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PSEG
Nuclear LLC

LR-N10-0075

MAR 11 2010

U. S. Nuclear Regulatory Commission
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Salem Nuclear Generating Station, Units 1 & 2
Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: **Response to NRC Request For Additional Information Regarding Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"**

References:
1. NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated January 11, 2008
2. PSEG LR-N08-0074, "Three-Month Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated April 10, 2008
3. PSEG LR N08-0234, Nine-Month Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated October 13, 2008
4. PSEG LR N09-0028, "Nine-Month Supplemental (Unit 1 Post-Outage) Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated February 10, 2009
5. PSEG LR N10-0014, "Nine-Month Supplemental (Unit 2 Post-Outage) Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated February 8, 2010

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6. Email from R. Ennis NRC to J. Keenan, "Draft Request For Additional Information Related To Response To Generic Letter 2008-01 Salem Nuclear Generating Station, Unit Nos. 1 and 2, Docket Nos. 50-272 and 50-311, dated October 15, 2009
7. NEI Letter of 06-18-2009, Industry Guidance – Evaluation of Unexpected Voids or Gas Identified in Plant ECCS and Other Systems

The Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2008-01 (Reference 1) to request that each licensee evaluate the licensing basis, design, testing, and Corrective Action Programs (CAP) for the Emergency Core Cooling Systems (ECCS), Decay Heat Removal (DHR) system, and Containment Spray system, to ensure that gas accumulation is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified.

References 2, 3, 4 and 5 provided the PSEG Nuclear LLC (PSEG) responses for Salem Nuclear Generating Station (SNGS) Unit 1 and Unit 2. In Reference 6, the NRC requested additional information that is required to complete the review. In response to this request, PSEG is providing the attached information.

This letter contains no new NRC commitments. Should you have any questions concerning this letter please contact Lee Marabella at (865) 339-1208.

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

Executed on 3/11/2010

Sincerely,

Carl J. Fricker
Site Vice President – Salem

Attachment: Salem Nuclear Generating Station Unit 1 and Unit 2 Response to GL 2008-01 Request For Additional Information.

Enclosure: Technical Evaluation 70079735, Operation 0432, ECCS Pump Suction Criteria

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Salem Nuclear Generating Station, Unit 1 and Unit 2 Response to GL 2008-01 Request For Additional Information

NRC Request 1:

The GL was intended to address all modes and all operating conditions and it is not limited to events and accidents evaluated in the Updated Final Safety Analysis Report. Please confirm that all subject systems are evaluated for all modes and all operating conditions.

RAI 1 Response:

Evaluations supporting the Nine-Month Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated October 13, 2008 (Reference 3) included a review of all applicable operating, maintenance and surveillance procedures for the subject systems listed below for both Salem Units. These procedures span all modes and operating conditions.

Subject Systems:

Containment Spray
Chemical Volume and Control
Safety Injection
Residual Heat Removal

PSEG confirms that all subject systems are evaluated for all modes and all operating conditions.

NRC Request 2:

Please demonstrate that adequate net positive suction head margin exists when air ingestion effects are considered in the calculations for the residual heat removal, safety injection, and containment spray pumps.

RAI 2 Response:

Salem is implementing the maximum allowable acceptable pump suction voiding limits as found in Table 1 of NEI Letter of 06-18-2009, Industry Guidance – Evaluation of Unexpected Voids or Gas Identified in Plant ECCS and Other Systems (Reference 7). These criteria have been conservatively determined from the best available open literature in the industry at this time, as well as the recent PWROG test results. Further application of conservatism is not required, and engineering judgment in the application of these generic criteria to specific conditions within a plant are within NRC guidelines for determining a reasonable expectation of Operability for the Structures, Systems and Components (SSCs).

Salem Units 1 and 2 maintain ECCS system piping void free on a 31 day basis by venting to solid stream with surveillance S1/2.OP-ST.SJ-0009, "Emergency Core Cooling Systems – Tave >350F", under Technical Specification 4.5.2.2. The pump suctions are maintained in a void free state with the combination of this surveillance, properly sloped piping and installed vents as documented in the field verifications performed as part of the NRC GL 2008-01 9-Month response.

As demonstrated in the enclosure to this letter, adequate net positive suction head margin exists when air ingestion effects are considered in the calculations for the residual heat removal, safety injection, and containment spray pumps.

NRC Request 3:

Please briefly summarize the revised fill and vent procedures with respect to guidance for instrumentation lines. Also briefly discuss the details of any confirmatory testing followed by fill procedures.

RAI 3 Response:

Reference 3 stated:

"The fill and vent procedures were reviewed to determine if venting of instrument lines was included. Backfilling of instrumentation is performed only in the RHR procedure."

Upon further review, a number of additional ECCS procedures have been identified that do include guidance for the filling and venting of instrumentation lines. For example, the majority of the flow transmitters in the ECCS use specific calibration procedures. The majority of these use "Calibration Volume Chambers" (CVCs). By utilizing a CVC, the transmitter is calibrated "wet" thus air will not be introduced into the transmitter or process sensing lines. There are also portable CVCs available for those wet DP transmitters that do not have permanently installed chambers. For transmitters that do not have individual procedures, I&C technician training provides guidance for filling and venting of instrumentation lines in accordance with station general instrumentation calibration procedures. Therefore, no additional fill and vent procedures from the Reference 3 procedural reviews were revised with respect to guidance for backfill of instrumentation lines.

With respect to confirmatory testing, the standard practice is for Operations to verify proper instrument response when systems are placed in service upon completion of filling and venting or maintenance activities. Abnormal system or instrumentation response is investigated and corrected prior to declaring the system or instrumentation operable.

NRC Request 4:

Training was not identified in the GL but it is considered to be a necessary part of applying procedures and other activities when addressing issues identified in the GL. Please briefly discuss training.

RAI 4 Response:

GL 2008-01 did not require discussion of training to satisfy the 10 CFR 50.54(f) request; therefore, none was provided in the GL response for Salem. When any station procedure is modified, an assessment for training needs and change management is required in accordance with procedure AD-AA-101, "Processing of Procedures and Training and Reference Materials (T&RMs)." The determination is typically a function of the nature of the change and the perceived impact on the organization. If the assessment concludes training is required, the training is generally accomplished prior to, or in parallel with, issuance of the revised procedure.

The issue addressed by NRC GL 2008-01 (Managing Gas Accumulation in Safety Systems) is a required topic in the Licensed Operator Long Range Training Plan, as discussed by INPO SOER 97-1 (Potential Loss of High Pressure Injection and Charging Capability from Gas Intrusion). This SOER is also addressed in the Chemical & Volume Control System lesson plan which is used for Initial Operator Training, and for Non-Licensed Operator Continuing Training. When GL 2008-01 was issued, training on the key points of this document and SER 2-05, Rev.1 (Gas Intrusion in Safety Systems) was completed for all operators between 5/13/08 - 7/17/08. In addition, the current segment (1/5/10 - 3/11/10) of Salem Licensed and Non-Licensed Operator Continuing Training includes the related topic of Water Hammer. This training specifically discusses the seven types of water hammer scenarios detailed in the EPRI Water Hammer Handbook of Nuclear Plant Engineers and Operators, their causes, the damage they can cause, and what Operators need to know regarding prevention of such events. Training of personnel performing ultrasonic testing (UT) inspection is in accordance with procedure OU-AA-122, "Qualification and Certification of Nondestructive Examination (NDE) Personnel." Engineering personnel received SOER 97-1, SER 2-05 and GL 2008-01 specific training in September/October, 2008. The topics of gas intrusion (aka gas accumulation) and water hammer are addressed in initial engineering orientation training and selected SOERs and Nantel (National Academy for Nuclear Training e-learning) Computer Based Training (CBT) "Mechanical Engineering" course developed by EPRI.

Salem Nuclear Generating Station, Unit 1 and Unit 2 Response to GL 2008-01 Request For Additional Information

PSEG is an active participant in the NEI Gas Accumulation Team, which is currently working with the Institute of Nuclear Power Operations (INPO) in the development of generic training modules for gas accumulation and management. These training modules target the Engineering, Operations and Maintenance disciplines. Based on this active participation, PSEG plans to evaluate these training modules following their completion for their applicability to PSEG.

Enclosure to LR-N10-0075

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Salem is implementing the allowable pump suction voiding limits as found in Table 1 of NEI Letter of 06-18-2009, Industry Guidance – Evaluation of Unexpected Voids or Gas Identified in Plant ECCS and Other Systems.

	$\%\frac{Q}{Q_{BEP}}$	BWR Typical Pumps	PWR Typical Pumps		
			Single Stage (WDF)	Multi-Stage Stiff Shaft (CA)	Multi-Stage Flexible Shaft (RLIJ, JHF)
Steady State Operation > 20 seconds	40%-120%	2%	2%	2%	2%
Steady State Operation > 20 seconds (see Note)	< 40% or > 120%	1%	1%	1%	1%
Transient Operation ≤ 5 seconds	70%-120%	10%			10%
Transient Operation ≤ 5 seconds (see Note)	< 70% or > 120%	5%			5%
Transient Operation ≤ 20 seconds	70%-120%		5%	20%	
Transient Operation ≤ 20 seconds (see Note)	< 70% or > 120%		5%	5%	

Note: Further review by the respective Owner's Groups may determine that criteria for pump operation below 70% BEP may not be required, as the conditions are bounded by the set of criteria for the 70%-120% BEP range.

These criteria as provided by NEI have been conservatively determined from the best available open literature in the industry at this time, as well as the recent PWROG test results not previously documented. Further application of conservatism is not required, and engineering judgment in the application of these generic criteria to specific conditions within a plant are within NRC guidelines for determining a reasonable expectation of Operability for the SSCs. Salem Plants 1 and 2 maintain ECCS system piping void free on a 31 day basis by venting to solid stream with surveillance S1/2.OP-ST.SJ-0009 Emergency Core Cooling Systems – Tave >350F under Technical Specification 4.5.2.2. The pump suctions are maintained in a void free state with a combination of this surveillance, properly sloped piping and installed vents as documented in the field verifications performed as part of the NRC GL 2008-01 9-Month response. The acceptable suction voids for the individual ECCS subsystems are evaluated as follows:

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Containment Spray:

This system by design is maintained in a void free with properly sloped piping and installed vents as documented in the field verifications performed as part of the NRC GL 2008-01 9-Month response.

Salem Unit 1 and 2 is implementing a 5% voiding limit criteria for Containment Spray Pump suction piping in Section 3.0 Precautions and Limitations of S1.OP-SO.CS-0001 (Q), "Preparation of the Containment Spray System for Normal Operation":

"If system restoration with normal fill and vent procedures cannot be fully implemented (i.e. not all vents used) and portions of suction piping remain suspect, Ultrasonic testing of the identified suction piping should be utilized to evaluate the presence of gas voiding (5% Void Acceptance Criteria) to determine pump operability." (CAP Notification 20453029)

This will be performed by UT and determining the voided cross section of pipe. Field observations for 11, 12, 21 and 22 CS Pumps have this horizontal section of pipe at approx.20 feet in length and per the Pipe Specification as being 10 inch nominal, Schedule 10S pipe (S-C-MPOO-MGS-0001 SPS50).

5% Pipe Void Calculation for 11, 12, 21 and 22 Containment Spray Pumps
Pipe Cross Section: 0.59 FT2
Length: 20 FT
Volume: 0.59 FT2 x 20 FT = 11.8 FT3
5% Void: 11.8 FT3 x 0.05 = 0.59 FT3

To evaluate the void introduction to the pump, the NEI / PWROG has generated a simplified equation approach to explain the gas volume transport mechanisms of kinematic shock and the transition of a two phase separation to bubbly flow. The application and use of the NEI Simplified Equation was demonstrated to NRC representatives during the NEI Gas Accumulation Workshop Jan 21-22, 2010. This calculation represents the latest Owners group Purdue Pump testing data and gas transport mechanisms.

Simplified Equation
$V_{allowable} = Q_{max} \times \alpha \times \Delta t \times (Pp/P1)$

Qmax – Maximum Pump Flow
α – Initial static void in horizontal pipe section prior to pump downcomer
Δt – Transit time of void at pump suction
(Pp/P1) is a volume correction for the pump downcomer if 10 feet or greater

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Examples of allowable void from the simplified equation:

- Static Void $\leq$ 5% for smaller pipes, $\leq$2% for larger pipes
- Vallowable = Qmax X α X Δt X (Pp/P1)

Containment Spray:
Vallowable = 2600 gpm x 0.05 x (5 sec/60 sec) x 1
Vallowable = 10.8 gallons or 1.45 cubic feet

To ensure plug flow does not occur and a transition to bubbly flow by kinematic shock does occur, the simplified equation requirement needs a downcomer pipe volume of at least four times the void being introduced from two phase to a single phase. Field observations have this vertical section of pipe at approx. 6 feet in length and per the Pipe Specification as being 10 inch nominal, Schedule 10S (S-C-MPOO-MGS-0001 SPS50).

Containment Spray Pump Downcomer Volume Calculation
Pipe Cross Section: 0.59 FT2
Length: 6 FT
Volume: 0.59 FT2 x 6 FT = 3.5 FT3
25% Void Limit: 3.3 FT3 x 0.25 = 0.89 FT3 Void limit to transition to bubbly flow

The downcomer volume as calculated has the capacity to prevent a plug flow condition from a measured void in the horizontal section of suction piping at greater than 5%. Therefore the 5% voiding limit criteria (0.59 cubic feet) is being implemented in S1.OP-SO.CS-0001 (Q), "Preparation of the Containment Spray System for Normal Operation", complies with the NEI/PWROG guidelines.

Chemical Volume Control / High Head Safety Injection:

Currently Salem Unit 1 and 2 Charging Pump suction piping has a 5% voiding limit criteria in place as found in procedure S1/2.OP-SO.CVC-0007, "Fill and Vent of CVCS", in steps 3.12. This is performed by UT and determining the voided cross section of pipe. Field observations have this horizontal section of pipe at approx.12 feet in length and per the Pipe Specification as being 6 inch nominal, Schedule 40S (S-C-MPOO-MGS-0001 SPS48).

5% Pipe Void Calculation
Pipe Cross Section: 0.20 FT2
Length: 12 FT
Volume: 0.20 FT2 x 12 FT = 2.4 FT3
5% Void: 2.4 FT3 x 0.05 = 0.12 FT3

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Allowable void as calculated with the simplified Equation:

The Salem Unit 1 and 2 Charging pumps are representative of the data found in line 1 (Diablo Canyon – Westinghouse 4 loop PWR fitted with RLIJ 2 ½ inch Pumps) and the V allowable suction void of 4.67 gallons. The calculated 5% void in the Salem suction piping of 0.12 FT3 or 0.9 gallons is well within these guidelines.

Pumps	Q max	α	Δt	V allowable	X-Section
CCPs	560	10%	5 second	4.67 gal	≤ 5%
SIPs	670	10%	5 second	5.58 gal	≤ 5%
RHRPs	4500	2%	20 second	30 gal	≤ 2%
HPSI	1800	10%	5 second	12 gal	≤ 5%
LPSI	5500	2%	20 seconds	36 gal	≤ 2%

To ensure plug flow does not occur and a transition to bubbly flow by kinematic shock does occur, the simplified equation requirement needs a downcomer pipe volume of at least four times the void being introduced from two phase to a single phase. Field observations have this vertical section of pipe at approx. 5 feet in length (DWG 205228 SHT 2) and per the Pipe Specification as being 6 inch nominal, Schedule 40S (S-C-MPOO-MGS-0001 SPS48).

Charging Pump Downcomer Volume Calculation
Pipe Cross Section: 0.20 FT2
Length: 5 FT
Volume: 0.20 FT2 x 5 FT = 1.0 FT3
25% Void Limit: 1.0 FT3 x 0.25 = 0.25 FT3 Void limit to transition to bubbly flow

The downcomer volume as calculated has the capacity to prevent a plug flow condition from a measured void in the horizontal section of suction piping at 10% or two times 0.12 FT3. Even at the 10% initial void in the horizontal section of piping, the actual void fraction (X section) being introduced to the pump suction is 5% as indicated in line 1 of the Simplified Equation Examples listed above. Therefore the 5% voiding limit criteria already in place in procedure S1/2.OP-SO.CVC-0007, "Fill and Vent of CVCS", in steps 3.12 complies with the NEI/PWROG guidelines and has a conservative safety factor of two.

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

A detailed evaluation utilizing Gothic analysis has been performed for Salem Units 1 and 2 Safety injection Pumps (S-C-SJ-MDC-1893 Allowable Volume Of Non-Condensable Gases in RHR Recirc. Cross Connect Piping) encompassing both high head and intermediate head pumps. This evaluation was performed in response to NRC Notice 88-23 "Potential For Gas Binding of High Pressure Safety Injection Pumps During a Loss of Coolant Accident" dated May 12, 1988. Results of this analysis limit this volume to 1.6 FT3 to ensure a void fraction of 5% or less is introduced to the pump suctions, which was derived from the vendor's recommended guidelines of 5% (Westinghouse letter to Salem Units 1 and 2, Attachment 1 of S-C-SJ-MDC-1893).

Safety Injection / Intermediate Head Safety Injection:

Salem Unit 1 and 2 is implementing a 5% voiding limit criteria for Safety Injection Pump suction piping in Section 3.0 Precautions and Limitations of S1.OP-SO.SJ-0001 (Q), "Preparation of the Safety Injection System for Operation":

"If system restoration with normal fill and vent procedure cannot be fully implemented (i.e. not all vents used) and portions of suction piping remain suspect, Ultrasonic testing of the identified suction piping should be utilized to evaluate the presence of gas voiding (5% Void Acceptance Criteria) to determine pump operability." (CAP Operation 70093423 OP 10/20)

This will be performed by UT and determining the voided cross section of pipe. Field observations for 11, 21 and 22 SJ Pumps have this horizontal section of pipe at approx.10 feet in length and per the Pipe Specification as being 6 inch nominal, Schedule 40S (S-C-MPOO-MGS-0001 SPS49). The 12 SJ Pump horizontal pipe section was found to be 8 inches nominal in diameter, Schedule 40S (DWG 205234 SHT 2).

5% Pipe Void Calculation for 11, 21 and 22 Pumps
Pipe Cross Section: 0.20 FT2
Length: 10 FT
Volume: 0.20 FT2 x 10 FT = 2.0 FT3
5% Void: 2.0 FT3 x 0.05 = 0.10 FT3

12 SJ Pump 8 inch horizontal header
Pipe Cross Section: 0.35 FT2
Length: 10 FT
Volume: 0.35 FT2 x 10 FT = 3.5 FT3
5% Void: 3.5 FT3 x 0.05 = 0.175 FT3

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Allowable void as calculated with the simplified Equation:

The Salem Unit 1 and 2 Safety Injection Pumps are representative of the data found in line 2 (Diablo Canyon – Westinghouse 4 loop PWR fitted with 2 ½ inch JTCH / Multi-Stage Flex Shaft Pumps) and the V allowable suction void of 5.58 gallons. The calculated 5% void in the Salem suction piping of 0.10 FT3 (0.75 gallons) and 0.175 FT3 (1.3 gallons -12 Pump) is well within these guidelines.

Pumps	Q max	α	Δt	V allowable	X-Section
CCPs	560	10%	5 second	4.67 gal	≤ 5%
SIPs	670	10%	5 second	5.58 gal	≤ 5%
RHRPs	4500	2%	20 second	30 gal	≤ 2%
HPSI	1800	10%	5 second	12 gal	≤ 5%
LPSI	5500	2%	20 seconds	36 gal	≤ 2%

To ensure plug flow does not occur and a transition to bubbly flow by kinematic shock does occur, the simplified equation requirement needs a downcomer pipe volume of at least four times the void being introduced from two phase to a single phase. Field observations have this vertical section of pipe at approx. 6 feet in length and per the Pipe Specification as being 6 inch nominal, Schedule 40S (S-C-MPOO-MGS-0001 SPS49).

Charging Pump Downcomer Volume Calculation
Pipe Cross Section: 0.20 FT2
Length: 6 FT
Volume: 0.20 FT2 x 6 FT = 1.2 FT3
25% Void Limit: 1.2 FT3 x 0.25 = 0.3 FT3 Void limit to transition to bubbly flow

The downcomer volume as calculated has the capacity to prevent a plug flow condition from a measured void in the horizontal section of suction piping at greater than 10% or three times 0.10 FT3. Even at the 10% initial void in the horizontal section of piping, the actual void fraction (X section) being introduced to the pump suction is 5% as indicated in line 2 of the Simplified Equation Examples listed above. The 8 inch horizontal piping found on Safety Injection pump 12 at 0.175 FT3 still does not pose a risk as the combined header if found at 5% void would generate a 0.275 FT3 void (0.175 FT3 + 0.1 FT3). Therefore the 5% voiding limit criteria implemented in S1.OP-SO.SJ-0001 (Q), "Preparation

of the Safety Injection System for Operation", complies with the NEI/PWROG guidelines and has a conservative safety factor of two or better.

A detailed evaluation utilizing Gothic analysis has been performed for Salem Units 1 and 2 Safety injection Pumps (S-C-SJ-MDC-1893 Allowable Volume Of Non-Condensable Gases in RHR Recirc. Cross Connect Piping) encompassing both high head and intermediate head pumps. This evaluation was performed in response to NRC Notice 88-23 "Potential For Gas Binding of High Pressure Safety Injection Pumps During a Loss of Coolant Accident" dated May 12, 1988. Results of this analysis limit this volume to 1.6 FT3 to ensure a void fraction of 5% or less is introduced to the pump suctions, which is per the vendor's recommended guidelines of 5% (Westinghouse letter to Salem Units 1 and 2, Attachment 1 of S-C-SJ-MDC-1893).

Residual Heat Removal / Low Head Safety Injection:

Salem Unit 1 and 2 is implementing a 2% voiding limit criteria for Residual Heat Removal Pump suction piping in Section 3.0 Precautions and Limitations of S1.OP-SO.RHR-0001(Q), "Initiating RHR":

"If system restoration with normal fill and vent procedures cannot be fully implemented (i.e. not all vents used) and portions of suction piping remain suspect, Ultrasonic testing of the identified suction piping should be utilized to evaluate the presence of gas voiding limited to 4.0 cubic feet/30 gallons (2% Void Acceptance Criteria) to determine pump operability."(CAP Operation 70093426 OP 10/20)

This will be performed by UT and determining the voided cross section of pipe. Field observations for RHR piping is the transition from the 20 inch header to a 12 inch header on the 84" level and a downward drop to a minor transition at the suction isolation valves on 55 level and a continuation to the 45' level where the RHR pumps are located. The pump suctions are maintained in a void free state with properly sloped piping and installed vents as documented in the field verifications performed as part of the NRC GL 2008-01 9-Month response. The more problematic sections of piping are found in the RHR Hot leg suction piping as evaluated in S-C-RHR-MEE-390 with the installation of vent valves 2RH81 and 2RH82. A single line system representation from the analysis shows the 14 inch header drop of a total of 44 feet with horizontal transitions ranging from 30 to 40 feet.

Allowable void as calculated with the simplified Equation:

The Salem Unit 1 and 2 Residual Heat Removal Pumps are representative of the data found in line 3 (Diablo Canyon – Westinghouse 4 loop PWR fitted with Single Stage Stiff Shaft Pumps) and the V allowable suction void of 30 gallons.

Technical Evaluation 70079735 Operation 0432
ECCS Pump Suction Criteria

Pumps	Q max	α	Δt	V allowable	X-Section
CCPs	560	10%	5 second	4.67 gal	≤ 5%
SIPs	670	10%	5 second	5.58 gal	≤ 5%
RHRPs	4500	2%	20 second	30 gal	≤ 2%
HPSI	1800	10%	5 second	12 gal	≤ 5%
LPSI	5500	2%	20 seconds	36 gal	≤ 2%

To ensure plug flow does not occur and a transition to bubbly flow by kinematic shock does occur, the simplified equation requirement needs a downcomer pipe volume of at least four times the void being introduced from two phase to a single phase. The downcomer section consists of multiple drops from 91' to 47' that allow for the full V allowable of 30 gallons or 4.0 cubic feet. The vertical section of pipe is 14 inch, schedule 40S (S-C-MPOO-MGS-0001 SPS51) and approx. 44 feet in length.

RHR Downcomer Volume Calculation for final drop of 59" to 47"
Pipe Cross Section: 0.96 FT2
Length: 44 FT
Volume: 0.96 FT2 x 44 FT = 42.2 FT3
25% Void Limit: 42.2 FT3 x 0.25 = 10.56 FT3 Void limit to transition to bubbly flow (This equates to 79 gallons)

Therefore the 2% voiding limit criteria is being implemented in Section 3.0 Precautions and Limitations of S1.OP-SO.RHR-0001(Q), "Initiating RHR", complies with the NEI/PWROG guidelines. The 4.0 cubic foot void being injected is also with in the PWROG guidelines for maximum injected void 5 cubic feet to prevent thermal impact on the reactor core.