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May 23, 2022

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

10 CFR 50.90

SUSQUEHANNA STEAM ELECTRIC STATION RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT TO REVISE REACTOR STEAM DOME PRESSURE – LOW INSTRUMENTATION FUNCTION ALLOWABLE VALUE
PLA-8005

Docket No. 50-387 and 50-388

References:

1) *Susquehanna letter to NRC, "Proposed Amendment to Licenses NPF-14 and NPF-22: Revise Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Value (PLA-7950)," dated October 5, 2021 (ADAMS Accession No. ML21279A026).*

2) *Susquehanna letter to NRC, "Supplement to License Amendment to Revise Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Value (PLA-7979)," dated December 16, 2021 (ADAMS Accession No. ML21350A265).*

3) *NRC letter to Susquehanna, "Regulatory Audit Plan in Support of License Amendment Request to Revise Technical Specifications for Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Values (EPID L-2021-LLA-0062)," dated March 4, 2022 (ADAMS Accession No. ML22056A012).*

4) *NRC email to Susquehanna, "NRC Request for Additional Information – Susquehanna License Amendment Request (EPID L-2021-LLA-0184)," dated April 21, 2022 (ADAMS Accession No. ML22111A313).*

Pursuant to 10 CFR 50.90, Susquehanna Nuclear, LLC (Susquehanna), submitted, in Reference 1, a request for an amendment to the Technical Specifications (TS) for the

Susquehanna Steam Electric Station (SSES), Units 1 and 2, Facility Operating License numbers NPF-14 and NPF-22. The proposed amendment would modify TS 3.3.5.1, Emergency Core Cooling Systems (ECCS) Instrumentation. Specifically, the proposed amendment would modify the TS Allowable Values (AVs) for the ECCS Instrumentation, Core Spray and Low Pressure Coolant Injection Reactor Steam Dome Pressure – Low Instrumentation Functions 1.c, 1.d, 2.c, and 2.d, in TS Table 3.3.5.1-1. Susquehanna provided supplemental information in Reference 2, including revised TS markups which superseded those provided in Reference 1 in their entirety.

In Reference 3, the NRC notified Susquehanna of the intent to conduct a virtual regulatory audit from March 9 through April 29, 2022. During the virtual audit, Susquehanna personnel met with members of the NRC staff to discuss specific questions provided by the NRC staff. Upon completion of the regulatory audit, the NRC provided a Request for Additional Information (RAI) in Reference 4. Enclosure 1 provides Susquehanna's response to the RAI. Enclosure 2 provides calculation excerpts referenced in the RAI response in Enclosure 1.

Susquehanna has reviewed the information supporting a finding of No Significant Hazards Consideration and the Environmental Consideration provided to the NRC in Reference 1 and determined the information provided herein does not impact the original conclusions in Reference 1.

There are no new or revised regulatory commitments contained in this submittal.

Should you have any questions regarding this submittal, please contact Ms. Melisa Krick, Manager – Nuclear Regulatory Affairs, at (570) 542-1818.

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

Executed on May 23, 2022.

K. Cimorelli

Enclosures:

1. Response to Request for Additional Information
2. Calculation Excerpts

Copy: NRC Region I
Mr. C. Highley, NRC Senior Resident Inspector
Ms. A. Klett, NRC Project Manager
Mr. M. Shields, PA DEP/BRP

Enclosure 1 to PLA-8005

Response to Request for Additional Information

Response to Request for Additional Information

On October 5, 2021, Susquehanna Nuclear, LLC (Susquehanna) submitted a license amendment request (LAR) for the Susquehanna Steam Electric Station (SSES) in Reference 1. Specifically, Susquehanna requested a revision to Technical Specification (TS) 3.3.5.1, "Emergency Core Cooling Systems (ECCS) Instrumentation." The proposed amendment would modify the TS Allowable Values (AVs) for the ECCS Instrumentation, Core Spray and Low Pressure Coolant Injection (LPCI) Reactor Steam Dome Pressure – Low Instrumentation Functions 1.c, 1.d, 2.c, and 2.d, in TS Table 3.3.5.1-1. Susquehanna provided supplemental information in Reference 2, including revised TS markups which superseded those provided in Reference 1 in their entirety. In Reference 3, the NRC notified Susquehanna of the intent to conduct a virtual regulatory audit from March 9 through April 29, 2022. During the virtual audit, Susquehanna personnel met with members of the NRC staff to discuss specific questions provided by the NRC staff. Upon completion of the regulatory audit, the NRC provided a Request for Additional Information (RAI) in Reference 4. The response to this RAI is provided below.

RAI-1

In its license amendment request, the licensee proposed to increase the upper analytical limit (UAL) from the current value of 440 pounds per square inch gauge (psig) to 445 psig. The NRC staff requests the licensee to describe how it calculated the proposed UAL of 445 psig and justify the acceptability of the proposed UAL. The staff requests the licensee to include the information from the licensee's audit question response posted in the audit portal.

Susquehanna Response

The UAL for this submittal was determined using the same approach as that currently approved by the NRC.

When the proposed UAL was developed, the head of water (approximately 50 psi) that would be present in the both the Residual Heat Removal (RHR) and Core Spray systems was taken into account. The RHR and Core Spray piping systems have a design pressure of 450 psig and 500 psig, respectively. The American Society of Mechanical Engineers (ASME) Code allows for a "maximum pressure" of the piping under Emergency/Faulted service levels. The current maximum pressure of the RHR piping is 495 psig which when accounting for the 50 psi of water head yields a UAL of 445 psig. The current maximum pressure of the Core Spray system is 550 psig which when accounting for the 50 psi of water head yields an UAL of 500 psig. These maximum pressures for the RHR and Core Spray piping still meet Code requirements. The bounding RHR system UAL was used. This was the same approach used to develop the current TS UALs except the RHR piping was reanalyzed for a maximum pressure of 495 psig instead of 490 psig (previous value).

The pressure associated with the head of water in each system was determined in the following manner. A head of water was assumed from the reactor vessel (elevation 780.8') to the Core Spray (plant elevation 649.83') or RHR pump discharge check valve (plant elevation 651.54'). This yields a water column of approximately 130 ft. The water column is divided into two distinct zones by the closed containment isolation valve (HV1(2)51F015A/B for RHR and HV1(2)52F005A/B for Core Spray). Upon reaching a steam dome pressure of 445 psig the containment isolation valves could open, thereby exposing the low pressure piping to this reactor pressure. The piping in the reactor building is assumed to be at reactor building conditions when determining the pressure associated with this column of water. The piping within containment and also the head of water in the reactor vessel is assumed to be at saturated reactor conditions (445 psig) given that it is directly tied to the reactor vessel and the recirculation loops prior to the containment valve opening. Note that these assumptions are the same as previously approved by the NRC.

The UAL values described above continue to provide substantial margin. First, the RHR system discharge piping was hydrostatically tested to 1.25x the design pressure (i.e., tested at 562.5 psig). Second, the LOCA (e.g., hydrodynamic) and seismic loads occur concurrently when the reactor pressure has not encroached on the UAL. Therefore, when the Core Spray and RHR valves begin to open, the hydrodynamic and seismic loads will not be present. This results in substantial margin in the piping analyses and would allow for a significantly higher UAL.

Based on this discussion, the head of water was accounted for in the analysis and substantial margin still exists for the piping system.

RAI-2

The NRC staff requests the licensee to provide the following information pertaining to the calculations posted in the audit portal.

a. Pages 14 to 21 of Appendix A to Calculation EC-080-1006, Revision 3, for Unit 1.

b. Pages 14 to 21 of Appendix A to Calculation EC-080-1007, Revision 4, for Unit 2.

Susquehanna Response

The requested calculation excerpts are provided in Enclosure 2 to this letter. Note that the revision bars in the excerpts denote changes from the versions of the calculations used to support Susquehanna's original submittal in Reference 1, which were superseded by the versions of the calculations used to support the supplement in Reference 2. The revision bars do not denote changes from what was provided during the regulatory audit.

References

1. Susquehanna letter to NRC, "Proposed Amendment to Licenses NPF-14 and NPF-22: Revise Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Value (PLA-7950)," dated October 5, 2021 (ADAMS Accession No. ML21279A026).

2. Susquehanna letter to NRC, "Supplement to License Amendment to Revise Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Value (PLA-7979)," dated December 16, 2021 (ADAMS Accession No. ML21350A265).

3. NRC letter to Susquehanna, "Regulatory Audit Plan in Support of License Amendment Request to Revise Technical Specifications for Reactor Steam Dome Pressure – Low Instrumentation Function Allowable Values (EPID L-2021-LLA-0062)," dated March 4, 2022 (ADAMS Accession No. ML22056A012).

4. NRC email to Susquehanna, "NRC Request for Additional Information – Susquehanna License Amendment Request (EPID L-2021-LLA-0184)," dated April 21, 2022 (ADAMS Accession No. ML22111A313).

Enclosure 2 to PLA-8005

Calculation Excerpts

Susquehanna Calculations

EC-080-1006, Revision 3, Appendix A
Pages 14-21

EC-080-1007, Revision 4, Appendix A
Pages 14-21

Appendix A

Setpoint Determination to Support TS Change

(LDCNs 5633-5636, PLAs-7950 and 7979)

Objective: This appendix will determine new Analytical Limit, Allowable Value, Nominal Trip Setpoint, Process (Device) Setpoint, and As-Found and As-Left Tolerances for installed Core Spray and RHR – LPCI Injection on Low Reactor Vessel Pressure, PISB211N021A-D. These new setpoints support the Technical Specification change submittal to the NRC (LDCNs 5633 – 5636, PLAs-7950 and 7979).

Description: Barton 288 dP switches are used in a gauge pressure application to monitor reactor steam dome pressure. These switches provide a low pressure permissive for LPCI and Core Spray system injection and high-pressure isolation of the LPCI/CS injection lines to protect them from overpressure. The Allowable Value for these setpoints are controlled in the Technical Specifications; the nominal trip setpoints are controlled in the Technical Requirements Manual.

The switches' normal operating pressure is the reactor steam dome pressure plus the sensing line head, referenced to atmosphere.

The switches are not being replaced as part of the Technical Specification change.

Conclusions and Recommendations

Instrument PSB211N021	**AL (psig)**	**AV (psig)**	**NTSP (psig)**	**DS (psig)**	**t_{AL} (psi)**	**t_{AF} (psi)**
A - LOWER	≥ 380	≥ 382	412.5	426.1	±5	16.0
A - UPPER	≤ 445	≤ 443				16.0
B - LOWER	≥ 380	≥ 382	412.5	425.2	±5	16.0
B - UPPER	≤ 445	≤ 443				16.0
C - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
C - UPPER	≤ 445	≤ 443				16.0
D - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
D - UPPER	≤ 445	≤ 443				16.0

Assumptions / Inputs

1. DCP 97-9076 replaced the original Barksdale pressure switch with a Barton pressure indicating switch.

2. The core spray and RHR piping contains both high and low pressure piping. To prevent over-pressure of the low pressure piping on these systems, the systems contain a check valve on the high pressure piping to prevent over pressure of the low pressure piping (RHR Check Valve – HV1(2)51F050A/B and Core Spray – HV1(2)52F006A/B). In the Technical Specification change submittal to the NRC (LDCNs 5633 – 5636 and PLAs-7950 and 7979), these check valves are credited as the single failure proof method of preventing over-pressurization of the low pressure piping. Since the check valves provide over pressure protection, the reactor pressure open permissive for the system injection valves (RHR Injection Valve – HV1(2)51F015A/B and Core Spray – HV1(2)52F005A/B) and the reactor pressure permissive for the RHR and Core Spray pump starts are being removed from the Technical Specifications. Note the maximum developed head of the RHR and Core Spray pumps will not cause a pipe over

pressure condition. Even though the reactor pressure open permissive for the system injection valves and the core spray and RHR reactor pressure pump start permissive are being removed from the plant Technical Specifications, the permissive logic is still required per FSAR Section 7.3 and will be maintained in the plant. The NRC has requested supplemental information (NRC ADAMS ascension number ML21316A124) on the original SSES submittal request. After discussion with the NRC, SSES has decided to re-implement the upper pressure permissive limit (PLA-7979).

3. Lower Analytical Limit: 380 psig section 7.3 (EC-FUEL-1452 revision 21). During the DBE, the core spray/LPCI injection valves begin to stroke open at 380 psig and the vessel continues to depressurize during the valve stroke. Thus, when the valves are full open, the vessel pressure is low enough to allow CS/LPCI injection (at injection pressures specified in EC-FUEL-1452 revision 21).

Upper Analytical Limit: 445 psig. In the NRC SER for Unit 2 TS Amendment 155 (NIMS document ID NRC 2000-0022, ADAMS ascension number ML010160354), the NRC states:

> "The CS system and LPCI system initiation logic has a low-pressure permissive function which prevents the CS system injection valves HV-252-F005A/B and the LPCI system injection valves HV-251-F017A/B from opening until reactor pressure has decreased to the system's design pressure."

A review of the NIMS data base determined that the RHR and Core Spray system design basis system piping pressure is 450 psig and 500 psig, respectively. The selection of 445 psig as the Upper Analytical Limit provides margin to the RHR system design pressure (note core spray design pressure is bounded by the RHR system) consistent with the NRC SER.

4. This calculation will follow the methodology in NEDC-31336 (calculation EC-PUPC-1004).

5. Per FSAR Section 7.3, the upper allowable value is low enough that the reactor dome pressure has fallen to a value below the core spray and RHR/LPCI maximum allowable piping pressure to preclude piping failure. The lower allowable value is high enough to ensure that the ECCS injection prevents the fuel peak cladding temperature from exceeding the limits of 10 CFR 50.46.

Method

Analytical Limit

> Upper Analytical Limit: The upper analytical limit used in the analysis is 445 psig which, as stated in Assumption 3, meets the requirements of the previous NRC SER. Calculation EC-PIPE-16071 provides additional information justifying the selected upper analytical limit.
>
> Lower Analytical Limit: Per assumption 3 of this appendix, the lower analytical is 380 psig.

Allowable Value (AV)

The Allowable Value is determined from the Analytic Limit, the device accuracy, and the calibration accuracy per the guidance in NEDC-31336 Section 1.2.3.2.

$AV_{LOWER} \geq AL_{LOWER} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + PMA^2 + PEA^2)^{½}$

$AV_{UPPER} \leq AL_{UPPER} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + PMA^2 + PEA^2)^{½}$

Where:

n = the number of standard deviations (σ) used in specifying the individual components of uncertainty.

1.645 is the Z value for a one-sided normal distribution in order to achieve a 95% probability of success (i.e., AL avoidance)

Accuracy of Repeatability (A_{acc})

A_{acc} is the accuracy (repeatability) of the Barton 288A (differential) pressure indicating switches. The 2σ (95%) value for switch "accuracy of repeatability" is ±0.25% of full scale (IOM 311 Volume 3, tab 15, p. 294)

The "2σ" value of $A_{acc-2\sigma}$ = ±0.25%(500 psig) = ±1.25 psig

The "1σ" value of $A_{acc-1\sigma} = A_{acc-2\sigma}/2$ = ±0.625 psig

Calibration Error (C_{acc})

The calibration error (C_{acc}) is associated with the repeatability of the measurement and test equipment used to calibrate the instrument. Uncertainties in reading the M&TE output are also relevant factors.

A conservative calibration error 1σ factor (C_{acc}) equivalent to the instrument error ($A_{acc1\sigma}$) is assumed.

Process Measurement Accuracy (PMA)

PMA is defined in GE NEDC-31336 (calculation EC-PUPC-1004) section 1.2.1 as the process variable measurement effects (e.g., the effect of changing fluid density on level measurement) aside from the primary element and sensor. There are no effects due to changing conditions associated with this parameter and it can be considered 0 for this application.

Primary Element Accuracy (PEA)

PEA is defined in GE NEDC-31336 (calculation EC-PUPC-1004) section 1.2.1 as the accuracy of the device (exclusive of the sensor) which is in contact with the process, resulting in some form of interaction (e.g., in an orifice meter, the orifice plate, adjacent parts of the pipe and the pressure connections constitute the primary element). There are no interactions due to contact with the process that would impact the accuracy of the device. This parameter is considered 0 for this application.

Allowable Values

Upper and Lower Analytic limits for the reactor vessel pressure setpoint

AL_{upper} = 445 psig

AL_{lower} = 380 psig

Allowable Values are offset from the Analytic Limits by allowances for the accuracy of switch repeatability (A_{acc}) and the calibration error (C_{acc}) per GE-NEDC-31336 (Section 1.2.3.2). Note that the Process Measurement Accuracy (PMA) and the Process Element Accuracy (PEA) = 0

$AV_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2)^{½}$ where n = 1 (σ value multiplier)

$AV_{upper} = 445 – 1.645/1 * (0.625^2 + 0.625^2)^{½}$

AV_{upper} = 443.55 psig

$AV_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2)^{½}$ where n = 1 (σ value multiplier)

$AV_{lower} = 380 + 1.645/1 * (0.625^2 + 0.625^2)^{½}$

AV_{lower} = 381.45 psig

Conservatively, LDCNs 5633 – 5636 and PLAs-7950 and 7979 will use a Lower Allowable Value of greater than or equal to 382 psig and an Upper Allowable Vale of less than or equal to 443 psig.

Nominal Trip Setpoints

Per GE NEDC-31336 (Section 1.2.3.3), the Nominal Trip Setpoint associated with each Analytic Limit is determined by:

$NTSP_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

Where D = Drift Allowance

Attachment 1 calculated the instrument drift of the Barton 288A pressure switches and determined the drift value to be 6.07 psig based on actual plant data. Based on information in EC-080-1014 revision 0 provided by the vendor, a drift value of 10 psig is more appropriate when temperature effects are included. The pertinent parts of EC-080-1014 are reproduced here:

The device setpoint drift associated with temperature variation has been determined by the manufacturer to be 0.83% (of Span) per 50°F change in ambient (device) temperature.

The annual ambient temperature range in Rooms I/II-401, I-500, and I/II-512 is approximately 30°F (Calculation EC EQQL-1004). The setpoint drift will be assumed to occur over this maximum variation.

Therefore, the temperature drift, D_T is:

D_T = 0.83%(30F/50F)*1057psi (note current span is 500 psi but data is for a span of 1057 psi which is conservatively used)

D_T = 5.26 psi

Relative Humidity Drift D_{RH},

The device setpoint drift associated with humidity variation has been determined by the manufacturer to be 0.26% (of Span) per 30% change in ambient Relative Humidity.

The design basis summer outside air temperature is 92°F dry bulb and 78°F wet bulb. Assuming that the room is 10°F warmer than outside air, the corresponding relative humidity is 45% in the room, rounded up to 50% RH. In the winter outside air has a higher humidity but once that air is heated it becomes very dry, the C-1815 lower limit is 10% RH. Therefore, a change of 40% RH is the maximum expected change at the device location.

D_{RH} = 0.26%(40%/30%)*1057 psi

D_{RH} = 3.66 psi

Time-Dependent Drift, D_{TD}

Because the temperature and Relative Humidity drift testing took place over an extended period of time, the time-dependent drift is considered to be included in the Temperature and Relative Humidity drift factors.

For conservatism a nominal drift of D_{TD} = 2 psi is assumed.

Total Drift D

The temperature related drift (D_T) and humidity related drift (D_{RH}) are dependent variables and are therefore added together. The sum of these drifts is RMS combined with the time dependent drift (D_{TD}) to determine the total drift (D).

$D = ((D_T + D_{RH})^2 + D_{TD}^2)^{0.5}$

$D = ((5.26 \text{ psi} + 3.66 \text{ psi})^2 + 2^2)^{0.5}$

D = 9.15 psi conservatively 10 psi

Therefore, a drift value of 10 psig will be used.

Therefore, the Nominal Trip Setpoint limits are:

$NTSP_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{upper} = 445 – 1.645/1 * (0.625^2 + 0.625^2 + 10^2)^{½}$

$NTSP_{upper}$ = 428.5 psig

$NTSP_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{lower} = 380 + 1.645/1 * (0.625^2 + 0.625^2 + 10^2)^{½}$

$NTSP_{lower} = 396.5$ psig

The Nominal Trip Setpoint will be established at the midpoint of the Upper and Lower NTSP.

NTSP = (428.5 psig + 396.5 psig)/2 = 412.5 psig

As Found Tolerance (t_{AF})

The NTSP allows a nominal $t_{AF\text{-}UPPER}$ and $t_{AF\text{-}LOWER}$= 30.5 psig

$t_{AF\text{-}UPPER} = AV_{upper} – NTSP$ = 443 psig – 412.5 psig = 30.5 psig

$t_{AF\text{-}LOWER} = NTSP – AV_{lower}$ = 412.5 psig – 382 psig = 30.5 psig

Device Setpoint (DS)

The Device Setpoint (DS) is the NTSP offset by the static head in the sensing line

$DS = NTSP + P_{HC}$

Head Correction

The reference leg static head pressure determined by EC-INST-4039, EC-INST-4040, EC-INST-1509 and EC-INST-1510.

PIS-B21-1N021	Calc	P_{HC} (psi) Upper	P_{HC} (psi) Lower
A	EC-INST-1509	13.6	13.6
B	EC-INST-4039	12.7	12.7
C	EC-INST-1510	23.0	21.4
D	EC-INST-4040	23.0	21.4

PIS-B21-1N021C, D are measured from a RPV Level sensing line variable tap, so the static head is variable with the water level in the RPV (see EC-INST-1510 and EC-INST-4040). This setpoint is most likely to be reached with low water level in the Reactor Vessel, so the Lower head correction value is used. The setpoint is offset by <2 psi at higher reactor water level.

PIS-B21-1N021	NTSP (psig)	P_{HC} (psi)	DS (psig)
A	412.5	13.6	426.1
B	412.5	12.7	425.2
C	412.5	21.4	433.9
D	412.5	21.4	433.9

As-Left Tolerance

The As-Left tolerance is the allowed variation in the device setpoint that will remain within the range of acceptable setpoints. This range is the difference between the upper and lower NTSP limits.

$t_{AL}^* < \pm (NTSP_{UPPER} - NTSP_{LOWER})/2$

$t_{AL}^* < \pm (428.5 - 396.5)/2$

$t_{AL}^* < \pm 16.0$ psi

* Because of switch stability issues, the As-Left Tolerance should be minimized. Historically ± 5 psi has been used (see SI-1/280-301).

Results:

Instrument PSB211N021	AL (psig)	AV (psig)	NTSP (psig)	DS (psig)	t_{AL} (psi)	t_{AF} (psi)
A - LOWER	≥ 380	≥ 382	412.5	426.1	±5	16.0
A - UPPER	≤ 445	≤ 443				16.0
B - LOWER	≥ 380	≥ 382	412.5	425.2	±5	16.0
B - UPPER	≤ 445	≤ 443				16.0
C - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
C - UPPER	≤ 445	≤ 443				16.0
D - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
D - UPPER	≤ 445	≤ 443				16.0

Technical Specifications (TS) and Technical Requirements Manual (TRM)

The current Technical Specification setpoint and Allowable Values are specified in LCO Table 3.3.5.1-1 (last changed Amendment 155).

ECCS System	Table 3.3.5.1-1 Function	AV Lower Current	AV Lower Proposed	AV Upper Current	AV Upper Proposed
Core Spray	1.c, 1.d	≥ 407 psig	≥ 382 psig	≤ 433 psig	≤ 443 psig
LPCI	2.c, 2.d	≥ 407 psig	≥ 382 psig	≤ 433 psig	≤ 443 psig

The Allowable Value limits determined in this appendix ($AV_{LOWER} \geq 401.45$ psig and $AV_{UPPER} \leq 438.5$ psig) are conservative with respect to the current and proposed TS.

The current TRM Nominal Trip Setpoint limits (TRM Date 02/02/2010) are specified in Table 2.2-1:

ECCS System	Table 2.2-1 Function	Lower NTSP Current	NTSP Lower Proposed	NTSP Upper Current	NTSP Upper Proposed
Core Spray	2.2.3.1.3	≥ 413 psig	≥ 396.5 psig	≤ 427 psig	≤ 428.5 psig
LPCI	2.2.3.2.3	≥ 413 psig	≥ 396.5 psig	≤ 427 psig	≤ 428.5 psig

Appendix A

Setpoint Determination to Support TS Change

(LDCNs 5633-5636, PLAs-7950 and 7979)

Objective: This appendix will determine new Analytical Limit, Allowable Value, Nominal Trip Setpoint, Process (Device) Setpoint, and As-Found and As-Left Tolerances for installed Core Spray and RHR – LPCI Injection on Low Reactor Vessel Pressure, PISB212N021A-D. These new setpoints support the Technical Specification change submittal to the NRC (LDCNs 5633 – 5636 and PLAs-7950 and 7979).

Description: Barton 288 dP switches are used in a gauge pressure application to monitor reactor steam dome pressure. These switches provide a low pressure permissive for LPCI and Core Spray system injection and high-pressure isolation of the LPCI/CS injection lines to protect them from overpressure. The Allowable Value for these setpoints are controlled in the Technical Specifications; the nominal trip setpoints are controlled in the Technical Requirements Manual.

The switches' normal operating pressure is the reactor steam dome pressure plus the sensing line head, referenced to atmosphere.

The switches are not being replaced as part of the Technical Specification change.

Conclusions and Recommendations

Instrument PSB212N021	AL (psig)	AV (psig)	NTSP (psig)	DS (psig)	t_{AL} (psi)	t_{AF} (psi)
A - LOWER	≥ 380	≥ 382	412.5	426.1	±5	16.0
A - UPPER	≤ 445	≤ 443				16.0
B - LOWER	≥ 380	≥ 382	412.5	425.2	±5	16.0
B - UPPER	≤ 445	≤ 443				16.0
C - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
C - UPPER	≤ 445	≤ 443				16.0
D - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
D - UPPER	≤ 445	≤ 443				16.0

Assumptions / Inputs

1. DCP 97-9076 replaced the original Barksdale pressure switch with a Barton pressure indicating switch.

2. The core spray and RHR piping contains both high and low pressure piping. To prevent over-pressure of the low pressure piping on these systems, the systems contain a check valve on the high pressure piping to prevent over pressure of the low pressure piping (RHR Check Valve – HV1(2)51F050A/B and Core Spray – HV1(2)52F006A/B). In the Technical Specification change submittal to the NRC (LDCNs 5633 – 5636, PLAs-7950 and 7979), these check valves are credited as the single failure proof method of preventing over-pressurization of the low pressure piping. Since the check valves provide over pressure protection, the reactor pressure open permissive for the system injection valves (RHR Injection Valve – HV1(2)51F015A/B and Core Spray – HV1(2)52F005A/B) and the reactor pressure permissive for the RHR and Core Spray pump starts are being removed from the Technical Specifications. Note the maximum developed head of the RHR and Core Spray pumps will not cause a pipe over pressure condition.

Even though the reactor pressure open permissive for the system injection valves and the core spray and RHR reactor pressure pump start permissive are being removed from the plant Technical Specifications, the permissive logic is still required per FSAR Section 7.3 and will be maintained in the plant. The NRC has requested supplemental information (NRC ADAMS ascension number ML21316A124) on the original SSES submittal request. After discussion with the NRC, SSES has decided to re-implement the upper pressure permissive limit (PLA-7979).

3. Lower Analytical Limit: 380 psig section 7.3 (EC-FUEL-1452 revision 21). During the DBE, the core spray/LPCI injection valves begin to stroke open at 380 psig and the vessel continues to depressurize during the valve stroke. Thus, when the valves are full open, the vessel pressure is low enough to allow CS/LPCI injection (at injection pressures specified in EC-FUEL-1452 revision 21).

Upper Analytical Limit: 445 psig. In the NRC SER for Unit 2 TS Amendment 155 (NIMS document ID NRC 2000-0022, ADAMS ascension number ML010160354), the NRC states:

> "The CS system and LPCI system initiation logic has a low-pressure permissive function which prevents the CS system injection valves HV-252-F005A/B and the LPCI system injection valves HV-251-F017A/B from opening until reactor pressure has decreased to the system's design pressure."

A review of the NIMS data base determined that the RHR and Core Spray system design basis system piping pressure is 450 psig and 500 psig, respectively. The selection of 445 psig as the Upper Analytical Limit provides margin to the RHR system design pressure (note core spray design pressure is bounded by the RHR system) consistent with the NRC SER.

4. This calculation will follow the methodology in NEDC-31336 (calculation EC-PUPC-1004).

5. Per FSAR Section 7.3, the upper allowable value is low enough that the reactor dome pressure has fallen to a value below the core spray and RHR/LPCI maximum allowable piping pressure to preclude piping failure. The lower allowable value is high enough to ensure that the ECCS injection prevents the fuel peak cladding temperature from exceeding the limits of 10 CFR 50.46.

Method

Analytical Limit

> Upper Analytical Limit: The upper analytical limit used in the analysis is 445 psig which, as stated in Assumption 3, meets the requirements of the previous NRC SER. Calculation EC-PIPE-16071 provides additional information justifying the selected upper analytical limit.
>
> Lower Analytical Limit: Per assumption 4 of this appendix, the lower analytical is 380 psig.

Allowable Value (AV)

The Allowable Value is determined from the Analytic Limit, the device accuracy, and the calibration accuracy per the guidance in NEDC-31336 Section 1.2.3.2.

$AV_{LOWER} \geq AL_{LOWER} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + PMA^2 + PEA^2)^{½}$

$AV_{UPPER} \leq AL_{UPPER} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + PMA^2 + PEA^2)^{½}$

Where:

n = the number of standard deviations (σ) used in specifying the individual components of uncertainty.

1.645 is the Z value for a one-sided normal distribution in order to achieve a 95% probability of success (i.e., AL avoidance)

Accuracy of Repeatability (A_{acc})

A_{acc} is the accuracy (repeatability) of the Barton 288A (differential) pressure indicating switches. The 2σ (95%) value for switch "accuracy of repeatability" is ±0.25% of full scale (IOM 311 Volume 3, tab 15, p. 294)

The "2σ" value of $A_{acc-2\sigma}$ = ±0.25%(500 psig) = ±1.25 psig

The "1σ" value of $A_{acc-1\sigma} = A_{acc-2\sigma}/2$ = ±0.625 psig

Calibration Error (C_{acc})

The calibration error (C_{acc}) is associated with the repeatability of the measurement and test equipment used to calibrate the instrument. Uncertainties in reading the M&TE output are also relevant factors.

A conservative calibration error 1σ factor (C_{acc}) equivalent to the instrument error ($A_{acc1\sigma}$) is assumed.

Process Measurement Accuracy (PMA)

PMA is defined in GE NEDC-31336 (calculation EC-PUPC-1004) section 1.2.1 as the process variable measurement effects (e.g., the effect of changing fluid density on level measurement) aside from the primary element and sensor. There are no effects due to changing conditions associated with this parameter and it can be considered 0 for this application.

Primary Element Accuracy (PEA)

PEA is defined in GE NEDC-31336 (calculation EC-PUPC-1004) section 1.2.1 as the accuracy of the device (exclusive of the sensor) which is in contact with the process, resulting in some form of interaction (e.g., in an orifice meter, the orifice plate, adjacent parts of the pipe and the pressure connections constitute the primary element). There are no interactions due to contact with the process that would impact the accuracy of the device. This parameter is considered 0 for this application.

Allowable Values

Upper and Lower Analytic limits for the reactor vessel pressure setpoint

AL_{upper} = 445 psig

AL_{lower} = 380 psig

Allowable Values are offset from the Analytic Limits by allowances for the accuracy of switch repeatability (A_{acc}) and the calibration error (C_{acc}) per GE-NEDC-31336 (Section 1.2.3.2). Note that the Process Measurement Accuracy (PMA) and the Process Element Accuracy (PEA) = 0

$AV_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2)^{½}$ where n = 1 (σ value multiplier)

$AV_{upper} = 445 – 1.645/1 * (0.625^2 + 0.625^2)^{½}$

AV_{upper} = 443.55 psig

$AV_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2)^{½}$ where n = 1 (σ value multiplier)

$AV_{lower} = 380 + 1.645/1 * (0.625^2 + 0.625^2)^{½}$

AV_{lower} = 381.45 psig

Conservatively, LDCNs 5633 – 5636 and PLAs-7950 and 7979 will use a Lower Allowable Value of greater than or equal to 382 psig and an Upper Allowable Value of less than or equal to 443 psig.

Nominal Trip Setpoints

Per GE NEDC-31336 (Section 1.2.3.3), the Nominal Trip Setpoint associated with each Analytic Limit is determined by:

$NTSP_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

Where D = Drift Allowance

Calculation EC-080-1006 Attachment 1 calculated the instrument drift of the Barton 288A pressure switches and determined the drift value to be 6.07 psig based on actual plant data. Based on information in EC-080-1014 revision 0 provided by the vendor, a drift value of 10 psig is more appropriate when temperature effects are included. The pertinent parts of EC-080-1014 are reproduced here:

The device setpoint drift associated with temperature variation has been determined by the manufacturer to be 0.83% (of Span) per 50°F change in ambient (device) temperature.

The annual ambient temperature range in Rooms I/II-401, I-500, and I/II-512 is approximately 30°F (Calculation EC EQQL-1004). The setpoint drift will be assumed to occur over this maximum variation.

Therefore, the temperature drift, D_T is:

D_T = 0.83%(30F/50F)*1057psi (note current span is 500 psi but data is for a span of 1057 psi which is conservatively used)

D_T = 5.26 psi

Relative Humidity Drift D_{RH},

The device setpoint drift associated with humidity variation has been determined by the manufacturer to be 0.26% (of Span) per 30% change in ambient Relative Humidity.

The design basis summer outside air temperature is 92°F dry bulb and 78°F wet bulb. Assuming that the room is 10°F warmer than outside air, the corresponding relative humidity is 45% in the room, rounded up to 50% RH. In the winter outside air has a higher humidity but once that air is heated it becomes very dry, the C-1815 lower limit is 10% RH. Therefore, a change of 40% RH is the maximum expected change at the device location.

D_{RH} = 0.26%(40%/30%)*1057 psi

D_{RH} = 3.66 psi

Time-Dependent Drift, D_{TD}

Because the temperature and Relative Humidity drift testing took place over an extended period of time, the time-dependent drift is considered to be included in the Temperature and Relative Humidity drift factors.

For conservatism a nominal drift of D_{TD} = 2 psi is assumed.

Total Drift D

The temperature related drift (D_T) and humidity related drift (D_{RH}) are dependent variables and are therefore added together. The sum of these drifts is RMS combined with the time dependent drift (D_{TD}) to determine the total drift (D).

$D = ((D_T + D_{RH})^2 + D_{TD}^2)^{0.5}$

$D = ((5.26\text{ psi} + 3.66\text{ psi})^2 + 2^2)^{0.5}$

D = 9.15 psi conservatively 10 psi

Therefore, a drift value of 10 psig will be used.

Therefore, the Nominal Trip Setpoint limits are:

$NTSP_{upper} = AL_{upper} - (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{upper} = 445 - 1.645/1 * (0.625^2 + 0.625^2 + 10^2)^{½}$

$NTSP_{upper} = 428.5$ psig

$NTSP_{lower} = AL_{lower} + (1.645/n)*(A_{acc}^2 + C_{acc}^2 + D^2)^{½}$

$NTSP_{lower} = 380 + 1.645/1 * (0.625^2 + 0.625^2 + 10^2)^{½}$

$NTSP_{lower} = 396.5$ psig

The Nominal Trip Setpoint will be established at the midpoint of the Upper and Lower NTSP.

NTSP = (428.5 psig + 396.5 psig)/2 = 412.5 psig

As Found Tolerance (t_{AF})

The NTSP allows a nominal $t_{AF\text{-}UPPER}$ and $t_{AF\text{-}LOWER}$ = 30.5 psig

$t_{AF\text{-}UPPER} = AV_{upper} - NTSP$ = 443 psig – 412.5 psig = 30.5 psig

$t_{AF\text{-}LOWER} = NTSP - AV_{lower}$ = 412.5 psig – 382 psig = 30.5 psig

Device Setpoint (DS)

The Device Setpoint (DS) is the NTSP offset by the static head in the sensing line

$DS = NTSP + P_{HC}$

Head Correction

The reference leg static head pressure determined by EC-INST-4041 – EC-INST-4044

PIS-B21-2N021	Calc	P_{HC} (psi) Upper	P_{HC} (psi) Lower
A	EC-INST-4041	13.6	13.6
B	EC-INST-4042	12.7	12.7
C	EC-INST-4043	23.0	21.4
D	EC-INST-4044	23.0	21.4

PIS-B21-2N021C, D are measured from a RPV Level sensing line variable tap, so the static head is variable with the water level in the RPV (see EC-INST-4043 and EC-INST-4044). This setpoint is most likely to be reached with low water level in the Reactor Vessel, so the Lower head correction value is used. The setpoint is offset by <2 psi at higher reactor water level.

PIS-B21-2N021	NTSP (psig)	P_{HC} (psi)	DS (psig)
A	412.5	13.6	426.1
B	412.5	12.7	425.2
C	412.5	21.4	433.9
D	412.5	21.4	433.9

As-Left Tolerance

The As-Left tolerance is the allowed variation in the device setpoint that will remain within the range of acceptable setpoints. This range is the difference between the upper and lower NTSP limits.

$t_{AL}^{*} < \pm (NTSP_{UPPER} - NTSP_{LOWER})/2$

$t_{AL}^{*} < \pm (428.5 - 396.5)/2$

$t_{AL}^{*} < \pm 16.0$ psi

* Because of switch stability issues, the As-Left Tolerance should be minimized. Historically ± 5 psi has been used (see SI-1/280-301).

Results:

Instrument PSB212N021	AL (psig)	AV (psig)	NTSP (psig)	DS (psig)	t_{AL} (psi)	t_{AF} (psi)
A - LOWER	≥ 380	≥ 382	412.5	426.1	±5	16.0
A - UPPER	≤ 445	≤ 443				16.0
B - LOWER	≥ 380	≥ 382	412.5	425.2	±5	16.0
B - UPPER	≤ 445	≤ 443				16.0
C - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
C - UPPER	≤ 445	≤ 443				16.0
D - LOWER	≥ 380	≥ 382	412.5	433.9	±5	16.0
D - UPPER	≤ 445	≤ 443				16.0

Technical Specifications (TS) and Technical Requirements Manual (TRM)

The current Technical Specification setpoint and Allowable Values are specified in LCO Table 3.3.5.1-1 (last changed Amendment 155).

ECCS System	Table 3.3.5.1-1 Function	AV Lower Current	AV Lower Proposed	AV Upper Current	AV Upper Proposed
Core Spray	1.c, 1.d	≥ 407 psig	≥ 382 psig	≤ 433 psig	≤ 443 psig
LPCI	2.c, 2.d	≥ 407 psig	≥ 382 psig	≤ 433 psig	≤ 443 psig

The Allowable Value limits determined in this appendix ($AV_{LOWER} \geq 401.45$ psig and $AV_{UPPER} \leq 438.5$ psig) are conservative with respect to the current and proposed TS.

The current TRM Nominal Trip Setpoint limits (TRM Date 02/02/2010) are specified in Table 2.2-1:

ECCS System	Table 2.2-1 Function	Lower NTSP Current	NTSP Lower Proposed	NTSP Upper Current	NTSP Upper Proposed
Core Spray	2.2.3.1.3	≥ 413 psig	≥ 396.5 psig	≤ 427 psig	≤ 428.5 psig
LPCI	2.2.3.2.3	≥ 413 psig	≥ 396.5 psig	≤ 427 psig	≤ 428.5 psig