235 psig
K_1 = 1.195
K_2 = 0.015 / °F
K_3 = 0.00072 / psig
ΔI = $q_t - q_b$, where q_t and q_b are percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of rated power.
f(ΔI) = function of ΔI, percent of rated core power as shown in the Kewaunee COLR.
τ_1 30.0 seconds
τ_2 4.0 seconds

The Overtemperature ΔT (OTΔT) Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. Further, the OTΔT Reactor Trip will only be analyzed for the following condition:

- OTΔT Reactor Trip with no FΔI

The two conditions listed below are also associated with the OTΔT Reactor Trip. These conditions are not credited in the USAR Chapter 14 Safety Analysis and will not be analyzed here.

- OTΔT Reactor Trip with (+) FΔI
- OTΔT Reactor Trip with (-) FΔI

Note: FΔI is the Delta Flux Penalty generated from the Upper and Lower Power Range Neutron Flux Detectors (i.e., Q_U and Q_L).

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields the following Limiting Trip Setpoints (LTSP) for the OTΔT Reactor Trip with no FΔI condition as described above:

- LTSP for OTΔT Reactor Trip with no FΔI = 130.0 % - 8.403 % = 121.597 % ΔT Power

Subtracting the NON COT error components from the Analytical Limit yields the following Allowable Value (AV) for the OTΔT Reactor Trip with no FΔI contribution as described above:

- AV for OTΔT Reactor Trip with no FΔI = 130.0 % - 5.883 % = 124.117 % ΔT Power

For the most limiting condition (i.e., OTΔT Reactor Trip with no FΔI) the Actual Nominal Trip Setpoint of 118.25 % ΔT Power (e.g., based on T_{AVG} = 572.0 ^oF) is conservative with respect to the Limiting Trip Setpoint of 121.597 % ΔT Power. The As Found Tolerance Value of 121.25 % ΔT Power is conservative with respect to the Allowable Value of 124.117 % ΔT Power. This As Found Tolerance Value of $\leq$ 121.25 % ΔT Power is based on maintaining a Nominal Trip Setpoint value of 118.25 % ΔT Power. Note that this analysis is based on static conditions such that dynamic components are not considered.

The statistical combination of the COT and NON COT error components from CSA Calculation C11865 (Ref. 5.94) with the appropriate modifications described in Section 3.2 for the OTΔT Reactor Trip are given below. The COT and NON COT error components are used in Figure 4.5.7 to determine the Nominal Trip Setpoint (NTSP), Allowable Value (AV), As Found Tolerance (AFT), and As Left Tolerance (ALT) for the most limiting condition.

<u>OTΔT Reactor Trip with no FΔI</u>

$\text{NON COT}_{error} = SE_1 + SE_2 + SE_{3a} \pm [PMA_3^2 + PMA_4^2 + PMA_5^2 + PMA_6^2 + PMA_7^2 + PEA^2 + (CSA_{3\ NON\ COT})^2 + (CSA_{4\ NON\ COT})^2 + (CSA_{5\ NON\ COT})^2 + (CSA_{6\ NON\ COT})^2 + M7MTE^2 + M18MTE^2 + RTE_1^2 + RTE_2^2 + RTE_3^2]^{1/2}$

Where the following terms are taken from Calculation C11865 (Ref. 5.94):

$CSA_{3\ NON\ COT} = [(CSA_1\ NON\ COT)^2 + (CSA_2\ NON\ COT)^2 + (M3MTE)^2]^{1/2}$

$CSA_{3\ NON\ COT} = (0.548^2 + 0.548^2 + 0.173^2)^{1/2} = 0.794$ % of ΔT span

$CSA_{4\ NON\ COT} = [(CSA_1\ NON\ COT * 0.667)^2 + (CSA_2\ NON\ COT * 0.667)^2 + (M4MTE)^2\ ]^{1/2}$

$CSA_{4\ NON\ COT} = [(0.548 * 0.667)^2 + (0.548 * 0.667)^2 + 0.245^2)^{1/2} = 0.572$ % of ΔT span

$CSA_{5\ NON\ COT} = (PEA^2 + (SCA_3 + SMTE_3)^2 + SD_3^2 + SPE_3^2 + STE_3^2 + SPSE_3^2 + M10MTE^2)^{1/2}$

$CSA_{5\ NON\ COT} = (0.0^2 + (0.096 + 0.150)^2 + 0.288^2 + 0.0^2 + 0.883^2 + 0.061^2 + 0.0^2)^{1/2} = 0.963$ % of ΔT span

$CSA_{6a\ NON\ COT} = (M15MTE^2 + M16MTE^2)^{1/2}$

$CSA_{6a\ NON\ COT} = (0.346^2 + 0.200^2)^{1/2} = 0.400$ % of ΔT span

Thus, the total NON COT_{error} is equal to:

$NON\ COT_{error} = 0.267 + 0.722 + 0.867 \pm [0.0^2 + 0.0^2 + 0.0^2 + 0.0^2 + 1.133^2 + 0.0^2 + 0.794^2 + 0.572^2 + 0.963^2 + 0.400^2 + 0.374^2 + 0.224^2 + 0.5^2 + 0.5^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm 3.922$ % of span = $\pm$ 5.883 % ΔT Power

$COT_{error} = (CSA_{3\ COT}^2 + CSA_{4\ COT}^2 + CSA_{5\ COT}^2 + CSA_{6a\ COT}^2 + M7^2 + M18^2 + RD_1^2 + RD_2^2 + RD_3^2)^{1/2}$

Where the following terms are taken from Calculation C11865 (Ref. 5.94):

$CSA_{3\ COT} = [(CSA_1\ COT)^2 + (CSA_2\ COT)^2 + (M3)^2\ ]^{1/2}$

$CSA_{3\ COT} = (0.417^2 + 0.417^2 + 0.707^2)^{1/2} = 0.921$ % of ΔT span

$CSA_{4\ COT} = [(CSA_1\ COT * 0.667)^2 + (CSA_2\ COT * 0.667)^2 + M4^2]^{1/2}$

$CSA_{4\ Cot} = [(0.417 * 0.667)^2 + (0.417 * 0.667)^2 + 0.707^2)^{1/2} = 0.809$ % of ΔT span

$CSA_{5\ COT} = M10$

$CSA_{5\ COT} = 0.0 = 0.0$ % of ΔT span

$CSA_{6a\ COT} = [(M15MTE)^2 + (M16MTE)^2]^{1/2}$

$CSA_{6a\ COT} = (0.500^2 + 0.500^2)^{1/2} = 0.707$% of ΔT span

Thus, the COT_{error} is equal to:

$COT_{error} = (0.921^2 + 0.809^2 + 0.0^2 + 0.707^2 + 0.5^2 + 0.5^2 + 1.0^2 + 1.0^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 2.346 % of ΔT span = $\pm$ 3.519 % ΔT Power (The calculated COT error will be conservatively rounded back to $\pm$ 2.0 % of ΔT span = $\pm$ 3.0 % ΔT Power for the As Found Tolerance)

Static As Found Tolerance (AFT) = Computed Setpoint $\pm$ 3.0 % ΔT Power
Static As Left Tolerance (ALT) = Computed Setpoint $\pm$ 2.4 % ΔT Power (1)

(1) ALT = $\pm (COTerror^2 - RD_1^2 - RD_2^2 - RD_3^2)^{1/2} = \pm (2.346^2 - 1.0^2 - 1.0^2 - 1.0^2)^{1/2}$
ALT = $\pm$ 1.582 % of ΔT span = $\pm$ 2.373 % ΔT Power (round to $\pm$ 2.4 % ΔT Power)

KEWAUNEE'S OVERTEMPERATURE DELTA T REACTOR TRIP

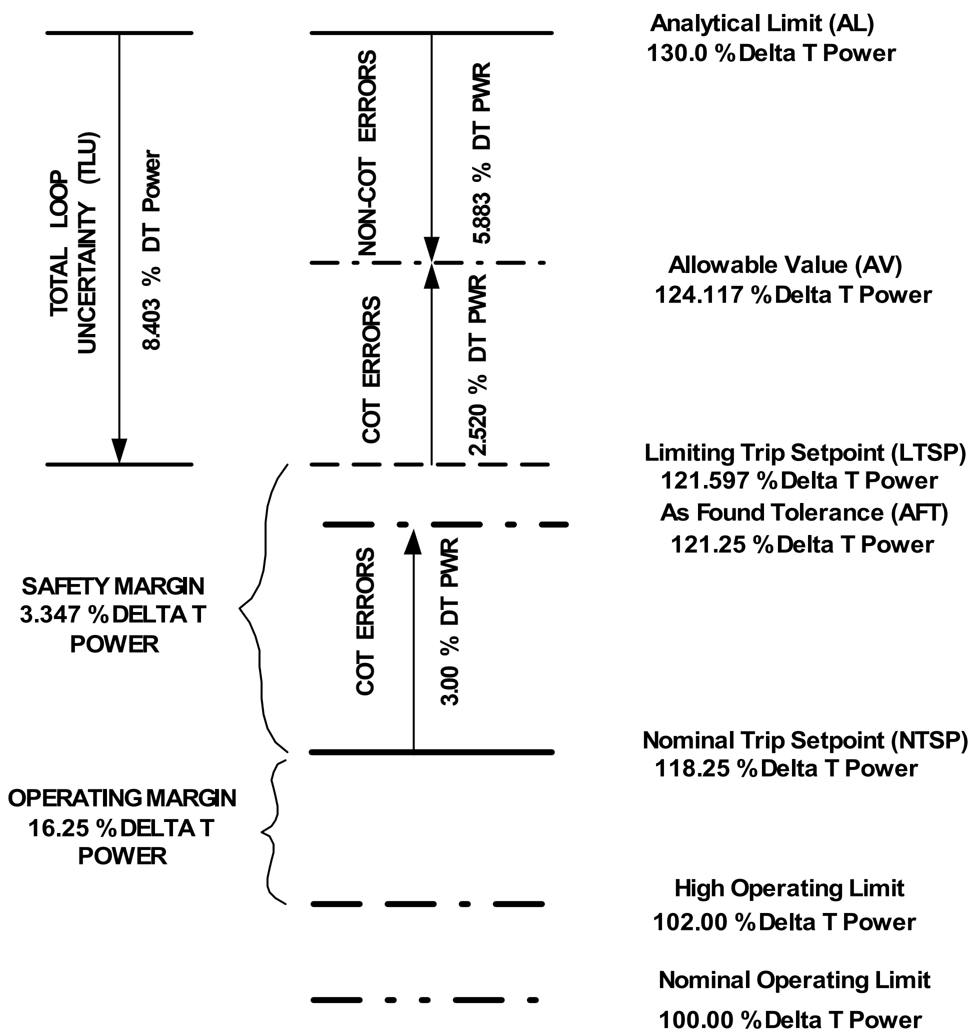

Figure 4.5.7

4.5.8 Overpower ΔT Reactor Trip

As Found Tolerance: See below (Refs. 5.1, 5.90, 5.94, and 5.105)

" The channel's maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 1.546 % of the ΔT span " (Note that 1.525 % of the ΔT span is equal to 2.288 % ΔT Power)

The Overpower ΔT Reactor Trip Setpoint is variable and is constantly calculated based on actual plant conditions. For this reason, the Allowable Value cannot be expressed as a constant. The Overpower ΔT Reactor Trip is a backup reactor trip function and is not credited in the USAR Chapter 14 Safety Analysis (Ref. 5.1). The As Found Tolerance of ± 1.525 % of ΔT span = ± 2.288 % ΔT Power(1) is based on the COT error components from CSA Calculation (Ref. 5.94). The As Left Tolerance is based on the As Found Tolerance minus Rack Drift.

Static As Found Tolerance (AFT) = Computed Setpoint ± 2.288 % ΔT Power(1)
Static As Left Tolerance (ALT) = Computed Setpoint ± 1.724 % ΔT Power (2)

---

(1) The Overpower ΔT Reactor Trip COT error is taken from Calculation C11865 (Ref. 5.94).

$AFT = \pm (M_1^2 + M_2^2 + M_3^2 + M_4^2 + M_5^2 + M_6^2 + M_{17}^2 + RD_1^2 + RD_2^2)^{1/2}$
$AFT = \pm (0.417^2 + 0.417^2 + 0.707^2 + (0.707 * 0.667)^2 + 0.034^2 + 0.034^2 + 0.5^2 + 1.0^2 + (1.0 * 0.069)^2)^{1/2}$
AFT = ± 1.525 % of ΔT span = ± 2.288 % ΔT Power

(2) $ALT = \pm (COTerror^2 - RD_1^2 - RD_2^2)^{1/2} = \pm (1.525^2 - 1.0^2 - 0.069^2)^{1/2}$
ALT = ± 1.149 % of ΔT span = ± 1.724 % ΔT Power

4.5.9 Pressurizer Low Pressure Reactor Trip

As Found Tolerance: 1904 PSIG ± 10.0 PSIG (Refs. 5.1, 5.90, 5.93, and 5.105)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 1858.82 PSIG. Adding the NON COT error components to the Analytical Limit yields an Allowable Value (AV) of 1855.94 PSIG. The Actual Nominal Trip Setpoint of 1904 PSIG is conservative with respect to the Limiting Trip Setpoint. The current Custom Technical Specification (CTS) LSSS value of ≥ 1875 PSIG is conservative with respect to the Allowable Value. The current Custom Technical Specification (CTS) LSSS value of ≥ 1875 PSIG is non-conservative based on the calculated COT error components determined in Calculation C10818 (Ref. 5.93). The LSSS value of ≥ 1875 PSIG will be changed to an As Found Tolerance value of ≥ 1894 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. This As Found Tolerance is based on a Nominal Trip Setpoint value of 1904.0 PSIG. The Nominal Trip Setpoint value of 1904 PSIG will allow a 10.0 PSIG margin to be used for the COT error components. The As Found Tolerance value of ≥ 1894 PSIG is sufficiently close enough to the calculated value using the CSA rack error terms from Calculation C10818 (Ref. 5.93).

The calculated As Found Tolerance for this function is ≥ 1894.20 PSIG. The 0.20 PSIG offset is accommodated in the 45.18 PSIG Safety Margin for this trip as illustrated in Figure 4.5.9.

The statistical combination of the COT and NON COT error components from CSA Calculation C10818 (Ref. 5.93) are given below. The COT and NON COT error components are used in Figure 4.5.9 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$NON\ COT_{error} = SE \pm [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + M3MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.0^2 + (0.250 + 0.391)^2 + 0.75^2 + 0.0^2 + 2.300^2 + 0.158^2 + 0.0^2 + 0.200^2 + 0.283^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 2.580 % of span = $\pm$ 20.64 PSIG

$COT_{error} = \pm (M1^2 + M2^2 + M3^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.225 % of span = $\pm$ 9.80 PSIG (round to $\pm$ 10 PSIG)

As Found Tolerance (AFT) = 1904 PSIG ± 10.0 PSIG
As Left Tolerance (ALT) = 1904 PSIG ± 5.7 PSIG(1)

See Figure 4.5.9 for specific details.

(1) ALT = $\pm (COTerror^2 - RD^2)^{1/2} = \pm (1.225^2 - 1.0^2)^{1/2} = \pm$ 0.71 % of span = $\pm$ 5.7 PSIG

KEWAUNEE'S PRESSURIZER LOW PRESSURE REACTOR TRIP

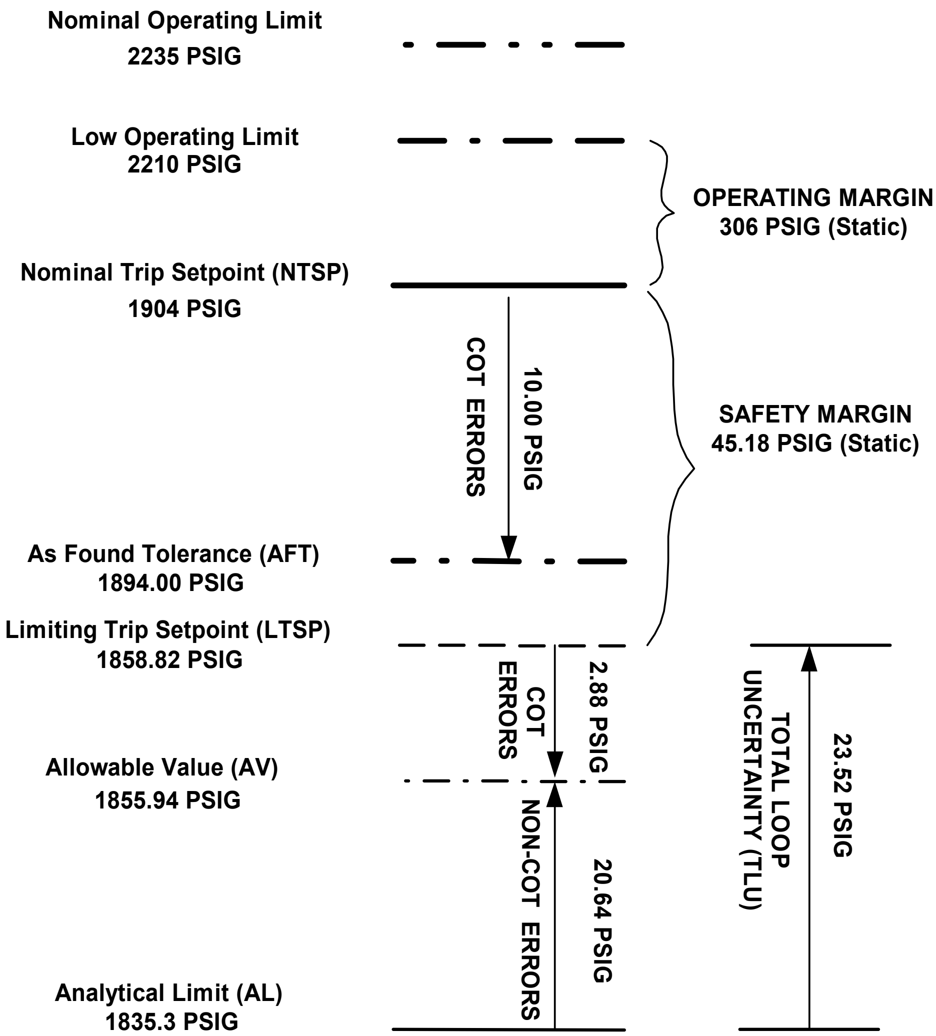

Figure 4.5.9

4.5.10 Pressurizer High Pressure Reactor Trip

As Found Tolerance: 2377 PSIG ± 9.0 PSIG (Refs. 5.1, 5.90, 5.93, and 5.105)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 2387.64 PSIG. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 2389.78 PSIG. The Actual Nominal Trip Setpoint of 2377 PSIG is conservative with respect to the Limiting Trip Setpoint. The current Custom Technical Specification (CTS) LSSS value ≤ 2385 PSIG is conservative with respect to the Allowable Value. The CTS LSSS value ≤ 2385 PSIG will be revised to an As Found Tolerance Value of ≤ 2386 PSIG based on the COT error components calculated below. The revised As Found Tolerance Value of ≤ 2386 PSIG is also conservative with respect to the Allowable Value, however it is slightly non-conservative with respect to the calculated value using the CSA rack error components from Calculation C10818 (Ref 5.93). The calculated As Found Tolerance Value for this function is ≤ 2385.94 PSIG. The 0.06 PSIG offset from the calculated value is accommodated within the Safety Margin for this function (i.e., 10.64 PSIG). The As Found Tolerance value of ≤ 2386 PSIG is based on the Nominal Trip Setpoint value of 2377.0 PSIG.

The statistical combination of the COT and NON COT error components from CSA Calculation C10818 (Ref. 5.93) are given below. The COT and NON COT error components are used in Figure 4.5.10 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$\text{NON COT}_{error} = \text{SE} \pm [\text{PMA}^2 + \text{PEA}^2 + (\text{SCA+SMTE})^2 + \text{SD}^2 + \text{SPE}^2 + \text{STE}^2 + \text{SPSE}^2 + \text{M1MTE}^2 + \text{M2MTE}^2 + \text{RTE}^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + (0.250 + 0.391)^2 + 0.75^2 + 0.0^2 + 2.300^2 + 0.158^2 + 0.0^2 + 0.200^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = \pm$ 2.565 % of span = ± 20.52 PSIG

$\text{COT}_{error} = \pm (\text{M1}^2 + \text{M2}^2 + \text{RD}^2)^{1/2}$

$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.118 % of span = ± 8.944 PSIG (round to ± 9.0 PSIG)

As Found Tolerance (AFT) = 2377 PSIG ± 9.0 PSIG
As Left Tolerance (ALT) = 2377 PSIG ± 4.0 PSIG[(1)]

See Figure 4.5.10 for specific details.

---

(1) ALT = ± M2 = ± 0.5 % of span = ± 4.0 PSIG

KEWAUNEE'S PRESSURIZER HIGH PRESSURE REACTOR TRIP

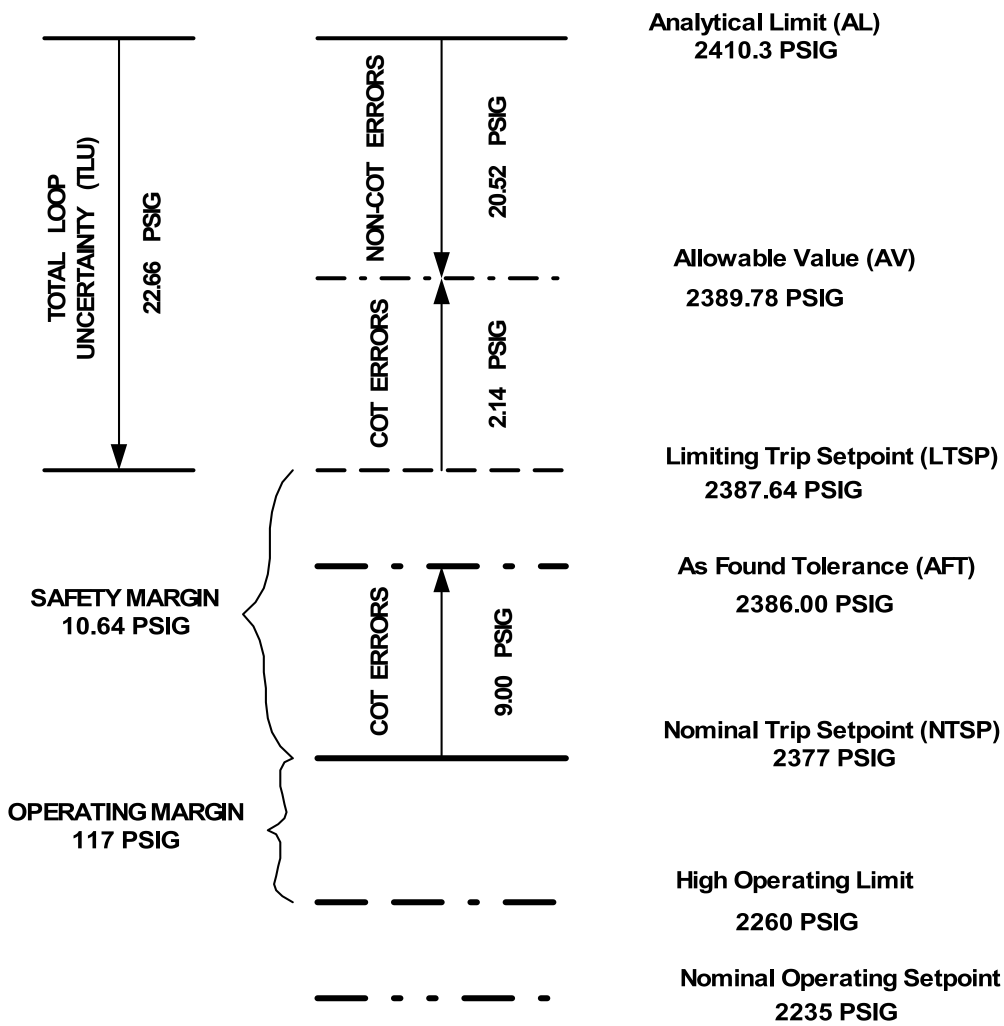

Figure 4.5.10

4.5.11 Reactor Coolant Flow Low Reactor Trip (Normalized)

Allowable Value: As Found Tolerance = 93% Flow $\pm$ 1.1% Flow
(Refs. 5.1, 5.90, 5.96, 5.106, and 5.120)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 90.52 % Flow. Adding the NON COT error components to the Analytical Limit yields an Allowable Value (AV) of 90.27 % Flow. The current Nominal Trip Setpoint of 93.0 % Flow is conservative with respect to the Limiting Trip Setpoint and the current Custom Technical Specification (CTS) LSSS value of $\geq$ 90.0 % Flow is non conservative with respect to the Allowable Value. The CTS LSSS value $\geq$ 90.0 % Flow will be changed to an As Found Tolerance value of $\geq$ 91.9 % Flow based on the calculated value using the CSA rack error terms from Calculation C10819 (Ref 5.96). The As Found Tolerance of $\geq$ 91.9 % Flow is conservative and conforms to the methodology described in TSFT-493, Rev. 4 and RIS 2006-17.

The calculated As Found Tolerance Value for this function is $\geq$ 91.853 % Flow. The 0.047 % Flow offset will be negated resulting in a conservative As Found Tolerance value of $\geq$ 91.9 % Flow for this trip as illustrated in Figure 4.5.11.

The statistical combination of the COT and NON COT error components from CSA Calculation C10819 (Ref. 5.96) are given below. The COT and NON COT error components are used in Figure 4.5.11 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

NON COT_{error} (ΔP span) = $[(SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M2MTE^2]^{1/2}$

NON COT_{error} (ΔP span) = $[(0.250 + 0.110)^2 + 0.50^2 + 0.0^2 + 0.713^2 + 0.110^2 + 0.200^2]^{1/2}$

NON COT_{error} (ΔP span) = $\pm$ 0.970 % of ΔP span = $\pm$ 0.574 % of Flow span @ 93 % Flow(1)

NON COT_{error} (Flow span) = SE $\pm$ $(PMA^2 + PEA^2 + RTE^2)^{1/2}$

NON COT_{error} (Flow span) = 0.372 $\pm$ $(2.455^2 + 0.455^2 + 0.5^2)^{1/2}$

NON COT_{error} (Flow span) = 2.918 % of Flow span

TOTAL NON COT_{error} (Flow span) = $(2.918^2 + 0.574^2)^{1/2}$ = 2.974 % of Flow span = 3.271 % Flow @ 93.0 % Flow (e.g., the Nominal Trip Setpoint).

COT_{error} (ΔP span) = $\pm$ M2

COT_{error} (ΔP span) = $\pm$ 0.50 % of ΔP span

COT_{error} (ΔP span) = $\pm$ 0.50 % of ΔP span = $\pm$ 0.296 % of Flow span @ 93 % Flow = $\pm$ 0.326 % Flow(1)

COT_{error} (Flow span) = RD = $\pm$ 1.0 % of Flow span = $\pm$ 1.10 % Flow

TOTAL COT_{error} (Flow span) = $(0.296^2 + 1.0^2)^{1/2}$ = 1.043 % of Flow span = 1.147 % Flow @ 93.0 % Flow (e.g., the Nominal Trip Setpoint) [1]

As Found Tolerance (AFT) = 93% Flow ± 1.1% Flow[1]
As Left Tolerance (ALT) = 93% Flow ± 0.55% Flow[2]

See Figure 4.5.11 for specific details.

KEWAUNEE'S REACTOR COOLANT LOW FLOW REACTOR TRIP

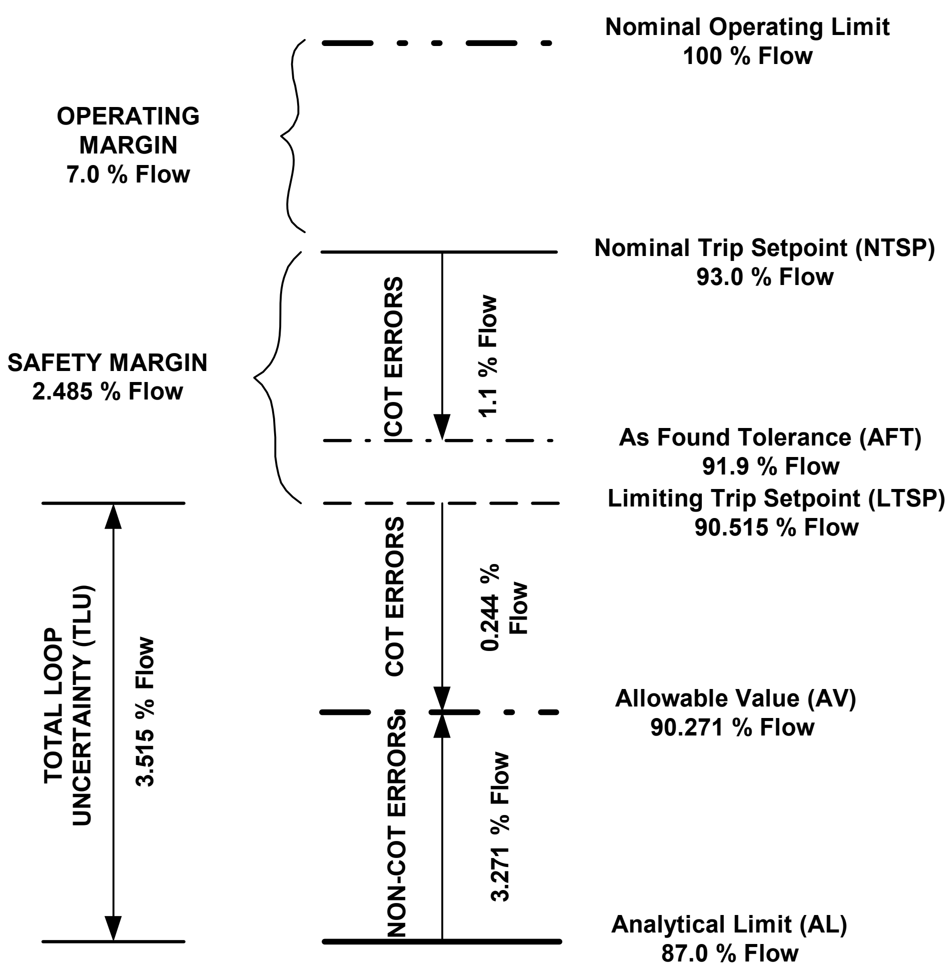

Figure 4.5.11

(1) The equation to convert % ΔP error to % Flow error is: % flow span = (ΔP uncertainty) * 0.5 * (flow max / flow x) (Ref. 5.120)
(2) The calculated As Left Tolerance is ± 0.296 % of Flow Span. This tolerance is too restrictive and will be set at ± 0.5 % of Flow Span (i.e., like all other Bistable tolerances). The + 0.204 % of Flow Span offset is accommodated in the Safety Margin of 2.485 % Flow = 2.259 % of Flow Span.

4.5.12 Reactor Coolant Pump Undervoltage

As Found Tolerance: 76.667 ± 0.885 % of normal voltage = 92 ± 1.06 VAC (Refs. 5.1, 5.90, 5.127, and 5.128)

The current Custom Technical Specification (CTS) LSSS for this function is ≥ 75 % of normal voltage. The current Nominal Trip Setpoint for this function is 91 to 93 VAC where 92 VAC is the centerline voltage = 76.667 % of voltage span (Ref. 5.127). This analysis assumes that 120 VAC from the potential transformer is equal to 100 % of bus voltage/normal voltage which is equal to 4160 VAC. The Reactor Coolant Pump Undervoltage Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) Calculation has been performed for this function. The calibration accuracy for this trip function is 92 ± 1.0 VAC = 76.667 ± 0.833 % of normal voltage (Ref. 5.127). The COT error from Calculation C11891 is ± 1.06 VAC = ± 0.885 % of normal voltage. Therefore, the As Found Tolerance for the Reactor Coolant Pump Undervoltage Trip is 76.667 ± 0.885 % of normal voltage = 92 ± 1.06 VAC based on device calibration accuracy and drift from Reference 5.128. The As Left Tolerance for the Reactor Coolant Pump Undervoltage Trip is 76.667 ± 0.833 % of normal voltage = 92 ± 1.0 VAC based on the device calibration accuracy from Reference 5.127. The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value 92 VAC = 76.667 % of normal voltage.

As Found Tolerance (AFT) = 76.667 ± 0.885 % of normal voltage = 92 ± 1.06 VAC(1)
As Left Tolerance (ALT) = 76.667 ± 0.833 % of normal voltage = 92 ± 1.0 VAC(2)

---

(1) AFT = $\pm (SCA^2 + SD^2)^{1/2} = \pm (0.833^2 + 0.300^2)^{1/2} = \pm 0.885$ % of normal voltage = ± 1.06 VAC
(2) ALT = ± SCA = ± 0.833 % of normal voltage = ± 1.0 VAC

4.5.13 Reactor Coolant Pump Underfrequency

As Found Tolerance: 57 ± 0.3 Hz (Refs. 5.1, 5.90, 5.126, and 5.127)

The current Custom Technical Specification (CTS) LSSS for this function is ≥ 55.0 Hz. The current Nominal Trip Setpoint for this function is 57 ± 0.1 Hz (Ref. 5.127). The Reactor Coolant Pump Underfrequency Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) Calculation has been performed for this function. Based on Calculation C11890 (Ref. 5.126), the COT error allowance for this function is ± 0.3 Hz. The calibration accuracy for this trip function is ± 0.1 Hz (Ref. 5.127). The As Found Tolerance of 57 ± 0.3 Hz is based on the COT error from Calculation C11890 and the As Left Tolerance of 57 ± 0.1 Hz is conservatively based on device calibration accuracy from Reference 5.127. The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value of 57 Hz.

As Found Tolerance (AFT) = 57 ± 0.3 Hz(1) (3)
As Left Tolerance (ALT) = 57 ± 0.1 Hz(2)

---

(1) AFT = $\pm (SCA^2 + SD^2)^{1/2} = \pm (6.66^2 + 0.667^2)^{1/2} = \pm 6.69$ % of frequency span or (6.69% /100%) x 4.5 Hz(3) = ± 0.3 Hz
(2) ALT = Current Calibration Accuracy from Reference 5.127 = ± 0.1 Hz
(3) The frequency span of 4.5 Hz is taken from Calculation C11890 (Ref. 5.126).

4.5.14 Pressurizer High Level Reactor Trip

As Found Tolerance: 85.0 % Level ± 1.12 % Level (Refs. 5.1, 5.90, 5.92, and 5.109)

The current Custom Technical Specification (CTS) LSSS for this function is ≤ 90.0 % Level. The current Nominal Trip Setpoint for this function is 85.0 % Level (Ref. 5.109). The Pressurizer High Level Reactor Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) Calculation has been performed for this function. Based on Calculation C10982 (Ref. 5.92), the COT error allowance for this function is ± 1.118 % of span = ± 1.118 % Level. The calibration accuracy for this trip function is ± 0.5 % of span = ± 0.5 % Level (Ref. 5.109). The As Found Tolerance based on the COT error from Calculation C10982 is 85 ± 1.118 % Level (round to 85 ± 1.12 % Level). The As Left Tolerance is 85 ± 0.5 % Level is based on device calibration accuracy from Reference 5.109. The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value of 85 % Level.

As Found Tolerance (AFT) = 85.0 % Level ± 1.12 % Level(1)
As Left Tolerance (ALT) = 85.0 % Level ± 0.5 % Level(2)

---

(1) AFT = $\pm (M2^2 + RD^2)^{1/2} = \pm (0.5^2 + 1.0^2)^{1/2}$ = ± 1.118 % span = ± 1.118 % Level
(2) ALT = ± M2 = ± 0.5 % span = ± 0.5 % Level

4.5.15 Steam Generator Water Level Low Low Reactor Trip / Auxiliary Feedwater Initiation

As Found Tolerance: 17.0 % Level ± 1.12 % Level (Refs. 5.1, 5.90, 5.97, 5.112, and 5.134)

Note: The Analytical Limit for this function is 0.0 % NR Level (Ref. 5.1). The Channel Statistical Allowance (CSA) for this function has a large negative Process Measurement Accuracy (PMA) bias term which results in a negative CSA value. For conservatism, the absolute value of the larger CSA value from Reference 5.97 will be used in this analysis.

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 4.496 % NR Level. Adding the NON COT error components to the Analytical Limit yields an Allowable Value (AV) of 4.087 % NR Level. The Actual Nominal Trip Setpoint of 17.0 % NR Level (Ref. 5.112) is conservative with respect to the Limiting Trip Setpoint and the current Custom Technical Specification (CTS) LSSS value of ≥ 5.0 % NR Level is conservative with respect to the Allowable Value. The CTS LSSS value of ≥ 5.0 % NR Level is non-conservative based on the calculated COT error components determined in Calculation C11116 (Ref. 5.97). The CTS LSSS value of ≥ 5.0 % NR Level will be changed to an As Found Tolerance value of ≥ 15.88 % NR Level to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. The As Found Tolerance Value of ≥ 15.88 % NR Level is based on maintaining a Nominal Trip Setpoint value of 17.0 % NR Level.

The statistical combination of the COT and NON COT error components from CSA Calculation C11116 (Ref. 5.97) are given below. The COT and NON COT error components are used in Figure 4.5.15 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$NON\ COT_{error} = PMA_2 \pm (PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE + M1MTE^2 + M3MTE^2 + RTE^2)^{1/2}$

$NON\ COT_{error} = 2.518 \pm [0.0^2 + (0.250+0.217)^2 + 0.280^2 + 0.577^2 + 1.241^2 + 0.060^2 + 0^2 + 0.200^2 + 0.5^2]^{1/2}$

$NON\ COT_{error}$ = + 4.087 % of span = + 4.087 % NR Level (worst case).

$COT_{error} = \pm (M1^2 + M3^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{½}$

COT_{error} = ± 1.118 % of span = ± 1.118 % NR Level (round to ± 1.12 % NR Level)

As Found Tolerance (AFT) = 17.0 % Level ± 1.12 % Level(1)
As Left Tolerance (ALT) = 17.0 % Level ± 0.5 % Level(2)

See Figure 4.5.15 for specific details.

---

(1) AFT = $\pm (M3^2 + RD^2)^{½} = \pm (0.5^2 + 1.0^2)^{½}$ = ± 1.118 % span = ± 1.118 % Level (round to ± 1.12 % NR Level)
(2) ALT = ± M3 = ± 0.5 % span = ± 0.5 % Level

KEWAUNEE'S STEAM GENERATOR LO-LO LEVEL REACTOR TRIP

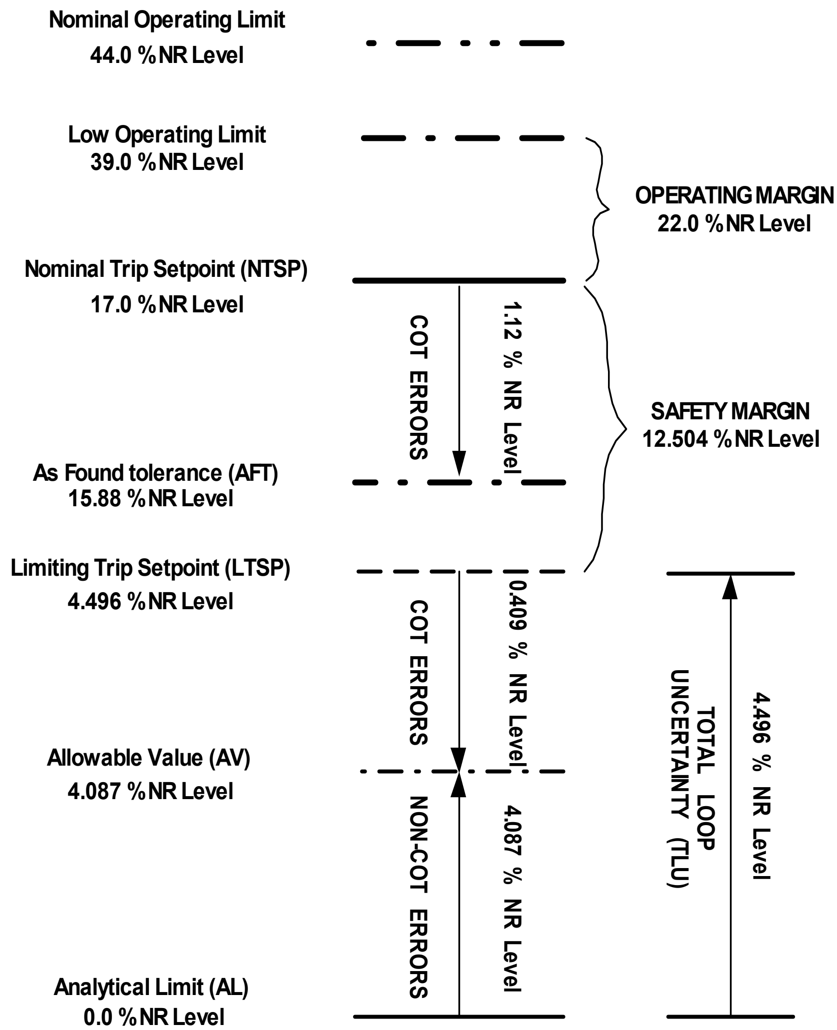

Figure 4.5.15

4.5.16 Steam Generator Water Level Low Coincident Reactor Trip

As Found Tolerance: 25.5 % Level ± 1.12 % NR Level (Refs. 5.1, 5.90, 5.97, and 5.112)

The Steam Generator Water Level Low Coincident Reactor Trip is not addressed in the current version of Kewaunee's Custom Technical Specifications (CTS). This function will now be included in the Setpoint Control Program based on the requirements of ITS Table 3.3.1-1, item 15. The current Nominal Trip Setpoint for this function is 25.5 % NR Level (Ref. 5.112). The Steam Generator Water Level Low Coincident Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) Calculation has been performed for this function. Based on Calculation C11116 (Ref. 5.97), the COT error allowance for this function is ± 1.118 % of span = ± 1.118 % NR Level. The calibration accuracy for this trip function is ± 0.5 % of span = ± 0.5 % Level (Ref. 5.112). The As Found Tolerance based on the COT error from Calculation C11116 is 25.5 ± 1.118 % NR Level (round to 25.5 ± 1.12 % NR Level). The As Left Tolerance is 25.5 ± 0.5 % NR Level is based on the device calibration accuracy from Reference 5.112. The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value of 25.5 % NR Level.

As Found Tolerance (AFT) = 25.5 % Level ± 1.12 % NR Level(1)
As Left Tolerance (ALT) = 25.5 % Level ± 0.5 % NR Level(2)

---

(1) AFT = $\pm (M2^2 + RD^2)^{1/2} = \pm (0.5^2 + 1.0^2)^{1/2}$ = ± 1.118 % span = ± 1.118 % NR Level
(2) ALT = ± M2 = ± 0.5 % span = ± 0.5 % NR Level

4.5.17 Steam Flow Feed Flow Mismatch Coincident Reactor Trip

As Found Tolerance: 0.87 * 10^6 PPH ± 0.063 * 10^6 PPH (Refs. 5.1, 5.90, 5.98, 5.108, and 5.130)

The Steam Flow Feed Flow Mismatch Coincident Reactor Trip is not addressed in the current version of Kewaunee's Custom Technical Specifications (CTS). This function will now be included in the Setpoint Control Program based on the requirements of ITS Table 3.3.1-1, item 15. The current Nominal Trip Setpoint for this function is 0.87 * 10^6 Pound Per Hour (PPH) (Ref. 5.108). Based on Reference 5.108, the maximum Steam and Feedwater flowrate is 4.47 * 10^6 PPH and the nominal flowrate at 100 % power (i.e., $Flow_{nom}$) is ≈ 3.82 * 10^6 PPH (Ref. 5.98). This means that the current Nominal Trip Setpoint is set at 22.77 % of $Flow_{nom}$. The Steam Flow Feed Flow Mismatch Coincident Reactor Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1) and a Channel Statistical Allowance (CSA) Calculation has not been performed for this function. The COT error allowance for this function will be based on the applicable module calibration accuracies given in Reference 5.108 and the standard ± 1.0 % of span Rack Drift (RD) value from Reference 5.5. Based on References 5.108 and 5.130, there are four modules with calibration accuracies that develop this trip function. The COT error allowance based on References 5.5 and 5.108 is ± 1.414 % of Flow Span = ± 0.063 * 10^6 PPH (1). The As Found Tolerance based on References 5.5, 5.108, and 5.130 is 0.87 * 10^6 PPH ± 0.063 * 10^6 PPH. The As Left Tolerance based on calibration accuracy of the four devices from Reference 5.108 is 0.87 * 10^6 PPH ± 0.045 * 10^6 PPH. The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value of 0.87 * 10^6 PPH.

As Found Tolerance (AFT) = 0.87 * 10^6 PPH ± 0.063 * 10^6 PPH (1)
As Left Tolerance (ALT) = 0.87 * 10^6 PPH ± 0.045 * 10^6 PPH (2)

---

(1) AFT = ± $(FM\text{-}466A^2 + FC\text{-}466B/C^2 + FM\text{-}464A^2 + FM\text{-}464B^2 + RD^2)^{1/2}$
AFT = ± $(0.5^2 + 0.5^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$ = ± 1.414 % of Flow Span = ± 0.063 * 10^6 PPH
(2) ALT = ± $(FM\text{-}466A^2 + FC\text{-}466B/C^2 + FM\text{-}464A^2 + FM\text{-}464B^2)^{1/2}$
ALT = ± $(0.5^2 + 0.5^2 + 0.5^2 + 0.5^2)^{1/2}$ = ± 1.00 % of Flow Span = ± 0.0447 * 10^6 PPH (round to ± 0.045 * 10^6 PPH)

4.5.18 Turbine Trip Low Fluid Oil Pressure

As Found Tolerance: 45.0 PSIG ± 0.5 PSIG (Refs. 5.1 and 5.144)

The current Custom Technical Specifications (CTS) does not address the Turbine Trip Low Fluid Oil Pressure function. Improved Technical Specifications (ITS) has added this function to ITS Table 3.3.1-1. Based on Reference 5.144, the current Nominal Trip Setpoint for Turbine Trip Low Fluid Oil Pressure is 45.0 PSIG (decreasing). The Turbine Trip Low Fluid Oil Pressure function is not credited in the Chapter 14 Safety Analysis (Ref. 5.1). Based on Reference 5.144, the calibration accuracy for the pressure switch is ± 0.5 PSIG. For this application, the As Found Tolerance and As Left Tolerance will be set at the same value, i.e., ± 0.5 PSIG.

As Found Tolerance (AFT) = 45.0 PSIG ± 0.5 PSIG
As Left Tolerance (ALT) = 45.0 PSIG ± 0.5 PSIG

---

(1) AFT = Calibration Procedure Setpoint = ± 0.5 PSIG (Reference 5.144)
(2) ALT = Calibration Procedure Setpoint = ± 0.5 PSIG (Reference 5.144)

Note: Reference 5.144 is applicable in CTS. The procedure is being converted for ITS and will become MA-KW-ISP-TB-001, Revsion 0, TB-Turbine Pressure Switches and Indicators Calibration.

4.5.19 Safety Injection (SI) Input from Engineered Safety Features Actuation System (ESFAS)

See Section 4.6.

Reactor Trip Permissives

Note : Only the limiting As Found Tolerance value will be addressed in analysis for each Reactor Trip Permissive described below.

4.5.20 Permissive P-6, Intermediate Range Neutron Flux

As Found Tolerance: Permissive P-6 unblock should occur between 1 * 10^{-5}% Rated Power and 1.27 * 10^{-5}% Rated Power (Refs. 5.1, 5.90, and 5.116)

The current Custom Technical Specification (CTS) LSSS for this function is > 10^{-5}% Rated Power. The current Nominal Trip Setpoint for this function is set equal to the CTS LSSS value, i.e., 1 * 10^{-5}% Rated Power. Permissive P-6 is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1) and a Channel Statistical Allowance (CSA) calculation has not been performed for this function. The COT error allowance for this function will be based on a portion of the calibration accuracy for the Intermediate Range Front Panel Meter at the nominal unblock trip setpoint value of 1 * 10^{-5}% Rated Power, i.e., 7.9 * 10^{-6}% Rated Power to 1.27 * 10^{-5}% Rated Power as specified in Reference 5.116. Only the high end of the tolerance value will be used to develop the As Found Tolerance for this function such that the current CTS LSSS value of 10^{-5}% Rated Power will be the low end of the tolerance. The As Found Trip for Permissive P-6 should occur between 1 * 10^{-5}% Rated Power and 1.27 * 10^{-5}% Rated Power. Since this As Found Tolerance does not include a Rack Drift value, the As Left Tolerance will be equal to the As Found Tolerance.

As Found Tolerance (AFT) = Permissive P-6 unblock should occur between 1 * 10^{-5}% Rated Power and 1.27 * 10^{-5}% Rated Power
As Left Tolerance (ALT) = Permissive P-6 unblock should occur between 1 * 10^{-5}% Rated Power and 1.27 * 10^{-5}% Rated Power

4.5.21 Permissive P-7, Block Low Power Reactor Trips and Enable High Power Trips

P-10 As Found Tolerance (AFT) = 11.0 % RTP ± 1.2 % RTP
P-13 As Found Tolerance (AFT) = 8.8 % Turbine Load ± 1.25 % Turbine Load
(Refs. 5.1, 5.90, 5.91, 5.104, and 5.132)

The current Custom Technical Specification (CTS) LSSS for Permissive P-7 is ≤ 12.2 % of Rated Power for both inputs, i.e., P-10 and P-13. Permissive P-7 is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however, a Channel Statistical Allowance (CSA) Calculation has been performed for Permissive P-10. Permissive P-7 is made up of input signals from Turbine First Stage Pressure (P-13) and NIS Power Range (P-10). Signals to the P-7 and P-10 permissives are supplied from the same bistables in the NIS Power Range drawers. P-7 and P-10 will both enable and block functions from the "trip" and "reset" points of these bistables. The calibration procedure (Ref. 5.104) for the NIS Power Range P-10 unblock input into Permissive P-7 sets the Nominal Trip Setpoint at 11.0 % RTP (increasing). The current Nominal Trip Setpoint for the Turbine First Stage Pressure input to P-7, i.e., P-13 is 8.8 % of Turbine Load (e.g., based on a nominal Turbine First Stage Pressure value of 583.5 PSIG @ 100 % Power). The COT error associated with P-10 taken from Calculation C11705 (Ref. 5.91) is ± 1.085 % of span = ± 1.3 % RTP (round back to ± 1.2 % RTP)[(1)]. The COT error associated with P-13 is ± 1.12 % of span = ± 1.25 % Turbine Load based on the P-13 Bistable calibration accuracy from Reference 5.132 and the standard Rack Drift (RD) error value from Reference 5.5[3]. The As Found Tolerance for the P-10 input to P-7 is 11.0 ± 1.2 % RTP[1]. The As Left Tolerance for the P-10 input to P-7 is 11.0 ± 0.5 % RTP[2]. The As Found Tolerance for the P-13 input to P-7 is 8.8 ± 1.25 % Turbine Load[3]. The As Left Tolerance for the P-13 input to P-7 is 8.8 ± 0.56 % Turbine Load[4].

P-10 As Found Tolerance (AFT) = 11.0 % RTP ± 1.2 % RTP[1]
P-10 As Left Tolerance (ALT) = 11.0 % RTP ± 0.5 % RTP[2]
P-13 As Found Tolerance (AFT) = 8.8 % Turbine Load ± 1.25 % Turbine Load[3]
P-13 As Left Tolerance (ALT) = 8.8 % Turbine Load ± 0.56 % Turbine Load[4]

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(1) AFT = $\pm (M1^2 + M5^2 + RD^2)^{½} = \pm (0.05^2 + 0.417^2 + 1.0^2)^{½} = \pm$ 1.085 % of span = ± 1.3 % RTP. This COT error will be rounded back to ± 1.2 % RTP to conform to the current CTS LSSS of ≤ 12.2 % RTP (i.e., 11 % + 1.2 % is ≤ 12.2 %)
(2) ALT = $\pm (M1^2 + M5^2)^{½} = \pm (0.05^2 + 0.417^2)^{½} = \pm$ 0.42 % of span = ± 0.5 % RTP.
(3) AFT = $\pm (PC\text{-}466A^2 + RD^2)^{½} = \pm (0.5^2 + 1.0^2)^{½} = \pm$ 1.12 % of span. The range of the Turbine First Stage Pressure Transmitters is 0 to 650 PSIG and the nominal 100 % Power pressure is 583.5 PSIG. (1.12 %/100 %)*650 PSIG = 7.28 PSIG. Then, (7.28 PSIG/583.5 PSIG) * 100 % Turbine Load = 1.25 % Turbine Load.
(4) ALT = ± 0.5 % of span = (0.5 %/100 %)*650 PSIG = 3.25 PSIG. Then, (3.25 PSIG/583.5 PSIG) * 100 % Turbine Load = 0.56 % Turbine Load.

4.5.22 Permissive P-8, Power Range Neutron Flux

As Found Tolerance (AFT) = 9.5 % RTP ± 1.3 % RTP (Refs. 5.1, 5.90, 5.91, and 5.104)

The current Custom Technical Specification (CTS) LSSS for Permissive P-8 is < 10.0 % of Rated Power. The Nominal Trip Setpoint for the unblock portion of Permissive P-8 is 9.5 % RTP (Ref. 5.104). Permissive P-8 is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1) and a Channel Statistical Allowance (CSA) Calculation has not been performed for this function. However, CSA Calculation C11705 (Ref. 5.91) has identified the COT error components associated with Permissive P-10 which uses identical circuitry to that of Permissive P-8 to generate their respective functions. The COT error associated with Permissive P-10, taken from Calculation C11705 (Ref. 5.91), is ± 1.085 % of span = ± 1.3 % RTP[1]. This COT error is also applicable for Permissive P-8 and will be used to develop the As Found Tolerance. Based on a Nominal Trip Setpoint of 9.5 % RTP and a COT error of ± 1.3 % RTP, the As Found Tolerance for Permissive P-8 is 9.5 ± 1.3 % RTP. Note that the high end of the As Found Tolerance (i.e., 9.5 % RTP + 1.3 % RTP = 10.8 % RTP) is non-conservative with respect to the current CTS LSSS of < 10 % RTP, however this As Found tolerance is acceptable because there is no specific Analytical Limit associated with this permissive. The As Left Tolerance will be equal to the COT error minus Rack Drift (RD)[2]. The As Found and As Left Tolerance are based on maintaining a Nominal Trip Setpoint of 9.5 % RTP.

As Found Tolerance (AFT) = 9.5 % RTP ± 1.3 % RTP[1]
As Left Tolerance (ALT) = 9.5 % RTP ± 0.5 % RTP[2]

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(1) AFT = $\pm (M1^2 + M5^2 + RD^2)^{½} = \pm (0.05^2 + 0.417^2 + 1.0^2)^{½} = \pm$ 1.085 % of span = ± 1.3 % RTP.
(2) ALT = $\pm (M1^2 + M5^2)^{½} = \pm (0.05^2 + 0.417^2)^{½} = \pm$ 0.42 % of span = ± 0.5 % RTP.

Note: The error terms used above are from Calculation C11705 (Ref. 5.91) and they are used for Permissive P-10.

4.5.23 Permissive P-10, Power Range Neutron Flux Unblock Low Power Reactor Trips and Block High Power Trips

As Found Tolerance (AFT) = 9.0 % RTP ± 1.3 % RTP (Refs. 5.1, 5.90, 5.91, and 5.104)

The current Custom Technical Specification (CTS) LSSS for Permissive P-10 (i.e., unblock the low power trips) is ≥ 7.8 % of Rated Power. The calibration procedure (Ref. 5.104) for the NIS Power Range P-10 unblock of the low power trips sets the Nominal Trip Setpoint at 9.0 % RTP (decreasing). Permissive P-10 is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however, a Channel Statistical Allowance (CSA) Calculation has been performed for this function. Based on Reference 5.91, the COT error associated with P-10 is ± 1.085 % of span = ± 1.3 % RTP[(1)]. This COT error will be used to develop the As Found Tolerance for this function. Based on a Nominal Trip Setpoint of 9.0 % RTP and a COT error of ± 1.3 % RTP, the As Found Tolerance for Permissive P-10 is 9.0 ± 1.3 % RTP. Note that the low end of the As Found Tolerance (i.e., 9.0 % RTP - 1.3 % RTP = 7.7 % RTP) is non-conservative with respect to the current CTS LSSS of ≥ 7.8 % RTP, however this As Found tolerance is acceptable because there is no specific Analytical Limit associated with this permissive. The As Left Tolerance will be equal to the COT error minus Rack Drift (RD)[(2)]. The As Found and As Left Tolerance are based on maintaining a Nominal Trip Setpoint of 9.0 % RTP.

As Found Tolerance (AFT) = 9.0 % RTP ± 1.3 % RTP[(1)]
As Left Tolerance (ALT) = 9.0 % RTP ± 0.5 % RTP[(2)]

---

(1) AFT = $\pm (M1^2 + M5^2 + RD^2)^{1/2} = \pm (0.05^2 + 0.417^2 + 1.0^2)^{1/2} = \pm$ 1.085 % of span = ± 1.3 % RTP.
(2) ALT = $\pm (M1^2 + M5^2)^{1/2} = \pm (0.05^2 + 0.417^2)^{1/2} = \pm$ 0.42 % of span = ± 0.5 % RTP.

4.6 Limiting Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances for Kewaunee Engineered Safety Features Actuation System (ESFAS) Instrumentation to support the Setpoint Control Program

Note: Only the limiting As Found Tolerance value will be addressed in analysis for each ESFAS Trip Function described below.

4.6.1 Safety Injection, Manual Initiation

As Found Tolerance: There is no specific ESFAS Trip Setpoint associated with this function.

4.6.2 High Containment Pressure – Safety Injection

As Found Tolerance: **As Found Tolerance = 3.6 PSIG ± 0.335 PSIG (Refs. 5.1, 5.90, 5.95, 5.110, and 5.111)**

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 4.237 PSIG. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 4.328 PSIG. The current CTS Setting Limit for this function is ≤ 4.0 PSIG. The CTS Setting Limit for this function of ≤ 4.0 PSIG is conservative with respect to the Allowable Value, however it is non-conservative with respect to the calculated As Found Tolerance value of 3.6 PSIG ± 0.335 PSIG (i.e., 3.935 PSIG) . The Actual Nominal Trip Setpoint of 3.6 PSIG is conservative with respect to the Limiting Trip Setpoint. The CTS Setting Limit of ≤ 4.0 PSIG will be changed to an As Found Tolerance value of 3.6 PSIG ± 0.335 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17.

The statistical combination of the COT and NON COT error components from CSA Calculation C11006 (Ref. 5.95) are given below. The COT and NON COT error components are used in Figure 4.6.2 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$$\text{NON COT}_{error} = [PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.388)^2 + 0.375^2 + 0.0^2 + 1.950^2 + 0.0^2 + 0.0^2 + 0.200^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = \pm 2.241 \text{ \% of span} = \pm 0.672 \text{ PSIG}$$

$$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{½}$$

$$\text{COT}_{error} = \pm 1.118 \text{ \% of span} = \pm 0.335 \text{ PSIG}$$

As Found Tolerance (AFT) = 3.6 PSIG ± 0.335 PSIG
As Left Tolerance (ALT) = 3.6 PSIG ± 0.15 PSIG(1)

See Figure 4.6.2 for specific details.

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(1) ALT = ± M2 = ± 0.5 % of span = ± (0.5 % / 100 %) * 30 PSIG = ± 0.15 PSIG

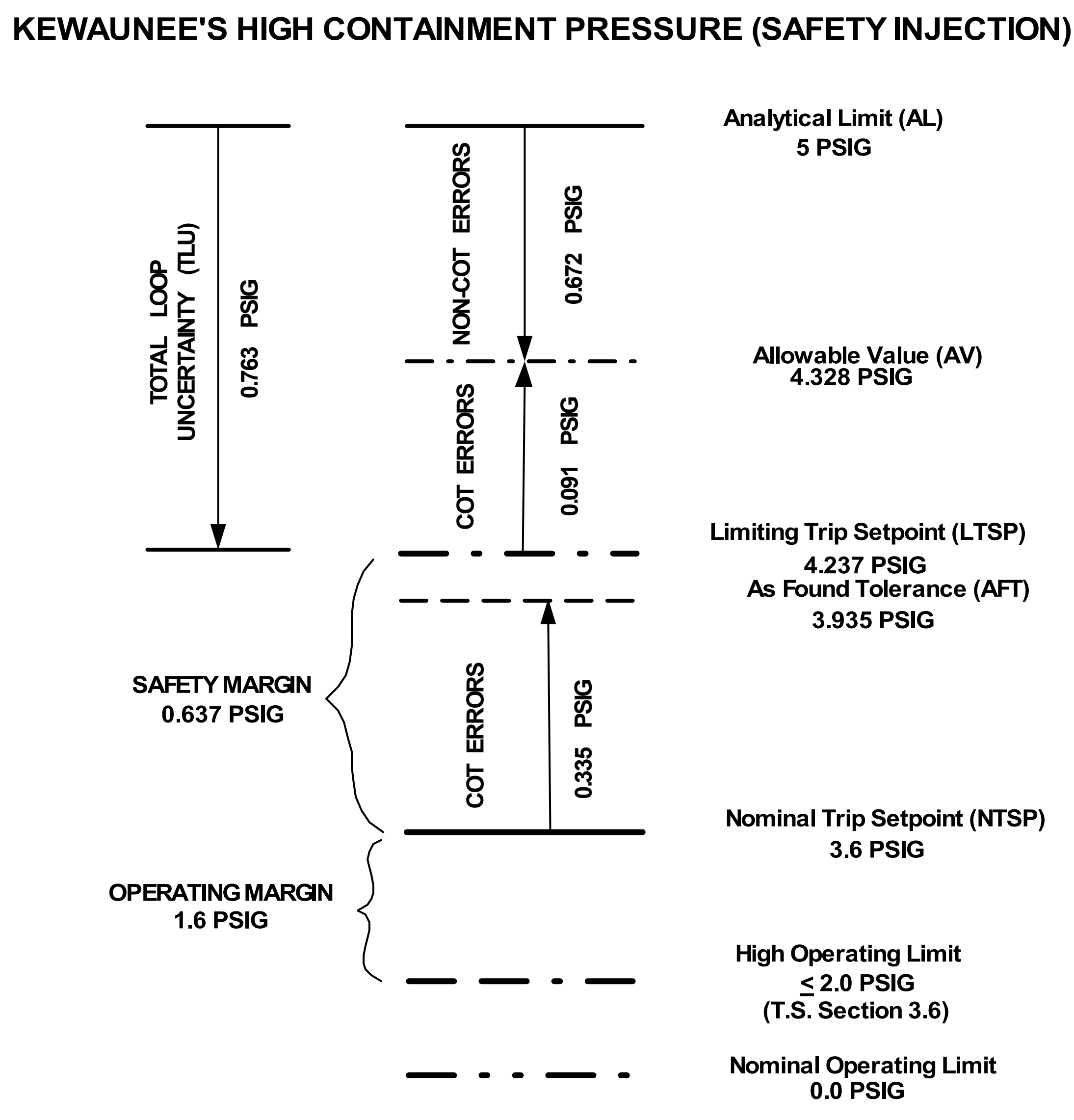

Figure 4.6.2

4.6.3 High - High Containment Pressure (Containment Spray)

As Found Tolerance: **As Found Tolerance = 21.0 PSIG ± 0.671 PSIG**
(Refs. 5.1, 5.90, 5.95, 5.110, and 5.111)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 21.622 PSIG. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 21.827 PSIG. The current CTS Setting Limit for this function is ≤ 23.0 PSIG. The CTS Setting Limit for this function of ≤ 23.0 PSIG is set equal to the Analytical Limit and is non-conservative with respect to the Allowable Value. In addition, the current CTS Setting Limit is also non-conservative with respect to the calculated As Found Tolerance value of 21.0 PSIG ± 0.671 PSIG (i.e., 21.671 PSIG). The Actual Nominal Trip Setpoint of 21.0 PSIG is conservative with respect to the Limiting Trip Setpoint. The CTS Setting Limit of ≤ 23.0 PSIG will be changed to an As Found Tolerance value of 21.0 PSIG ± 0.671 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17.

The statistical combination of the COT and NON COT error components from CSA Calculation C11006 (Ref. 5.95) are given below. The COT and NON COT error components are used in Figure 4.6.3 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$\text{NON COT}_{error} = (PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2)^{1/2}$

$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.261)^2 + 0.375^2 + 0.0^2 + 1.677^2 + 0.0^2 + 0.0^2 + 0.2^2 + 0.5^2)^{1/2}$

$\text{NON COT}_{error} = \pm$ 1.955 % of span = $\pm$ 1.173 PSIG

$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{½}$

$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.118 % of span = $\pm$ 0.671 PSIG

As Found Tolerance (AFT) = 21.0 PSIG ± 0.671 PSIG
As Left Tolerance (ALT) = 21.0 PSIG ± 0.300 PSIG(1)

See Figure 4.6.3 for specific details.

(1) ALT = ± M2 = ± 0.5 % of span = ± (0.5 % / 100 %) * 60 PSIG = ± 0.30 PSIG

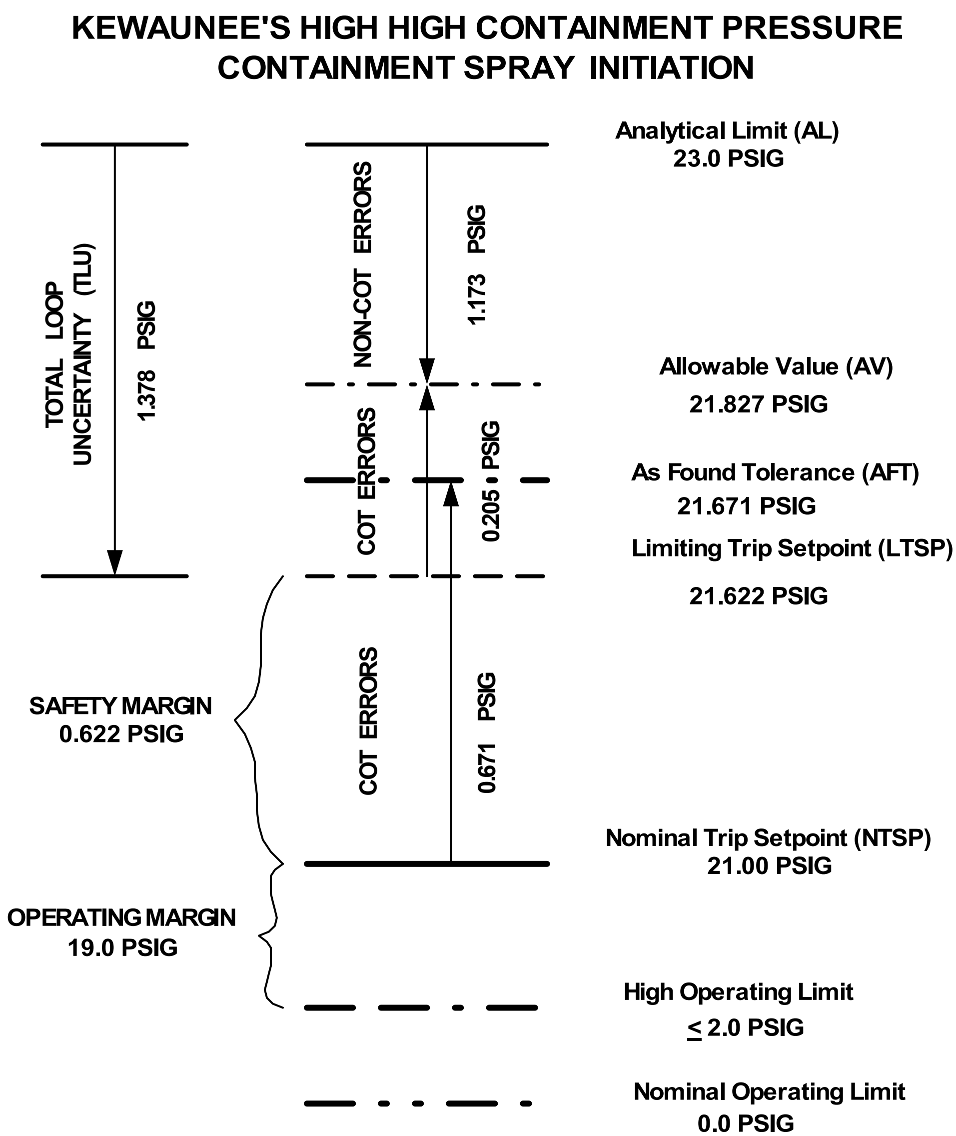
KEWAUNEE'S HIGH HIGH CONTAINMENT PRESSURE
CONTAINMENT SPRAY INITIATION
Analytical Limit (AL)
23.0 PSIG
TOTAL LOOP UNCERTAINTY (TLU)
1.378 PSIG
NON-COT ERRORS
1.173 PSIG
Allowable Value (AV)
21.827 PSIG
COT ERRORS
0.205 PSIG
As Found Tolerance (AFT)
21.671 PSIG
Limiting Trip Setpoint (LTSP)
21.622 PSIG
SAFETY MARGIN
0.622 PSIG
COT ERRORS
0.671 PSIG
Nominal Trip Setpoint (NTSP)
21.00 PSIG
OPERATING MARGIN
19.0 PSIG
High Operating Limit
≤ 2.0 PSIG
Nominal Operating Limit
0.0 PSIG

Figure 4.6.3

4.6.4 High - High Containment Pressure (Steam Line Isolation)

As Found Tolerance: **As Found Tolerance = 15.0 PSIG ± 0.671 PSIG (Refs. 5.1, 5.90, 5.95, 5.110, and 5.111)**

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 15.622 PSIG. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 15.827 PSIG. The current CTS Setting Limit for this function is ≤ 17.0 PSIG. The CTS Setting Limit for this function of ≤ 17.0 PSIG is set equal to the Analytical Limit and is non-conservative with respect to the Allowable Value. In addition, the current CTS Setting Limit is also non-conservative with respect to the calculated As Found Tolerance value of 15.0 PSIG ± 0.671 PSIG (i.e., 15.671 PSIG). The Actual Nominal Trip Setpoint of 15.0 PSIG is conservative with respect to the Limiting Trip Setpoint. The CTS Setting Limit of ≤ 17.0 PSIG will be changed to an As Found Tolerance value of 15.0 PSIG ± 0.671 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17.

The statistical combination of the COT and NON COT error components from CSA Calculation C11006 (Ref. 5.95) are given below. The COT and NON COT error components are used in Figure 4.6.4 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$$\text{NON COT}_{error} = (PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2)^{1/2}$$

$$\text{NON COT}_{error} = [0.0^2 + 0.0^2 + (0.5+0.261)^2 + 0.375^2 + 0.0^2 + 1.677^2 + 0.0^2 + 0.0^2 + 0.2^2 + 0.5^2)^{1/2}$$

$$\text{NON COT}_{error} = \pm 1.955 \text{ \% of span} = \pm 1.173 \text{ PSIG}$$

$$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.118 \text{ \% of span} = \pm 0.671 \text{ PSIG}$$

As Found Tolerance (AFT) = 15.0 PSIG ± 0.671 PSIG
As Left Tolerance (AFT) = 15.0 PSIG ± 0.300 PSIG[(1)]

See Figure 4.6.4 for specific details.

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(1) ALT = ± M2 = ± 0.5 % of span = ± (0.5 % / 100 %) * 60 PSIG = ± 0.30 PSIG

KEWAUNEE'S CONTAINMENT PRESSURE HI-HI STEAM LINE ISOLATION INITIATION

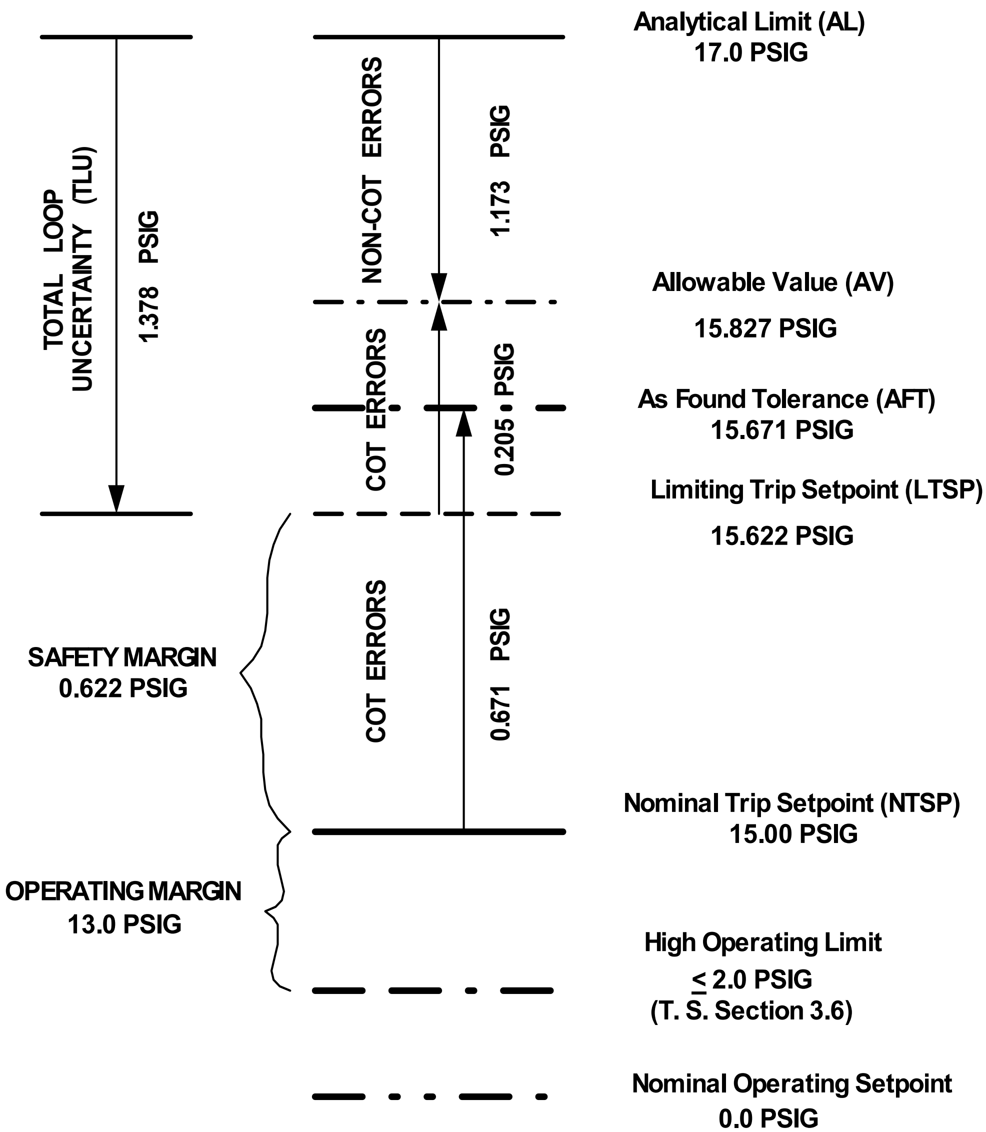

Figure 4.6.4

4.6.5 Pressurizer Low Pressure (Safety Injection)

As Found Tolerance: 1830 PSIG ± 10 PSIG (Refs. 5.1, 5.90, 5.93, and 5.105)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 1755.62 PSIG. Adding the NON COT error components to the Analytical Limit yields an Allowable Value (AV) of 1754.94 PSIG. The Actual Nominal Trip Setpoint of 1830 PSIG is conservative with respect to the Limiting Trip Setpoint. The current Custom Technical Specification (CTS) Setting Limit value of ≥ 1815 PSIG is conservative with respect to the Allowable Value. The current Custom Technical Specification (CTS) LSSS value ≥ 1815 PSIG is non-conservative based on the calculated COT error components determined in Calculation C10818 (Ref. 5.93). The Setting Limit value of ≥ 1815 PSIG will be changed to an As Found Tolerance value of 1830 PSIG ± 10.0 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. The revised As Found Tolerance value of ≥ 1820 PSIG will allow a 10.00 PSIG margin to be used for the COT error components. The revised As Found Tolerance value of ≥ 1820 PSIG is conservative with respect to the calculated Allowable Value but is non-conservative with respect to the calculated As Found Tolerance value using the CSA rack error terms from Calculation C10818 (Ref. 5.93).

The calculated As Found Tolerance value for this function is ≥ 1821.06 PSIG based on using the COT error components. The 1.06 PSIG offset is accommodated in the 74.38 PSIG Safety Margin for this trip as illustrated in Figure 4.6.5.

The statistical combination of the COT and NON COT error components from CSA Calculation C10818 (Ref. 5.93) are given below. The COT and NON COT error components are used in Figure 4.6.5 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$$\text{NON COT}_{error} = SE + IR \pm [PMA^2 + PEA^2 + RE_{DBE}^2 + SPTE^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M4MTE^2 + RTE^2]^{1/2}$$

$$\text{NON COT}_{error} = 0.0 + 0.174 \pm [0.0^2 + 0.0^2 + 1.688^2 + 8.0^2 + (0.250 + 0.391)^2 + 0.75^2 + 0.0^2 + 2.300^2 + 0.158^2 + 0.0^2 + 0.2^2 + 0.5^2]^{1/2}$$

$$\text{NON COT}_{error} = -\ 8.395\ \%\ \text{or}\ +\ 8.743\ \%\ \text{of span} = +\ 69.944\ \text{PSIG (worst case)}$$

$$\text{COT}_{error} = \pm (M1^2 + M4^2 + RD^2)^{1/2}$$

$$\text{COT}_{error} = \pm (0.0 + 0.5^2 + 1.0^2)^{1/2}$$

$$\text{COT}_{error} = \pm 1.118\ \%\ \text{of span} = \pm 8.944\ \text{PSIG (round to} \pm 10\ \text{PSIG)}$$

As Found Tolerance (AFT) = 1830 PSIG ± 10 PSIG
As Left Tolerance (ALT) = 1830 PSIG ± 4.0 PSIG(1)

See Figure 4.6.5 for specific details.

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(1) ALT = ± M4 = ± 0.5 % of span = ± 4.0 PSIG

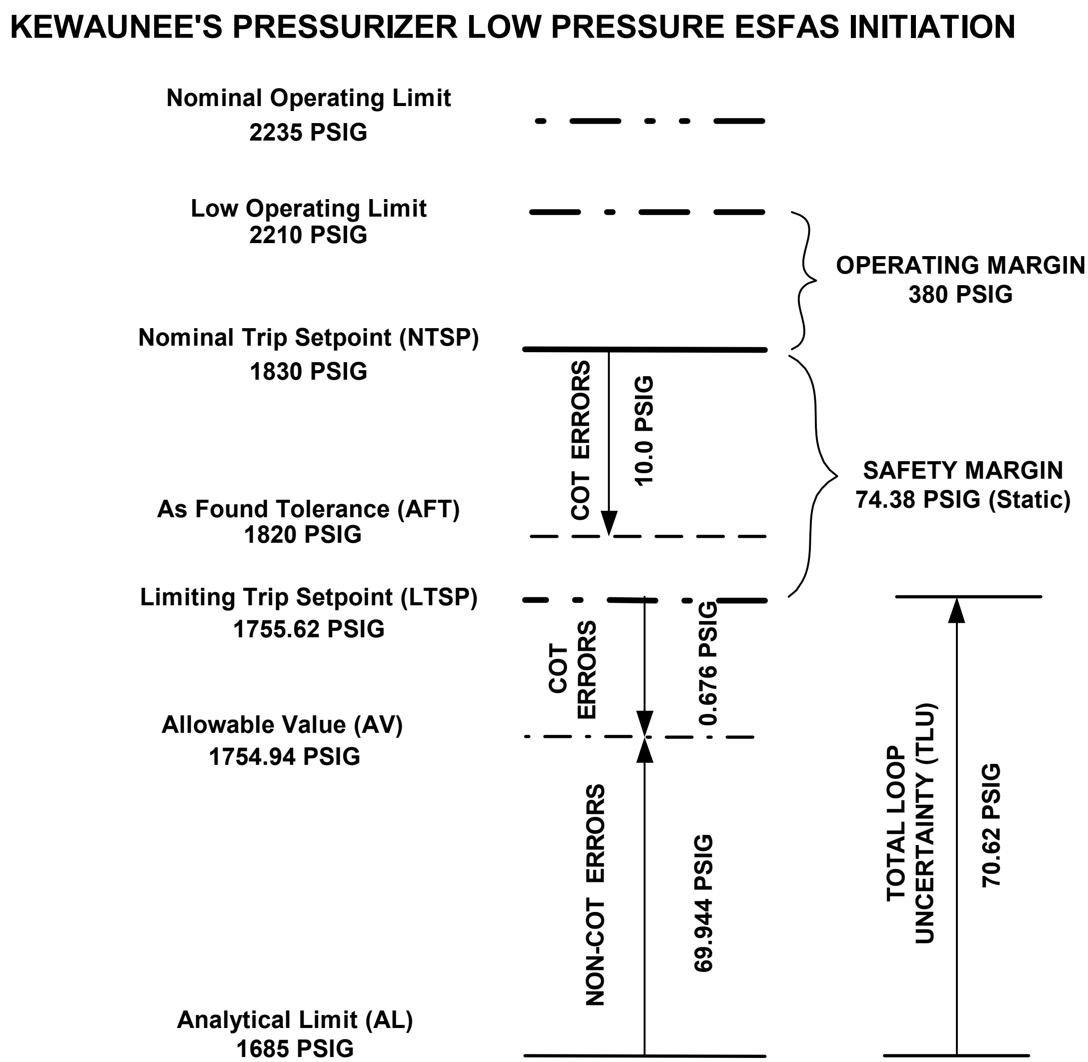
KEWAUNEE'S PRESSURIZER LOW PRESSURE ESFAS INITIATION
Nominal Operating Limit
2235 PSIG
Low Operating Limit
2210 PSIG
OPERATING MARGIN
380 PSIG
Nominal Trip Setpoint (NTSP)
1830 PSIG
COT ERRORS
10.0 PSIG
SAFETY MARGIN
74.38 PSIG (Static)
As Found Tolerance (AFT)
1820 PSIG
Limiting Trip Setpoint (LTSP)
1755.62 PSIG
COT ERRORS
0.676 PSIG
Allowable Value (AV)
1754.94 PSIG
NON-COT ERRORS
69.944 PSIG
TOTAL LOOP UNCERTAINTY (TLU)
70.62 PSIG
Analytical Limit (AL)
1685 PSIG

Figure 4.6.5

4.6.6 High Steam Flow Coincident with Safety Injection and Coincident with Tavg – Low Low

As Found Tolerance: $0.75 * 10^6$ lbs/hr $\pm$ $0.149 * 10^6$ lbs/hr
(Refs. 5.1, 5.90, 5.98, 5.108, and 5.120)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of $0.944 * 10^6$ lbs/hr. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of $0.981 * 10^6$ lbs/hr. The current CTS Setting Limit for this function is $0.745 * 10^6$ lbs/hr. The CTS Setting Limit for this function of $0.745 * 10^6$ lbs/hr is set conservative with respect to the Allowable Value. The current Nominal Trip Setpoint of $0.494 * 10^6$ lbs/hr is conservative with respect to the Limiting Trip Setpoint, however it is set overly conservative and at an unstable flowrate during startup. The current Nominal Trip Setpoint will be changed to $0.75 * 10^6$ lbs/hr equivalent to 19.63 % of $Flow_{nom}$(4). This revised Nominal Trip Setpoint will now be set at a more stable flowrate which should allow the trip to lock in without excessive relay chatter (i.e., passing through trip and reset multiple times) during the power escalation. The CTS Setting Limit of $0.745 * 10^6$ lbs/hr will be changed to an As Found Tolerance Value of $0.75 * 10^6$ lbs/hr $\pm$ $0.149 * 10^6$ lbs/hr to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. This As Found Tolerance Value of $0.75 * 10^6$ lbs/hr $\pm$ $0.149 * 10^6$ lbs/hr is based on maintaining a Nominal Trip Setpoint value of $0.75 * 10^6$ lbs/hr.

The statistical combination of the COT and NON COT error components from CSA Calculation C10854 (Ref. 5.98) are given below. Calculation C10854 is based on a Nominal Trip Setpoint of $0.494 * 10^6$ lbs/hr versus the revised Nominal Trip Set point of $0.75 * 10^6$ lbs/hr which allows the current Channel Statistical Allowance (CSA) value to be used in this analysis since it is conservative. The COT and NON COT error components are used in Figure 4.6.6 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$$NON\ COT_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$$

$$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.066^2 + 3.333^2 + (0.250+0.187)^2 + 0.386^2 + 0.503^2 + 1.557^2 + 0.158^2 + 0.0^2 + 0.2^2 + 0.5^2]^{1/2}$$

$NON\ COT_{error} = \pm$ 3.801% of ΔP span = $\pm$ 17.197 % of Flow Span = $\pm$ $0.769 * 10^6$ lbs/hr(1)

$$COT_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$$

$$COT_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$$

$COT_{error} = \pm$ 1.118% of ΔP span = $\pm$ 3.332 % of Flow Span = $\pm$ $0.149 * 10^6$ lbs/hr(2)

As Found Tolerance (AFT) = $0.75 * 10^6$ lbs/hr $\pm$ $0.149 * 10^6$ lbs/hr(2)
As Left Tolerance (ALT) = $0.75 * 10^6$ lbs/hr $\pm$ $0.067 * 10^6$ lbs/hr(3)

See Figure 4.6.6 for specific details.

KEWAUNEE'S HI STEAM FLOW COINCIDENT WITH SI AND LO-2 T_{AVG}

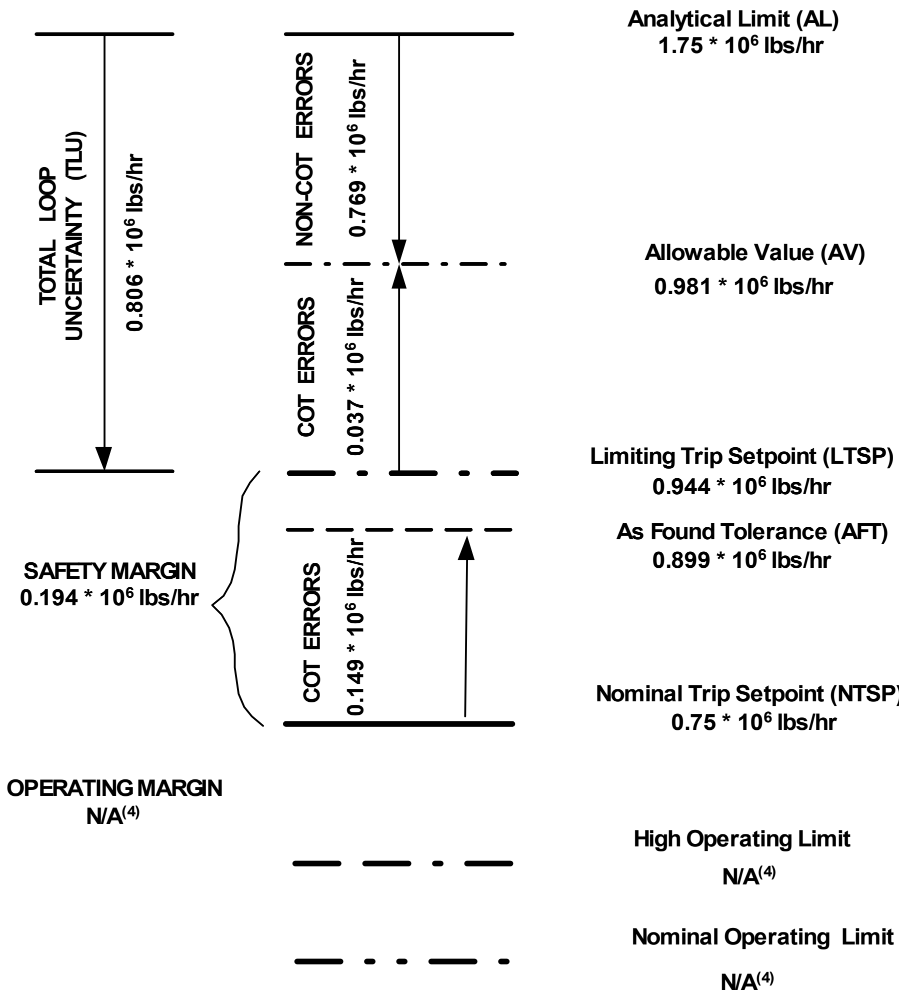

Figure 4.6.6

(1) The equation to convert % ΔP error to % Flow error is: % flow span = (ΔP uncertainty) * 0.5 * (flow max / flow x) (Ref. 5.120). According to Reference 5.98, flow max = 4.47 * 10^6 lbs/hr and based on Reference 5.108, flow x = 0.494 * 10^6 lbs/hr. Therefore, the NON COT_{error} in terms of % Flow = ± 3.801 * 0.5 * (4.47 / 0.494) = 17.197 % Flow span = (17.197/100) * 4.47 = ± 0.769 * 10^6 lbs/hr.

(2) Using the information from Note 1 above and substituting the revised Nominal Trip Setpoint of 0.75* 10^6 lbs/hr , the AFT = COT_{error} in terms of % Flow = ± 1.118 * 0.5 * (4.47 / 0.75) = 3.332 % Flow span = (3.332/100) * 4.47 = ± 0.149 * 10^6 lbs/hr.

(3) The ALT = ± M2 = ± 0.5 % of ΔP span. Using the information from Note 1 above and substituting the revised Nominal Trip Setpoint of 0.75* 10^6 lbs/hr, the ALT in terms of % Flow = ± 0.5 * 0.5 * (4.47 / 0.75) = 1.49 % Flow span = (1.49/100) * 4.47 = ± 0.067 * 10^6 lbs/hr.

(4) The High Steam Flow portion of this ESFAS function is always active and will be locked in as a partial coincident trip at ≈ 0.75 * 10^6 lbs/hr, i.e., at ≈ 19.63 % Power where % power = (flow x / flow nom) * 100 = (0.75 / 3.82) * 100 = 19.63. Based on Reference 5.98, $Flow_{nom}$ (nominal steam flow at 100 % power) = 3.82 * 10^6 lbs/hr.

4.6.7 High High Steam Flow Coincident with Safety Injection

As Found Tolerance: 4.3439 * 10^6 lbs/hr $\pm$ 0.026 * 10^6 lbs/hr
(Refs. 5.1, 5.90, 5.98, 5.108, and 5.120)

Subtracting the Total Loop Uncertainty (TLU) from the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 7.668 * 10^6 lbs/hr. Subtracting the NON COT error components from the Analytical Limit yields an Allowable Value (AV) of 7.673 * 10^6 lbs/hr. The current CTS Setting Limit for this function is 4.4 * 10^6 lbs/hr. The CTS Setting Limit for this function of 4.4 * 10^6 lbs/hr is set conservative with respect to the Allowable Value; however, the current CTS Setting Limit is set non-conservative with respect to the calculated As Found Tolerance value of 4.3439 * 10^6 lbs/hr $\pm$ 0.026 * 10^6 lbs/hr (i.e., 4.3699 * 10^6 lbs/hr). The Actual Nominal Trip Setpoint of 4.3439 * 10^6 lbs/hr is conservative with respect to the Limiting Trip Setpoint. The CTS Setting Limit of 4.4 * 10^6 lbs/hr will be changed to an As Found Tolerance Value of 4.3439 * 10^6 lbs/hr $\pm$ 0.026 * 10^6 lbs/hr to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. This As Found Tolerance Value of 4.3439 * 10^6 lbs/hr $\pm$ 0.026 * 10^6 lbs/hr is based on maintaining a Nominal Trip Setpoint value of 4.3439 * 10^6 lbs/hr.

The statistical combination of the COT and NON COT error components from CSA Calculation C10854 (Ref. 5.98) are given below. The COT and NON COT error components are used in Figure 4.6.7 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$\text{NON COT}_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + RTE^2]^{1/2}$

$\text{NON COT}_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 3.333^2 + (0.250+0.187)^2 + 0.386^2 + 0.503^2 + 1.557^2 + 0.158^2 + 0.0^2 + 0.2^2 + 0.5^2]^{1/2}$

$\text{NON COT}_{error} = \pm$ 3.800% of ΔP span = $\pm$ 1.955 % of Flow Span = $\pm$ 0.087 * 10^6 lbs/hr(1)

$\text{COT}_{error} = \pm (M1^2 + M2^2 + RD^2)^{1/2}$

$\text{COT}_{error} = \pm (0.0^2 + 0.5^2 + 1.0^2)^{1/2}$

$\text{COT}_{error} = \pm$ 1.118% of ΔP span = $\pm$ 0.575 % of Flow Span = $\pm$ 0.026 * 10^6 lbs/hr(2)

As Found Tolerance (AFT) = 4.3439 * 10^6 lbs/hr $\pm$ 0.026 * 10^6 lbs/hr(2)
As Left Tolerance (ALT) = 4.3439 * 10^6 lbs/hr $\pm$ 0.011 * 10^6 lbs/hr(3)

See Figure 4.6.7 for specific details.

KEWAUNEE'S HI HI STEAM FLOW COINCIDENT WITH SAFETY INJECTION

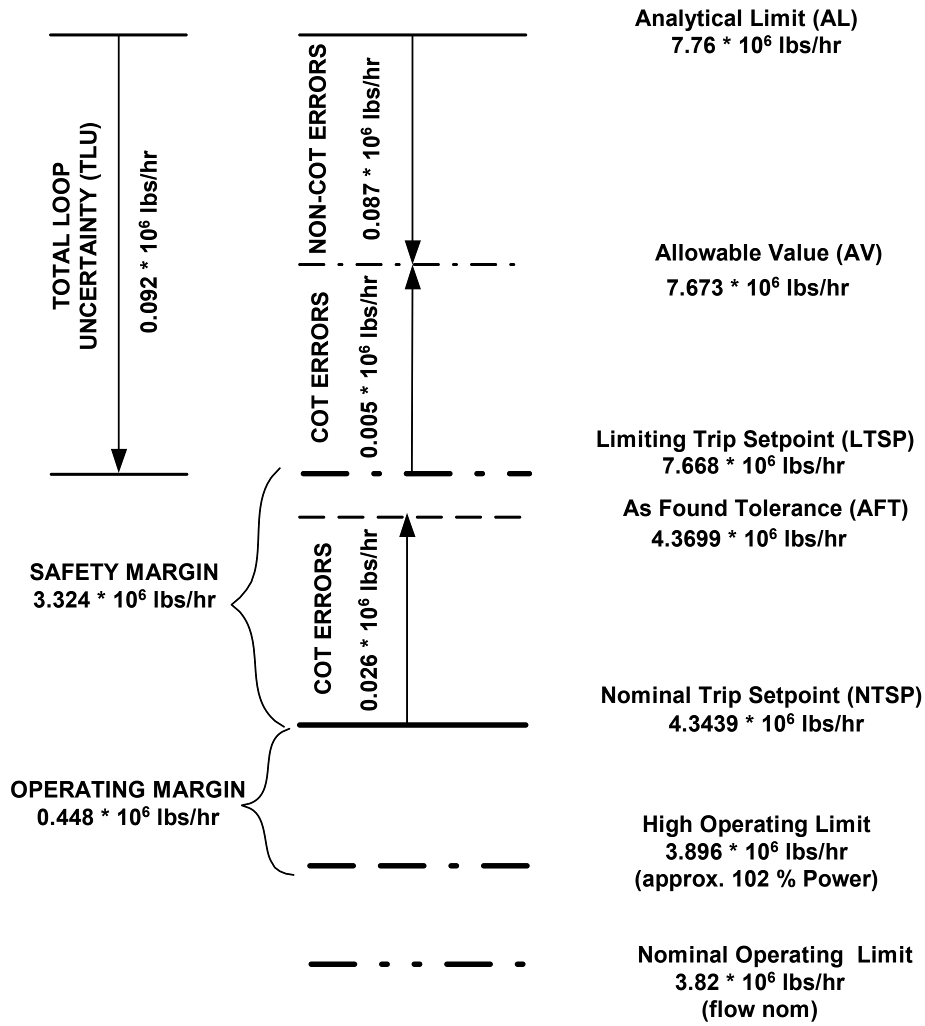

Figure 4.6.7

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(1) The equation to convert % ΔP error to % Flow error is: % flow span = (ΔP uncertainty) * 0.5 * (flow max / flow x) (Ref. 5.120). According to Reference 5.98, flow max = 4.47 * 10^6 lbs/hr and based on Reference 5.108, flow x = 4.3439 * 10^6 lbs/hr. Therefore, the NON COT_{error} in terms of % Flow = ± 3.800 * 0.5 * (4.47 / 4.3439) = 1.955 % Flow span = (1.955/100) * 4.47 = ± 0.087 * 10^6 lbs/hr.

(2) Using the information from Note 1 above, the AFT = COT_{error} in terms of % Flow = ± 1.118 * 0.5 * (4.47 / 4.3439) = 0.575 % Flow span = (0.575/100) * 4.47 = ± 0.026 * 10^6 lbs/hr.

(3) The ALT = ± M2 = ± 0.5 % of ΔP span. Using the information from Note 1 above, the ALT in terms of % Flow = ± 0.5 * 0.5 * (4.47 / 4.3439) = 0.257 % Flow span = (0.257/100) * 4.47 = ± 0.011 * 10^6 lbs/hr.

4.6.8 Low-Low T_{AVG} Coincidence input to Steam Line Isolation

As Found Tolerance Value: 541.0 °F ± 1.38 °F (Refs. 5.1, 5.90, 5.94, and 5.105)

The current Custom Technical Specification (CTS) Setting Limit for this function is ≥ 540.0 °F. The current Nominal Trip Setpoint for this function is ≥ 541.0 °F (Ref. 5.105). The Low T_{AVG} Coincidence input to the Steam Line Isolation ESFAS function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) Calculation has been performed for this function. Based on Calculation C11865 (Ref. 5.94), the COT error allowance for this function is ± 1.38 % of span = ± 1.38 °F. The As Found Tolerance based on the COT error from Calculation C11865 is 541 °F ± 1.38 °F. The CTS Setting Limit for this function of ≥ 540.0 °F is set slightly conservative with respect to the calculated As Found Tolerance value of 541 °F ± 1.38 °F (i.e. 539.62 °F). The As Found Tolerance being slightly non-conservative with respect to the current CTS Setting Limit is acceptable because there is no Analytical Limit associated with this function. The As Left Tolerance will be based on the COT error allowance minus Rack Drift (i.e., RD_2 from Ref. 5.94). The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint Value of 541 °F.

As Found Tolerance (AFT) = 541.0 °F ± 1.38 °F(1)
As Left Tolerance (ALT) = 541 °F ± 0.95 °F (2)

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(1) AFT = ± $((M1 * 0.667)^2 + (M2 * 0.667)^2 + M4^2 + M8^2 + RD_2^2)^{½}$ = ±$((0.417 * 0.667)^2 + (0.417 * 0.667)^2 + 0.707^2 + 0.5^2 + 1.0^2)^{½}$ = ± 1.38 % of T_{AVG} span
(2) (2) ALT = ± $((M1 * 0.667)^2 + (M2 * 0.667)^2 + M4^2 + M8^2)^{½}$ = ± $((0.417 * 0.667)^2 + (0.417 * 0.667)^2 + 0.707^2 + 0.5^2)^{½}$ = ± 0.95 % of T_{AVG} span
(3) The effective gain of the T_{AVG} summing junction is set by the relationship of the T_{AVG} span versus the span of T_{HOT} and T_{COLD} (i.e., 520 to 620 °F versus 500 to 650 °F, span equal to 150 °F). For Kewaunee, the effective gain is 0.6667 V/V, therefore % T_{AVG} span is equal to % T_{HOT} span or T_{COLD} span * 0.6667.

4.6.9 Steam Line Pressure - Low

As Found Tolerance: 514.0 PSIG ± 17.15 PSIG (Refs. 5.1, 5.90, 5.98, 5.108, and 5.145)

Adding the Total Loop Uncertainty (TLU) to the Analytical Limit (AL) yields a Limiting Trip Setpoint (LTSP) of 496.366 PSIG. Adding the NON COT error components to the Analytical Limit yields an Allowable Value (AV) of 489.31 PSIG. The Actual Nominal Trip Setpoint of 514.0 PSIG is conservative with respect to the Limiting Trip Setpoint. The current Custom Technical Specifications (CTS) Setting Limit of ≥ 500 PSIG is conservative with respect to the calculated Allowable Value and conservative with respect to the calculated As Found Tolerance. The As Found Tolerance of 514 PSIG ± 17.15 PSIG is based on the calculated COT error allowance from Calculation C10854 (Ref. 5.98). The Custom Technical Specifications (CTS) Setting Limit of ≥ 500 PSIG will be changed to an As Found Tolerance of 514 PSIG ± 17.15 PSIG to conform to the requirements of TSFT-493, Rev. 4 and RIS 2006-17. The calculated As Left Tolerance will be based on the COT error allowance from Calculation C10854 minus Rack Drift (RD). The As Found and As Left Tolerances are based on maintaining a Nominal Trip Setpoint of 514.0 PSIG.

The statistical combination of the COT and NON COT error components from CSA Calculation C10854 (Ref. 5.98) are given below. The COT and NON COT error components are used in Figure 4.6.9 to determine the Limiting Trip Setpoint (LTSP) and the Allowable Value (AV).

$NON\ COT_{error} = SE \pm [EA^2 + PMA^2 + PEA^2 + (SCA+SMTE)^2 + SD^2 + SPE^2 + STE^2 + SPSE^2 + M1MTE^2 + M2MTE^2 + M3MTE^2 + RTE^2]^{1/2}$

$NON\ COT_{error} = 0.0 \pm [0.0^2 + 0.0^2 + 0.0^2 + (0.250 + 0.180)^2 + 0.429^2 + 0.0^2 + 1.475^2 + 0.158^2 + 0.0^2 + 0.283^2 + 0.2^2 + 0.5^2]^{1/2}$

$NON\ COT_{error} = \pm$ 1.715 % of span = $\pm$ 24.01 PSIG

$COT_{error} = \pm (M1^2 + M2^2 + M3^2 + RD^2)^{1/2}$

$COT_{error} = \pm (0.0^2 + 0.5^2 + 0.5^2 + 1.0^2)^{1/2}$

$COT_{error} = \pm$ 1.225 % of span = $\pm$ 17.15 PSIG

As Found Tolerance (AFT) = 514.0 PSIG ± 17.15 PSIG
As Left Tolerance (ALT) = 514 PSIG ± 10.0 PSIG[(1)]

See Figure 4.6.9 for specific details.

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(1) $ALT = (M1^2 + M2^2 + M3^2)^{1/2} = \pm (0.0^2 + 0.5^2 + 0.5^2)^{1/2} = \pm$ 0.707 % of span = ± 9.898 PSIG (round to ± 10. PSIG)

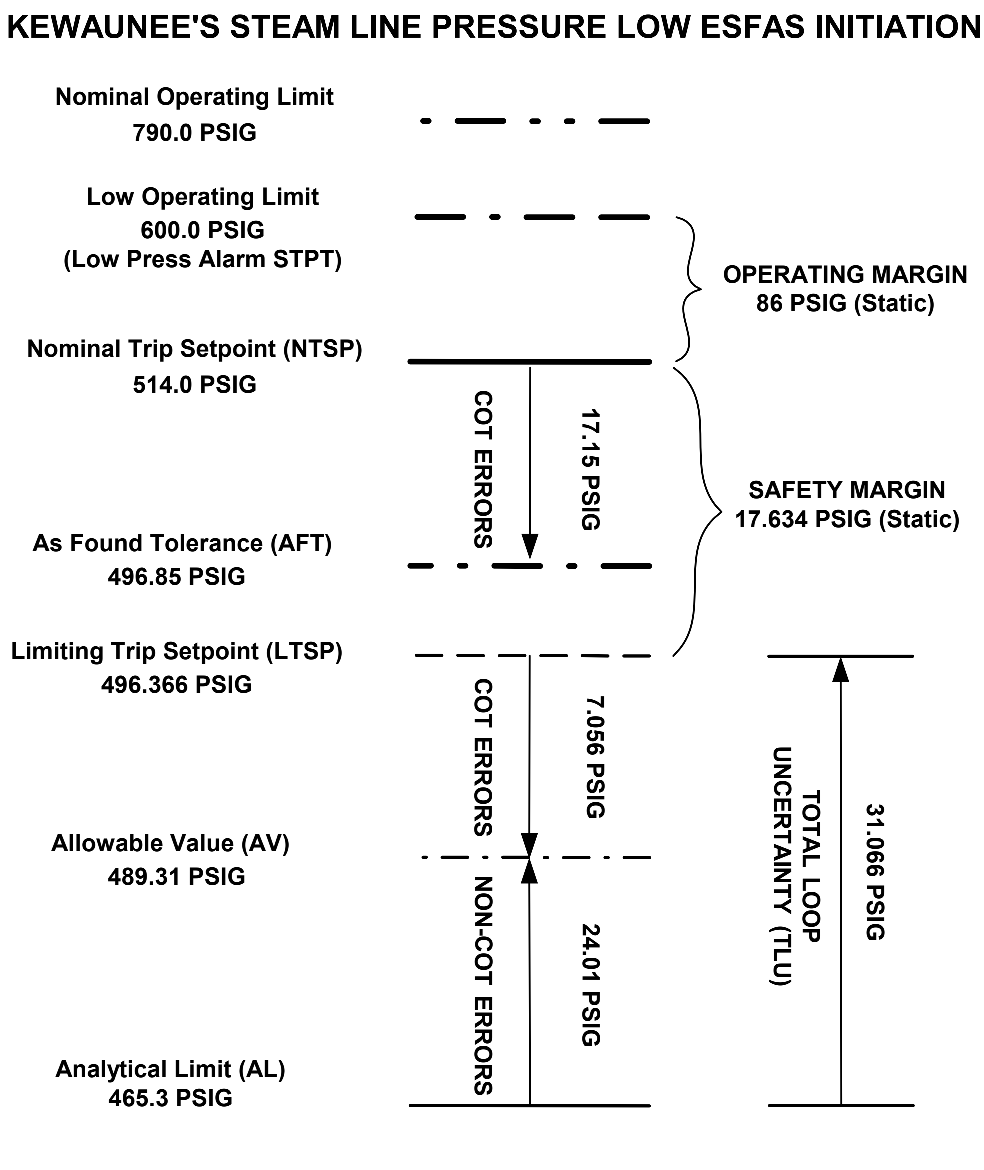
KEWAUNEE'S STEAM LINE PRESSURE LOW ESFAS INITIATION
Nominal Operating Limit
790.0 PSIG
Low Operating Limit
600.0 PSIG
(Low Press Alarm STPT)
OPERATING MARGIN
86 PSIG (Static)
Nominal Trip Setpoint (NTSP)
514.0 PSIG
COT ERRORS
17.15 PSIG
SAFETY MARGIN
17.634 PSIG (Static)
As Found Tolerance (AFT)
496.85 PSIG
Limiting Trip Setpoint (LTSP)
496.366 PSIG
COT ERRORS
7.056 PSIG
TOTAL LOOP
UNCERTAINTY (TLU)
31.066 PSIG
Allowable Value (AV)
489.31 PSIG
NON-COT ERRORS
24.01 PSIG
Analytical Limit (AL)
465.3 PSIG

Figure 4.6.9

4.6.10 Steam Generator Water Level Low Low Reactor Trip / Auxiliary Feedwater Initiation

See item 4.5.15.

4.6.11 SG Water Level - High High

See Section 3.5.3.

4.7 Limiting Trip Setpoints, Allowable Values, As Found Tolerances, and As Left Tolerances for Kewaunee Instrumentation associated with LCO's 3.3.5, 3.3.6, and 3.3.7 to support the Setpoint Control Program

4.7.1 Safeguards Bus Undervoltage (Loss of Voltage)

As Found Tolerance: **84.47 ± 0.200 % of Bus Voltage = 101.69 ± 0.241 VAC with a time delay of 1.75 seconds ± 0.25 seconds (Refs. 5.1, 5.90, 5.102, & 5.129)**

The current Custom Technical Specification (CTS) Setting Limit for this function is 85 % ± 2 % of bus voltage in ≤ 2.5 secs. The current Nominal Trip Setpoint for this function is 101.49 to 101.89 VAC where 101.69 VAC is the centerline voltage = 84.47 % of bus voltage[1] (Ref. 5.102 & 5.129). This analysis assumes that 120.39 VAC from the potential transformer is equal to 100 % of bus voltage which is equal to 4160 VAC per the conversion factor as noted in footnote 1. The Safeguards Bus Undervoltage Loss of Power Trip is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) calculation has been performed for this function. The calibration accuracy for this trip is 101.69 ± 0.2 VAC = 84.47 ± 0.166 % of bus voltage [1] (Ref. 5.129). The COT error from Calculation C11709 is ± 0.200 % of bus voltage = ± 0.241 VAC. Therefore, the As Found Tolerance for the Safeguards Bus Undervoltage Loss of Power Trip is 84.47 ± 0.200 % of bus voltage = 101.69 ± 0.241 VAC[1] based on the device calibration accuracy from Reference 5.102. The As Left Tolerance for the Safeguards Bus Undervoltage Loss of Power Trip is 84.47 ± 0.166 % of bus voltage = 101.69 ± 0.200 VAC based on the device calibration accuracy from Reference 5.129. The As Found Tolerance and As Left Tolerance are based on maintaining a Nominal Trip Setpoint Value of 101.69 VAC = 84.47 % of bus voltage.

The time delay associated with this trip is based on a setpoint of 1.75 seconds ± 0.01 seconds (Ref. 5.129). Calculation C11709 (Ref. 5.102) gives a total error associated with the relays as 14.14 % of the settings. Utilizing the total error of 14.14 % of the setting provides a range of 1.50 seconds to 2.00 seconds based on a setpoint of 1.75 seconds. Therefore, the Time Delay As Found Tolerance is 1.75 seconds ± 0.25 seconds. The Time Delay As Left Tolerance is 1.75 ± 0.10[5] second based on the device calibration accuracy from Reference 5.129.

As Found Tolerance (AFT) = 84.47 ± 0.200 % of bus voltage = 101.69 ± 0.241 VAC[2]
As Left Tolerance (ALT) = 84.47 ± 0.166 % of bus voltage = 101.69 ± 0.200 VAC[3]
Time Delay As Found Tolerance = 1.75 Seconds ± 0.25 seconds
Time Delay As Left Tolerance = 1.75 Seconds ± 0.10 seconds[5]

As Found Tolerance (AFT) = 84.15 ± 0.200 % of bus voltage = 101.31 ± 0.241 VAC[4]
As Left Tolerance (ALT) = 84.15 ± 0.166 % of bus voltage = 101.31 ± 0.200 VAC[4]

---

(1) Convert % bus Voltage to VAC as follows:
4160*(% bus Volts / 100) / (sqrt (3) * 20 * 0.9975) = VAC
Where 20 is the PT turn down ratio and 0.9775 is the Ratio Correction Factor (Ref. 5.102).
(2) AFT = ± SCA = ± 0.200 % bus voltage (From Reference 5.102).
(3) ALT = Current Calibration Accuracy from Reference 5.129 = ± 0.166 % bus voltage.
(4) Calculation C11709 (Ref. 5.102) recommends a setpoint change for the Safeguards Bus Undervoltage Loss of Voltage Trip. The recommended setpoint will be 101.31 ± 0.200 VAC = 84.15 ± 0.166 % of bus voltage for the relay Dropout.

The COT error from Calculation C11709 is + 0.200 % of bus voltage = + 0.241 VAC. Therefore, the As Found Tolerance for the Safeguards Bus Undervoltage Loss of Power Trip is 84.15 + 0.200 % of bus voltage = 101.31 + 0.241 VAC based on the device calibration accuracy from Reference 5.102. The As Left Tolerance for the Safeguards Bus Undervoltage Loss of Power Trip is 84.15 + 0.166 % of bus voltage = 101.31 + 0.200 VAC based on the recommendation from Reference 5.102. The As Found Tolerance and As Left Tolerance are based on implementing the recommendations of Calculation C11709 and setting the Nominal Trip Setpoint to a value of 101.31 VAC = 84.15 % of bus voltage. The same Time Delay Tolerances apply for the new setpoints.

(5) Undervoltage relays 27A/B5, 27C/B5, 26A/B6, 27C/B6 have an As Left time delay of 0.01 seconds listed in the Electrical Preventive Maintenance Procedures with an As Found time delay of 0.1 seconds. The procedure value of 0.01 seconds is conservative to the As Left Tolerance of 0.1 seconds as described above.

4.7.2 Safeguards Bus Second Level Undervoltage (Degraded Voltage)

As Found Tolerance: 93.80 + 0.179 % of bus voltage = 112.93 + 0.215 VAC with a time delay of 6.72 seconds + 0.68 seconds (Refs. 5.1, 5.90, 5.102, & 5.129)

The current Custom Technical Specification (CTS) Setting Limit for this function is 93.6 % + 0.9 % of bus voltage in ≤ 7.4 secs. The current Nominal Trip Setpoint for this function is 112.73 to 113.13 VAC where 112.93 VAC is the centerline voltage = 93.80 % of bus voltage[1] (Ref. 5.102 & 5.129). This analysis assumes that 120.39 VAC from the potential transformer is equal to 100 % of bus voltage which is equal to 4160 VAC per the conversion factor as noted in footnote 1. The Safeguards Bus Second Level Undervoltage Degraded Voltage Trip is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1); however a Channel Statistical Allowance (CSA) calculation has been performed for this function. The calibration accuracy for this trip is 112.93 + 0.2 VAC = 93.80 + 0.166 % of bus voltage [1] (Ref. 5.129). The COT error from Calculation C11709 is + 0.179 % of bus voltage = + 0.215 VAC. Therefore, the As Found Tolerance for the Safeguards Bus Second Level Undervoltage Degraded Voltage Trip is 93.80 + 0.179 % of bus voltage = 112.93 + 0.215 VAC based on the device calibration accuracy from Reference 5.102. The As Left Tolerance for the Safeguards Bus Second Level Undervoltage Degraded Voltage Trip is 93.80 + 0.166 % of bus voltage = 112.93 + 0.200 VAC based on the device calibration accuracy from Reference 5.129. The As Found Tolerance and As Left Tolerance are based on maintaining a Nominal Trip Setpoint Value of 112.93 VAC = 93.80 % of bus voltage.

The time delay associated with this trip is based on a setpoint of 6.72 seconds + 0.01 seconds (Ref. 5.129). Calculation C11709 (Ref. 5.102) gives a total error associated with the relays as 10.1 % of the settings. Utilizing the total error of 10.1 % of the setting provides a range of 6.04 seconds to 7.40 seconds based on a setpoint of 6.72 seconds. Therefore, the Time Delay As Found Tolerance is 6.72 seconds + 0.68 seconds. The Time Delay As Left Tolerance is 6.72 + 0.10[5] second based on the device calibration accuracy from Reference 5.129.

As Found Tolerance (AFT) = 93.80 + 0.179 % of bus voltage = 112.93 + 0.215 VAC[2]
As Left Tolerance (ALT) = 93.80 + 0.166 % of bus voltage = 112.93 + 0.200 VAC [3]
Time Delay As Found Tolerance = 6.72 Seconds + 0.68 seconds
Time Delay As Left Tolerance = 6.72 Seconds + 0.10 seconds[5]

As Found Tolerance (AFT) = 93.50 + 0.200 % of bus voltage = 112.57 + 0.215 VAC[4]
As Left Tolerance (ALT) = 93.50 + 0.166 % of bus voltage = 112.57 + 0.200 VAC[4]

(1) Convert % bus Voltage to VAC as follows:
4160*(% bus Volts / 100) / (sqrt (3) * 20 * 0.9975) = VAC
Where 20 is the PT turn down ratio and 0.9775 is the Ratio Correction Factor (Ref. 5.102).
(2) AFT = ± SCA = ± 0.179 % bus voltage (From Reference 5.102).
(3) ALT = Current Calibration Accuracy from Reference 5.129 = ± 0.166 % bus voltage.
(4) Calculation C11709 (Ref. 5.102) recommends a setpoint change for the Safeguards Bus Undervoltage Degraded Voltage Trip. The recommended setpoint will be 112.57 ± 0.200 VAC = 93.50 ± 0.166 % of bus voltage for the relay Dropout. The COT error from Calculation C11709 is ± 0.179 % of bus voltage = ± 0.215 VAC. Therefore, the As Found Tolerance for the Safeguards Bus Undervoltage Degraded Voltage Trip is 93.50 ± 0.179 % of bus voltage = 112.57 ± 0.215 VAC based on the device calibration accuracy from Reference 5.102. The As Left Tolerance for the Safeguards Bus Undervoltage Degraded Voltage Trip is 93.50 ± 0.166 % of bus voltage = 112.57 ± 0.200 VAC based on the recommendation from Reference 5.102. The As Found Tolerance and As Left Tolerance are based on implementing the recommendations of Calculation C11709 and setting the Nominal Trip Setpoint to a value of 112.57 VAC = 93.50 % of bus voltage. The same Time Delay Tolerances apply for the new setpoints.
(5) Undervoltage (Degraded Voltage) relays 27AY/B5, 27CY/B5, 26AY/B6, 27CY/B6 have an As Left time delay of 0.01 seconds listed in the Electrical Preventive Maintenance Procedures with an As Found time delay of 0.1 seconds. The procedure value of 0.01 seconds is conservative to the As Left Tolerance of 0.1 seconds as described above.

4.7.3 Forebay Level

As Found Tolerance: 162” H2O ± 9” H2O (Refs. 5.1, 5.90, 5.101 & 5.121)

The current Custom Technical Specifications (CTS) do not list a Setting Limit value associated with the Forebay Level Trip. The Forebay Level Trip function is not credited in the Kewaunee USAR Chapter 14 Safety Analysis (Ref. 5.1). The current As Found Nominal Trip Setpoint for this function is 162 Inches H2O Decreasing ± 9.0 Inches H2O per Reference 5.121. The current As Left Nominal Trip Setpoint is 162 Inches H2O Decreasing ± 4.5 Inches H2O per Reference 5.121. Per Calculation C11220 (Ref. 5.101) testing concluded that at a water level of 565’ 3”, acceptable conditions exist for continued operation of the SW pumps. The setpoint of 162” H2O is equivalent to 566’ Forebay water level per Reference 5.101, which yields a difference of 9” H2O to be used for the As Found Tolerance.

As Found Tolerance (AFT) = 162” H2O ± 9” H2O(1)
As Left Tolerance (ALT) = 162” H2O ± 4.5” H2O(2)

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(1) AFT = Margin from minimum level for SW Pump operation – Existing Setpoint Equivalent (Ref. 5.101) = 566’ – 565’3” = 9”
(2) ALT = Current As Left Calibration Accuracy from Reference 5.121 = 4.5”

4.7.4 Containment Purge and Vent System Radiation Particulate Detector and Radioactive Gas Detector Containment Ventilation Isolation

Containment Gas Radiation Monitors (R12 and R21)

As Found Tolerance: 2.2 E+05 CPM + BKG
(Refs. 5.1, 5.90, 5.113, 5.114, 5.115, 5.123, 5.124, 5.131, & 5.143)

The current Custom Technical Specifications (CTS) Setting Limit for this function states "≤ radiation levels in exhaust duct as defined in footnote(3)". The current Nominal Trip Setpoint (4) for the Containment Gas Radiation Monitors are 8.00 E +04 CPM for the High Alarm Setpoint per References 5.123 and 5.143. The Containment Gas Radiation monitors are not credited in the Chapter 14 Safety Analysis (Ref. 5.1). The Alert and Alarm setpoints are determined IAW the methodology outlined in the Kewaunee Power Station Offsite Dose Calculation Manual (ODCM) and documented in Calculation C10690 (Ref. 5.115). The High Alarm Setpoint provides the Containment Isolation signal. The calculated High Alarm Setpoint per the ODCM and Calculation C10690 (Refs. 5.113 & 5.115) is currently 2.2 E +05 CPM + Background (BKG). The Setpoints listed in Reference 5.123 are set conservative to the values determined in the ODCM and Calculation C10690 (Refs. 5.113 & 5.115). There are currently no Analytical Limits or Allowable Values associated with this function (Ref. 5.1). The determination of the setpoints is not within the scope of the Setpoint Control Program and the current High Alarm Nominal Trip Setting of 8.00E +04 CPM is conservative with respect to the calculated value listed in the ODCM and Calculation C10690. Based on Reference 5.113 & 5.115 the As Found Tolerance will be 2.2 E +05 CPM + Background. The As Left Tolerance will be based on the existing High Alarm Setpoint listed in Reference 5.123.

As Found Tolerance (AFT) = 2.2 E+05 CPM + BKG (1)
As Left Tolerance (ALT) = 8.00 E+04 CPM (2)

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(1) AFT = Setpoint taken from Reference 5.113 & 5.115
(2) ALT = Calibration Procedure Setpoint = 8.0 E+04 CPM (Reference 5.123 & 5.124)
(3) Footnote three from Technical Specification Table 3.5-1 page 2 of 2 states "The setting limits for max radiation levels are derived from ODCM Specification 3.4.1 and Table 2.2, and USAR Section 6.5."
(4) The Alert Setpoint is determined IAW References 5.113 and 5.115 and is set at 2.00 E +04 CPM per Reference 5.123. The Alert Setpoint provides an alarm function only and the Containment Isolation signal is provided by the High Alarm Setpoint.

4.7.5 Containment Particulate Radiation Monitor (R11)

As Found Tolerance: 8.00 E+04 CPM
(Refs. 5.1, 5.90, 5.113, 5.114, 5.115, 5.122, 5.124, & 5.131)

The current Custom Technical Specifications (CTS) Setting Limit for this function states "≤ radiation levels in exhaust duct as defined in footnote(3)". The current Nominal Trip Setpoint for the Containment Particulate Radiation Monitor is 5.00 E +04 CPM for the alert setpoint and 8.00 E +04 CPM for the High Alarm per Reference 5.122. The Containment Particulate Radiation monitor is not credited in the Chapter 14 Safety Analysis (Ref. 5.1). Per USAR Table 11.2.7 the Setpoint is set "Statistically significant level above background". The Design Change Process which is controlled by the 50.59/72.48 process is utilized to determine any setpoint changes associated with the Containment Particulate Radiation Monitors. The existing setpoints are shown on drawing E-2021 (Ref. 5.124) and were derived utilizing this process and will be maintained as the As Found Tolerance and the As Left Tolerance.

As Found Tolerance (AFT) = 8.00 E+04 CPM (1)
As Left Tolerance (ALT) = 8.00 E+04 CPM (2)

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(1) AFT = Calibration Procedure Setpoint = 8.0 E+04 CPM (Reference 5.122, & 5.124)
(2) ALT = Calibration Procedure Setpoint = 8.0 E+04 CPM (Reference 5.122 & 5.124)
(3) Footnote three from Technical Specification Table 3.5-1 page 2 of 2 states "The setting limits for max radiation levels are derived from ODCM Specification 3.4.1 and Table 2.2, and USAR Section 6.5."

4.7.6 Control Room Ventilation Radiation Monitor (R23)

As Found Tolerance: 1.00 E+04 CPM (Refs. 5.1, 5.114, 5.124, & 5.125)

The current Custom Technical Specifications (CTS) Setting Limit does not specify a Setting Limit for this Radiation Monitor. The Improved Technical Specifications have added this monitor. The current Nominal Trip Setpoint for the Control Room Ventilation Radiation Monitor is 5.00 E +03 CPM for the alert setpoint and 1.00 E +04 CPM for the High Alarm per References 5.124 and 5.125. The Control Room Ventilation Radiation Monitor is not credited in the Chapter 14 Safety Analysis (Ref. 5.1). Per USAR Table 11.2.7 the Setpoint is set "Statistically significant level above background". The Design Change Process which is controlled by the 50.59/72.48 process is utilized to determine any setpoint changes associated with the Control Room Radiation Monitor. The existing setpoints are shown in drawing E-2021 (Ref. 5.124) and were derived utilizing this process and will be maintained as the As Found Tolerance and the As Left Tolerance.

As Found Tolerance (AFT) = 1.00 E+04 CPM (1)
As Left Tolerance (ALT) = 1.00 E+04 CPM (2)

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(3) AFT = Calibration Procedure Setpoint = 1.0 E+04 CPM (Reference 5.124, & 5.125)
(4) ALT = Calibration Procedure Setpoint = 1.0 E+04 CPM (Reference 5.124, & 5.125)

4.7.7 Turbine Building Service Water Header Isolation

As Found Tolerance: **82.5 PSIG ± 1.0 PSIG** **(Refs. 5.1, 5.114, 5.140, & 5.141)**

The current Custom Technical Specifications (CTS) does not address the Turbine Building Service Water Header Isolation function. Improved Technical Specifications (ITS) has added this function to ITS Table 3.3.2-1. Based on References 5.140 and 5.141, the current Nominal Trip Setpoint for Turbine Building Service Water Low Pressure Isolation is 82.5 PSIG (decreasing). The Turbine Building Service Water Header Isolation function is not credited in the Chapter 14 Safety Analysis (Ref. 5.1). Based on Reference 5.140, the calibration accuracy for the pressure switch is ± 1.0 PSIG. For this application, the As Found Tolerance and As Left Tolerance will be set at the same value, i.e., ± 1.0 PSIG.

As Found Tolerance (AFT) = 82.5 PSIG ± 1.0 PSIG
As Left Tolerance (ALT) = 82.5 PSIG ± 1.0 PSIG

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(5) AFT = Calibration Procedure Setpoint = ± 1.0 PSIG (Reference 5.140)
(6) ALT = Calibration Procedure Setpoint = ± 1.0 PSIG (Reference 5.140)

5.0 REFERENCES

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5.2 Technical Report EE-0101, Revision 10, Setpoint Basis Document – Analytical Limits, Setpoints and Calculations for Technical Specification Instrumentation At North Anna and Surry Power Stations, Dated 12-11-07.

5.3 Westinghouse - NAPS Reactor Protection System/Engineered Safety Features Actuation System Setpoint Methodology (NRC Letter - S/N 541, Dated 09-28-78).

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5.8 North Anna Power Station Technical Specifications.

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5.35 Dominion Virginia Power Calculation EE-0432, Revision 4 with Add. 00A, CSA Calculation for Surry Power Station, Steam Generator Narrow Range Level, Units 1&2, Loops L-1474, L-1475, L-1476, L-1484, L-1485, L-1486, L-1494, L-1495, L-1496, L-2474, L-2475, L-2476, L-2484, L-2485, L-2486, L-2494, L-2495, L-2496.

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