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10 CFR 50.90

September 24, 2018
Serial: RA-18-0171

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400/Renewed License No. NPF-63

Subject: Supplemental Information for License Amendment Request Regarding Reactor Trip System and Engineered Safety Features Actuation System Instrumentation Trip Setpoints

Ladies and Gentlemen:

By letter dated July 30, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18211A546), Duke Energy Progress, LLC (Duke Energy), requested an amendment to the Technical Specifications of Renewed Facility Operating License No. NPF-63 for Shearon Harris Nuclear Power Plant, Unit 1 (HNP). The proposed license amendment would modify Technical Specification Table 2.2-1, “Reactor Trip System Instrumentation Trip Setpoints,” and Technical Specification Table 3.3-4, “Engineered Safety Features Actuation System Instrumentation Trip Setpoints,” to optimize safety analysis margin in the Final Safety Analysis Report Chapter 15 transient analyses.

The Nuclear Regulatory Commission (NRC) staff has reviewed the application and concluded that the information delineated in the enclosure to their letter dated September 6, 2018 (ADAMS Accession No. ML18242A162), is necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment in terms of regulatory requirements for ensuring that instrument setpoints are initially within, and remain within, the Technical Specification limits. In response to the request for supplemental information, HNP is submitting the enclosed additional information to support acceptance review of the proposed amendment.

The content of this supplemental correspondence does not change the No Significant Hazards Consideration provided in the original submittal.

No regulatory commitments are contained in this letter.

In accordance with 10 CFR 50.91(b), HNP is providing the state of North Carolina with a copy of this supplemental correspondence.

Should you have any questions regarding this submittal, please contact Jeffery Robertson, HNP Regulatory Affairs Manager, at (919) 362-3137.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 24, 2018.

Sincerely,

Bentley K. Jones

Bentley K. Jones

cc: J. Zeiler, NRC Senior Resident Inspector, HNP
W. L. Cox, III, Section Chief N.C. DHSR
M. Barillas, NRC Project Manager, HNP
C. Haney, NRC Regional Administrator, Region II

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RA-18-0171

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT NO. 1
DOCKET NO. 50-400 / RENEWED LICENSE NO. NPF-63

SUPPLEMENTAL INFORMATION FOR LICENSE AMENDMENT REQUEST
REGARDING REACTOR TRIP SYSTEM AND ENGINEERED SAFETY FEATURES
ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

Enclosure
(23 pages including cover)

By letter dated July 30, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18211A546), Duke Energy Progress, LLC (Duke Energy), requested an amendment to the Technical Specifications (Tech Specs) of Renewed Facility Operating License No. NPF-63 for Shearon Harris Nuclear Power Plant, Unit 1 (HNP). The proposed license amendment would modify Tech Spec Table 2.2-1, “Reactor Trip System Instrumentation Trip Setpoints,” and Tech Spec Table 3.3-4, “Engineered Safety Features Actuation System Instrumentation Trip Setpoints,” to optimize safety analysis margin in the Final Safety Analysis Report Chapter 15 transient analyses.

During the Nuclear Regulatory Commission (NRC) staff’s acceptance review of the requested license amendment, the NRC staff found the application contained an insufficiency and supplemental information has been requested to enable the NRC staff to make an independent assessment regarding the acceptability of the proposed amendment in terms of regulatory requirements for ensuring that instrument setpoints are initially within, and remain within, the Tech Spec limits. In response to the request for supplemental information, HNP is submitting the enclosed additional information to support acceptance review of the proposed amendment.

Request for Supplemental Information #1

Description of the methodology used for the calculation of the Total Allowance (TA), Z Term, Sensor Error (S), Trip Setpoint (TS), and Allowable Value (AV) for the proposed Technical Specifications including Functional Units Nos. 12, 2.a, 9, 10, 7, 8, and 1.d as discussed in Tables 1 through 7 of the LAR [license amendment request].

Duke Energy Response #1

Tech Spec TSs and AVs for Reactor Trip System (RTS) and Engineered Safety Features Actuation System (ESFAS) instrumentation are determined using the generic methodology established in Sections 9.8.2.2 and 9.8.2.4 of Duke Energy procedure EGR-NGGC-0153, “Engineering Instruments Setpoints.” The most recent revision of this procedure (Revision 12) was submitted to the NRC as Attachment 4 of H.B. Robinson Steam Electric Plant, Unit 2, letter dated February 10, 2014 (ADAMS Accession No. ML14052A065). This procedure is utilized when preparing instrument uncertainty calculations, including HNP setpoint calculation HNP-I/INST-1010, “Evaluation of RTS/ESFAS Tech Spec Related Setpoints, Allowable Values, and Uncertainties,” portions of which have been previously submitted to the NRC in HNP letters dated May 18, 2001, and August 25, 2011 (ADAMS Accession Nos. ML011450219, ML11243A121 and ML11243A122, respectively). HNP-I/INST-1010 delineates the channel statistical allowance (CSA) and the “five-column” Tech Spec terms, as established by the original engineering methodology and operability determination bases contained in Westinghouse Letter Report FCQL-355, “Westinghouse Setpoint Methodology for Protection Systems, Shearon Harris,” for each RTS/ESFAS Trip Setpoint function. This setpoint calculation was used as the basis for the calculations summarized in Response #3 below and the values provided in Tables 1 through 7 of the original LAR submittal.

The methodology uses a CSA to compute the total channel uncertainty. The components of the CSA include the “square root of the sum of the squares” error components of the total loop, including the sensor errors, rack errors, process measurement accuracies, and measurement and test equipment (M&TE) errors; any applicable biases are added algebraically. This combined analysis method is provided in Section 9.6.2.3 of EGR-NGGC-0153. The CSA term is the equivalent of the Total Loop Uncertainty.

<u>**Request for Supplemental Information #2**</u>

For the methodology described in (1),

a. A list of regulatory guidance and standards that the methodology followed.
b. Description of the assumptions or changes in assumptions for the calculation, including the bases for new or changed assumptions.
c. Description of the types of errors (e.g., instrument errors, environmental errors (including harsh environments), electromagnetic interference/radio frequency interference errors, power supply errors, process errors, measurement and test errors, drift, etc.). Include a specific list of the uncertainties and the magnitude of each uncertainty that are deemed to have been double counted in the thermo-hydraulic analysis, and in the instrument setpoint and loop accuracy calculations.

Duke Energy Response #2a

EGR-NGGC-0153, in its entirety, implements, in part, the HNP commitment to Regulatory Guide 1.105, “Instrument Setpoints”, Revision 1. The uncertainty methodology described in the procedure is based on ANSI/ISA-67.04.01-2000, “Setpoints for Nuclear Safety-Related Instrumentation” and ISA-RP67-04.02-2000, “Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation.”

Duke Energy Response #2b

No changes to the calculation methodology are proposed for the RTS and ESFAS instrumentation trip setpoints amendment request. With the exception of the Reactor Coolant Flow – Low trip function, this request preserves the existing TSs and updates individual uncertainty terms to calculate new analytical limits/safety analysis limits (SAL). The Reactor Coolant Flow – Low Tech Spec reactor TS is adjusted to provide additional margin to address a future reduction in Reactor Coolant System (RCS) minimum flow as discussed in Section 3.1 of Attachment 1 to the LAR. As a result, the individual uncertainty terms were changed to reflect a change in the Tech Spec reactor TS, plant configuration, or the basis for the term. The uncertainty terms and calculations are described in Response #3. The new or changed assumptions are addressed below, and are bolded both below and in Response #3.

<u>Functional Unit No. 12 – Reactor Coolant Flow – Low</u>

The process measurement accuracy (PMA) term is reduced from 0.4% span to **0.3% span** due to a reduction in the assumed automatic rod control uncertainty allowance from 6.8˚F to **5.1˚F** to better match the calculated automatic rod control uncertainty, +4.9/-4.0 ˚F. The sensor and rack uncertainty terms are reduced slightly due to the increase in the Reactor Coolant Flow – Low Tech Spec TS from 90.5% to 91.7%. The sensor and rack uncertainty terms are originally given in ΔP span, and are converted to % flow span to calculate the CSA. The conversion factor C from ΔP span to % flow span decreased due to the increase in the TS as follows:

$$C_{old} = \frac{\%FlowSpan}{Low\ Flow\ TS * 2} = \frac{120}{90.5 * 2} = 0.663$$

$$C_{new} = \frac{\%FlowSpan}{Low\ Flow\ TS * 2} = \frac{120}{\mathbf{91.7} * 2} = \mathbf{0.654}$$

Functional Unit No. 2.a – Power Range, Neutron Flux – High Setpoint

A reduction in the NI [nuclear instrumentation] system component uncertainty from 5% RTP [Rated Thermal Power] to **3.2% RTP** is described in Section 3.2 of Attachment 1 to the LAR. The previous value of 5% RTP contained transient NI terms (e.g., downcomer attenuation, rod shadow effects) that are now accounted for explicitly in the transient analyses. This is a more conservative treatment of the transient effects as it results in an additive adjustment to power uncertainty versus the statistical treatment by keeping those effects in the PMA_2 term. When those transient effects are zeroed out, the remaining PMA term is calibration of the excore detectors to the power calorimetric, which must remain within 2% RTP per Tech Spec Table 4.3-1 Note 2. This term is adjusted to be the maximum that it can be between when the excore detectors are calibrated at 70% RTP and the nominal trip setpoint of 108% RTP. The resultant PMA_2 term is 3.2% RTP. Term PMA_2 in Table 3.2 of Response #3 accounts for this reduced uncertainty term. The conversion from % RTP to % span is as follows:

PMA_2 = (**3.2 % RTP**) / 120 % RTP x 100% Span = **2.667 % span**

Functional Unit No. 9 – Pressurizer Pressure – Low

No changes are made to the component system uncertainties of this reactor trip function. The TA is reduced to reduce the SAL while retaining greater than 1% calculation margin (CM).

Functional Unit No. 10 – Pressurizer Pressure – High

No changes are made to the component uncertainties of this reactor trip function. The TA is reduced to reduce the SAL while retaining greater than 1% CM.

Functional Unit No. 7 – Overtemperature ΔT (OTΔT)

As described in Section 3.4a of Attachment 1 to the LAR, a decrease in the K_3 setpoint from 0.0012/psig to **0.001/psig** is planned. The reduction in K_3 causes a decrease in Conv2, the conversion factor from % pressure span to % ΔT span. The reduction in Conv2 reduces pressurizer pressure uncertainty terms input to the trip function given in Table 3.5 of Response #3. Note that although the input to the OTΔT reactor trip function is unitless $\Delta T/\Delta T_0$, it is considered to have the unit %RTP for this factor. Conv2 is calculated as follows:

$$Conv2_{old} = K_3 * Prz\ Span/\Delta T\ Span = \frac{0.12\%RTP}{psig} * \frac{800\ psig}{100\%\ Prz\ Span} * \frac{100\%\ \Delta T\ Span}{150\%\ RTP} = 0.64$$

$$Conv2_{new} = \frac{\mathbf{0.10\%RTP}}{psig} * \frac{800\ psig}{100\%\ Prz\ Span} * \frac{100\%\ \Delta T\ Span}{150\%\ RTP} = \mathbf{0.533}$$

The basis for term pma_{budt}, the ΔT burndown bias term, is changed from a bounding calculation to a quarterly surveillance limit consistent with the HNP surveillance procedure. As described in Section 3.4a of Attachment 1 to the LAR, this increases the bias term from 0.6˚F to **0.7˚F**, or from 0.64% ΔT span to **0.74% ΔT span** (100% ΔT span = 94.2 ˚F). This change is reflected in Table 3.5 of Response #3.

Functional Unit No. 8 – Overpower ΔT (OPΔT)

The basis for term pma_{budt}, the ΔT burndown bias term, is changed from a bounding calculation to a quarterly surveillance limit consistent with the HNP surveillance procedure. As described in Section 3.4b of Attachment 1 to the LAR, this increases the bias term from 0.6˚F to **0.7˚F**, or from 0.64% ΔT span to **0.74% ΔT span**. This change is reflected in Table 3.6 of Response #3.

Functional Unit No. 1.d – Safety Injection, Pressurizer Pressure – Low

No changes are made to the component uncertainties of this ESFAS. The TA is reduced to reduce the SAL while retaining greater than 1% CM.

Duke Energy Response #2c

A description of the errors and the magnitude of the associated uncertainties are provided in Tables 3.1 through 3.7 in Response #3. Table 2.1 below provides a description of the initial condition uncertainties used in the calculation of the HNP statistical design limit (SDL) which are relevant to this discussion per Section 3.0 of Attachment 1 to the LAR. The calculation of the SDL follows the statistical core design (SCD) methodology described in DPC-NE-2005-P-A, "Thermal-Hydraulic Statistical Core Design Methodology." This is provided for information only; the calculations provided in Response #3 do not adjust or remove terms which are deemed to be double counted, and therefore do not impact the Tech Spec changes proposed in the LAR.

Table 2.1
Uncertainty Terms Assumed in Calculation of the SDL (SCD Method)

Parameter	**Uncertainty**	**Description**
Reactor Power	±0.34% RTP	Uncertainty associated with a power calorimetric performed using the LEFM [Leading Edge Flow Meter].
RCS Flow Rate	±2.2% flow	Uncertainty associated with the RCS flow calorimetric used to satisfy the Tech Spec minimum RCS flow requirement.
Pressurizer Pressure	±50 psi*	Calculated as the pressurizer pressure control uncertainty plus an operational allowance.
Reactor Average Temperature	±5.0 ˚F*	Uncertainty associated with automatic rod control, including a 1.5˚F controller deadband.

* These uncertainties have increased since Appendix I of DPC-NE-2005-P-A was reviewed and approved.

Uncertainty terms common to the SDL and the TSs are described in Response #3. The instrument setpoint and loop accuracy calculations conservatively assume a reactor power uncertainty of 2.0% based on a calorimetric performed with the less accurate feedwater venturis. The instrument setpoint and loop accuracy calculations assume an automatic rod control uncertainty of 5.1˚F, while the SDL assumes 5.0˚F. The calculated automatic rod control uncertainty is +4.9/-4.0 ˚F, so both assumed values are conservative.

Request for Supplemental Information #3

A summary of the calculations of the TA, Z Term, S, TS, and AV for the proposed Technical Specifications, including Functional Unit Nos. 12, 2.a, 9, 10, 7, 8, and 1.d as discussed in Tables 1 through 7 of the LAR.

Duke Energy Response #3

Table 1 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 12, Reactor Coolant Flow – Low. The inputs to the calculation of the requested terms are listed below in Table 3.1. All **bolded** values represent values that are different than the terms currently being used.

Table 3.1
Uncertainty Terms for Functional Unit No. 12 – Reactor Coolant Flow – Low

Uncertainty Term	Value (% Flow Span)	Used in SDL
PMA1 = process measurement accuracy	**0.3**	X
PMA2 = process measurement accuracy	1.33	X
PEA = primary element accuracy	0.33	
SMTE = sensor M&TE uncertainty	0.0	
SD = sensor drift	**0.49**	
STE = sensor temperature effect	0.0	
SPE = sensor pressure effect	0.0	
SCA = sensor accuracy	0.0	
SRA = sensor reference accuracy	**0.16**	
RMTE = rack M&TE	0.33	
RD = rack drift	**0.65**	
RTE = rack temperature effect	0.33	
RCA = rack accuracy	0.33	
EA = environmental allowance	0.0	
SEISMIC = seismic allowance	0.0	
BIAS = calorimetric flow measurement	0.13	
CSA = channel statistical allowance	**2.06**	

Term PMA_1 is the sensitivity of cold leg density to temperature and pressure. It is calculated by the following:

PMA_1 = [(Cold leg pressure effect x Pressure Uncertainty)^2 + (Cold leg temperature effect x Temperature Uncertainty)^2]$^{1/2}$

= [(0.00077% flow/psi x **50 psi**)^2 + (0.0704% flow/˚F x **5.1˚F**)^2]$^{1/2}$ / 120 % flow x 100% span

= **0.3% Span**

Term PMA_2 is the RCS flow calorimetric uncertainty without the inclusion of bias terms. In response to NRC Request 2.c above, PMA_1 is a function of the temperature and pressure uncertainty assumed in the SDL and PMA_2 is a component of the 2.2% RCS flow calorimetric uncertainty assumed in the SDL as described in Table 2.1.

The uncertainty terms listed in Table 3.1 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 12 as follows:

CSA = [$(PMA_1)^2 + (PMA_2)^2$ + (PEA)^2 + (SMTE + SD)^2 + (STE)^2 + (SPE)^2 + (SRA)^2 + (SCA + SMTE)^2 + (RMTE + RD)^2 + (RTE)^2 + (RCA+RMTE)^2]$^{1/2}$ + CalorimetricBias

= [(**0.30**)^2 + (1.33)^2 + (0.33)^2 + (0.0 + **0.49**)^2 + (0.0)^2 + (0.0)^2 + (**0.16**)^2 + (0.0 + 0.0)^2 + (0.33 + **0.65**)^2 + (0.33)^2 + (0.33 + 0.33)^2]$^{1/2}$ + 0.13

= **2.06 % Flow Span**

TS = **91.7% RCS Flow**

SAL = **88.0% RCS Flow**

TA = (TS – SAL) = (**91.7 – 88.0**) / 120 % flow x 100% Flow Span = **3.08 % Flow span**

CM = (TA – CSA) = **3.08 – 2.06** = **1.02 % Flow Span**

S = [(SD) + (SCA)] = [(**0.49**) + (0.00)] = **0.49 % Flow Span**

Z = (A)$^{1/2}$ + Biases

= [$(PMA_1)^2 + (PMA_2)^2$ + (PEA)^2 + (SPE)^2 + (STE)^2 + (RTE)^2]$^{1/2}$ + CalorimetricBias

= [(**0.30**)^2 + (1.33)^2 + (0.33)^2 + (0.0)^2 + (0.0)^2 + (0.33)^2]$^{1/2}$ + 0.13

= **1.58% Flow Span** (rounded up)

R = T, which is the lesser of:

T_1 = (RD + RCA) = [(**0.65**) + (0.33)] = **0.98 % Flow Span**

T_2 = (TA – S – Z) = [(**3.08**) – (**0.49**) – (**1.58**)] = **1.01 % Flow Span**

AV = (TS – R) = [(**91.7**) – (**0.98** x 120 % Flow / 100% Flow Span)] = **90.6 % RCS Flow** (rounded up)

Table 2 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 2.a, Power Range, Neutron Flux – High Setpoint. The inputs to the calculation of the requested terms are listed below in Table 3.2.

Table 3.2
Uncertainty Terms for Functional Unit No. 2.a – Power Range, Neutron Flux – High Setpoint

Uncertainty Term	Value (% Span)	Used in SDL
PMA1 = calorimetric uncertainty	1.667	
PMA2 = detector uncertainty	**2.667**	
PEA = primary element accuracy	0.0	
SMTE = sensor (NI) M&TE uncertainty	0.0	
SD = sensor (NI) drift	0.0	
STE = sensor (NI) temperature effect	0.0	
SPE = sensor (NI) pressure effect	0.0	
SCA = sensor (NI) accuracy	0.0	
SRA = sensor reference accuracy	0.0	
RMTE = rack M&TE	0.05	
RD = rack drift	1.0	
RTE = rack temperature effect	0.83	
RCA = rack accuracy	0.5	
EA = environmental allowance	0.0	
SEISMIC = seismic allowance	0.0	
BIAS	0.0	
CSA = channel statistical allowance	**3.46**	

Term PMA_1, calorimetric uncertainty, is based on the 2% RTP (1.667 % span) uncertainty associated with performing a power calorimetric using feedwater venturis. The feedwater venturis are used in the event the Ultrasonic LEFMs are unavailable, which is conservatively assumed for all analyses initiated from less than 98.3% RTP, the pre-MUR [Measurement Uncertainty Recapture] uprate RTP of 2900 MWth.

In response to NRC Request 2.c above, the SCD assumes a 0.34% power calorimetric uncertainty associated with performing a power calorimetric using LEFMs. As the power calorimetric uncertainty assumed in the calculation of the SDL is smaller than that assumed in the trip CSA, no double counting is considered to have occurred.

The uncertainty terms listed in Table 3.2 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 2.a as follows:

CSA = $[\ (PMA_1)^2 + (PMA_2)^2 + (PEA)^2 + (SMTE + SD)^2 + (STE)^2 + (SPE)^2 + (SRA)^2 + (SCA + SMTE)^2 + (RMTE + RD)^2 + (RTE)^2 + (RCA+RMTE)^2\ ]^{1/2}$

= $[\ (1.667)^2 + (\mathbf{2.667})^2 + (0.0)^2 + (0.0 + 0.0)^2 + (0.0)^2 + (0.0)^2 + (0.0)^2 + (0.0 + 0.0)^2 + (0.05 + 1.0)^2 + (0.83)^2 + (0.5 + 0.05)^2\ ]^{1/2}$

= **3.46 % Span**

TS = 108.0% RTP

SAL = **113.5% RTP**

TA = (SAL – TS) = **113.5** – 108.0 / 120 % RTP x 100% Span = **4.58 % Span**

CM = TA – CSA = **4.58** – **3.46** = **1.12 % Span**

S = [(SD) + (SCA)] = [(0.00) + (0.00)] = 0.00 % Span

Z = $(A)^{1/2}$ + Biases

= $[\ (PMA_1)^2 + (PMA_2)^2 + (PEA)^2 + (SPE)^2 + (STE)^2 + (RTE)^2\ ]^{1/2}$

= $[\ (1.667)^2 + (\mathbf{2.667})^2 + (0.0)^2 + (0.0)^2 + (0.0)^2 + (0.83)^2\ ]^{1/2}$

= **3.25% Span**

R = T, which is the lesser of:

T_1 = (RD + RCA) = [(1.00) + (0.50)] = 1.50 % Span

T_2 = (TA – S – Z) = [(**4.58**) – (0.0) – (**3.25**)] = **1.33 % Span**

AV = (TS + R) = [(108.0) + (**1.33** x 120 % RTP / 100% Span)] = **109.60 % RTP**

Table 3 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 9, Pressurizer Pressure – Low. The inputs to the calculation of the requested terms are listed below in Table 3.3.

Table 3.3
Uncertainty Terms for Functional Unit No. 9 – Pressurizer Pressure – Low

Uncertainty Term	Value (% Span)	Used in SDL
PMA = process measurement accuracy	0.0	X
PEA = primary element accuracy	0.0	X
SMTE = sensor M&TE uncertainty	0.71	X
SD = sensor drift	1.00	X
STE = sensor temperature effect	1.4375	X
SPE = sensor pressure effect	0.0	X
SCA = sensor accuracy	0.5	X
SRA = sensor reference accuracy	0.25	X
RMTE = rack M&TE	0.5	X
RD = rack drift	1.0	X
RTE = rack temperature effect	0.5	X
RCA = rack accuracy	0.5	X
EA = environmental allowance	0.0	X
SEISMIC = seismic allowance	0.0	X
BIAS	0.0	X
CSA = channel statistical allowance	3.16	

In response to NRC Request 2.c above, no terms from the Pressurizer Pressure – Low trip function are directly used in calculation of the 50 psi pressurizer pressure uncertainty input to the SDL. The trip function utilizes a Rosemount pressure transmitter and the automatic pressurizer pressure control system utilizes a Barton pressure transmitter. However, use of the SDL with the analytical limit of the Pressurizer Pressure – Low trip setpoint effectively penalizes safety analyses by the uncertainty of the trip function and the uncertainty of automatic pressurizer pressure system. As these are independent systems measuring the same control variable their uncertainty is not additive. The uncertainty assumed in the Pressurizer Pressure – Low trip function is therefore considered double counted. This determination does not affect the calculation of the new Tech Spec TA for the Pressurizer Pressure – Low trip function proposed in the LAR.

The uncertainty terms listed in Table 3.3 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 9 as follows:

CSA = $[(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (STE)^2 + (SPE)^2 + (SRA)^2 + (SCA + SMTE)^2 + (RMTE + RD)^2 + (RTE)^2 + (RCA+RMTE)^2]^{1/2}$

= $[(0.0)^2 + (0.0)^2 + (0.71 + 1.00)^2 + (1.4375)^2 + (0.0)^2 + (0.25)^2 + (0.5 + 0.71)^2 + (0.5 + 1.0)^2 + (0.5)^2 + (0.5 + 0.5)^2]^{1/2}$

= 3.16 % Span

TS = 1960 psig

SAL = **1923 psig**

TA = (TS – SAL) = (1960 – **1923**) / 800 psi x 100% Span = **4.625 % Span**

CM = TA – CSA = **4.625** – 3.16 = **1.46 % Span** (rounded down)

S = [(SD) + (SCA)] = [(1.0) + (0.5)] = 1.50 % Span

Z = $(A)^{1/2}$ + Biases

= $[(PMA)^2 + (PEA)^2 + (SPE)^2 + (STE)^2 + (RTE)^2]^{1/2}$

= $[(0.0)^2 + (0.0)^2 + (0.0)^2 + (1.4375)^2 + (0.5)^2]^{1/2}$

= 1.52% Span

R = T, which is the lesser of:

T_1 = (RD + RCA) = [(1.00) + (0.50)] = 1.50 % Span

T_2 = (TA – S – Z) = [(**4.62**) – (1.5) – (1.52)] = **1.60 % Span**

AV = (TS – R) = [(1960.0) – (1.50 x 800 psi / 100% Span)] = 1948.0 psig

Table 4 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 10, Pressurizer Pressure – High. The inputs to the calculation of the requested terms are listed below in Table 3.4.

Table 3.4
Uncertainty Terms for Functional Unit No. 10 – Pressurizer Pressure – High

Uncertainty Term	Value (% Span)	Used in SDL
PMA = process measurement accuracy	0.0	X
PEA = primary element accuracy	0.0	X
SMTE = sensor M&TE uncertainty	0.71	X
SD = sensor drift	1.00	X
STE = sensor temperature effect	1.4375	X
SPE = sensor pressure effect	0.0	X
SCA = sensor accuracy	0.5	X
SRA = sensor reference accuracy	0.25	X
RMTE = rack M&TE	0.5	X
RD = rack drift	1.0	X
RTE = rack temperature effect	0.5	X
RCA = rack accuracy	0.5	X
EA = environmental allowance	0.0	X
SEISMIC = seismic allowance	0.0	X
BIAS	0.0	X
CSA = channel statistical allowance	3.16	

In response to NRC Request 2.c above, no terms from the Pressurizer Pressure – High trip function are directly used in calculation of the 50 psi pressurizer pressure uncertainty input to the SDL. The trip function utilizes a Rosemount pressure transmitter and the automatic pressurizer pressure control system utilizes a Barton pressure transmitter. However, use of the SDL with the analytical limit of the Pressurizer Pressure – High trip setpoint effectively penalizes safety analyses by the uncertainty of the trip function and the uncertainty of automatic pressurizer pressure system. As these are independent systems measuring the same control variable their uncertainty is not additive. The uncertainty assumed in the Pressurizer Pressure – High trip function is therefore considered double counted. This determination does not affect the calculation of the new Tech Spec TA for the Pressurizer Pressure – High trip function proposed in the LAR.

The uncertainty terms listed in Table 3.4 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 10 as follows:

CSA = [$(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (STE)^2 + (SPE)^2 + (SRA)^2 + (SCA + SMTE)^2 + (RMTE + RD)^2 + (RTE)^2 + (RCA+RMTE)^2$]$^{1/2}$

= [$(0.0)^2 + (0.0)^2 + (0.71 + 1.00)^2 + (1.4375)^2 + (0.0)^2 + (0.25)^2 + (0.5 + 0.71)^2 + (0.5 + 1.0)^2 + (0.5)^2 + (0.5 + 0.5)^2$]$^{1/2}$

= 3.16 % Span

TS = 2385 psig

SAL = **2422 psig**

TA = (SAL – TS) = (**2422** – 2385) / 800 psi x 100% Span = **4.625 % Span**

CM = TA – CSA = **4.625** – 3.16 = **1.46 % Span** (rounded down)

S = [(SD) + (SCA)] = [(1.0) + (0.5)] = 1.50 % Span

Z = $(A)^{1/2}$ + Biases

= [$(PMA)^2 + (PEA)^2 + (SPE)^2 + (STE)^2 + (RTE)^2$]$^{1/2}$

= [$(0.0)^2 + (0.0)^2 + (0.0)^2 + (1.4375)^2 + (0.5)^2$]$^{1/2}$

= 1.52% Span

R = T, which is the lesser of:

T_1 = (RD + RCA) = [(1.00) + (0.50)] = 1.50 % Span

T_2 = (TA – S – Z) = [(**4.62**) – (1.5) – (1.52)] = **1.60 % Span**

AV = (TS + R) = [(2385.0) + (1.50 x 800 psi / 100% Span)] = 2397.0 psig

Table 5 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 7, Overtemperature ΔT. The inputs to the calculation of the requested terms are listed in Table 3.5. The Overtemperature ΔT reactor trip function is complex with many inputs, so for clarity, only the non-zero uncertainty terms are presented in Table 3.5 and the subsequent calculations.

The Overtemperature ΔT reactor trip takes inputs from pressurizer pressure, reactor average temperature, ΔT, and ΔI [flux difference]. Each of these uncertainty sources requires a different conversion factor to convert to % ΔT span. The conversion factors used to convert uncertainty terms to % ΔT span are given in Table 3.5. The conversion factors are as follows:

Conv1 = Conversion factor from % R/E span to % ΔT span = % R/E span / % ΔT span

= (120 ˚F / 100% R/E span) / (94.2 ˚F / 100% ΔT span)

= 1.274 % ΔT span / % R/E span

Conv2 = Conversion factor from % pressure span to % ΔT span = K_3 x % Pressure Span / % ΔT span

= (**0.1 %RTP / psi**) x (800 psi / 100% pressure span) / (150% RTP / 100% ΔT span)

= **0.533 % ΔT span / % pressure span**

Conv3 = Conversion factor from % Tavg span to % ΔT span = K_2 x % Tavg Span / % ΔT span

= (2.24 %RTP / ˚F) x (100 ˚F / 100% Tavg span) / (150% RTP / 100% ΔT span)

= 1.493 % ΔT span / % Tavg span

Conv4 = Conversion factor from % ΔI span to % ΔT span = % ΔI span x ΔI gain / % ΔT span

= (120 % ΔI / 100% ΔI span) x (150% RTP / 100% ΔI) / (150% RTP / 100% ΔT span)

= 1.2 % ΔT span / % ΔI span

Table 3.5
Uncertainty Terms for Functional Unit No. 7 – Overtemperature ΔT

Uncertainty Term	Value (% ΔT Span)	Conversion Factor	Used in SDL
$PMA_{\Delta I1}$ = Tech Spec Incore / Excore Mismatch	3.00	1% ΔT span / %ΔI	
$PMA_{\Delta I2}$ = Incore Map ΔI Uncertainty	1.30	1% ΔT span / %ΔI	
PMA_{cal} = Power Calorimetric Uncertainty	1.33	0.67 % ΔT span / %RTP	
srartd = ΔT reference accuracy	0.21	1.06% ΔT span / ˚F	X
relin = R/E non-linearity uncertainty	0.25	Conv1	X
dtrcal = ΔT rack calibration uncertainty	0.35	–	
dtrmte = ΔT rack MT&E uncertainty	0.26	–	
dtrte = ΔT rack temperature effect	0.50	–	
dtrd = ΔT rack drift limit	1.00	–	
Tavg_rca = Tavg rack calibration uncertainty	0.52	Conv3	X
Tavg_mte = Tavg rack MT&E uncertainty	0.39	Conv3	X
Tavg_rd = Tavg rack drift limit	1.49	Conv3	X
rcal_ΔI = ΔI rack calibration uncertainty	0.12	Conv4	
rmte_ΔI = ΔI rack MT&E uncertainty	0.085	Conv4	
rrd_ΔI = ΔI rack drift limit	0.60	Conv4	
sra_ps = Pressurizer pressure sensor accuracy	**0.13**	**Conv2**	X
sca_ps = Pressurizer pressure sensor calibration uncertainty	**0.27**	**Conv2**	X
smte_ps = Pressurizer pressure sensor MT&E uncertainty	**0.38**	**Conv2**	X
ste_ps = Pressurizer pressure sensor temperature effect	**0.77**	**Conv2**	X
sd_ps = Pressurizer pressure sensor drift limit	**0.53**	**Conv2**	X
rcal_ps = Pressurizer pressure rack calibration uncertainty	**0.05**	**Conv2**	X
rmte_ps = Pressurizer pressure rack MT&E uncertainty	**0.11**	**Conv2**	X
rrd_ps = Pressurizer pressure rack drift limit	**0.27**	**Conv2**	X
pma_{budt} = ΔT burndown effect	**0.74**	1.06% ΔT span / ˚F	X
pma_{butavg} = T_{avg} burndown effect	0.45	Conv3	X
pma_{Tavg_asym} = T_{avg} asymmetry	1.49	Conv3	
pma_{TP_Tr} = Allowance for mismatch between T’ and T_{ref}	1.05	Conv3	
CSA = channel statistical allowance	8.39	–	

In response to NRC Request 2.c above, the RTD [Resistance Temperature Detector] and Tavg uncertainty terms and components of pma_{budt} and pma_{butavg} are inputs to the automatic rod control uncertainty calculation which are used in the calculation of the SDL. These terms are therefore considered double counted. Additionally, the pressurizer pressure terms are comprised of the same sensor error terms and smaller rack uncertainty terms than those in the Pressurizer Pressure – Low and Pressurizer Pressure – High trip functions. The 50 psi uncertainty assumed in the SDL is therefore considered double counted for the same reason discussed for those trip functions. As with the Neutron Flux – High Tech Spec setpoint above, the SDL accounts for 0.34% LEFM power uncertainty while the PMA_{cal} term is based on the 2% RTP (1.33% ΔT span) power uncertainty associated with the feedwater venturis. Hence, no double counting is considered for the power calorimetric uncertainty.

The uncertainty terms listed in Table 3.5 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 7. Aggregate sensor error and rack error terms are calculated first:

S_{RTD} = $[(\text{srartd})^2 / (\text{\# of cold leg RTDs}) + (\text{srartd})^2 / (\text{\# of hot leg RTDs})]^{0.5}$

= $[(0.21)^2 / (1) + (0.21)^2 / (3)]^{0.5}$

= 0.25% ΔT span (rounded up)

relin' = $[(\text{relin})^2 / (\text{\# of cold leg RTDs}) + (\text{relin})^2 / (\text{\# of hot leg RTDs})]^{0.5}$

= $[(0.25)^2 / (1) + (0.25)^2 / (3)]^{0.5}$

= 0.29% ΔT span

r_{dt} = $[(\text{dtrmte} + \text{dtrd})^2 + (\text{dtrte})^2 + (\text{dtrcal} + \text{dtrmte})^2]^{0.5}$

= $[(0.26 + 1.00)^2 + (0.50)^2 + (0.35 + 0.26)^2]^{0.5}$

= 1.49% ΔT span

r_{Tavg} = $[(\text{Tavg\_mte} + \text{Tavg\_rd})^2 + (\text{Tavg\_rca} + \text{Tavg\_mte})^2]^{0.5}$

= $[(0.39 + 1.49)^2 + (0.52 + 0.39)^2]^{0.5}$

= 2.09% ΔT span

$r_{\Delta I}$ = $[(\text{rmte\_}\Delta\text{I} + \text{rrd\_}\Delta\text{I})^2 + (\text{rcal\_}\Delta\text{I} + \text{rmte\_}\Delta\text{I})^2]^{0.5}$

= $[(0.085 + 0.60)^2 + (0.12 + 0.085)^2]^{0.5}$

= 0.72% ΔT span

S_{PRZ} = $[(\text{smte\_ps} + \text{sd\_ps})^2 + (\text{ste\_ps})^2 + (\text{sra\_ps})^2 + (\text{sca\_ps} + \text{smte\_ps})^2]^{0.5}$

= $[(\mathbf{0.38} + \mathbf{0.53})^2 + (\mathbf{0.77})^2 + (\mathbf{0.13})^2 + (\mathbf{0.27} + \mathbf{0.38})^2]^{0.5}$

= **1.36% ΔT span**

r_{prz} = [(rmte_ps + rrd_ps)^2 + (rcal_ps + rmte_ps)^2]$^{0.5}$

= [(**0.11** + **0.27**)^2 + (**0.05** + **0.11**)^2]$^{0.5}$

= **0.41% ΔT span**

Using the aggregate terms, the CSA is calculated as follows, allowing for calculation of the TA, Z Term, S, TS, and AV for Functional Unit 7:

CSA = [$(PMA_{\Delta I1})^2 + (PMA_{\Delta I2})^2 + (PMA_{cal})^2 + (S_{RTD})^2 + (relin')^2 + (S_{PRZ})^2 + (r_{dt})^2 + (r_{Tavg})^2 + (r_{prz})^2 + (r_{\Delta I})^2$]$^{1/2}$ + $pma_{budt} + pma_{butavg} + pma_{Tavg\_asym} + pma_{TP\_Tr}$

= [(3.00)^2 + (1.30)^2 + (1.33)^2 + (0.25)^2 + (0.29)^2 + (**1.36**)^2 + (1.49)^2 + (2.09)^2 + (**0.41**)^2 + (0.72)^2]$^{1/2}$+ **0.74** + 0.45 + 1.49 + 1.05

= **8.39 % ΔT Span**

TS = 118.5 % RTP (K_1 = 1.185)

SAL = 132.0 % RTP (K_1 = 1.32)

TA = (SAL – TS) = (132 – 118.5) / (150% RTP / 100% ΔT Span) = 9.0 % ΔT Span

CM = TA – CSA = 9.0 – **8.39** = **0.61 % ΔT Span**

S_{prz} = Sensor Error for Pressurizer Pressure = [(sd_ps) + (sca_ps)]

= [(**0.53**) + (**0.27**)] = **0.8 % ΔT span**

S_{temp} = Sensor Error for $\Delta T/T_{avg}$ = S_{RTD} = 0.25% ΔT Span (current Tech Spec value is retained)

Z = (A)$^{1/2}$ + Biases

= [$(PMA_{\Delta I1})^2 + (PMA_{\Delta I2})^2 + (PMA_{cal})^2$ + (ste_ps)^2 + (dtrte)^2]$^{1/2}$ + $pma_{budt} + pma_{butavg} + pma_{Tavg\_asym} + pma_{TP\_Tr}$

= [(3.00)^2 + (1.30)^2 + (1.33)^2 + (**0.77**)^2 + (0.5)^2]$^{1/2}$ + **0.74** + 0.45 + 1.49 + 1.05

= **7.38% ΔT Span**

$AV_{\Delta T}$ = [(dtrd) + (dtrcal)] = [(1.0) + (0.35)] = 1.35% ΔT span ≈ 1.4% ΔT span

AV_{Tavg} = [(Tavg_rd) + (Tavg_rca)] / Conv3 = [(1.49) + (0.52)] / 1.493 = 1.35% Tavg span

AV_{prz} = [(rrd_ps) + (rcal_ps)] / Conv2 = [(**0.27**) + (**0.05**)] / **0.533** = 0.6% pressure span

$AV_{\Delta I}$ = [(rrd_ΔI) + (rcal_ΔI)] / Conv4 = [(0.6) + (0.12)] / 1.2 = 0.6% ΔI span

Table 6 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 8, Overpower ΔT. The inputs to the calculation of the requested terms are listed below in Table 3.6. The Overpower ΔT reactor trip function is complex with many inputs, so for clarity, only the non-zero uncertainty terms are presented in Table 3.6 and the subsequent calculations.

The Overpower ΔT reactor trip takes inputs from reactor average temperature and ΔT. Each of these uncertainty sources requires a different conversion factor to convert to % ΔT span. The conversion factors used to convert uncertainty terms to % ΔT span is given in Table 3.6. The conversion factors are as follows:

Conv1 = Conversion factor from % R/E span to % ΔT span = % R/E span / % ΔT span

= (120 ˚F / 100% R/E span) / (94.2 ˚F / 100% ΔT span)

= 1.274 % ΔT span / % R/E span

Conv2 = Conversion factor from % Tavg span to % ΔT span = K_6 x % Tavg Span / % ΔT span

= (0.2 %RTP / ˚F) x (100 ˚F / 100% Tavg span) / (150% RTP / 100% ΔT span)

= 0.133 % ΔT span / % Tavg span

Table 3.6
Uncertainty Terms for Functional Unit No. 8 – Overpower ΔT

Uncertainty Term	Value (% ΔT Span)	Conversion Factor	Used in SDL
PMA_{cal} = Power Calorimetric Uncertainty	1.33	0.67 % ΔT span / %RTP	
srartd = ΔT reference accuracy	0.21	1.06% ΔT span / ˚F	X
relin = R/E non-linearity uncertainty	0.25	Conv1	X
dtrcal = ΔT rack calibration uncertainty	0.35	–	
dtrmte = ΔT rack MT&E uncertainty	0.26	–	
dtrte = ΔT rack temperature effect	0.50	–	
dtrd = ΔT rack drift limit	1.00	–	
Tavg_rca = Tavg rack calibration uncertainty	0.05	Conv2	X
Tavg_mte = Tavg rack MT&E uncertainty	0.04	Conv2	X
Tavg_rd = Tavg rack drift limit	0.13	Conv2	X
pma_{budt} = ΔT burndown effect	**0.74**	1.06% ΔT span / ˚F	X
pma_{butavg} = T_{avg} burndown effect	0.04	Conv2	X
pma_{Tavg_asym} = T_{avg} asymmetry	0.13	Conv2	
pma_{TP_Tr} = Allowance for mismatch between T' and T_{ref}	0.09	Conv2	
CSA = channel statistical allowance	3.04	–	

In response to NRC Request 2.c above, the RTD and Tavg uncertainty terms and components of pma_{budt} and pma_{butavg} are inputs to the automatic rod control uncertainty calculation which is used in the calculation of the SDL. These terms are therefore considered double counted. As with the Neutron Flux – High Tech Spec setpoint above, the SDL accounts for a 0.34% LEFM power uncertainty while the PMA_{cal} terms is based on the 2% RTP (1.33% ΔT span) power uncertainty associated with the feedwater venturis. Hence, no double counting is considered for the power calorimetric uncertainty.

The uncertainty terms listed in Table 3.6 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 8. Aggregate sensor error and rack error terms are calculated first:

$$S_{RTD} = [\ (srartd)^2 / (\#\text{ of cold leg RTDs}) + (srartd)^2 / (\#\text{ of hot leg RTDs})\ ]^{0.5}$$

$$= [\ (0.21)^2 / (1) + (0.21)^2 / (3)\ ]^{0.5}$$

$$= 0.25\%\ \Delta T\text{ span (rounded up)}$$

$$r_{dt} = [\ (dtrmte + dtrd)^2 + (dtrte)^2 + (dtrcal + dtrmte)^2\ ]^{0.5}$$

$$= [\ (0.26 + 1.00)^2 + (0.50)^2 + (0.35 + 0.26)^2\ ]^{0.5}$$

$$= 1.49\%\ \Delta T\text{ span}$$

$$r_{Tavg} = [\ (Tavg\_mte + Tavg\_rd)^2 + (Tavg\_rca + Tavg\_mte)^2\ ]^{0.5}$$

$$= [\ (0.04 + 0.13)^2 + (0.05 + 0.04)^2\ ]^{0.5}$$

$$= 0.19\%\ \Delta T\text{ span}$$

$$relin' = [\ (relin)^2 / (\#\text{ of cold leg RTDs}) + (relin)^2 / (\#\text{ of hot leg RTDs})\ ]^{0.5}$$

$$= [\ (0.25)^2 / (1) + (0.25)^2 / (3)\ ]^{0.5}$$

$$= 0.29\%\ \Delta T\text{ span}$$

Using the aggregate terms, the CSA is calculated as follows, allowing for calculation of the TA, Z Term, S, TS, and AV for Functional Unit 8:

$$CSA = [\ (PMA_{cal})^2 + (S_{RTD})^2 + (relin')^2 + (r_{dt})^2 + (r_{Tavg})^2\ ]^{1/2} + pma_{budt} + pma_{butavg} + pma_{Tavg\_asym} + pma_{TP\_Tr}$$

$$= [\ (1.33)^2 + (0.25)^2 + (0.29)^2 + (1.49)^2 + (0.19)^2\ ]^{1/2} + \mathbf{0.74} + 0.04 + 0.13 + 0.09$$

$$= \mathbf{3.04\ \%\ \Delta T\ Span}\text{ (rounded up)}$$

TS = **110.0 % RTP (K_4 = 1.10)**

SAL = **115.0 % RTP (K_4 = 1.15)**

TA = (SAL – TS) = (**115 – 110**) / 150% RTP x 100% Span = **3.33 % ΔT Span**

CM = TA – CSA = **3.33 – 3.04** = **0.29 % ΔT Span**

S_{temp} = Sensor Error for $\Delta T/T_{avg}$ = S_{RTD} = 0.25% ΔT Span (current Tech Spec value is retained)

Z = $(A)^{1/2}$ + Biases

= $[\,(PMA_{cal})^2 + (dtrte)^2\,]^{1/2} + pma_{budt} + pma_{butavg} + pma_{Tavg\_asym} + pma_{TP\_Tr}$

= $[\,(1.33)^2 + (0.5)^2\,]^{1/2}$ + **0.74** + 0.04 + 0.13 + 0.09

= **2.43% ΔT Span** (rounded up)

$AV_{\Delta T}$ = [(dtrd) + (dtrcal)] = [(1.0) + (0.35)] = 1.35% ΔT span ≈ 1.4% ΔT span

AV_{Tavg} = [(Tavg_rd) + (Tavg_rca)] / Conv2 = [(0.13) + (0.05)] / 0.133 = 1.35% Tavg span

The allowable value for ΔI is taken from the Overtemperature ΔT calculation. Because the term is presented in ΔI span, it is independent of ΔI gain.

$AV_{\Delta I}$ = 0.6% ΔI span

Table 7 of Attachment 1 to the LAR describes a proposed change to Tech Spec Functional Unit No. 1.d, Safety Injection, Pressurizer Pressure – Low. The inputs to the calculation of the requested terms are listed below in Table 3.7. A harsh environment is assumed, resulting in an 8.0% span temperature bias and a 0.95% span radiation bias.

Table 3.7
Uncertainty Terms for Functional Unit No. 1.d – Safety Injection, Pressurizer Pressure – Low

Uncertainty Term	Value (% Span)	Used in SDL
PMA = process measurement accuracy	0.0	
PEA = primary element accuracy	0.0	
SMTE = sensor M&TE uncertainty	0.71	
SD = sensor drift	1.00	
STE = sensor temperature effect	1.4375	
SPE = sensor pressure effect	0.0	
SCA = sensor accuracy	0.5	
SRA = sensor reference accuracy	0.25	
RMTE = rack M&TE	0.5	
RD = rack drift	1.0	
RTE = rack temperature effect	0.5	
RCA = rack accuracy	0.5	
EA = environmental allowance, temperature	8.0	
SEISMIC = seismic allowance	0.0	
BIAS = radiation allowance	0.95	
CSA = channel statistical allowance	12.11	

The Safety Injection, Pressurizer Pressure – Low setpoint is outside the applicable range of the SDL, so no double counting is considered to have occurred.

The uncertainty terms listed in Table 3.7 are used to calculate the TA, Z Term, S, TS, and AV for Functional Unit No. 1.d as follows:

CSA = $[(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (STE)^2 + (SPE)^2 + (SRA)^2 + (SCA + SMTE)^2 + (RMTE + RD)^2 + (RTE)^2 + (RCA+RMTE)^2]^{1/2} + EA + BIAS$

= $[(0.0)^2 + (0.0)^2 + (0.71 + 1.00)^2 + (1.4375)^2 + (0.0)^2 + (0.25)^2 + (0.5 + 0.71)^2 + (0.5 + 1.0)^2 + (0.5)^2 + (0.5 + 0.5)^2]^{1/2} + 8.0 + 0.95$

= 12.11 % Span

TS = 1850 psig

SAL = **1742 psig**

TA = (TS – SAL) = (1850 – **1742**) / 800 psi x 100% Span = **13.5 % Span**

CM = TA – CSA = **13.5** – 12.11 = **1.39 % Span**

S = [(SD) + (SCA)] = [(1.0) + (0.5)] = 1.50 % Span

Z = $(A)^{1/2}$ + Biases

= $[(PMA)^2 + (PEA)^2 + (SPE)^2 + (STE)^2 + (RTE)^2]^{1/2} + EA + BIAS$

= $[(0.0)^2 + (0.0)^2 + (0.0)^2 + (1.4375)^2 + (0.5)^2]^{1/2} + 8.0 + 0.95$

= 10.47% Span

R = T, which is the lesser of:

T_1 = (RD + RCA) = [(1.00) + (0.50)] = 1.50 % Span

T_2 = (TA – S – Z) = [(**13.5**) – (1.5) – (10.47)] = **1.53 % Span**

AV = (TS – R) = [(1850) – (1.50 x 800 psi / 100% Span)] = 1838.0 psig

Request for Supplemental Information #4

On page 3 of Attachment 1 to the LAR it is stated that “part of the CSA [channel statistical allowance] is already included in the DNB [departure from nucleate boiling] limit.” Please provide a discussion of the equations and calculations used to determine CSA with sufficient information to support this statement. The requested CSA information is applicable to the proposed Technical Specifications, including Functional Unit Nos. 12, 2.a, 9, 10, 7, 8, and 1.d as discussed in Tables 1 through 7 of the LAR.

Duke Energy Response #4

The uncertainties included in the SDL which are relevant to the LAR are provided in Response #2c. The equations and calculations used to determine the CSA for each Tech Spec functional unit impacted by the LAR are provided in Response #3. Where applicable, uncertainty terms common to the SDL and Tech Spec functional units are described in Response #3 to highlight the terms which Duke Energy believes to be double counted. This is provided for information only; the calculations provided in Response #3 do not adjust or remove terms which are deemed to be double counted, and therefore do not impact the Tech Spec changes proposed in the LAR.