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PSEG
Nuclear LLC

Generic Letter 2004-02

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United States Nuclear Regulatory Commission
Document Control Desk
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SALEM GENERATING STATION – UNIT 1 and UNIT 2
FACILITY OPERATING LICENSE NOS. DPR-70 and DPR-75
NRC DOCKET NOS. 50-272 and 50-311

Subject: SUPPLEMENTAL RESPONSE TO NRC GENERIC LETTER (GL) 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS"

References: (1) NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004.

(2) Letter from PSEG to NRC, "90-Day Response to Generic Letter 2004-02 Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors, Salem Nuclear Generating Station, Units 1 and 2, Facility Operating License Nos. DPR-70 and DPR-75, Docket Nos. 50-272 and 50-311," dated March 4, 2005.

(3) Letter from PSEG to NRC, "Response to Generic Letter 2004-02 Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors, Salem Nuclear Generating Station, Units 1 and 2, Facility Operating License Nos. DPR-70 and DPR-75, Docket Nos. 50-272 and 50-311," dated September 1, 2005.

Paper Copy replacing CD-Rom ... CD-Rom failed NRC requirements A116 NRR

(4) Letter from NRC to PSEG, "Salem Nuclear Generating Station, Units 1 & 2 Request for Additional Information Re: Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design-Basis Accidents at Pressurized-Water Reactors" (TAC Nos. MC4712 and MC4713)," dated February 9, 2006.

(5) Letter from Michael L. Scott, Chief Safety Issue Resolution Branch Division of Safety Systems Office of the Nuclear Reactor Regulation to Harold Chernoff, Chief Plant Licensing Branch I-2 Division of Operating Reactor Licensing Office of the Nuclear Reactor Regulation "Salem Units 1 and 2 Draft Open Items From the Staff Audit of Corrective Actions to Address Generic Letter 2004-02 (TAC Nos. MC4712 and MC4713), dated October 24, 2007.

(6) Letter from NRC to Mr. Anthony R. Pietrangelo (Nuclear Energy Institute), "Plant Specific Requests for Extension of Time to Complete One or More Corrective Actions for Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated November 8, 2007.

(7) Letter from NRC to Mr. Anthony R. Pietrangelo (Nuclear Energy Institute), "Revised Content Guide for Generic Letter 2004-02 Supplemental Response," dated November 21, 2007.

(8) Letter from NRC to Mr. Anthony R. Pietrangelo (Nuclear Energy Institute), "Supplemental Licensee Responses to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated November 30, 2007.

(9) Letter from PSEG to NRC, "Request for Extension of Completion Dates for Salem Units 1 and 2 Corrective Actions Required by NRC Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated December 10, 2007.

(10) Letter from NRC to Mr. William Levis, "Salem Nuclear Generating Station, Units 1 & 2 – Approval of Request for Extension of Completion Date for Generic Letter 2004-02 Corrective Actions" (TAC Nos. MC4712 and MC4713), dated December 21, 2007.

The purpose of this letter is to provide PSEG Nuclear LLC's (PSEG) supplemental response to the Generic Letter (GL) 2004-02 (Reference 1). The U.S. Nuclear Regulatory Commission (NRC) issued Reference 1 requesting that addressees perform an evaluation of the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system function.

Additionally, the GL requested addressees to provide the NRC with a written response in accordance with 10 CFR 50.54(f). The request was based on identified potential susceptibility of the pressurized water reactor (PWR) recirculation sump screens to debris blockage during Design Basis Accidents (DBA) requiring recirculation of ECCS or CSS and on the potential for additional adverse effects due to debris blockage of flow paths necessary for ECCS and CSS recirculation and containment drainage.

Reference 2 provided the PSEG's initial response to the GL, followed by a supplemental response in Reference 3. Attachment 1 to this letter contains the detailed supplemental response prepared in accordance with the guidance of Reference 7 and consistent with dates provided in Reference 8.

Reference 4 requested additional information regarding the PSEG responses as documented in References 2 and 3. Attachment 2 contains the response to the Request for Additional Information in Reference 4.

During the week of October 1, 2007, the NRC conducted a detailed audit of the Salem Units 1 and 2 new sump design, associated analyses, testing, modifications and evaluations. The audit open items are documented in Reference 5. Attachment 3 contains PSEG's response to the NRC audit open items as documented in Reference 5.

Attachment 4 contains the references listed in this response and the Enclosure contains a compact disc with the drawings referenced in response to question 3f.1.

Reference 9 documents PSEG's request for an extension to complete the Salem Units 1 and 2 corrective actions required by NRC GL 2004-02, as allowed by Reference 6. Reference 10 documents the NRC approval of the extension request. Specifically, NRC approved an extension to June 30, 2008 for the following items:

- Completion and evaluation of the final chemical head loss tests performed by CCI,
- Incorporation of the head loss test results into the strainer head loss and NPSH calculations,
- Completion of Downstream Effects and In-Vessel Calculations.

Accordingly, PSEG is deferring all responses associated with these items in accordance with the approved extension request. The deferred responses are identified in the attachments to this letter. There are no additional regulatory commitments provided in this submittal from those commitments documented in Reference 9.

Should you have any questions regarding this submittal, please contact Mr. Enrique Villar at 856-339-5456.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 29 day of February 2008.

Sincerely,

Robert C. Braun
Site Vice President - Salem

Attachments (4)
Enclosures (1)

C Mr. S. Collins, Administrator – Region I
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Mr. R. Ennis, Project Manager - Salem Unit 1 and Unit 2
U. S. Nuclear Regulatory Commission
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List of Commitments
Salem Generating Station Units 1 and 2

The following table identifies those actions committed to by PSEG. Any other statements in this letter are provided for information purposes and are not considered regulatory commitments.

COMMITMENT	COMMITTED DATE OR "OUTAGE"	COMMITMENT TYPE	
		ONE-TIME ACTION (YES/NO)	PROGRAM-MATIC (YES/NO)
1. Completion and evaluation of Salem's final chemical head loss test in the vendor's Multi-Functional Test Loop (MFTL), 2. Incorporation of the test results from the MFTL into the head loss and NPSH calculations, 3. Completion of Downstream Effects and In-Vessel Calculations Upon completion of the testing, the formal documentation of the test report and associated calculations will be completed. PSEG will revised its response to GL 2004-02 no later than June 30, 2008	June 30, 2008	Yes	No

Salem Nuclear Generating Station Units 1 and 2
Docket Nos 50-272 and 50-311
Generic Letter 2004-02
Supplemental Response for Salem

Executive Summary

The resolution to Generic Letter (GL) 2004-02 necessitated the replacement of the existing containment sump strainers, which had a surface area of approximately 85 ft^2 and a mesh size of 1/8-inch. The replacement sump strainers for Salem Unit 1 and 2, provided by Control Components Incorporated (CCI), have filtering surface areas of 4,854 ft^2 and 4,656 ft^2 respectively.

Both Salem Unit strainers have 1/12-inch (nominal) perforations. In addition, a 9-inch tall debris interceptor with a 4-inch horizontal lip extending in the upstream direction has been installed around the perimeter of the strainer to hinder debris transport to the strainer. The debris interceptor consists of grating with perforated plate (mesh size = 1/8 inch) attached to the downstream side of the grating.

The replacement strainers are designed such that the head loss experienced with the worst-case debris and chemical precipitate load combination is less than the limiting hydraulic allowable head loss. The limiting allowable head loss provided to the strainer vendor is 1.80 feet for Salem Unit 1 and 3.14 feet for Salem Unit 2 based on single train operation. The flow rates for single train operation are 5,110 gpm for Salem Unit 1 and 4,980 gpm for Salem Unit 2. The limiting allowable head loss for two-train operation is 6.91 feet for both Salem Units. The maximum two-train operation flow rate is 8,827 gpm, although 9,000 gpm is conservatively used in the design.

The limiting allowable head loss for one and two train operation includes 0.90 feet of retained margin for both Salem Units. The limiting allowable head loss occurs at high sump temperatures where the containment pressure is considered equal to the vapor pressure of the water in the sump.

Salem submitted a Licensing Amendment Request (LAR) that was approved by the NRC on November 15, 2007, in order to credit the partial pressure of air initially in containment, which is used in the determination of the allowable head loss at lower sump temperatures. The strainers are also designed such that the head loss is less than the structural limit for all conditions.

The replacement strainers have a minimum submergence of 3-5/16 inches during recirculation based on the minimum flood level and the height of the installed strainers. This is a conservative value based on a level instrument uncertainty of 1 inch, which is 0.25 inches greater than the actual uncertainty (see below). However, a minimum submergence of 3 inches is conservatively used to assess the potential for vortexing. Testing and analysis have shown that vortexing will not occur under maximum flow conditions for both a clean and debris-laden strainer.

PSEG has also installed new level switches for both Salem Units. The new level switches have an accuracy of ±0.75 inches and are more accurate than the existing level indicators; thus providing a more accurate indication of the containment flood level. These level switches alert the control room operator when sufficient containment sump level has been achieved to support initiation of cold leg recirculation.

The minimum flood level calculation considered the hold up of water due to blockage of refueling cavity and loss of water into the reactor cavity. The calculation shows that a concurrent flooding of these areas is not a credible condition. Therefore, the calculation conservatively considered the flooding of reactor cavity that holds larger volume of water.

- Hold-up of water in upper areas of containment
- Hold-up of water in the reactor cavity
- Minimum water in the RWST from beginning of Loss of Coolant Accident (LOCA) to Emergency Core Cooling System (ECCS) switchover
- Hold-up of water in the containment atmosphere (spray droplets and vapor)
- Water condensed on containment heat sinks
- Water to fill initially empty piping (e.g. Containment Spray System (CSS) piping)

The minimum flood level calculation considered the hold up of water due to blockage of the refueling cavity and loss of water into the reactor cavity. The calculation shows that a concurrent flooding of these areas is not a credible condition. Therefore, the calculation conservatively considered the flooding of the reactor cavity, which holds a larger of volume of water.

PSEG modified three of four wire mesh doors and folding gates in the stairwell near the accumulators for both Salem Units. The modifications replaced wire mesh with bars spaced 12 inches apart in the bottom 3 feet of doors/gates. The wire mesh was removed to prevent water hold-up in the inner annulus. The bars were added to the bottom of the doors/gates to meet the radiation protection personnel safety requirements. However, the door/gate nearest to the strainer module was not modified in either Salem Unit because blockage of these doorways would result in a more tortuous path for debris, thus potentially reducing the overall debris transport.

CCI has performed debris bypass and head loss tests for the Salem replacement strainers including several head loss tests with chemical precipitates; however, the final bypass and head loss tests with chemical effects will be performed in Spring 2008.

The previous testing was performed using a one-sided test strainer module, while the future tests will use a more prototypical two-sided test strainer module with a prototypical strainer submergence and flow, which is based on the Salem strainer installation.

Also, the previous chemical effects head loss tests were performed using precipitates generated in the test loop, while the future chemical effects head loss tests are planned to be performed using precipitates generated using the Westinghouse particulate generator method described in WCAP-16530-NP in which precipitates are generated outside the test loop.

The chemical effects head loss tests are planned to test a range of chemical precipitate loads from the nominal 30-day precipitate quantity (100%) to a greater quantity (150%) to provide margin. The tests also plan on utilizing in-flume agitation (if necessary) to ensure that the majority of debris introduced transports to the strainer module (i.e. near field effects will not be credited).

As part of the resolution to GL 2004-02, PSEG removed all calcium silicate insulation in Salem Unit 1 and 2 from containment areas, which could be impacted by a LOCA jet. The calcium silicate insulation was replaced with Transco Reflective Metal Insulation (RMI). In addition, Min-K was replaced with Transco RMI or NUKON (due to space constraints) wherever possible.

PSEG implemented a number of programmatic controls to assess and control the introduction of potential debris sources to containment. The programmatic controls include requirements related to coatings, containment housekeeping, materiel condition, and modifications.

The design debris load is determined based on the deterministic methodology for debris generation and transport outlined in Nuclear Energy Institute NEI 04-07 and its associated NRC Safety Evaluation (SE). The baseline guidance is used with some analytical refinements (e.g., Computational Fluid Dynamics (CFD)). The methodology based on plant specific testing is listed below.

- A reduced zone of influence (ZOI) for qualified epoxy coatings and jacketed NUKON insulation is used in the debris generation calculation based on the testing performed by Westinghouse documented in WCAP-16568-P and WCAP-16710-P (Reference 26), respectively. The ZOI used for qualified epoxy coatings is 5D, which is conservative relative to the 4D justified by the testing. Similarly, the ZOI used for jacketed NUKON is 8D is conservative relative to the 5D justified by the testing.

- PSEG performed plant specific fiber erosion testing at Fauske and Associates Incorporated (FAI) for the primary types of fiber insulation in containment, NUKON and Kaowool. This testing used a nominal flume velocity of 0.70 ft/s, which is approximately equal to the maximum velocity in the post-LOCA sump pool. The testing indicated that the 30-day erosion fractions for NUKON and Kaowool would be 30% and 10%, respectively. For conservatism, the design debris load is based on 30-day erosion fractions of 40% and 15%, respectively.

The debris generation calculation determined separate debris loads for Salem Unit 1 and 2. The Salem Unit 2 debris load has been determined based on the containment configuration following the Spring 2008 outage, when the steam generators (SG) will be replaced and insulated with Transco RMI. The NRC approved an extension request for this approach on August 11, 2006.

The break locations analyzed are on the primary piping and are chosen to maximize the quantity and types of debris. The design fiber, Transco RMI, and qualified coatings debris load includes 5% margin and the design MRI debris load includes at least 10% margin for both Salem Unit 1 and 2. Similarly, the Min-K debris load includes a minimum of 20% margin.

In addition, while a Salem Unit 2 plant walkdown indicated a latent debris load of only 33 lbm (Reference A.15), a latent debris load of 200 lbm is included in the design debris load calculation for both Salem Units. The debris transport calculation determined that the required sacrificial area to account for foreign materials such as labels, tapes, placards, etc. is 429 ft^2; however, for conservatism, the screen design is based on a sacrificial area of 500 ft^2.

The debris transport calculation utilized CFD analysis performed using FLUENT to determine which debris would transport to the installed strainers. This analysis contained the following conservatisms:

- No debris retention in inactive volumes credited
- Inertial capture of debris ignored
- Plant specific erosion rates are determined based on a flow velocity of 0.7 ft/s. This velocity is greater than the flow velocity in 98% of the post LOCA sump pool.
- Margin added to plant specific fiber erosion rates (see above)
- Design debris load is not time dependent; it is based on a 30-day eroded fiber fraction
- No debris retention in upper containment credited
- Debris retention on grating ignored

- Transport based on containment incipient tumbling velocities
- All debris transported to the debris interceptor of the strainer, even though there are some areas of the sump pool where debris would stall.

The Salem Unit 1 and 2 quantities of dissolved chemicals in the post-LOCA sump as well as the quantity of precipitates, which form due to the dissolved chemicals, were determined based on a mission time of 30 days and the methodology provided in WCAP-16530-NP. The methodology utilized in this calculation did not deviate from that approved by the NRC in the SE for WCAP-16530-NP. In addition, none of the refinements outlined in WCAP-16785-NP were used.

The chemical effects analysis was performed maximizing the amount of material dissolution in the sump pool. The containment spray duration was modeled as 30-days, which leads to conservative dissolution quantities for non-submerged material.

The insulation quantities were based on the debris generation calculation, where 5% margin was added to the fiber quantities (see above). In addition, 10% margin was added to the submerged aluminum metal and paint quantities. Similarly, the quantity of exposed concrete used in the chemical effects analysis included 10% margin.

The ECCS components and systems that are required to operate and pass debris laden fluid during the recirculation phase of recovery from a postulated LOCA have been identified and have been evaluated for blockage and wear from debris that could pass through the installed strainers.

The ECCS equipment at Salem will remain capable of passing sufficient flow to the reactor to adequately cool the core during the 30-day mission time for the postulated LOCA. The downstream component wear evaluation was performed using the guidance provided in WCAP-16406-P, Revision 1, and its associated NRC SE. The downstream wear evaluation is the same for Salem Unit 1 and 2 and uses input, which are bounding.

The in-vessel chemical effects analysis for Salem is based on guidance from the "Draft NRC Staff Review Guidance for Evaluation of Downstream Effects of Debris Ingress into the PWR RCS on Long Term Core Cooling Following a LOCA," WCAP-16793-NP, and Option 2 of the additional guidance for modeling post-LOCA core deposition which is contained in the enclosure to PWROG letter OG-07-534.

At the time of this submittal, PSEG is in compliance with the requirements of GL 2004-02 except for the items described below, which PSEG received NRC approval for an extension request until June 30, 2008. The NRC granted this extension on December 21, 2007. (Reference A.27)

The items for which an extension request was granted are:

- Completion and evaluation of the final chemical head loss tests performed by CCI,
- Incorporation of the head loss test results into the strainer head loss and NPSH calculations,
- Completion of downstream effects and in-vessel calculations.

Note, the approach for the incomplete items has been outlined above. With the completion of the above tasks, both Salem Units will be in compliance with the regulatory requirements listed in GL 2004-02.

Specific Guidance for Review Areas

1. Overall Compliance:
Provide information requested in GL 2004-02 Requested Information Item 2(a) regarding compliance with regulations.
GL 2004-02 Requested Information Item 2(a)
Confirmation that the ECCS and CSS recirculation functions under debris loading conditions are or will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this GL. This submittal should address the configuration of the plant that will exist once all modifications required for regulatory compliance have been made and this licensing basis has been updated to reflect the results of the analysis described above.

The ECCS and the CSS during the recirculation phase of a LOCA are in compliance with the regulatory requirements listed in the Generic Letter 2004-02 except for the items described below. PSEG submitted and received NRC approval to extend completion of these items until June 30, 2008 (Reference A.27)

The items for which an extension request was granted are:

- Completion and evaluation of the final chemical head loss tests performed by CCI,
- Incorporation of the head loss test results into the strainer head loss and ECCS Pump NPSH calculations,

- Completion of downstream effects and in-vessel calculations.

With the completion of the above tasks both Salem Units will be in compliance with the regulatory requirements listed in GL 2004-02. Details of the plant configuration after the implementation of GL 2004-02 are provided in the Executive Summary.

2. General Description of and Schedule for Corrective actions: Provide a general description of actions taken or planned, and dates for each. For actions planned beyond December 31, 2007, reference approved extension requests or explain how regulatory requirements will be met as per Requested Information Item 2(b). (Note: All requests for extension should be submitted to the NRC as soon as the need becomes clear, preferably not later than October 1, 2007.)

During the recirculation phase of a LOCA two Residual Heat Removal (RHR) pumps take suction through separate lines from the containment sump and discharge through separate paths to the Reactor Coolant System (RCS). The RHR pumps direct flow into the reactor, containment spray, high head pumps (CV) and intermediate head pumps (SI).

The following are the proposed/implemented changes at Salem Unit 1 and 2.

- PSEG replaced the original strainers. The original containment sump strainer area for each Salem Unit was approximately 85 ft^2. The new ECCS containment sump strainer modules installed at Salem Unit 1 and 2 have a surface area of 4,854 ft^2 and 4,656 ft^2 respectively. The new surface area was based on debris load and chemical precipitates, as well as plant layout. In addition to providing a significant increase in strainer surface area, the new design in both Salem Units incorporates a reduction in strainer hole size from an original 1/8 inch nominal to 1/12 inch nominal for the new strainers. The Salem Unit 1 strainers were installed during the Spring 2007 refueling outage (Reference A.31). The Salem Unit 2 strainers were installed during the Fall 2006 refueling outage (Reference A.32).

- PSEG installed a debris interceptor. A 9-inch tall debris interceptor is bolted to the front feet of the strainer modules to prevent large debris from reaching the strainer pockets. The debris interceptor is made of grating with bearing bars on 15/16-inch centers and cross bars on 4-inch centers. Attached to the back of the grating is perforated plate with 1/8-inch diameter perforations. The top of the debris interceptor has an overhanging lip that keeps larger debris from lifting off the floor and flowing over the debris interceptor. At the end of the strainer train, the debris interceptor wraps around the side and extends to the containment liner to limit debris transport to the back of the strainers.

- PSEG installed new level switches for both Salem Units. The new level switches have an accuracy of ±0.75 inches and are more accurate than the existing level indicators; thus providing a more accurate indication of the containment flood level. These level switches alert the control room operator when sufficient containment sump level has been achieved as necessary to support initiation of cold leg recirculation. The Salem Unit 1 and 2 installations were done during the Spring 2007 and Fall 2006 refueling outages respectively.

- PSEG replaced all the calcium silicate insulation within the ZOI at Salem Unit 1 and 2 (Reference A.29 and A.30). Min-K insulation was replaced with reflective metallic insulation wherever possible. In some cases NUKON insulation was used due to accessibility concerns. In all cases, the added NUKON and the remaining Min-K insulation were accounted for in the debris generation calculation. The Salem Unit 1 and Salem Unit 2 replacements were done during the Spring 2007 and Fall 2006 refueling outages respectively.

- PSEG submitted a licensing basis change on August 15, 2007 to revise the licensing basis for the Net Positive Suction Head available (NPSHa) methodology for the ECCS and CSS pumps as described in the Appendix 3A of the Salem Updated Final Safety Evaluation Report (UFSAR). The NRC approved the request on November 15, 2007 (Reference A.8).

- PSEG will replace the Salem Unit 2 SG during the Spring 2008 refueling outage. The new SG will be insulated with Transco RMI. The existing SG are insulated with NUKON. On June 7, 2006, PSEG submitted an extension request for Salem Unit 2 SG insulation replacement until the end of the Spring 2008 refueling outage. On August 11, 2006, the NRC approved the extension request (Reference A.26).

- PSEG revised appropriate Administrative Procedures. As part of the newly installed containment sump strainers, PSEG revised its administrative procedures (Reference A.36 and A.37) to ensure that potential sources of debris that may be introduced into containment will be assessed for adverse effects on the ECCS and CSS recirculation functions. These programmatic controls include requirements related to coatings, containment housekeeping, materiel condition, and modifications. The procedure revisions were issued on December 18, 2007.

In addition to the above modifications, the following documents have been generated to support the GL 2004-02 actions:

- Debris Generation Calculation
- Debris Transport Calculation (including CFD analysis)
- Post-LOCA Chemical Effects Analysis
- Minimum Containment Flood Level Calculation
- Downstream Wear Effects Calculation (Rev 0 of WCAP 16406-P)
- Mission Time Evaluation
- Minimum Air Pressure Calculation
- Latent Debris Walkdown and Evaluation
- Strainer Structural/Seismic Analysis
- Foreign Material Walkdowns

The following documents will be finalized prior to the NRC approved extension date of June 30, 2008 (Reference A.27):

- Final Chemical Effect Head Loss Test Report
- Strainer Head Loss Calculation
- ECCS Pump NPSH Calculation
- Downstream Wear Effects Calculation (Rev 1 of WCAP 16406-P)
- In-Vessel Evaluation

3. Specific Information Regarding Methodology for Demonstrating Compliance:

3a. Break Selection

The objective of the break selection process is to identify the break size and location that present the greatest challenge to post-accident sump performance.

3a.1) Describe and provide the basis for the break selection criteria used in the evaluation.

Eight breaks were investigated at Salem Generating Station (for a sketch of the break locations see response under Item 3b.1 and 3b.2). However, two of these breaks were Alternate Methodology breaks (not shown on the sketch on page 12), which Salem Generating Station did not utilize, and therefore, they are not reported in the final debris generation calculation (Reference A.1). The six remaining reported breaks were all located on the primary piping. The breaks locations are:

- Two breaks are located on the crossover leg, which has the largest diameter of the primary piping with a 31-inch inner diameter.

- Three breaks are located on the hot leg, which has the next largest diameter of the primary piping with a 29-inch inner diameter, and

- One break is located on the cold leg, which has the smallest diameter of the primary piping with a 27.5-inch inner diameter.

The locations of the analyzed breaks were chosen to maximize the amount and types of debris generated. Therefore, breaks were placed near large equipment, specifically the SG, reactor coolant pumps, pressurizer, and also near walls and the floor. Finally, breaks were located in areas expected to maximize the transport of debris to the sump strainer.

3a.2) State whether secondary line breaks were considered in the evaluation (e.g., main steam and feedwater lines) and briefly explain why or why not.

Secondary pipe breaks were not considered for this analysis. Based upon a review (Reference A.1) of the plant UFSAR and Emergency Operating Procedures (EOPs), a Main Steam Line Break or a Feedwater Line Break will not result in recirculation and, therefore, need not be considered. Additionally, breaks of small lines (less than 2 inches) were not investigated, because they are bounded by the larger breaks.

3a.3) Discuss the basis for reaching the conclusion that the break size(s) and locations chosen present the greatest challenge to post-accident sump performance.

As discussed previously, breaks were preferentially located near large equipment and walls and floors. Breaks were also conservatively investigated on only the largest possible pipes in containment to maximize the debris generation. Additionally, breaks on the largest pipes in containment are most likely to result in the automatic initiation of containment spray, and thus include the debris contribution from containment sprays in addition to the local effects at the break to the production of the largest and most varied amount of debris types.

These conservative steps ensure the largest amount and mixture of debris types, which presents the greatest challenge to the sump strainer.

3b. Debris Generation/Zone of Influence (ZOI) (excluding coatings)

The objective of the debris generation/ZOI process is to determine, for each postulated break location: (1) the zone within which the break jet forces would be sufficient to damage materials and create debris; and (2) the amount of debris generated by the break jet forces.

3b.1) Describe the methodology used to determine the ZOIs for generating debris. Identify which debris analyses used approved methodology default values. For debris with ZOIs not defined in the guidance report (GR)/safety evaluation (SE), or if using other than default values, discuss method(s) used to determine ZOI and the basis for each.

3b.2) Provide destruction ZOIs and the basis for the ZOIs for each applicable debris constituent.

Following is the response to items 3b1 and 3b.2.

The bioshield, for both Salem Units, contains four RCS Loops (as shown in the following figure for Salem Unit 1). At the basement level, all four loops are open to one another; however, the northern loops (11 or 13) are mostly isolated from the southern loops (12 or 14) by the primary shield wall and other walls, which are not shown in the figure (see References A.46 and A.47).

The walls create three passageways between the northern and southern loops, which range in width from 2 feet 11 inches to 11 feet 5 inches (see References A.48 and A.49). These restrict the break jet thereby limiting the potential for breaks in one pair of loops (i.e., north or south loops) impacting the other pair of loops.

The primary shield wall in particular provides a shadowing effect between the loops, such that a break in one loop will not necessarily affect all other loops. Above elevation 100 feet, walls exist which completely isolate the northern and southern loops (see A.50 and A.51).

Salem Nuclear Generating Station Units 1 and 2
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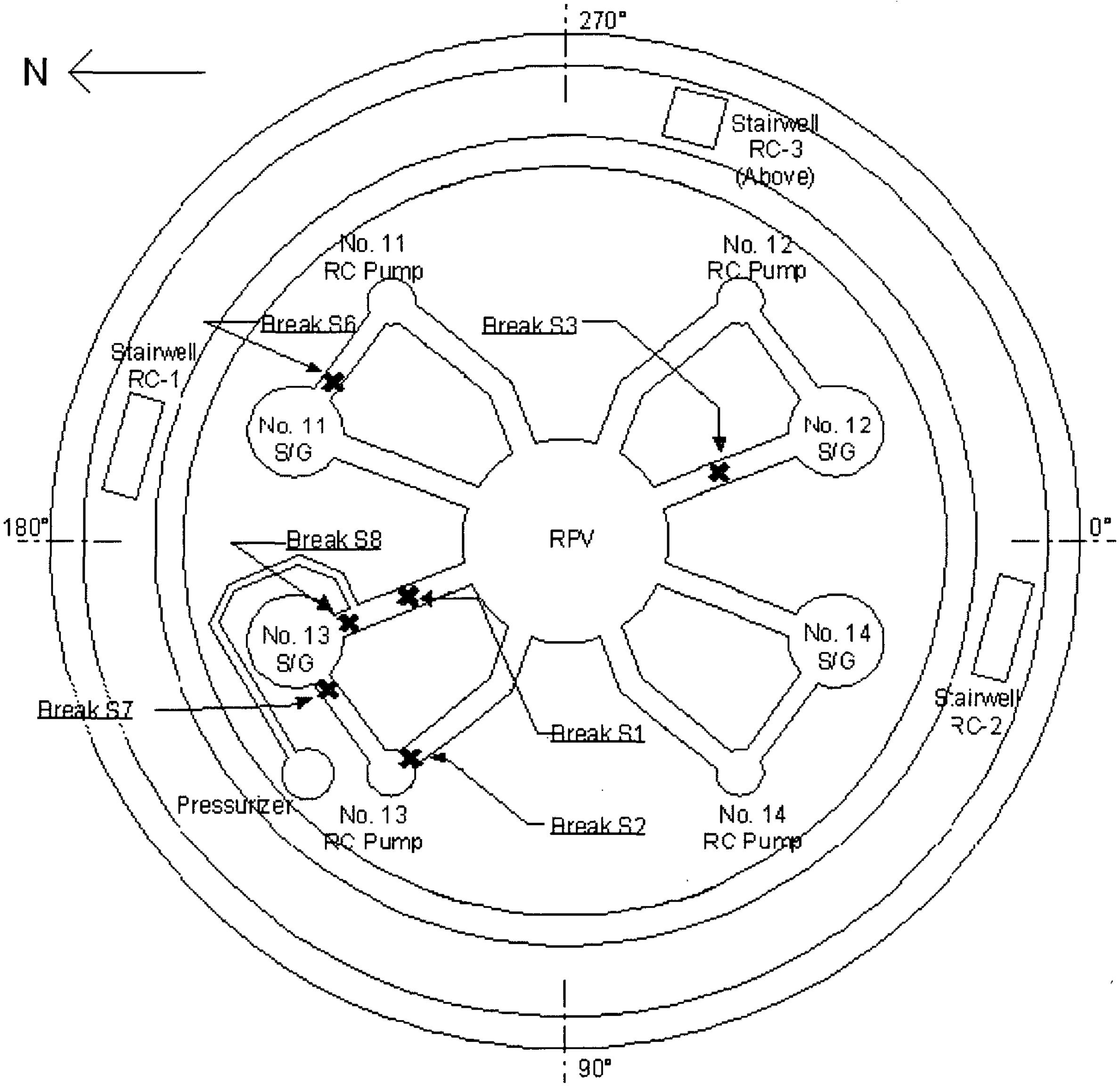


SALEM UNIT 1 BREAK LOCATIONS

The insulation in containment at Salem consists of jacketed and un-jacketed NUKON fiberglass, generic fiberglass, Kaowool, Min-K, MRI and Transco RMI.

For MRI, Min-K and all fiber insulation (with the exception of jacketed NUKON located in Salem Unit 1), the modeled ZOI is large enough to encompass all insulation located on two of the four RCS loops. Since two loops are affected for all the postulated breaks, the MRI, Min-K and fibrous insulation loads are the same for all breaks with the exception of Break S3 which is located on other side of the

Reactor Pressure Vessel (RPV); therefore, it does not impact the insulation on the pressurizer (see previous figure).

This is not the case for jacketed NUKON in Salem Unit 1. Due to the reduced ZOI of jacketed NUKON in Salem Unit 1, this insulation type is more sensitive to break location. Therefore, the NUKON debris generation at Salem Unit 1 was analyzed for each break individually; however, for conservatism, the debris generated by the bounding break location has been applied to all breaks.

Based on industry testing by Westinghouse (Reference 26) jacketed NUKON at Salem Unit 1 is evaluated based on an 8D ZOI ("D" being the inside diameter of pipe at the postulated break), which is conservative relative to the 5D justified by testing. The Westinghouse data is applicable based on the discussion contained in document Vendor Technical Document (VTD) 901357 (Reference A.54).

Transco RMI debris generation has been analyzed in the same way as jacketed NUKON debris generation at Salem Unit 1. The SER (Reference 3) recommends a ZOI radius of 2D for Transco RMI; this ZOI value is used for the Salem Generating Station debris generation analysis.

In order to perform the calculation of debris generation for MRI, Min-K and all fiber insulation (with the exception of jacketed NUKON in Salem Unit 1), an inventory of the insulation based on piping stress isometrics, piping insulation drawings and piping arrangement drawings is utilized. This inventory is part of the debris generation calculation (Reference A.1). The total amount of each insulation type in each containment ZOI is found from this inventory. This information is then used to determine the debris total for each insulation type as described in the following paragraphs.

Salem Unit Comparison

The physical layout of the Salem Units, including major equipment types and locations is the same; however, the insulation types and locations vary. Both Salem Units contain a significant amount of MRI. In Salem Unit 1 the MRI is located on piping and the RCPs. In Salem Unit 2 the MRI is located on piping, the RCPs and the pressurizer.

Additionally, the Salem Unit 2 replacement SGs will have Transco RMI insulation. Both Salem Units contain similar amounts of Kaowool and generic fiberglass located on piping. Min-K insulation is limited to very small amounts in a few isolated areas in both Salem Unit 1 and 2. Salem Unit 2 also has minimal amounts of Min-K insulation on some piping. Debris totals for all insulation types are provided in Table 3b-1.

Finally, both Salem Units contain NUKON insulation. Salem Unit 1 contains a significant amount of NUKON insulation on the steam generators, pressurizer and piping. With the exception of the bottom hemisphere of the steam generators, this insulation is jacketed, and is, therefore, evaluated based upon an 8D ZOI as discussed previously. The unjacketed bottom hemisphere of the SG is considered debris for Salem Unit 1 breaks.

Salem Unit 2 also contains some NUKON insulation; however, since there is a relatively small amount and some of it is unjacketed; it is evaluated based on a 17D ZOI consistent with the NEI Guidance and NRC SER.

Piping Insulation

For generic fiberglass and Kaowool insulation on piping, the insulation inventory is utilized to calculate the total amount of that insulation type within the inner annulus. The piping insulation is considered divided evenly among the four primary loops. Therefore, any large break will affect approximately the same amount of debris as any other due to the large ZOIs of insulation under consideration.

The containment layout is relatively symmetric (except for the pressurizer and its associated piping). Due to the reactor wall and other walls, a break on one side will not impact the other side. The debris generation calculation assumed that half of the piping is located on each side. For conservatism, to account for any possible differences between the north and south side, the amount on each side was increased by 10%. In addition, the insulation on the pressurizer and associated piping was included for the breaks located on the side containing the pressurizer.

Unlike other insulation types (Kaowool, NUKON, Min-K, etc.), MRI insulation consists of thin sheets of metal with air-gaps between them. Therefore, rather than calculating a volume of debris generated, the area of these sheets is calculated. The debris generation calculation (Reference A.1) conservatively considers three layers of these sheets per inch (11 layers for 3.5 inch thickness, 9 layers for 3.0 inch thickness and 8 layers for 2.5 inch thickness).

The pressurizer surge line, pressurizer spray lines and residual heat removal lines all are insulated with MRI and these lines are all located in the same area of containment, near the pressurizer. Therefore, it would not be conservative to split the insulation debris evenly between the two areas of containment as done for other insulation types. Hence, these debris sources are included in the maximum debris total along with one-half of the remaining MRI insulation in the inner annulus.

The process for calculating the volume of Min-K insulation differs from all other debris types found on piping. Some Min-K insulation is located on the hot and cold legs inside the sleeves that line the penetrations through the primary reactor pressure vessel (RPV) cavity. In order for this insulation to become debris and enter the recirculation pool, a break would have to occur inside the RPV cavity, which would result in a much smaller debris volume due to the truncation of the break jet by the RPV cavity wall.

However, for conservatism, this insulation is included in the maximum debris total. There is also some Min-K on miscellaneous piping in Salem Unit 2, though not in Salem Unit 1 (all Min-K in Salem Unit 1 is located in the RPV penetrations on the primary piping). All of the Min-K on piping in Salem Unit 2 is included in the maximum debris volume case for that Salem Unit. An additional margin of 20% is added to the Min-K totals for both Salem Units.

Equipment Insulation

The Salem Unit 1 pressurizer and SG are insulated primarily with jacketed NUKON. In Salem Unit 2 the SGs are being replaced during the Spring 2008 outage with new SGs utilizing Transco RMI insulation. The shell of the Salem Unit 2 pressurizer is insulated with MRI and the hemispherical bottom is conservatively assumed to be insulated with unjacketed NUKON.

The reactor coolant pumps (RCPs) in both Salem Units are insulated with MRI and therefore generate equivalent debris amounts in both Salem Units. The method of calculating these debris loads is discussed in the following paragraphs.

The bottom dome of each steam generator and the pressurizer in Salem Unit 1 is insulated with unjacketed NUKON. Therefore, due to the size of the ZOI associated with unjacketed NUKON, the insulation on the bottom of two SG and the bottom dome of the pressurizer is included in the maximum debris total.

The shells of the SG and the pressurizer in Salem Unit 1 are insulated with jacketed NUKON. The amount of debris from jacketed NUKON is determined based upon the proximity of the break to the debris targets, using a ZOI of 8D, and the limiting case is applied to every break. Break S3 is an exception because it is not located near enough to the pressurizer to affect it; therefore, its jacketed NUKON debris load is calculated independent of the other breaks.

In Salem Unit 2 the insulation on the replacement SGs will have Transco RMI (Reference A.14). Since Transco RMI is subject to a relatively small ZOI of 2D, the volume of insulation debris generated on the SG is calculated based on its proximity to the postulated breaks. The limiting case is applied to every break.

The RCPs in both Salem Units are insulated with 3-inch thick MRI. The ZOI for MRI is 28.6D, which is large enough that a large break could affect three RCPs. Therefore, the area of MRI covering three of the RCPs is included in the debris total of each break.

Coatings

Coatings on steel, concrete and equipment in containment were also evaluated. All qualified coatings at Salem are epoxy coatings, which were evaluated for a 5D ZOI. Based upon the results of testing presented in WCAP-16568-P (Reference 22), a 4D ZOI is acceptable, but a 5D ZOI is conservatively used at Salem. All unqualified coatings are considered to be debris consistent with NEI 04-07 and its associated SER (References 2 and 3). Further discussion of coatings is contained in Section 3h of this response submittal.

Latent Debris and Foreign Materials

As discussed in Section 3d of this response submittal, latent debris and miscellaneous (foreign) materials are also included in the debris generation analysis. The amount of latent debris is calculated from walkdown data in accordance with NEI 02-01 (Reference 20), as reported in the plant walkdown report (Reference A.15). The amount of foreign material debris considered is a conservative maximum, which has been reinforced by walkdowns of both Salem Units (References A.16 and A.17). Further discussion of latent and foreign material debris is presented in the respective sections within this response submittal.

3b.3) Identify if destruction testing was conducted to determine ZOIs. If such testing has not been previously submitted to the NRC for review or information, describe the test procedure and results with reference to the test report(s).

Westinghouse testing detailed in WCAP-16710-P (Reference 26) has been utilized for the determination of the ZOI for jacketed NUKON insulation. The testing justified a 5D ZOI for jacketed NUKON; however, an 8D ZOI has been used for jacketed NUKON at Salem Unit 1. WCAP-16568-P (Reference 22) has been utilized for the determination of the ZOI for qualified coatings. A ZOI of 5D has been used for qualified epoxy coatings although testing justified a 4D ZOI.

3b.4) Provide the quantity of each debris type generated for each break location evaluated. If more than four break locations were evaluated, provide data only for the four most limiting locations.

The insulation and coating debris totals for the six breaks reported are presented in Tables 3b-1 – 3b-3. Two alternate methodology breaks were analyzed, but are not included in the final debris generation calculation. The amount of latent and foreign (miscellaneous) debris generated is provided in Section 3d of this response. Six breaks are being reported, rather than the suggested four, because five of the six breaks have identical debris loads.

Table 3b-1: Insulation Debris

Debris Type	Units	Break S1	Break S2	Break S3	Break S6	Break S7	Break S8
Insulation (Salem Unit 1)							
NUKON (SGs, Pressurizer, and Piping)	[ft^3]	537	537	476	537	537	537
Kaowool (Piping)	[ft^3]	128	128	128	128	128	128
Generic Fiberglass (Piping)	[ft^3]	45	45	45	45	45	45
Min - K (Piping)	[ft^3]	5.3	5.3	5.3	5.3	5.3	5.3
MRI (Piping and RC Pumps)	[ft^2]	33926	33926	33926	33926	33926	33926
Insulation (Salem Unit 2)							
NUKON (Pressurizer bottom and Piping)	[ft^3]	46	46	5	46	46	46
Kaowool (Piping)	[ft^3]	116	116	116	116	116	116
Generic Fiberglass (Piping)	[ft^3]	47	47	47	47	47	47
Min - K (Piping)	[ft^3]	24.5	24.5	24.5	24.5	24.5	24.5
MRI (Pressurizer, Piping, RC Pumps)	[ft^2]	37685	37685	31260	37685	37685	37685
Transco RMI (Steam Generators)	[ft^2]	3255	3255	3255	3255	3255	3255

NOTE:

(1) For Sketch of Break Locations see Response 3b.1 and 3b.2
(2) Some calcium silicate insulation on non-primary loop piping has been replaced with Transco RMI. However, this insulation is not included in the above table because the ZOI of Transco RMI is 2D; therefore, even for the largest break in containment, the ZOI is only approximately 5 feet. Therefore, no piping is expected to be affected.

Table 3b-2: Qualified Coating Debris

Steel Coating (Epoxy)	Concrete Floor Coating (Epoxy)	Concrete Wall Coating (Epoxy)
V [ft^3]	V [ft^3]	V [ft^3]
9.2	1.4	1.4

Table 3b-3: Unqualified Coating Debris

Unqualified Coatings in Containment			
Description	**Area**	**Thickness**	**Volume**
	[ft^2]	**[mils]**	**[ft^3]**
23, 24, 25 CFCU Bases, Primer Only	2	3.5	0.001
Fire Protection Piping [Carboline] 890 Instead	200	10.5	0.175
78', 100' Liner Plate Match Gray	250	7	0.146
22 CFCU Motor Mount, White	15	10.5	0.013
130' - 100' Liner and 21CFCU	200	7	0.117
Polar Crane Upgrade Stencil	50	10.5	0.044
Total			**0.496 ≅ 0.5**

Permanent Lead Shielding Blankets

At Salem Unit 1 and 2 permanent lead shield blankets are installed at various locations inside the bioshield area to reduce dose exposure. The debris generation due to these blankets was evaluated in accordance with WCAP 16727-NP (Reference 32) and is documented in Calculations 6S1-2258 (Reference A.59) and 6S2-2249 (Reference A.60). These calculations concluded that there would be no debris generated due the jet impingement on the lead blankets. However, for conservatism one (1) ft^3 of additional fiber is added to account for potential debris from permanent lead shielding blankets installed in each Salem Unit.

Table 3b-4: Permanent Lead Blanket Debris

Lead Shielding Blanket Fibers	Units	All Breaks
Salem Unit 1	[ft^3]	1.0
Salem Unit 2	[ft^3]	1.0

3b.5) Provide total surface area of all signs, placards, tags, tape, and similar miscellaneous materials in containment

Foreign material debris is discussed in greater detail along with latent debris in Section 3d of this response. The total foreign material debris area found in Salem Unit 1 is 572.3 ft^2 and in Salem Unit 2 is 525 ft^2.

3c. Debris Characteristics

The objective of the debris characteristics determination process is to establish a conservative debris characteristics profile for use in determining the transportability of debris and its contribution to head loss.

3c.1) Provide the assumed size distribution for each type of debris.

The development of the size distributions used for Salem Unit 1 and 2 is discussed in Section 3c.4 of this response. The size distributions developed and used are as indicated in the following tables.

Table 3c-1: NUKON and Kaowool Size Distribution

Insulation	Category	Category Percentage
Unjacketed NUKON at Salem Unit 1, NUKON at Salem Unit 2 and Kaowool	Fines	15%
	Small Pieces	45%
	Large Pieces	40%
Jacketed NUKON at Salem Unit 1	Fines	25%
	Small Pieces	75%

Table 3c-2: MRI Size Distribution

Category	Category Percentage
Fines (≤ ½ inch)	5%
Small (½ inch < x < 4 inch)	70%
Large (≥ 4 inch)	25%

Table 3c-3: Transco RMI Size Distribution

Category	Category Percentage
Small (< 4 inch)	100%
Large (≥ 4 inch)	0%

3c.2) Provide bulk densities (i.e., including voids between the fibers/particles) and material densities (i.e., the density of the microscopic fibers/particles themselves) for fibrous and particulate debris.

NUKON and Kaowool

The bulk density of the NUKON insulation installed at Salem, included in the testing conducted by the screen vendor, Control Components, Inc. (CCI), is 2.4 lbm/ft^3 (Reference A.20).

Per Table 3-2 of the NEI Guidance (Reference 2) the bulk density of Kaowool insulation ranges from as low as 3.0 lbm/ft^3 to as high as 12 lbm/ft^3. The bulk density of the Kaowool insulation installed at Salem is 8 lbm/ft^3 (Reference A.20). This density will be used for the sump strainer performance testing.

Generic Fiberglass and Min-K

A bulk density of 6 lbm/ft^3 is assigned to generic fiberglass insulation (Reference A.20), because generic fiberglass is expected to be less dense than ceramic fiber insulation. The most dense fiberglass insulation listed in Table 3-2 of the NEI Guidance (Reference 2) is 5.5 lbm/ft^3; therefore, 6 lbm/ft^3 is conservative. Using a higher density than expected is conservative because a greater density will result in a greater mass of the debris type being used in the testing conducted by CCI.

Per Table 3-2 of the NEI Guidance (Reference 2) the bulk density of Min-K insulation ranges from as low as 8 lbm/ft^3 to as high as 16 lbm/ft^3. The maximum bulk density of Min-K delivered to Salem based upon supplier data is 16 lbm/ft^3 (Reference A.20), which is used in the analysis.

Transco RMI and MRI

Transco RMI and MRI are comprised of thin layers of stainless steel foil. Stainless steel has a density of 490 lbm/ft^3.

3c.3) Provide assumed specific surface areas for fibrous and particulate debris.

Specific Surface Areas for Debris

The specific surface area (S_v) is only used for preliminary analytically determined head loss values across a debris laden sump screen using the correlation given in NUREG/CR-6224. Since the head loss across the installed sump screen is determined via testing, these values are not used in the design basis for Salem. Therefore, these values are not provided as part of this response.

3c.4) Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.

The debris sources at Salem Generating Station include insulation, coating, foreign material and latent debris. The insulation debris includes fiber (NUKON, generic fiberglass, Min-K and Kaowool) and stainless steel reflective metallic insulation (Transco RMI and MRI). The characteristics of the insulation debris material are discussed in this section and the characteristics of the other debris types (e.g. coatings, foreign and latent materials) are included in sections 3h and 3d respectively of this response. As shown below, the size distribution is based on NRC approved guidance.

Size Distribution

NUKON and Kaowool

The debris size distribution used for unjacketed NUKON (located in Salem Unit 2) and Kaowool is the same. This is considered appropriate since both are soft fibrous materials and the range of expected densities for Kaowool extends higher than for NUKON, which indicates that it is less likely to fail as small and fine debris when subjected to the same jet pressure. Therefore, it is conservative to apply the NUKON size distribution to Kaowool debris. For NUKON, the SER guidance (Reference 3) endorses a size distribution of 60% fines and small pieces and 40% large and intact pieces. This distribution has also been used for Kaowool for the reasons given previously. This is considered appropriate and conservative.

Jacketed NUKON (located in Salem Unit 1) is subject to a ZOI of 8D, based on test data from WCAP-16710-P (Reference 26). The applicability of this data is discussed elsewhere in this response and documented in VTD 901357 (Reference A.54). The suggested NUKON size distribution contained in Table 3-3 of the SER (Reference 3) is not used for debris generated within an 8D ZOI. Instead the size distribution for jacketed NUKON at Salem Unit 1 is conservatively 100% small pieces and fine debris.

Table 3c-4: NUKON and Kaowool Size Distribution

Insulation	Category	Category Percentage
Unjacketed NUKON at Salem Unit 1, NUKON at Salem Unit 2 and Kaowool (Salem Unit 1 and 2)	Fines	15%
	Small Pieces	45%
	Large Pieces	40%
Jacketed NUKON at Salem Unit 1	Fines	25%
	Small Pieces	75%

Guidance pertaining to the relative amounts of each of these debris classes is presented on page II-7 of the SER, which states that the debris generation testing for NUKON resulted in 25% of the debris being "individual fibers" (fines) and the other 75% being small-piece debris.

Hence, 25% of small and fine NUKON debris is considered fines and the other 75% is considered small pieces. Therefore, for unjacketed NUKON at Salem Unit 1, all NUKON at Salem Unit 2, and Kaowool (at both Salem Units) 15% (60% x 25%) of the total debris is considered fines and 45% (60% x 75%) of the total debris is considered small-pieces (as indicated in the preceding table). For jacketed NUKON at Salem Unit 1, the 25%/75% split results in 25% of total being considered fines and 75% being considered small pieces.

Fines that enter the active recirculation pool are considered 100% transportable. Small pieces that enter the active recirculation pool are transported based on velocity data found in various references as discussed in Section 3e.

Generic Fiberglass and Min-K

The size distribution for all generic fiberglass and Min-K insulation is 100% fines. Fines that enter the active recirculation pool are considered 100% transportable.

Metal Reflective Insulation (MRI)

The relative amounts of each size category considered for MRI debris at Salem are presented in Table 3c-5. The size distribution for MRI debris is consistent with Section 3.4.3.3.2 of the NEI Guidance (Reference 2) and based on Figure 3-7 of NUREG/CR-6808 (Reference 18). The figure is generated from data obtained from a test of MRI; therefore, it allows for further refinement of the debris size distribution ascribed to MRI debris at Salem.

The size distribution presented in the figure is approximately 5% fines (1/4-inch and smaller), 70% small pieces (1/4-inch to 4-inch), and 25% large pieces (4-inch and larger). The debris sample from this test is typical of the debris from MRI cassettes nearest the modeled break. Using the size distribution for a cassette nearest the break for the entire MRI ZOI is conservative. Fines that enter the active recirculation pool are considered 100% transportable. Small and large pieces are transported based on velocity data found in various references as discussed in Section 3e.

Table 3c-5: MRI Size Distribution

Category	Category Percentage
Fines (≤ ½ inch)	5%
Small (> ½ inch and < 4 inch)	70%
Large (≥ 4 inch)	25%

Transco RMI

The relative amounts of each size category considered for Transco RMI debris at Salem Generating Station are presented in Table 3c-6. Transco RMI has a much sturdier encapsulation than MRI, which affects its destruction pressure and thus its size distribution. As specified in Section 3.4.2.2 of the SER, (see Reference 3), the destruction pressure for Transco RMI (114 psi at the distance of 2 D from the break) is much larger than the destruction pressure for MRI (2.4 psi at the distance of 28.6 D from the break).

Damage to the inner insulation occurs once the protective encapsulation is breached. As the debris generated by higher jet pressures is expected to be more finely fragmented, the percentage of small debris for Transco RMI is expected to be higher than for MRI. For conservatism, 100% of Transco RMI debris is treated as being small debris. Small pieces that enter the active recirculation pool are considered 100% transportable. Specifics of debris transport are discussed in Section 3e.

Table 3c-6: Transco RMI Size Distribution

Category	Category Percentage
Small (< 4 inch)	100%
Large (≥ 4 inch)	0%

Since only two samples are available for horizontal HVAC ducting, the samples collected for horizontal cable trays and horizontal HVAC ducting were combined and used for both categories.

3d. Latent Debris

The objective of the latent debris evaluation process is to provide a reasonable approximation of the amount and types of latent debris existing within the containment and its potential impact on sump screen head loss.

3d.1) Provide the methodology used to estimate quantity and composition of latent debris.

3d.2) Provide the basis for assumptions used in the evaluation.

Latent Debris

Latent debris sources are evaluated by containment walkdown as recommended by Section 3.5.2 of the NEI Guidance (Reference 2) and confirmed by the NRC SER (Reference 3). A walkdown of the Salem Unit 2 containment was conducted to determine the appropriate latent debris amount (Reference A.15, Attachment 8.1). The walkdown conforms to the guidance provided in NEI 02-01 (Reference 20) with only minor variations as discussed below.

As shown below, three or more samples were collected for most surface types. The additional samples collected for certain surface types increase the statistical accuracy of the evaluation. Less than three samples were collected for three Similarly, no samples are available for vertical cable trays; therefore, data from vertical HVAC ducting are used in place of vertical cable tray data. This approach is considered acceptable based on the similarity of the debris on these surfaces. No samples are available for grating; therefore, grating is assumed to have the same latent debris loading as the floor. A listing of the number of each sample type follows.

Number of Samples Collected

Liner	3	HVAC Duct (Vertical)	5
Equipment (Horizontal)	4	Pipe (Horizontal)	3
Equipment (Vertical)	5	Pipe (Vertical)	4
Floor	4	Cable Tray (Horizontal)	3
Wall	5	Cable Tray (Vertical)	0
HVAC Duct (Horizontal)	2	Grating	0

The mass of the samples is accurate to 0.01 grams and is used to determine the latent debris mass distribution (g/ft^2). A statistical analysis of the samples is performed in the calculation of latent debris (Reference A.15). The analysis determines a 90% confidence limit of the mean value for each type of surface based on a normal distribution.

The upper limit of the mean value for each surface type is then applied over the entire surface area of that type throughout containment. This analysis lends further confidence and conservatism to the latent debris mass determination.

Given that the Salem Units are subject to the same housekeeping and closeout procedures, it is reasonable to apply the Salem Unit 2 results to Salem Unit 1. Therefore, a walkdown for Salem Unit 1 was not performed.

The Salem Unit 2 walkdown determined that 33 lb_m (Reference A.15) of latent debris is present in the containment of that Salem Unit; however, for conservatism, 200 lb_m of latent debris is applied to both Salem Units and is considered to be an approximate maximum value (per Section 3.5.2.2 of NEI 04-07, Reference 2).

Consistent with the NRC SER (Reference 3), 15% of the latent debris load (by mass) is assumed to be fibrous debris and the other 85% (by mass) is treated as particulate debris. Likewise, consistent with the NRC SER (Reference 3), densities of 2.4 lb_m/ft^3 (bulk density) for fibrous debris and 168.6 lbm/ft^3 (2.7 g/cm^3) for particulate debris are used.

As the specific surface area of debris is only relevant for head loss calculations using the correlation in NUREG/CR-6224 (Reference 8) and head loss evaluations are now being conducted experimentally, the specific surface area of latent debris was not determined.

Foreign Materials

Labels, tags, stickers, placards and other miscellaneous or foreign materials are also evaluated via walkdown. A foreign material walkdown was conducted for each Salem Unit. The results of the walkdowns are reported in the Salem Unit specific walkdown reports (References A.16 and A.17). The walkdowns determine that Salem Unit 1 contains 555 ft^2 of labels and 17.3 ft^2 of placards; Salem Unit 2 contains 525 ft^2 of labels.

Miscellaneous foreign material is also discussed in more detail in the debris transport section of this response (Section 3e).

3d.3) Provide results of the latent debris evaluation, including amount of latent debris types and physical data for latent debris as requested for other debris under c. above.

The amount of latent and foreign debris considered for Salem Generating Station is provided in Table 3d-1. Per section 3.5.2.3 of SER (Reference 3), 15% of the latent debris (by mass) is considered fibrous with the remainder considered particulate.

Table 3d-1: Latent Debris

Latent Debris	Units	Salem Unit 1	Salem Unit 2
Fiber (15%)	(lb_m)	30	30
Particulate (85%)	(lb_m)	170	170
Total Latent Debris	(lb_m)	200	200

3d.4) Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.

In accordance with the SE for NEI 04-07 Section 3.5.2.2.2 (Reference 3), 75% of the calculated area of foreign materials is considered for screen sacrificial area.

A sacrificial area of 500.0 ft^2 is retained on the strainer surface area for labels, tags, stickers, placards and other miscellaneous or foreign materials (Reference A.2). This is greater than the recommended 75% of the total foreign material debris area of either Salem Unit, as endorsed by the NEI and NRC guidance documents (References 2 and 3).

Table 3d-1: Foreign Material Debris

Foreign Material Debris	Units	Salem Unit 1	Salem Unit 2
Foreign Material Debris Total	(ft^2)	572.3	525.0
Foreign Material Debris Reduced (75%)	(ft^2)	429.2	393.8

3e. Debris Transport

The objective of the debris transport evaluation process is to estimate the fraction of debris that would be transported from debris sources within containment to the sump suction strainers.

3e.1) Describe the methodology used to analyze debris transport during the blowdown, washdown, pool-fill-up, and recirculation phases of an accident.

3e.2) Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.

Response for Items 3e.1 and 3e.2

The debris transport analysis for the Salem Units was conducted in accordance with both the NEI Guidance (Reference 2) and its associated NRC SER (Reference 3). As such, each phase of post-LOCA transport is considered: blowdown, washdown, pool fill-up and recirculation. A detailed discussion of each transport phase, including information on its effect on overall debris transport at Salem, is provided in the following paragraphs.

Blowdown and Washdown

Blowdown transport is the transport of debris, which occurs immediately following a line break and is due to the break jet. Washdown transport is the debris transport, which occurs after the onset of CS and is due to the flow of water from the CS ring headers to the containment sump.

For the transport analysis at Salem Unit 1 and 2, it is conservative to consider some debris to be blown into upper containment by Blowdown and then transported to the containment 74 feet lower level by Washdown. The reason for this is that debris blown downward or outward from the break, rather than upward, is less likely to transport to the sump strainer prior to recirculation.
For conservatism, a portion of the debris with a direct path to upper containment is considered to transport upward to the 130 feet operating floor during Blowdown. The amount of each debris type for each break, which transports this way is determined from an examination of the debris' initial location in relation to the

break location and the potential pathways to upper containment. Once CS is initiated, Washdown drives this debris to openings in the operating floor. Approximately 20% of the operating floor is expected to drain to areas located above the sump strainers (Reference A.2). Therefore, 20% of the debris blown to the operating floor is considered to reach the grating above the strainer.

Finally, the Drywell Debris Transport Study (Reference 9) indicates that grating has a filtering effect on fibrous debris. The debris transporting from the operating floor to the sump strainer must pass through grating at two levels (operating floor and intermediate floor), resulting in transport of 56% of small pieces of debris through the grating to the pool below. Thus, 44% of the debris, which reaches the grating is held up. However, to be conservative, all debris that does not reach the grating or is held up on the grating is modeled as being returned to the sump pool and subject to recirculation transport.

Pool Fill-up

Conservatively, no inactive pools are credited. Therefore, all debris on the floor prior to Pool Fill-up remains on the floor in the active pool after Pool Fill-up. During Pool Fill-up debris is transported to the secondary shield wall doorways by the water spilling onto the floor from the break. Debris is then further transported by Recirculation, as discussed in the following section.

Recirculation

Debris in the containment pool is subject to transport by the pool flow present during Recirculation. For conservatism, any debris considered to be transported to upper containment during Blowdown that does not fully transport to the sump strainer during Blowdown and Washdown is considered to be in the pool at the onset of Recirculation. In accordance with the NEI Guidance and its associated NRC SER, (References 2 and 3), all fine debris that lands in the pool is assumed to transport to the sump strainer. The transport of small, large and intact pieces of debris during recirculation is dependent on the velocities present in the containment pool.

A CFD model developed using FLUENT was utilized to assist with the Recirculation evaluation. See Section 3e.3 for further discussion of the CFD and its use.

NUKON debris transport is investigated and reported in NUREG/CR-6772 (Reference 16). Transport velocities pertinent to NUKON debris transport at Salem Unit 1 and 2 are taken from this document. The document reports values at which some debris begins to move and at which a majority begins to move. These are referred to herein as the "incipient tumbling" and "bulk transport" velocities, respectively.

The incipient tumbling velocity is found to be 0.12 ft/s and even though more than 45% of the containment pool at Salem Unit 1 and 2 has Recirculation velocities less than or equal to 0.12 ft/s, all available NUKON debris is considered to transport to the debris interceptors in front of the sump strainer. NUREG/CR-6772 (Reference 16) also investigates lift-over curb velocities and reports that in order for NUKON debris to transport over a 6-inch curb the pool velocity needs to be greater than or equal 0.34 ft/s.

Plant specific transport testing conducted by Fauske and Associates (Reference A.19) indicates that the appropriate lift-over curb velocity for NUKON debris at Salem Generating Station, due to the debris interceptors installed there, is 0.51 ft/s. NUKON jacketing is expected to transport beyond the secondary shield wall doors during pool fill-up and then come to rest, as jacketing is not expected to transport at velocities below 0.7 ft/s, and there is no continuous flow path of this velocity between the secondary shield wall doors and the sump strainers.

Kaowool debris transport is also investigated and reported in NUREG/CR-6772 (Reference 16). The minimum incipient tumbling velocity of Kaowool is found to be 0.12 ft/s, which is for large pieces. As for NUKON, all Kaowool debris is assumed to transport to the debris interceptors in front of the sump strainer. The lift-over curb velocity for Kaowool reported in NUREG/CR-6772 (Reference 16) is 0.47 ft/s for large pieces and 0.41 ft/s for shredded pieces.

Plant specific transport testing conducted by Fauske and Associates (Reference A.19) indicates that the appropriate lift-over curb velocity for Kaowool debris at Salem Unit 1 and 2, due to the debris interceptors installed there, is 0.61 ft/s for very small pieces (smaller than ½ inch by ½ inch) and 0.69 ft/s for other Kaowool pieces. Kaowool jacketing is expected to transport beyond the secondary shield wall doors during pool fill-up and then come to rest. Jacketing is not expected to transport at velocities below 0.7 ft/s, and there is no continuous flow path of this velocity between the secondary shield wall doors and the sump strainers.

RMI debris transport is investigated in NUREG/CR-3616 (Reference 7) and NUREG/CR-6772 (Reference 16). Transport velocities pertinent to RMI debris transport at Salem Generating Station are taken from these documents. NUREG/CR-3616 (Reference 7) reports transport velocities for multiple sizes of RMI debris, but the minimum incipient tumbling velocity reported is 0.20 ft/s.

Conservatively, this incipient tumbling velocity is used to determine transport potential.

NUREG/CR-6772 finds the lift-over curb velocities for both ½ inch by ½ inch and 2 inch by 2 inch pieces of RMI is greater than 0.99 ft/s for a 6 inch curb. As with NUKON and Kaowool debris, all RMI debris is considered to transport to the debris interceptors in front of the sump strainer.

RMI jacketing is expected to transport beyond the secondary shield wall doors during pool fill-up and then come to rest. Jacketing is not expected to transport at velocities below 0.7 ft/s, and there is no continuous flow path of this velocity between the secondary shield wall door and the sump strainers.

Plant specific erosion values were evaluated by Fauske and Associates (Reference A.19). To examine the erosion rates of NUKON and Kaowool insulation, samples of the debris were constrained in the flow of water within a test flume.

Multiple debris sample sizes were evaluated, as well as multiple flow rates. The velocities chosen are reflective of the maximum velocities in the Salem Unit 1 and 2 containment sump pools and all velocities investigated are in excess of the expected transport velocities of the debris. The duration of the tests ranged from less than one hour to as much as 240 hours.

The final erosion fractions utilized are a conservative estimate of the actual erosion anticipated over a 30-day mission time. These rates are based upon a statistical analysis of the data collected by Fauske, which is contained in the debris transport calculation (Reference A.2).

The erosion data is split among those samples which were subjected to testing for approximately one day or less (26 hours for NUKON; 25 hours for Kaowool) and those samples, which were subjected to much longer testing (as much as 240 hours).

In all, 58 samples were included in the analysis (23 short-term NUKON samples, 11 long-term NUKON, 15 short-term Kaowool and 9 long-term Kaowool). The aforementioned statistical analysis contained in the debris transport calculation (Reference A.2) uses conservative methods to calculate an average erosion rate for each of the four debris categories.

The short and long-term erosion values for each debris type are then combined to determine a conservative erosion fraction for each debris type. An appropriate and conservative erosion fraction for NUKON pieces over a 30-day period is 30%; for Kaowool it is 10%. However, for additional conservatism and margin, the debris transport calculation (Reference A.2) uses erosion fractions of 40% for NUKON and 15% for Kaowool pieces.

3e.3) Identify any computational fluid dynamics codes used to compute debris transport fractions during recirculation and summarize the methodology, modeling assumptions, and results.

To assist in the determination of recirculation transport fractions, several CFD simulations were performed using a commercially available software package, Fluent™. The use of the program was validated by developing a model of the test apparatus described in NUREG/CR-6773 (Reference 17). The model was then evaluated to ensure that its results closely matched the results reported in NUREG/CR-6773 (Reference 17). Fluent™ was found to be in agreement with NUREG/CR 6773.

To gain an understanding of the effect of various parameters on the flow within containment, the following inputs were varied between CFD simulations: flood height, screen design, flow rate through the strainer, flow rate through the break, stairway obstructions, and debris interceptors and containment spray flow.

Two simulations (13 and 14) were used in the evaluation of debris transport. These simulations are representative of the installed strainer modules and the actual containment conditions at the minimum water level following a LOCA. The simulation results include a series of contour plots of velocity and turbulent kinetic energy, plots of flow path lines originating at the break locations and animations of the flow velocities as a function of elevation.

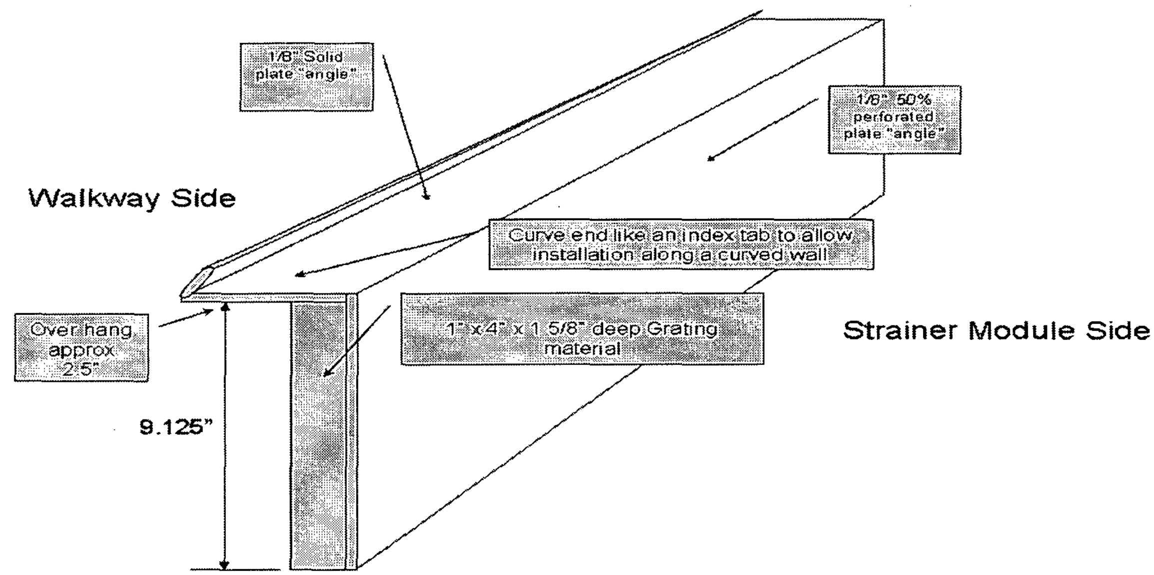
These results were combined with information in the GSI-191 literature and plant specific erosion test results to determine the overall transport fractions for small, large and intact pieces of debris (fines are 100% transportable regardless of pool velocities).

Simulations 13 and 14 of the CFD analysis investigate the installed strainer modules and as-built containment layout. Simulation 14 investigates two-train recirculation, which results in pool velocities higher than simulation 13. Therefore, simulation 14 is used for the determination of transport fractions.

As stated previously, all debris except for insulation jacketing, is conservatively considered to transport to the debris interceptors in front of the sump strainer during Recirculation. Once reaching the debris interceptors, the CFD analysis is utilized to determine the amount of debris capable of transporting over the interceptors (see Section 3e.4).

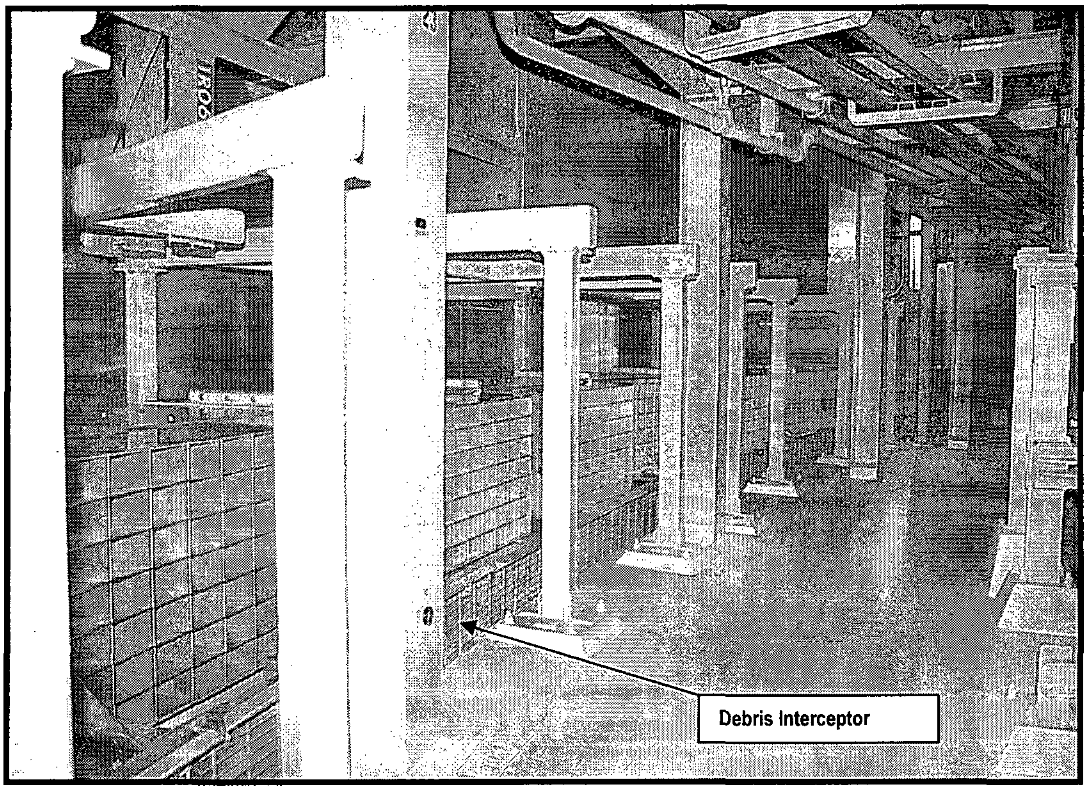
3e.4) Provide a summary of, and supporting basis for, any credit taken for debris interceptors.

Debris interceptors are installed at both Salem Unit 1 and 2 around the perimeter of the sump strainers. These debris interceptors are shaped like an upside down "L" with the lip of the interceptor (or the base of the letter "L") facing upstream.



Debris Interceptor Installed In Front of Strainer Modules

The interceptors stand 9.125-inches high and the lip extends 4-inches upstream (see picture above). They are constructed of grating, perforated plating and solid 11 gauge plate. Plant specific testing conducted by Fauske and Associates (Reference A.19) indicates that the lift-over curb velocities for these interceptors will be at least 50% greater than those reported in NUREG/CR-6772 (Reference 16) for a 6-inch curb. The calculation of debris transport over the debris interceptors is based on the Fauske data whenever possible.



Salem Unit 1 Strainer Module and Debris Interceptor Layout

The debris interceptors are not credited for holding up any fine debris. The debris interceptors are credited for holding up small and large pieces of NUKON, Kaowool and MRI insulation only. Small and large pieces of NUKON and Kaowool are subjected to erosion at the debris interceptor as discussed in Section 3e.1 and 3e.2.

NUKON fines, Kaowool fines, Min-K, generic fiberglass, MRI fines, Transco RMI fines, coatings, latent and foreign debris are all treated as traveling unimpeded to the sump strainer.

3e.5) State whether fine debris was assumed to settle and provide basis for any settling credited.

In accordance with the NEI Guidance and NRC SER, all fine debris is assumed to transport to the strainers.

3e.6) Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the strainers.

The amount of debris determined to transport to the sump strainer for the limiting break is provided in Table 3e-1.

Table 3e-1: Total Debris Generated and Transported to Strainer

Debris Type	Units	Generated Debris	Total Debris Transport	Total Debris Transport Fraction
Insulation (U1)				
NUKON (SGs, Pressurizer, and Piping)	[ft^3]	537	310.3	0.58
Kaowool (Piping)	[ft^3]	128	38.6	0.30
Generic Fiberglass (Piping)	[ft^3]	45	45	1.0
Min - K	[ft^3]	5.3	5.3	1.0
MRI (Piping and RC Pumps)	[ft^2]	33926	1700	0.05
Insulation (U2)				
NUKON (Pressurizer and Piping)	[ft^3]	46	23.3	0.51
Kaowool (Piping)	[ft^3]	116	35.0	0.30
Generic Fiberglass (Piping)	[ft^3]	47	47	1.0
Min - K	[ft^3]	24.5	24.5	1.0
MRI (Pressurizer, Piping, RC Pumps)	[ft^2]	37685	1900	0.05
Transco RMI (SGs)	[ft^2]	3255	3255	1.0
Qualified Epoxy Coatings (U1 and U2)	[ft^3]	12.6	12.6	1.0
Unqualified Coatings (U1 and U2)	[ft^3]	0.5	0.5	1.0
Latent Debris (U1 and U2)	[lbm]	200	200	1.0
Foreign Materials				
Labels (U1)	[ft^2]	555	555	1.0
Placards (U1)	[ft^2]	17.3	17.3	1.0
Labels (U2)	[ft^2]	525	525	1.0
Permanent Lead Shielding Blankets (Fiber Debris) - (U1 and U2)	[ft^3]	1.0	1.0	1.0

3f. Head Loss and Vortexing
The objectives of the head loss and vortexing evaluations are to calculate head loss across the sump strainer and to evaluate the susceptibility of the strainer to vortex formation.

3f.1) Provide a schematic diagram of the emergency core cooling system (ECCS) and containment spray systems (CSS).

The following are simplified P&ID drawings associated with the ECCS and CSS. These drawings are included in the compact disc attached to this response as Enclosure 1.

- Drawing 205250-Simp No 1 Salem Unit ECCS Simplified P&ID
- Drawing 205350-Simp No 2 Salem Unit ECCS Simplified P&ID
- Drawing 205234-Simp No 1 Salem Unit Safety Injection Simplified P&ID
- Drawing 205334-Simp No 2 Salem Unit Safety Injection Simplified P&ID
- Drawing 205235-Simp No 1 Salem Unit Containment Spray Simplified P&ID
- Drawing 205335-Simp No 2 Salem Unit Containment Spray Simplified P&ID

3f.2) Provide the minimum submergence of the strainer under small-break loss-of-coolant accident (SBLOCA) and large-break loss-of-coolant accident (LBLOCA) conditions.

Although the discussion is applicable to both SBLOCA and LBLOCA, it is expected that for some SBLOCAs the outflow from the RWST may be low enough that transition to recirculation phase may not be necessary. The plant may be stabilized before the RWST level depletes to the point of having to align the ECCS for recirculation.

The minimum submergence of the strainer for initiation of recirculation phase is 3-5/16 inches (Reference A.6) for both Salem Unit 1 and Salem Unit 2. However, conservatively vortex analyses have been performed using a 3-inch submergence and strainer testing will also use a 3-inch submergence.

The minimum strainer submergence was conservatively determined using the maximum elevation of the top of the strainer along with the minimum post-LOCA sump water level elevation. The maximum elevation of the top of the strainer is determined as the strainer module height plus the height of the strainer feet off the floor.

The strainer feet are adjustable and are conservatively modeled as fully extended. In addition, the floor in the outer annulus at Salem (where the strainer is located) is sloped upwards from the secondary shield wall to the containment liner (the total rise is 2 inches).

The strainer was conservatively considered to be located at the highest floor elevation, even though the strainer was placed several feet away from the containment liner. The floor elevation at this point is approximately 1 inch lower than at the liner.

3f.3) Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.

The Salem Unit 1 and 2 strainers are fully submerged in water when sump recirculation starts. Therefore, vortexing cannot occur within the strainer interior cavities into the suction pipe, as long as there is no vortexing and air entrainment from the water surface to the strainer screen.

To prove that there is no such air vortexing from the surface, CCI has conducted systematic tests to understand and evaluate this phenomenon. Two types of tests were conducted for the two basic types of vortexing from the surface.

The first, test was performed to prove that no local high velocities due to suction pump stopping/starting would lead to vortices and was originally done for the French PWR strainer market. Within this effort, two basic CCI strainer configurations were tested: strainer modules with perforated top covers (used to gain additional screen surface, mainly for substantial water submergence) and unperforated top covers (used mainly for smaller water submergences as for Salem).

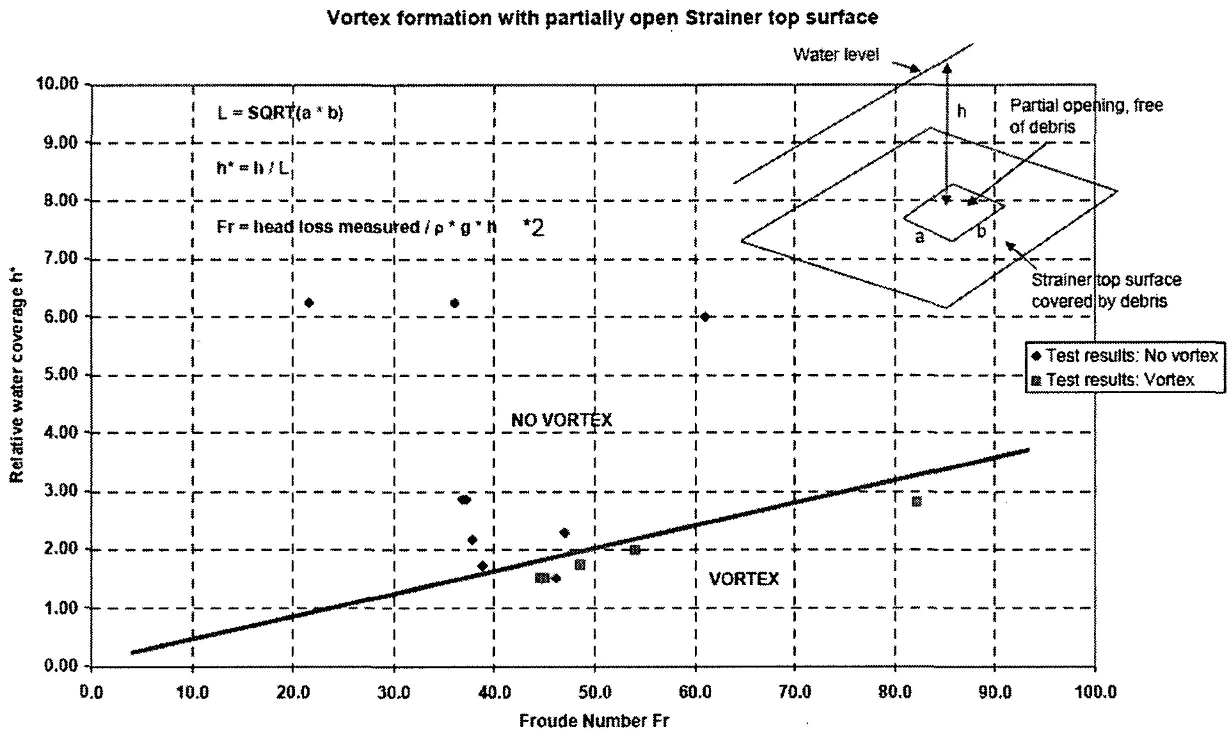
The test concluded that vortices would not form under normal suction operation, either with or without debris. No such vortices were ever observed during the numerous CCI head loss tests, which is attributed to fairly uniform velocities in these new large screens. The velocities are not high enough to lead to vortices.

CCI did observe vortices through a debris-loaded screen after stopping and restarting the suction pump. This is attributed to air bubbles contained in the internal cavities escaping through the screen and forming an open (i.e., without debris) screen window following the pump stopping.

The formation of some air bubbles in the strainer cavities is a common result of some de-aeration due to the lesser air solubility in water at the lower inside pressure. After restarting the pump and reestablishment of the head loss, these very localized "clean screen windows" with almost no flow resistance experience extremely high local velocities, which can lead to local air vortices from the water surface.

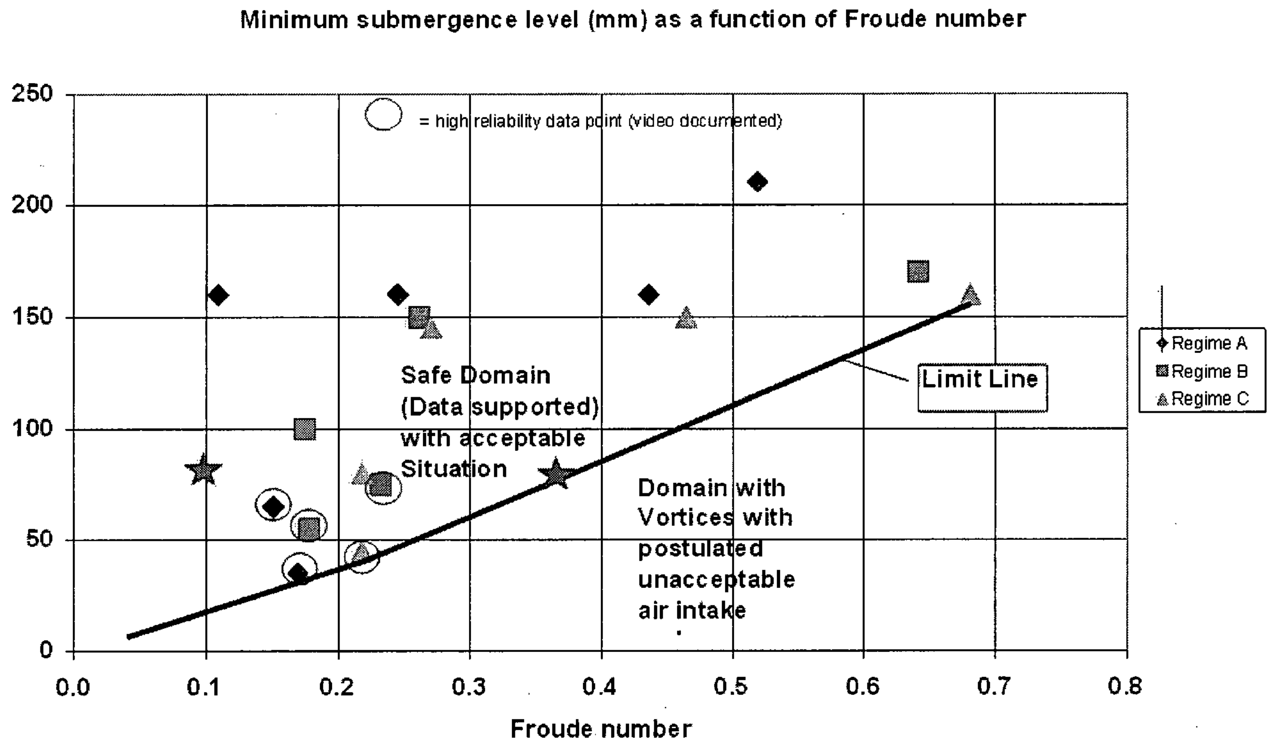
Parametric studies were performed under the French test program, with variation of the submergence level, the "open screen window", and the head loss across the screen. The results were expressed in an allowable normalized submergence as a function of the Froude number (defined here as the formula F_r = 2xhead loss measured/[pxgxh]). With the corresponding diagram, regimes of vortex forming and no-vortex forming are separated and used for assessment of a specific situation.

The most critical data point still showed no vortex and is used conservatively as the onset of vortexing threshold. For Salem, the postulated situation is less critical than the worst test data point, which still showed no vortices. Therefore, the proof of no vortexing for Salem was positive. This vortex evaluation for Salem is documented in Salem VTD 901030 (reference A.43).



The second type of vortex phenomenon is the vortexing due to potential flow non-uniformity which can arise in totally clean strainers. Since debris accumulation on the screen cannot be credited immediately after a LOCA, a totally clean screen is postulated. In the case of the strainer module arrangement of Salem, where there is a long train of strainer modules in series, the flow rate per module increases towards the sump with a clean screen. The pocket head loss is relatively small in comparison to the central duct head loss. This leads to a bypass of most of the modules by influx into the modules next to the sump only. This bypass leads to relatively high above-average velocities into the strainer pockets next to the sump that could potentially generate vortices.

Tests have been performed to explore the ranges of allowable parameters which do not show significant vortices. The results are displayed in a diagram, which forms the basis of the Salem assessment in the CCI vortexing report 3SA-096.071 which is documented in PSEG VTD 901380 (Reference A.72). This diagram shows the test data points and the specific data points (stars) of the Salem installation as
follows:



The regimes are defined as follows:

A. More or less stationary limited vortex cones at surface with no air intake into pockets
B. Infrequent in stationary vortices which cause singular air bubble intake at frequencies of 1 to 5 short duration vortices within 5 minutes
C. Frequent in stationary vortices with 2 to 5 vortices within 1 minute, however no air intake that would come close to 0.5% volumes flow.

The Froude number definition is $Fr = v^2 / g / h$, where v is the highest flow velocity into the pockets, and h is the submergence level. The two Salem points differ in the level of sub division of the axial duct flow coordinate in the duct system head loss calculation. The left star represents an element length (1200 mm) of one module, whereas the right star represents for an element length (400 mm), which equals the test loop configuration.

It can readily be seen that both star points are on the safe side of the limit line, which means that there is no substantial vortexing of this second type for Salem.

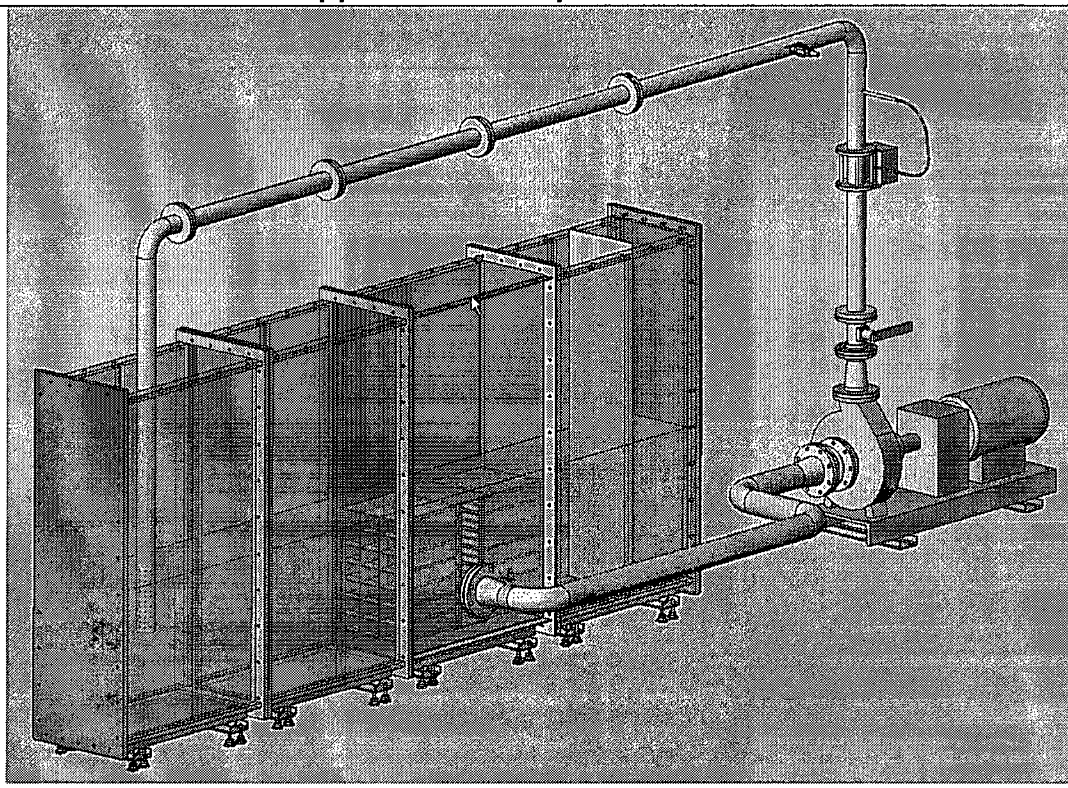
There are still conservatisms in this assessment, which are listed as follows:

- A clean screen was assumed while having a full break maximum flow rate of 9000 gpm after a LOCA. (With a small amount of debris, the module closest to the sump with the high flow rate would be covered by this debris first, thereby reducing the vortexing tendency dramatically).
- A hydrodynamic head loss formula for the duct axial flow was used, which is conservative compared with a duct flow with friction head loss. The formula used is more appropriate for a single side influx, but was used for conservatism in preference to the more continuous friction formula approach.
- The submergence level is assumed at the very low value of 3 inches for the top strainer module parts.

3f.4) Provide a summary of the methodology, assumptions, and results of prototypical head loss testing for the strainer, including chemical effects. Provide bases for key assumptions.

CCI developed and used a number of test facilities, which were all used to perform tests for the Salem specific conditions. The test facilities used included a small vertical flow loop, a large pool type horizontal flow loop, and a Multi-Functional Test Loop (MFTL), which will also be used during planned testing.

During the evolution of the Salem test program, it was concluded, that the best and most prototypical geometry and boundary conditions were represented by the MFTL. This loop is shown in the following figure in its latest test configuration for Salem and will be used in the planned head loss tests.



The two-sided test module represents a short segment of the long train of strainer modules, with a front side (21 pockets) with direct access of the water and a rear side (also 21 pockets), which faces the containment wall. As in the plant, the water flow to the front side is predominantly horizontal, whereas the flow to the rear side has to flow over the top of the module and enter from the rear side.

The water submergence of the strainer module is kept as close as possible to the 3 inch minimum submergence water level in the plant, which also allows observing any potential vortices during the head loss measurements.

The debris in the form of fibers, particulates and chemical precipitates are introduced in the compartment so that a realistic approach field with prototypical flow and sedimentation conditions, representing the plant after start of recirculation is modelled. The majority of the LOCA generated debris is added upstream of the test module, but some debris is added downstream, consistent with the transport analysis. In the planned chemical effects testing the chemical precipitates will be generated in an external precipitate generator per WCAP 16530-NP and added upstream of the test module.

During the planned tests, coatings will be modeled as particulate (reference section 3h.4). The debris being used in the upcoming testing includes: NUKON, Kaowool, Generic Fiberglass (modeled as NUKON), Min-K, Qualified and Unqualified Epoxy Coatings (modeled as stone flour – reference section 3h.4), Latent Fiber (modeled as NUKON, and Latent Particulate (modeled as stone flour)). RMI is not included in the planned tests because in past tests it has consistently provided lower head loss values. Planned test flow rates and scale factors are described in the response to GL2004-02 RAI 11. The debris preparation for the upcoming tests is described in Audit Open Item 6. Any debris and chemical precipitate that settle on the loop floor away from the strainer will be re-suspended using loop agitation during the thin bed, full load and chemical effects tests.

The final thin bed and full debris load head loss and chemical effects tests have not been completed. The results will be provided after testing completion.

In addition to the chemical tests, the MFTL is also used for fiber bypass testing and thin bed testing. Both final bypass testing and thin bed tests are planned to be performed. During the bypass testing, water samples are taken after the screen for laboratory analysis and later down-stream evaluation for the plant equipment downstream of the screen.

3f.5) Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.

The test arrangement described in item 3f.4 is a representative "slice" of the long train of modules in the plant. The accumulation of debris in this slice is also representative of the plant, including the debris which enters the pockets and which is deposited in the front and the rear sides of the module. Since the debris load used for testing is based on the maximum quantity of debris, which will transport beyond the debris interceptor. Therefore, the debris accommodation of the test strainer is representative of the installed strainer capability in the plant.

3f.6) Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.

The ability of the screen to resist formation of a thin bed will be documented by performing a test at the vendor facility. The thin bed testing has not been completed. PSEG has submitted and received an approval for an extension request until June 30, 2008 (Reference A.27). Upon completion of thin bed testing the information will be submitted to the NRC.

3f.7) Provide the basis for the strainer design maximum head loss.

The basis for the strainer design maximum head loss (maximum allowable head loss) is provided in the Section 3g.16 response. The maximum allowable head loss is determined based on the difference between the net positive suction head available (NPSHa) and net positive suction head required (NPSHr) for the RHR pumps during recirculation, less a retained margin of 0.90 feet. The computation of the maximum allowable strainer head loss is documented in Section 4.4 of Evaluation S-C-CAN-MEE-1896 (Reference A.7).

For sump temperatures (T_{sump}) less than the temperature (T_{sat} = 194 °F, Reference A.27) which corresponds to the vapor pressure of water at the minimum partial pressure of air in containment prior to an accident (10.1 psia, Reference A.27), the NPSHa is determined as the minimum partial pressure of air prior to an accident (h_a) plus the static head of water above the pump suction (h_s), less the friction and form losses in the suction piping (h_f) and the vapor pressure of the water at the post-LOCA sump temperature ($h_{v,sump}$);

For $T_{sump} < T_{sat}$: $\quad NPSH_a = h_a + h_s - h_f - h_{v,sump}$

For sump water temperatures greater than the temperature (T_{sat} = 194 F, Reference A.27) which corresponds to the vapor pressure of water at the minimum partial pressure of air in containment prior to an accident (10.1 psia, Reference A.27), the NPSHa is determined as the static head of water above the pump suction (h_s) less the friction and form losses in the suction piping (h_f);

For $T_{sump} > T_{sat}$: $\quad NPSH_a = h_s - h_f$

Note, in the NPSHa descriptions above, the suction piping losses do not include the strainer head loss, since the purpose of the analysis is to determine the maximum allowable head loss for the strainer.

The use of the minimum initial partial pressure of air in containment prior to an accident is discussed in the Section 3g.13 and 3g.15 responses. The minimum water level used is discussed in the Section 3g.1 and 3g.8 responses. The suction piping losses are discussed in the Section 3g.4 response. The pump flow rates and NPSHr values used are discussed in the Section 3g.1 and 3g.3 responses.

3f.8) Describe significant margins and conservatisms used in the head loss and vortexing calculations.

The basis of the GL 2004-02 evaluation is the methodology in NEI-04-07 and its associated SER. This methodology is regarded as having a substantial degree of conservatism in all its steps and assumptions starting from the break assumptions, debris generation, debris transport, and allowable head loss.

The evaluation in the head loss report is based on the assumption that the 30-day precipitate amounts are formed immediately upon the transient initiation. This combines high temperature head losses with full presence of chemical precipitates, which is highly conservative. Moreover, 150% of the total precipitate quantity for the 30-day period is planned to be used during the upcoming chemical effects head loss testing, further adding to the conservatism in the results.

For the vortexing assessment, the conservatisms and margins are addressed in the end paragraph in section 3f.3.

3f.9) Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.

The clean strainer head loss is defined as the flow head loss within the strainer internal cavities, which is added to the debris head loss derived from the tests. The clean head loss of the test strainer is nearly negligible due to the small velocities across the clean screen and the pocket channels. During clean head loss testing performed on October 1, 2005, the maximum clean head loss observed at a plant equivalent flow rate of 13,944 gpm was 0.14 mbar (Reference A.65). This is documented in VTD 901214 (Reference A.68) and VTD 901053 (Reference A.69).

The plant strainer train has a clean head loss that was calculated separately, because the velocities in the central duct which connects the modules, and in the transition to the sump suction box, have significantly higher values than in the test. While the debris layer head loss shows a laminar flow regime, the clean head loss in the central duct and transition section are governed by the turbulent flow regime.

The clean head loss in the long central duct of Salem is assessed by two Bernoulli type flow head loss calculations:

1) For conditions with no or little debris head loss, where a predominant portion of flow enters the last few modules before the sump, the clean head loss can be

assessed with handbook formulas, (Reference A.62), set up for a flow entering a main channel flow from a branch.
2) For conditions with substantial debris head loss, where much of the flow comes from far away modules, a better assessment is the frictional flow head loss with rough surfaces on the sides. In intermediate cases, both formulas are assessed and the larger clean head loss is used conservatively.

Since flow velocities and corresponding clean head losses increase towards the sump box, there has been increased design focus on the flow design of the transitions channels to the sump.

The Z-shaped transition with flow vanes and its adjacent diffuser channel, which leads to the box plenum, have been analyzed with more accurate means of CFD using the CFX code. The CFD calculations were performed in a transient mode to obtain converged head loss results for these parts.

3f.10) Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.

The debris head loss is derived from the head loss testing (see section 3f.4). Since the head loss testing will be performed at a scaled quantity of filtering surface, flow rate, nominal debris and chemical precipitates the measured test head losses will be prototypical for the plant.

An adjustment was made to account for the variation of sump water temperature, because the test water temperature is ambient temperature and the NPSH critical temperature of the plant is approximately 194°F, which occurs soon after the start of recirculation.

To correlate test head losses at ambient temperature to head losses at other temperatures, CCI uses the viscosity of the sump water to convert proportionately based on NUREG/CR-6224. Channelling effects have not been observed to date in the head loss testing performed to date for Salem.

The influence of chemicals on the viscosity of the post-LOCA sump solution is accounted for in the head loss by adjusting viscosities as measured in the Integrated Chemical Effect Test (ICET) tests.

As discussed in Section 3g.16, allowable head loss limits are also given, based on crediting initial air pressure in containment, which yields substantial margins at later time points with lower sump temperatures.

3f.11) State whether the sump is partially submerged or vented (i.e., lacks a complete water seal over its entire surface) for any accident scenarios and describe what failure criteria in addition to loss of net positive suction head (NPSH) margin were applied to address potential inability to pass the required flow through the strainer.

The Salem Unit 1 sump enclosure and strainer train are fully submerged with more than 3 inches of water cover at the time of switch over to recirculation operation. There are no vents or vent paths for the Salem Unit 1 strainer train.

The Salem Unit 2 sump enclosure and strainer train are also fully submerged with more than 3 inches of water cover at the time of switch over to recirculation operation. Salem Unit 2 containment sump level instruments penetrate the top of the sump enclosure. PSEG is considering level instrument configuration changes to improve maintenance access and design margin.

3f.12) State whether near-field settling was credited for the head-loss testing and, if so, provide a description of the scaling analysis used to justify near-field credit.

The MFTL, as described previously in item 3f.4, has a very short flume before the double-sided strainer module. This short volume before the strainer is necessary to have horizontal flow to the strainer and to introduce the debris and the chemical precipitates with sufficient area to distribute vertically through the approach region of the flume.

This small front side volume and the corresponding rear side volume are necessary in order to simulate a proper influx flow field into the strainer pockets. Some limited settling may occur in these spaces. Preventing this settling would have a detrimental effect of impairing proper flow into the pockets. Any settled debris will be re-suspended through agitation. There is no additional space provided to credit any settling in a longer flume. Therefore, the head loss testing does not credit near-field settling. The approach field scaling is prototypical, as the test configuration with the "slice" of the strainer train also represents the corresponding "slice" of the open space in front and behind the strainer.

3f.13) State whether temperature/viscosity was used to scale the results of the head loss tests to actual plant conditions. If scaling was used, provide the basis for concluding that boreholes or other differential-pressure induced effects did not affect the morphology of the test debris bed.

The scaling of head losses with temperature/viscosity has been used as presented in section 3f.10. To date, no boreholes have been observed in the head loss testing performed for Salem. In the absence of such effects, scaling up from test temperatures to high plant temperatures, (with corresponding reductions in head loss), the scaling is actually conservative because of less bed compression at lower head losses.

3f.14) State whether containment accident pressure was credited in evaluating whether flashing would occur across the strainer surface, and if so, summarize the methodology used to determine the available containment pressure.

The flashing evaluation documented in VTD 901030 (Reference A.43) was performed using post-LOCA containment pressure and sump water temperature response curves for a Double Ended Pump Suction (DEPS) LOCA scenario with minimum safeguards and no recirculation spray. These response curves are for a Salem Unit 2 LOCA with the replacement steam generator and are provided in Appendix A of WCAP-16503-NP (Reference A.5).

As stated in the response to Section 3g.14, the analyses in WCAP-16503-NP (Reference A.5) are performed using assumptions, which maximize the global containment pressure and temperature response due to design basis mass and energy release events. Sufficient margin is available such that flashing will not occur under any circumstance.

The flashing evaluation (Reference A.43) determined that the minimum margin available prior to flashing for the strainer head loss (~1.1 hours post-LOCA) is approximately 27 feet (0.82 bar). This is larger than the allowable strainer head loss at high sump temperatures. The maximum allowable strainer head loss at sump temperatures greater than 194°F is 6.91 feet at 9,000 gpm, as documented in the Section 3g.16 response.

Similarly, the minimum margin available prior to flashing for the strainer head loss later in the recirculation phase (~12 days post-LOCA) is approximately 41 feet (1.24 bar) with a containment pressure of 5 psig and a sump temperature of 120°F. This margin would be reduced by approximately 12 feet if the containment pressure were 0 psig. This would still result in a margin available prior to flashing greater than the maximum allowable strainer head loss of 26.5 feet at 120°F per Attachment 1 to S-C-CAN-MEE-1896 (Reference A.7).

Therefore, it is concluded that flashing will not occur, even if a more conservative LOCA pressure response were used.

The sump water temperature response for all Salem Unit 1 and Salem Unit 2 scenarios modeled in WCAP-16503-NP (Reference A.5) was compared and the most limiting (highest sump water temperature) scenario is for the case with the Salem Unit 2 Replacement Steam Generator (RSG) and a Double Ended Pump Suction (DEPS) break with minimum safeguards and no recirculation containment spray. Use of the maximum sump water temperature response is conservative for the flashing analysis since hotter water is more likely to flash.

3g. Net Positive Suction Head (NPSH)
The objective of the NPSH section is to calculate the NPSH margin for the ECCS and CSS pumps that would exist during a loss-of-coolant accident (LOCA) considering a spectrum of break sizes.

For both Salem Units, the RHR pumps are the only ECCS pumps taking suction from the containment sump during recirculation. Therefore, to ensure that the ECCS system has adequate flow, the NPSH available must be greater than the NPSH required for the RHR pumps.

Since final GL 2004-02 testing has not been completed at this time (PSEG has submitted and received an approval for an extension request for chemical testing until June 30, 2008 as detailed in Reference A.27). The NPSHa calculation, common to both Salem Unit 1 and 2, must be updated in two phases.

The first phase of updates concludes that the new strainer configuration is operable under the current design basis, which assumes that the strainers are 50% blocked with debris. The NPSHa calculation methodology used for this phase was the same as that used for the old ECCS sump screen. In accordance with the Salem UFSAR Appendix 3A, for conservatism, no credit is taken for containment air pressure in determining ECCS pump NPSHa.

The second phase, will be updated after strainer head loss testing is complete, verifies that the new strainer configuration is operable under the GL 2004-02 design basis. However, with the higher head loss from the new strainer configuration, the methodology described in Appendix 3A would be too conservative. Therefore, Salem requested and the NRC approved (Amendment Nos. 285 and 268) changes to the NPSH methodology that allows the use of the minimum partial pressure of air in the containment atmosphere prior to a LOCA.

Phase 1

The first phase for updating the NPSH calculation used a vendor provided strainer head loss value for the new strainer with 50% of the surface blocked with debris. This allowed Salem to return to power upon completion of the refueling outages while meeting the existing design basis with the new strainers installed.

The NPSHa was determined using the method, which assumed that the containment pressure was equal to the vapor pressure of the sump fluid; thus excluding the initial containment air pressure. Therefore, the NPSHa was determined to be the static head, the difference in elevation between the water level in containment and the suction inlet of the RHR pump, minus the friction losses (head losses) in the suction piping and the strainer head losses.

Phase 2

The final phase 2 NPSH calculation will be generated upon completion of the chemical head loss testing at the CCI vendor facility. The NPSH calculation will be revised for Phase 2.

3g.1) Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level.

The RHR pump flow rates vary depending on the pump configuration and the ECCS mode of operation. Since each RHR pump has its own suction line from the ECCS containment sump, the pump suction line losses can be based on the single pump flow rates. However, since the suction is through a single strainer train, the strainer head loss values for both single and dual RHR pump operating conditions were considered.

NPSHa values were determined using the maximum single pump flow rates for each operating condition, as this results in the maximum head loss through the RHR suction pipe. For comparison, the NPSHa for two-pump operation during Salem Unit 2 Cold Leg Recirculation was also calculated. In this case, at switchover to recirculation operation, the static head available is the lowest. Table 3g-1 shows the maximum flow rates for a single train of RHR (Reference A.41).

Table 3g-1: Maximum Flow Rates (Single Train of RHR)

Mode	**Maximum Sump Flow Rate [gpm]**
Cold Leg Recirculation (Salem Unit 1)	5,110
Cold Leg Recirculation (Salem Unit 2)	4,900
Recirculation Containment Spray (Salem Unit 1)	4,850
Recirculation Containment Spray (Salem Unit 2)	4,850
Hot Leg Recirculation (Salem Unit 1)	4,980
Hot Leg Recirculation (Salem Unit 2)	4,980

A flow rate of 5,110 gpm can only be achieved on Salem Unit 1 when one RHR pump is operating and additional flow is through the idle pump piping. The configuration consists of the operating RHR pump injecting via all four cold legs. A flow rate of 5,110 gpm is conservatively used as the highest single RHR pump flow rate for both Units.

In the case when both RHR pumps are running, the total flow is split between the two pumps. Westinghouse letter PSE-06-24 documented in VTD 900519 (Reference A.56), the maximum discharge from the containment sump during the recirculation alignment of two RHR pumps for Salem Unit 1 and 2 and is shown in Table 3g-2. The combined flow rate of Trains A and B (9,000 gpm) was used to determine the maximum strainer head loss for dual pump operation and are documented in PSEG Technical Evaluation 80089191 (Reference A.57).

Table 3g-2: Maximum Flow Rates (Two Train of RHR)

Mode	Flow Rate	Maximum Sump Flow (Reference A.56)	Maximum Sump Flow (Reference A.57)
Cold Leg Recirculation (Train A)	gpm	4,300	4,500
Cold Leg Recirculation (Train B)	gpm	4,300	4,500
Recirculation Containment Spray (Train A)	gpm	4,551	4,641
Recirculation Containment Spray (Train B)	gpm	4,275	4,359
Hot Leg Recirculation (Train A)	gpm	4,300	4,500
Hot Leg Recirculation (Train B)	gpm	4,300	4,500

Revision 3 of Westinghouse Calculation WCAP-16503-NP (Reference A.5) contains the sump water temperature profiles to be used for Salem Unit 1 and 2. The DEPS minimum safeguards LOCA scenario for Salem Unit 2 with replacement RSGs yields the harshest long-term temperature and pressure transients. For this case, the maximum sump structural temperature is 264°F at 1500 seconds, which is before recirculation begins.

The sump screen has an upper hydraulic design temperature of 260°F; which is higher than the calculated sump water temperature during recirculation phase; however, the screen is also designed to withstand sump water temperatures up to 264 °F.

The minimum sump water level at switchover to recirculation has increased from its original value of approximately 80 ft to 80.83 ft (80 feet 10 inch). This is the minimum water level based on the total channel uncertainty of the new sump level instruments, which were installed specifically for indicating sufficient water level for switchover to recirculation.

The new instruments maintain the setpoint of 80 feet 11 inches, but have an uncertainty of ¾ inch, conservatively rounded to ± 1 inch. Therefore, 80 feet 10 inch is the minimum water level at ECCS switchover to recirculation. Salem confirmed via calculation S-C-CAN-MDC-2061 (Reference A.21) that this level is reached prior to recirculation. Response 3g.8 describes in further detail the calculated minimum flood level.

3g.2) Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.

Addressed under response 3g.1 above.

3g.3) Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.

NPSHr is a function of the RHR pumps and the flow rate at which they operate. These values are based on the RHR pump operating curves provided with the pumps and verified by the vendor. The actual values for each pumping configuration are listed in section 3g.16.

3g.4) Describe how friction and other flow losses are accounted for.

The RHR line loss values were not directly affected by the modification of the sump strainer. Under the existing calculation, the line losses were determined according to the maximum single pump flow rates for each configuration. Standard frictional factors were used for pipe and fittings and were based on properties of clean water. These values were not changed for the Phase 1 update of the NPSH calculation.

For Phase 1, the new strainer head loss values were based on the strainer modules being 50% blocked by debris. For added conservatism, the strainer head loss value for the two pump operating condition was used in conjunction with the suction line friction head losses at the maximum single pump flow. In cases where this assumption was overly conservative, the strainer head loss value for single pump operation was used. As described in response 3g.1, the NPSHa for two-pump operation during Salem Unit 2 Cold Leg Recirculation was also calculated.

For Phase 2, the suction line losses identified in the original NPSH calculation are increased to account for the increased post-LOCA sump water viscosity due to chemical effects. The increase in sump water viscosity causes the frictional pressure drop through the suction piping to increase. However, it does not cause an increase in component (e.g. valves, tees, etc.) pressure drops since the pressure drop is due primarily to form losses, not friction. The increase in water viscosity is based on the viscosity data recorded as part of ICET#1, documented in Sections 4.5.5 and 4.5.6 of NUREG/CR-6914, Volume 2. ICET #1 utilized a sodium hydroxide (NaOH) buffer environment with NUKON fiber debris and is considered representative of Salem. The viscosity of clean water is based on 260°F water (at saturation pressure) for high temperature conditions and 60°F water (at atmospheric pressure) for low temperature conditions. The worst case between the two water temperatures is used in the suction line loss computation of the allowable strainer head loss.

3g.5) Describe the system response scenarios for LBLOCA and SBLOCAs.

When a LOCA occurs, an automatic Safety Injection (SI) signal is initiated via the Engineered Safety Features (ESF) System on Containment High Pressure (4 psig) or Low-Low Pressurizer Pressure (1765 psig), or manually via key switches in the control room.

The SI signal starts the Centrifugal Charging pumps, the SI Pumps, and the RHR Pumps. These pumps inject to the RCS cold legs taking suction from the RWST. The initial injection of borated water from the RWST to the RCS is referred to as the ECCS injection phase. The CS pumps start automatically when containment pressure reaches the initiation setpoint of 15 psig. The CS pumps will take suction from the RWST and discharge to the containment ring header.

The RWST level dictates the switchover to the recirculation phase. When RWST level reaches its low-level alarm at 15.2 feet, procedural guidance directs operators to realign to the recirculation phase.

Because of design differences between Salem Unit 1 and Salem Unit 2 there is a slightly different strategy for system swap over to recirculation operation.

For Salem Unit 1:

Once adequate sump inventory has been verified for the swap over to the recirculation phase, the following actions are taken:

Operators will stop the RHR pumps and manually reconfigure the pump suctions from the RWST to the recirculation sump. After the manual realignment of the pump suction is completed, the RHR pumps are restarted and recirculate the containment sump water to the RCS cold legs and provide suction to the Charging, SI pumps and to a CS pump. This alignment is referred to as cold leg recirculation.

For Salem Unit 2:

The procedure for transitioning to cold leg recirculation is similar to that for Salem Unit 1 except that the RHR pumps are not initially stopped to accomplish the swap over.

Once proper containment sump level is verified, operators arm a semi-automatic swap over system. This semi-automatic swap over system realigns the RHR pump suctions from the RWST to the recirculation sump. The remainder of the transition process is similar to that of Salem Unit 1 and controlled by emergency operating procedures.

Both Salem Units:

Once cold leg recirculation has been established for approximately 14 hours, EOPs will guide the operators into transition to hot leg recirculation. In hot leg recirculation the discharge of SI pumps is realigned from the RCS cold legs to the RCS hot legs to suppress any residual boiling and dissolve boric acid that may have deposited at the core outlet.

The above describes the response of the ECCS system to a Large Break LOCA (LBLOCA).

The difference between a LBLOCA and a Small Break LOCA (SBLOCA) is the size of the break. Depending on the size of the break, RCS pressure may stabilize at a value where RHR may not inject into the RCS. The break size is such that the CS system will not be required. For a SBLOCA, the outflow from the RWST may be low enough that the plant may be stabilized before the need to transition to the recirculation phase.

Additionally, SBLOCA produces a fraction of the debris generated by a LBLOCA and what was assumed in the debris generation calculation.

3g.6) Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.

Addressed in section 3g.5.

3g.7) Describe the single failure assumptions relevant to pump operation and sump performance.

The Salem ECCS system is required to withstand a single active failure during the injection phase, or a single active or single passive failure during recirculation operation provided no active failure was assumed during the injection phase.

EOPs are constructed to account for these potential single failures. EOPs provide guidance for events dealing from the total loss of off-site power to a single active or passive failure of an ECCS component in conjunction with the Loss of Off-Site power.

The newly installed screens have been designed and analyzed to meet system safety function under the most limiting single failure.

3g.8) Describe how the containment sump water level is determined.

A minimum containment flood level was determined based on an accounting of available water sources and subtracting entrapped water not available for containment flooding. The water sources and water entrapped are determined on a mass basis and then converted to volume based on the density of the sump water. The flood level is the net water volume available for flooding divided by the net floor area.

Determination of the minimum water level accounted for entrapped water in the following locations:

- Reactor Cavity and Reactor Coolant Drain Tank Pit – Water enters this area either from flowing over the 9 inch curb that surrounds the openings on 81 feet Elevation or from containment spray falling through the annular space around the reactor. Flow through the annular space is assumed to be equal to the percentage of the containment spray falling on the Control Rod Drive Missile Barrier.
- Sumps, Trenches and Piping – The containment sump, elevator pit, outer annulus trench, 16 inch drain piping and 12 inch drain piping are all conservatively assumed to be filled before ECCS switchover.
- Containment Air Space – A maximum containment net free volume is assumed to maximize the water vapor entrapped in the containment atmosphere following a LOCA and, therefore, minimizes the water available for flooding of the containment floor.
- Refueling Cavity – Using plant drawings, the refueling cavity area and containment area, are conservatively estimated to determine the portion of containment spray water that is entrapped in the refueling cavity.
- Condensation – A maximum heat sink surface area is assumed to maximize the water entrapped due to the condensation layer and therefore minimizes the water available for flooding of the containment floor. The heat sink surface temperature is assumed to be equal to the initial containment temperature throughout the transient.
- RCS Reflood – The maximum RCS volumes at full reactor power are

assumed during reflooding. An RCS temperature of 100°F is assumed for the liquid reflooding and a minimum containment pressure is assumed for the vapor reflooding of the RCS. This is conservative, because it maximizes the mass of water entrapped in the RCS reflood and therefore minimizes the water available for flooding of the containment floor.

- Spray water droplets in the containment atmosphere – This utilizes the terminal velocities of droplets and the falling distance from the highest spray ring elevation to the containment floor.
- Containment Spray Piping – Volume of CS piping filled during injection phase of LOCA.

To minimize the flood level, making the NPSHa calculation more conservative, the following minimum water sources were used:

- The minimum RWST water volume available for switchover to recirculation was determined based on the difference between the minimum level allowed by the Technical Specifications (TS) and the Low Level Alarm setpoint (207,800 gal for Salem Unit 1 and 204,500 gal for Salem Unit 2).
- The minimum RCS volume at full reactor power is 12,020 ft^3 for Unit 1 and Unit 2.
- The minimum volume of one accumulator is 6,223 gallons for both Unit 1 and Unit 2, resulting in a total accumulator volume of 24,892 gallons for all four accumulators per unit.
- The minimum net vapor available in the Containment Air Space at the start of the LOCA is 2571 lbm or 2,619,849 ft^3.
- The Spray Additive Tank (SAT) is not considered to contribute to the water available for flooding.

The minimum flood level calculation evaluated two cases to verify the flood level at the time of ECCS switchover is met. Both cases assume that a break occurs in the immediate vicinity of the Reactor Cavity opening on 81 feet Elevation, with the cavity filling prior to water flowing to the containment annulus, where it is available for recirculation operation.

Case 1 considers a break large enough to allow RCS blowdown but not large enough to allow the total ECCS flow to drain from the break (i.e., the ECCS pumps are able to keep the entire RCS full). For Case 2, the break considered is large enough to allow complete blowdown of the RCS and partially refill the RCS from the RWST (i.e., the ECCS injection flow drains from the break as fast as the ECCS pumps inject).

These two cases are considered to be the bounding cases for determining minimum available containment water level at the time the RWST reaches its low level alarm point. Initial filling of the reactor cavity is conservative because it limits the amount of water available to flood the containment floor, which is then available for recirculation operation.

If the required minimum water level elevation can be met under this condition, the required minimum containment flood level for recirculation operation will be met under all other conditions. This is because the reactor cavity cannot begin to fill until the flood level exceeds the cavity curb elevation of 81'-9" which is in excess of the minimum water level required for recirculation operation. Flooding to the containment at this elevation exceeds the required elevation at ECCS switchover; therefore, there is no need to consider cases with weir flow into the pit.

The calculated minimum containment flood level at the time the RWST reaches its low level alarm point is greater than the required water level of 80'-10" for adequate strainer submergence and ECCS recirculation operation, except for Case 1. For the Case 1 scenario, EOPs are currently in place to address this situation.

Based on these EOPs, if adequate water level does not exist for switching to recirculation operation at the time the RWST reaches it low level alarm, then injection from the RWST will continue until the RWST Low Low level set point is reached. The calculation confirmed that the minimum containment flood level required for ECCS recirculation operation 80'-10" is reached prior to the RWST reaching its Low Low level alarm point. Therefore, for the purposes of the NPSH calculation, the flood level was revised to 80'-10" for the cold leg recirculation mode.

3g.9) Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.

Addressed under response 3g.8 above.

3g.10) Describe whether and how the following volumes have been accounted for in pool level calculations: empty spray pipe, water droplets, condensation and holdup on horizontal and vertical surfaces. If any are not accounted for, explain why.

All items have been accounted for as described in response 3g.8 above.

3g.11) Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.

The minimum flood level calculation conservatively did not include the volume of equipment in containment that would displace water, as this would increase the water level. However, the volume of equipment is accounted for in a separate calculation to determine the maximum water level in containment (Reference A.10).

3g.12) Provide assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.

Addressed under response 3g.8 above.

3g.13) If credit is taken for containment accident pressure in determining available NPSH, provide description of the calculation of containment accident pressure used in determining the available NPSH.

Containment accident pressure is not credited in determining the available NPSH. However, the pre-accident partial pressure of air in containment is credited in determining the available NPSH for sump temperatures where the vapor pressure of sump water is less than the partial pressure of air in containment during normal operation. The approach in which the pre-accident air pressure is credited in determining the available NPSH is described in detail in §4.4 of Evaluation S-C-CAN-MEE-1896 (Reference A.7).

This approach constituted a change to the Salem licensing basis. Therefore, PSEG submitted LAR S07-05 (Reference A.8) to the NRC, which was approved by the NRC on November 15, 2007 (Reference A.9). The approval was documented in Amendments 285 and 268 for Salem Unit 1 and 2, respectively (Reference A.9).

The pre-accident air pressure in containment is determined in Calculation S-C-CAN-MDC-2144 (Reference A.3). This calculation computes the minimum partial pressure of air in containment, which could exist prior to an accident. To conservatively minimize the partial pressure of air, the Technical Specification minimum normal operating containment total pressure –1.5 psig (air plus water vapor) is used as an input. Instrument uncertainty is also accounted for.

The relative humidity is assumed to be 100% and the containment is assumed to be at its TS maximum normal operating temperature (120°F) to maximize the contribution of the water vapor partial pressure to the total pressure.
Once the partial pressure of air is determined using these assumptions, it is further reduced by assuming that the air is cooled to the minimum containment temperature (60°F) during normal operating conditions. Use of these assumptions results in a conservative pre-accident partial pressure of air for use in the NPSH analysis.

The minimum partial pressure of air in containment during normal operation is 10.1 psia for Salem Unit 1 and 10.18 psia for Salem Unit 2; however, the Salem Unit 1 value is conservatively used for both units. The pre-accident air pressure is credited for NPSH determination for sump water temperature less than 194°F. At this temperature, pre-accident air pressure is equal to the sump water vapor pressure.

3g.14) Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.

Containment accident pressure is not credited in determining the available NPSH. However, the following assumptions were used to minimize the pre-accident partial pressure of air in containment in the determination of available NPSH. These assumptions are documented in Calculation S-C-CAN-MDC-2144 (Reference A.3) and are provided in Section 3g.13.

- The containment temperature is assumed to be at the maximum value, 120°F, allowed by the TS.
- The relative humidity in the containment is assumed to be 100%.
- The final containment pressure is reduced by assuming that the containment temperature reduces from its maximum value to the minimum temperature, 60 °F.
- Initial containment pressure is reduced to account for instrument uncertainty.

The following assumptions were used for maximizing sump water temperature. These assumptions are documented in WCAP-16503-NP, Rev. 3 (Reference A.5).

- The ultimate heat sink temperature was assumed to be at its maximum value for the duration of the event.

- One RHR and one CCW heat exchanger were used, representing a loss of a safeguard train.
- RWST water temperature was assumed to be maximum, 100°F.

Revision 3 of Westinghouse Calculation WCAP-16503-NP contains the sump water temperature profiles to be used for Salem Unit 1 and 2. The Double Ended Pump Suction (DEPS) minimum safeguards LOCA scenario for Salem Unit 2 RSGs yields the harshest long-term temperature and pressure transients. For this case, the maximum sump temperature is 264°F at 1500 seconds, which is before recirculation begins at 1748 seconds.

At the onset of recirculation, the maximum sump temperature is 258°F. Therefore, the sump screen was designed to an upper limit hydraulic design temperature of 260°F, and was designed to withstand sump water temperatures up to 264°F.

Containment accident pressure is not credited in determining the available NPSH. However, the pre-accident partial pressure of air is utilized in determining the available NPSH. See the preceding response (3g.13) for the assumptions used in the determination of the pre-accident air pressure in containment.

The NPSH available is computed as a function of sump water temperature, not as a function of time. However, to determine the NPSH available at a specific time post-LOCA, the post-LOCA sump water temperature profiles provided in WCAP-16503-NP (Reference A.5) are used.

The analyses in WCAP-16503-NP (Reference A.5) are performed using assumptions, which maximize the global containment pressure and temperature response to design-basis mass and energy release events.

The sump water temperature response for all Unit 1 and Unit 2 scenarios modeled in WCAP-16503-NP (Reference A.5) were compared and the most limiting scenario (highest sump water temperature) was determined to be Salem Unit 2 RSG and a DEPS break with minimum safeguards and no recirculation containment spray. The sump water temperature profile is provided in Figure A.6.3-6 of WCAP-16503-NP and is repeated in the response to Item 3o.1.3d(i).

3g.15) Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.

For determining the NPSHa for phase two of the NPSH calculation revision, the assumption that the containment pressure is equal to the vapor pressure of the sump fluid was overly conservative. PSEG requested and the NRC approved the change request (Amendment Nos. 285 and 268) to the methodology that would allow the use of the minimum partial pressure of air in the containment atmosphere prior to a LOCA in determining the NPSHa.

The containment accident pressure is set equal to the sump water vapor pressure for sump water temperatures greater than 194°F (Reference A.7), where the vapor pressure of water in the sump is greater than the partial pressure of air (Reference A.7). Below this sump water temperature, the pre-accident partial pressure of air and the sump water vapor pressure are also included in the determination of NPSH available.

3g.16) Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.

Based on the information above, the results from the NPSH calculation for Phase 1 (50% blocked design basis) Reference A.41 are as shown in Table 3g-3.

Table 3g-3: Phase 1 NPSH Results

Mode	NPSHa (ft)	NPSHr (ft)	NPSH Margin (ft)
Cold Leg Recirculation (Salem Unit 1)	26.7	25.0	1.7
Cold Leg Recirculation (Salem Unit 2)	26.7	22.8	3.9
Cold Leg Recirculation (Two-pump) (Salem Unit 2)	23.8	20.2	3.6
Recirculation Containment Spray (Salem Unit 1)	26.2	22.0	4.2
Recirculation Containment Spray (Salem Unit 2)	27.7	22.0	5.7
Hot Leg Recirculation (Salem Unit 1)	25.7	24.0	1.7
Hot Leg Recirculation (Salem Unit 2)	27.4	24.0	3.4

Therefore, it was verified that the RHR pumps had sufficient NPSH to operate during the recirculation phase of the LOCA based on the pre GL 2004-02 design basis.

Since testing is not yet complete for the new strainer configuration, the NPSH calculation cannot be updated at this time. However, calculations were performed to determine the maximum allowable head loss across the new screen.

The maximum allowable sump screen head loss was determined as the NPSH available less the NPSH required by the RHR pumps less retained margin. Thus, the maximum allowable sump screen head loss is calculated using the following equation.

$HL_{allowable} = NPSH_A - NPSH_R - \text{Margin}$

Since there are three "maximum flow" configurations (Salem Unit 1 single pump, Salem Unit 2 single pump, and Salem Unit 1/2 two pump), three allowable strainer head loss curves were developed and documented in Calculation S-C-CAN-MEE-1896 (Reference A.7) as described below for the sump temperature range.

Figure 1: Allowable Strainer Head Loss at 5,110 gpm (Unit 1)

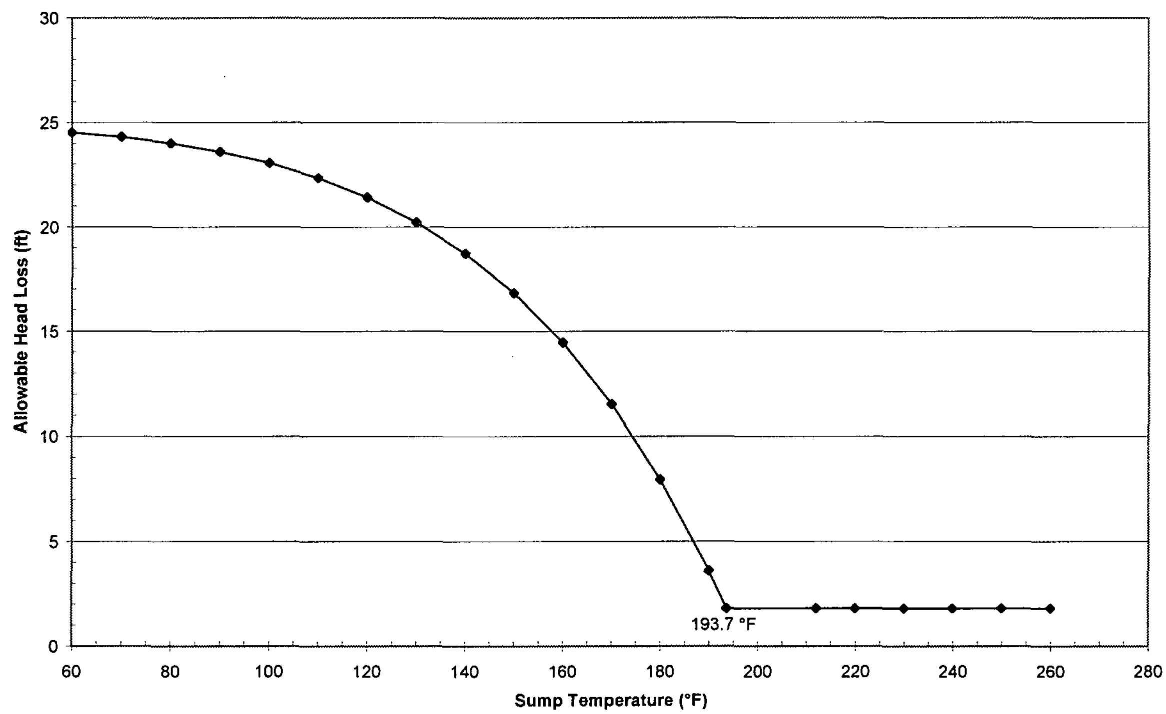


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Figure 2: Allowable Strainer Head Loss at 4,980 gpm (Unit 2)

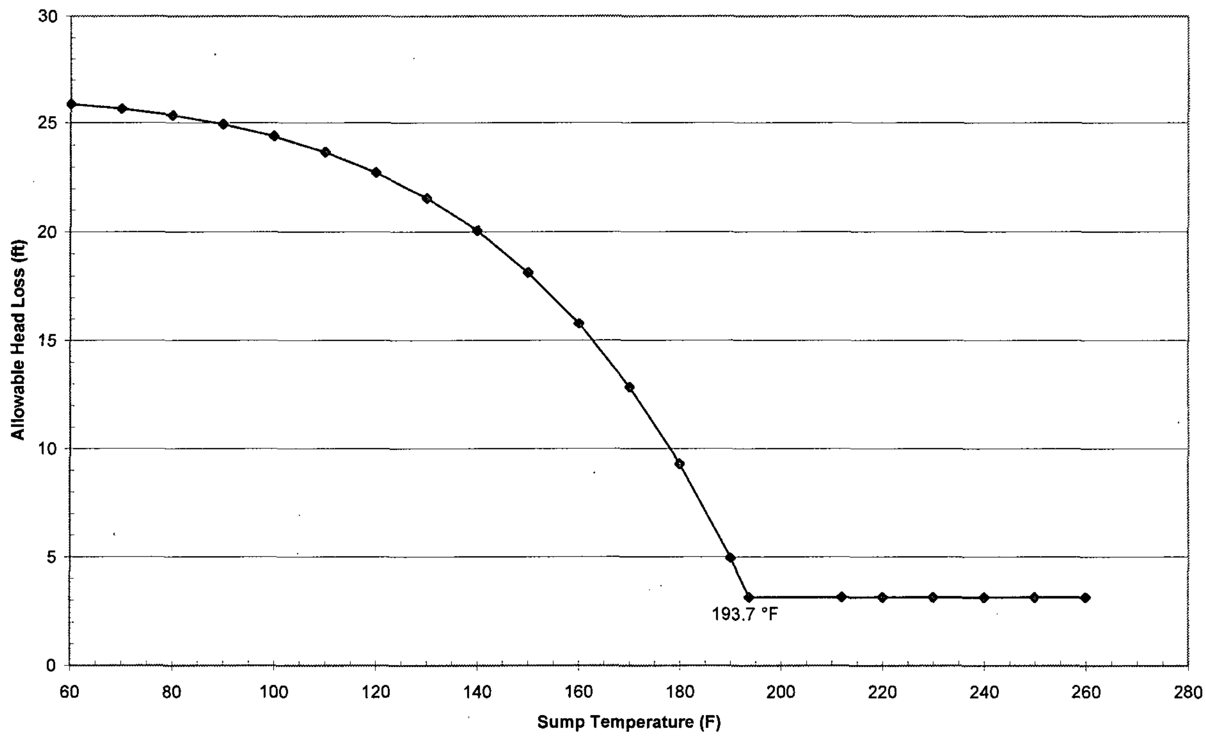
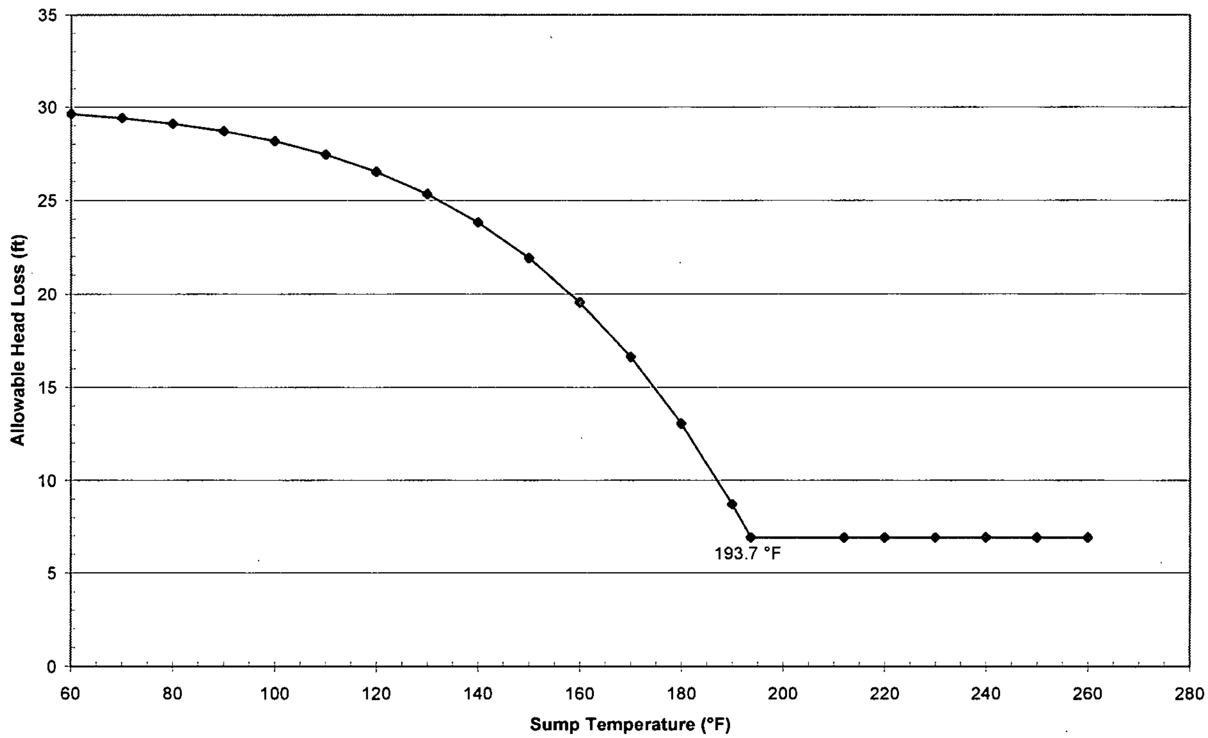


Figure 3: Allowable Strainer Head Loss at 9,000 gpm (Units 1 and 2)



These curves represent the maximum allowable strainer head loss values under all post LOCA maximum debris loads and chemical effects conditions. These design values have been met by the screen vendor and confirmed via testing. The retained margin is arbitrarily chosen to be 0.90 feet.

Using the inputs described above, the allowable head loss values for the new sump strainers at a temperature of 194°F (saturation temperature corresponding to the minimum containment air partial pressure, 10.1 psia) are as shown in Table 3g-4 (Reference A.7).

Table 3g-4: Allowable Head Loss (Sump Temperature of 194° F)

Scenario	Flow Rate	Head Loss
Salem Unit 1 Max Single Pump Flow (Cold leg recirc w/ 1 RHR pump)	5,110 gpm	1.80 ft
Salem Unit 2 Max Single Pump Flow (Hot leg recirc w/ 1 RHR pump)	4,980 gpm	3.14 ft
Salem Unit 1 and 2 Max Two Pump Flow (Recirc ctmt spray w/ 2 RHR pumps)	9,000 gpm	6.91 ft

As the sump pool cools during long-term recirculation, the head loss across the strainer increases. In these cases, credit can be taken for the partial pressure of air initially in containment when determining the allowable total head loss for the strainer, if necessary.

The above inputs will be used during the Phase 2 NPSH calculation update after strainer vendor testing is completed. The flood level and pump flow rates will be the same as what was used in the Phase 1 update. It is anticipated that the new strainer configuration will meet the requirements of the GL 2004-02 design basis while maintaining adequate NPSHa during recirculation. The analysis performed for Salem is in accordance with approved methodology.

3h. Coatings Evaluation

The objective of the coatings evaluation section is to determine the plant-specific ZOI and debris characteristics for coatings for use in determining the eventual contribution of coatings to overall head loss at the sump screen.

h.1) Provide a summary of type(s) of coating systems used in containment, e.g., Carboline CZ 11 Inorganic Zinc primer, Ameron 90 epoxy finish coat.

The following table summarizes the type(s) of coating systems installed in the Salem Generating Station Salem Unit 1 and 2 containments. The Dry Film Thicknesses (DFTs) are from the specification NC.DE-TS.ZZ-6006 (Reference A.28).

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Substrate	Salem System Specification
Carbon Steel Elevation Below 130 feet (original coating system)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Intermediate Coat E-1-8591 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat E-1-7844 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat E-1-1105 (Fire Protection only) DFT: 2.5 to 3.5 mils
Carbon Steel Elevation Below 130 feet (alternative and maintenance coating systems)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Intermediate Coat D-1-8591 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat D-1-7844 DFT: 2.5 to 3.5 mils
Carbon Steel Elevation 130 feet and above (original coating system)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Intermediate Coat E-1-7475 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat E-1-7475 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat E-1-1105 (Fire Protection only) DFT: 2.5 to 3.5 mils
Carbon Steel Elevation 130 feet and above (alternative and maintenance coating systems)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Intermediate Coat D-1-8591 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat D-1-9140 DFT: 2.5 to 3.5 mils
Containment Liner Plate (original coating system)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat E-1-7475 DFT: 2.5 to 3.5 mils
Containment Liner Plate (alternative and maintenance coating systems)	K and L Epoxy Primer 6548/7101 DFT: 2.5 to 3.5 mils
	K and L Epoxy Topcoat D-1-9140 DFT: 2.5 to 3.5 mils
Concrete Floors Elevation 130 feet and below (original coating)	Carboline Epoxy Surfacer 195S or 300S DFT: 8 to 12 mils
	Carboline Epoxy Topcoat Phenoline 300 DFT: 8 to 12 mils

Concrete Floors Elevation 130 feet and below (alternative and maintenance coating systems)	Carboline Epoxy Surfacer 2011S DFT: 20 to 24 mils
	Carboline Epoxy Topcoat 890 DFT: 4 to 6 mils
Concrete Walls and Ceilings Elevation 130 feet and below (original coating system)	Carboline Epoxy Surfacer 195S DFT: 8 to 12 mils
	Carboline Epoxy Intermediate and Topcoat Phenoline 305 DFT: 4 to 6 mils per coat (8-12 mils total)
Concrete Walls and Ceilings Elevation 130 feet and below (alternative and maintenance coating systems)	Carboline Epoxy Surfacer 2011S DFT: 12 to 20 mils
	Carboline Epoxy Intermediate and Topcoat 890 DFT: 4 to 6 mils per coat (8-12 mils total)

Note: In the above table K and L is Keeler and Long

Specific quantities of each of the above coating systems have not been estimated, since all are considered qualified epoxy coatings. The reference document is Salem's NC.DE-TS.ZZ-6006 Primary Containment Coatings (Reference A.28).

3h.2) Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.

In accordance with the guidance provided in NEI 04-07 and its associated SER (References 2 and 3), all coating debris is considered particulate and as such is modeled as transporting to the sump strainer.

3h.3) Discuss suction strainer head loss testing performed as it relates to both qualified and unqualified coatings and what surrogate material was used to simulate coatings debris.

During testing planned to begin in March 2008, the qualified/unqualified coating quantity that transports to the screen is specified as 12.6 ft^3 of qualified and 0.5 ft^3 of unqualified coatings. These coatings will be modelled as stone flour during the upcoming tests. Coatings have been modelled as particulate and not chips due to particulate being more conservative (reference section 3h.4).

While Salem has never performed testing with paint chips, it is CCI's experience through numerous tests of different clients that head loss tests with stone flour in lieu of paint chips create higher head losses and as such are more conservative (Reference 67).

3h.4) Provide bases for the choice of surrogates.

CCI has used a stone flour product manufactured by COOP (a Swiss Corporation) in the past for strainer performance testing and plans to continue using the same stone flour during future tests. The stone flour product demonstrates characteristics very similar to the latent debris and coating particulate. The size spectrum analysis measured its Sv value as 0.776 m^2/cm^3, which corresponds to a sphere diameter of 7.7 µm. This is a measured value, which is bounded by the 10 µm particulate constituent size given in NEI 04-07. Epoxy coating particulates are characterized by a sphere diameter of 10 µm (NEI Report 04-07 Rev. 0, December, 2004, Volume 1, Table 3-3, Coating Debris Characteristics). Since this is a theoretical value and available particulates always have a size distribution spectrum, CCI chooses to use a surrogate particulate product with a similar S_v value to the theoretical product with the spheres of 10 µm.

The quantity of particulates is defined by volume. However, CCI measures the particulate quantity for the tests by weight. The volume quantity has been converted to weight by the density of the surrogate particulates. The surrogate particle material density was measured to be 2680 kg/m^3 (167.4 lb/ft^3). In previous testing (Reference A.63) it was determined that stone flour transportation to the strainer module is comparable to that of paint particulate/small chips. For the testing, paint chips were ground down to various sizes from 0 – 4 mm. The graphs below show the sedimentation of paint particle sizes from 0 – 0.075 mm and stone flour. It can be seen that the transport of stone flour is comparable to that of the actual paint particulate. The stone flour settles at a slightly higher rate than the paint particulates. However, the trends are comparable and the stone flour settlement rate for Salem's case is typically within approximately 10% of the paint particulate rate. During head loss testing, if excessive sedimentation occurs in the test loop, the sedimentation is agitated back into suspension as described in the head loss test procedures.

In Figures 1 and 2 below, the specifical time t'=l/(v*h) where l= distance from debris introduction to the front of the strainer (0.5 m), v= water velocity and h= water flume height (0.741 m). The conditions for Table 1 are for the planned testing in March 2008.

	Plant Flow Rate (gpm)	Loop Flow Rate (m^3/hr)	Upstream flume Velocity (m/s)	Specifical Time (s/m)	% Sedimented Debris per Fig 1	% Sedimented Stone Flour per Fig 2
Salem Unit 1, Design Flow Rate	9000	28	0.0262	25.71	1	10
Salem Unit 2, Design Flow Rate	9000	29.33	0.0275	24.55	1	10
Salem Unit 1, Design Flow Rate	5110	15.9	0.0149	45.28	5	18
Salem Unit 2, Design Flow Rate	4980	16.23	0.0152	44.36	5	18

Table 1: Specifical time and Sedimentation for Planned Salem testing

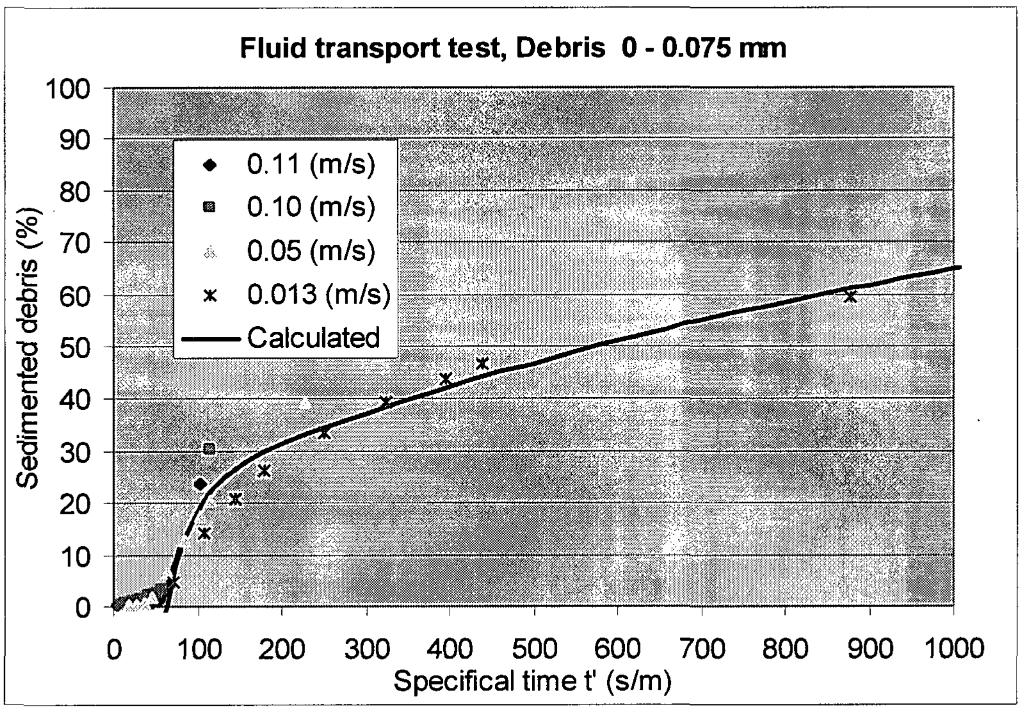

Figure 1: Paint Chip Sedimentation

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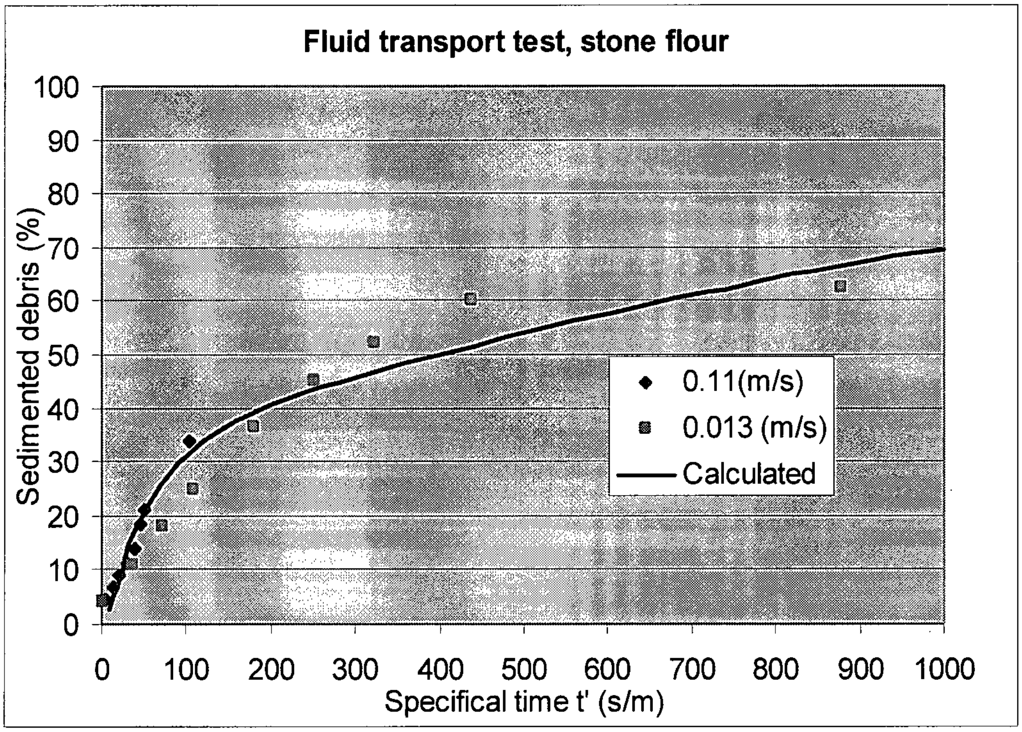


Figure 2: Stone Flour Sedimentation

Sulzer Innotec AG, Werkstoffanalysen 1501, 8404 Winterthur

S Y M P A T E C H E L O S Partikelgrößenanalyse 30.05.05 / 09:35:54.000

DISPERGIERSYSTEM Suspensionszelle (SUCELL) Ultraschall Dauer 0 s
Flüssigkeit wasser Pause s
Zusatz Rührerdrehzahl 50 %
Referenzmessung -999h00, 0.0%
MESSBEDINGUNG Brennweite 100mm Messzeit / Wartezeit maximal 25.0s
Zykluszeit 1000ms Start / Stop bei % auf Kanal
PROBE Steinmehl Dichte g/ccm Formfakt.

Kommentar1 SWATM05 0534
Kommentar2
Bearbeiter MM Datei C:\300506
LD-Auswertemodus (V.4.7.0)

xo/ µm	Q3/%	xo/ µm	Q3/%	xo/ µm	Q3/%	xo/ µm	Q3/%
		3.10	10.35	12.50	31.52	51.00	69.55
0.90	1.90	3.70	12.38	15.00	35.20	61.00	76.96
1.10	2.78	4.30	14.29	18.00	38.87	73.00	85.63
1.30	3.63	5.00	16.36	21.00	42.32	87.00	94.29
1.50	4.44	6.00	18.98	25.00	46.77	103.00	100.00
1.80	5.62	7.50	22.31	30.00	51.99	123.00	100.00
2.20	7.13	9.00	25.23	36.00	57.62	147.00	100.00
2.60	8.59	10.50	28.02	43.00	63.44	175.00	100.00

x10 = 3.00 µm x50 = 28.09 µm x90 = 80.06 µm
x16 = 4.88 µm x84 = 70.75 µm x99 = 100.20 µm
Sv = 0.776 m2/cm3 c_opt = 12.5 %

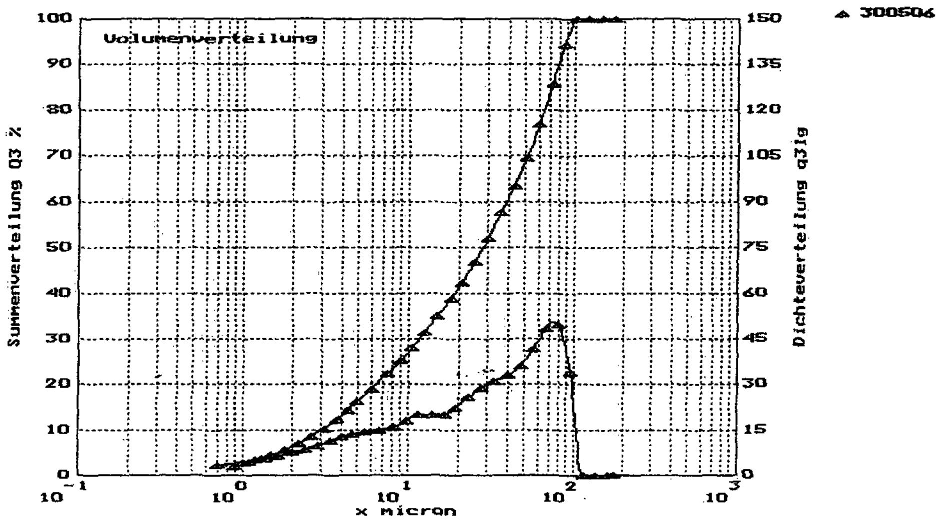


Figure 3: Stone Flour Particle Size Analysis

3h.5) Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on ZOI size for qualified and unqualified coatings.

All qualified coatings at Salem Generating Station are epoxy coatings, which are evaluated for a 5D ZOI. Based upon the results of testing presented in WCAP-16568-P (Reference 22) a 4D ZOI is acceptable, but a 5D ZOI is conservatively used for Salem Units. All unqualified coatings are considered to be debris consistent with NEI 04-07 and its associated SER (References 2 and 3).

To determine the amount of qualified coating debris generated at Salem, structural and civil drawings were consulted. The bounding break location is determined from inspection of these drawings, then the total surface area of coated steel and concrete within a 5D ZOI of the break location is calculated.

A conservative coating thickness, determined from plant specifications, is applied to this surface area to determine the total coating debris volume. A 25% margin is added to the steel coating total to account for miscellaneous surfaces that were not otherwise accounted for, such as handrails, kick plates, ladders and small supports.

The area of unqualified coatings in both units is known and reported in the debris generation calculation (Reference A.1). Since Salem Unit 2 contains more unqualified coatings (by both area and volume) than Salem Unit 1, the Salem Unit 2 value is applied to both Salem Units. All unqualified coatings are included in the design debris load. The amount is provided in Table 3h-2. All unqualified coatings in containment are tracked under a coating deviation form in procedure NC.DE-TS.ZZ-6006 (Reference A.28).

The amount of unqualified coatings is small and minor variations over time are not expected to have a significant impact on the overall acceptability of the debris generation (Reference A.1) and debris transport (Reference A.2) calculations, due to other margin and conservatism in the calculations.

Table 3h-1: Qualified Coating Debris

Steel Coating	Concrete Floor Coating	Concrete Wall Coating
V [ft^3]	**V [ft^3]**	**V [ft^3]**
9.2	1.4	1.4

Table 3h-2: Unqualified Coating Debris

Unqualified Coatings in Containment (Salem Unit 2)			
Description	**Area**	**Thickness**	**Volume**
	[ft^2]	**[mils]**	**[ft^3]**
23, 24, 25 CFCU Bases, Primer Only	2	3.5	0.001
Fire Protection Piping [Carboline] 890 Instead	200	10.5	0.175
78', 100' Liner Plate Match Gray	250	7	0.146
22 CFCU Motor Mount, White	15	10.5	0.013
130' - 100' Liner and Cab. 21CFCU	200	7	0.117
Polar Crane Upgrade Stencil	50	10.5	0.044
Total			**0.496 ≅ 0.5**

3h.6) Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.

For discussion of coating surrogate characteristics see section 3h.4.

3h.7) Describe any ongoing containment coating condition assessment program.

PSEG follows the guidance of ASTM D5163 (Reference A.39). During each refueling outage, engineering personnel walk through accessible areas of the containment, including Elevations 78ft, 100ft, and 130ft, and the bioshield elevations. The conditions of protective coatings installed on concrete and steel substrates are observed and corrective actions are taken if required.

The walkdowns consists of close visual observations (all up to about 10 feet in height) of the following structures and components: floors, walls, piping, structural steel, components (tanks, accumulators, fan units, etc.), hatches, polar crane, and containment liner.

Other structures and components greater than approximately 10 feet in height are visually observed from floor elevation for delaminations and cracks. This includes walls, ceilings, piping, structural steel, components (tanks, accumulators, fan Salem Units, etc.), hatches, the polar crane, and the containment liner. The polar crane is used for personnel to gain higher access to visually inspect the containment liner coatings, as well as the upper portions of the polar crane.

Personnel who perform coating inspections have the following qualifications:

- BS in engineering or related sciences
- Greater than five (5) years in nuclear engineering
- Two (2) years experience in protective coatings, including preparation and review of procedures
- Attended at least one (1) outside course on coatings taught by experts such as National Association of Corrosion Engineers (NACE), Electric Power Research Institute (EPRI), or Steel Structures Painting Council (SSPC).

Qualified coatings requiring maintenance are initially documented in accordance with the PSEG Corrective Action Program. Deficiencies are reviewed by engineering and supervisory personnel to recommend the proper level of attention. Work orders are generated and prioritized by Station management.

The person observing the coating conditions specifies whether the observed degraded condition should be immediately repaired, tracked for future repairs, or visual monitored. Typical repairs are performed by removing the delamination and scraping back to a sound coating.

As part of the newly installed strainers, Salem has issued a new coating condition monitoring program (Reference A.66). It provides guidance for the engineering department to conduct assessments of the conditions of the containment coatings during refueling outages. It incorporates the practices of ASTM D5163 (Reference A.39) and includes the adhesion test procedure outlined in EPRI Report 1014883 Section 4 (Reference A.61).

PSEG will continually update the containment coating condition assessment program by participating in EPRI and Nuclear Utilities Coating Council (NUCC) discussions to obtain feedback from other nuclear coating engineers and industry experts.

3i. Debris Source Term

The objective of the debris source term section is to identify any significant design and operational measures taken to control or reduce the plant debris source term to prevent potential adverse effects on the ECCS and CSS recirculation functions.

3i.1) Provide the information requested in GL 04-02 Requested Information Item 2.(f) regarding programmatic controls taken to limit debris sources in containment.

GL 2004-02 Requested Information Item 2(f)
A description of the existing or planned programmatic controls that will ensure that potential sources of debris introduced into containment (e.g., insulations, signs, coatings, and foreign materials) will be assessed for potential adverse effects on the ECCS and CSS recirculation functions. Addressees may reference their responses to GL 98-04", A Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment, to the extent that their responses address these specific foreign material control issues.

PSEG has existing programmatic controls to ensure that potential sources of debris are not introduced into containment. This includes Salem Radiation Procedure SC.SA-ST.ZZ-0001(Q), "Salem Containment Entries in Modes 1 through 4" that requires all personnel entering containment during Modes 1 through 4 to complete a Foreign Material Exclusion (FME) Area Accountability Log of all loose materials carried into containment. This procedure provides guidance to personnel conducting the containment visual inspection and maintaining compliance with TS (Reference A.45).

PSEG has implemented a FME Program (Reference A.40) that provides specific guidance to personnel performing work in the containment building.

PSEG has already implemented controls (Reference A.28) for the procurement, application, and maintenance of Service Level I protective coatings used in containment that is consistent with the licensing basis and regulatory requirements applicable to the Salem Station as stated in PSEG Letter dated November 12, 1998, Response to Generic Letter 98-04 dated July 14, 1998.

All the plant modifications are controlled through design change process procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37). These procedures ensure that the plant modifications do not create a negative impact on the existing plant components.

As part of the newly installed containment sump strainers, Salem has provided additional programmatic controls through procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37) to ensure that potential sources of debris are assessed for adverse effects on the ECCS and CS System recirculation functions. These programmatic controls include requirements related to coatings, insulation, containment housekeeping, materiel condition, and modifications.

In responding to GL 2004 Requested Information Item 2(f), provide the following:

3i.2) A summary of the containment housekeeping programmatic controls in place to control or reduce the latent debris burden. Specifically for RMI/low-fiber plants, provide a description of programmatic controls to maintain the latent debris fiber source term into the future to ensure assumptions and conclusions regarding inability to form a thin bed of fibrous debris remain valid.

Prior to entering Mode 4 from a refueling outage, a formal containment closeout procedure S1(2).OP-PT.CAN-0001 (Q) (Reference A.34) is performed to ensure that loose materials are removed. The closeout procedure requires a check for foreign materials such as tape, equipment labels, construction and maintenance debris (example rags, plastic bags, packaging, sawdust, etc.), and temporary equipment (example scaffolding, ladders, insulation material, etc). Additionally, the walkdown requires operations personnel to check for dirt, dust, lint, paint chip buildup, and loose paint/coatings on surfaces such as walls or floors in containment.

As part of containment closeout, the ECCS containment sump and sump screens are inspected utilizing procedure S1(2).OP-ST.SJ-0011(Q) (Reference A.35) for damage and debris. Refueling canal drains are verified to be unobstructed and that there are no potential debris sources in the refueling canal area that could obstruct the drains.

In support of the Generic Letter 2004-02 evaluation, a Salem Unit 2 containment walkdown was performed to determine the amount of latent debris (Reference A.15). The walkdown was performed using guidance provided in NEI 02-01. The latent debris density was estimated by weighing sample bags before and after sampling, dividing the net weight increase by the sampled surface area, adjusting the result based on an estimated sample efficiency, and converting the result to a density. The results showed the amount of latent debris in containment to be 33 lbm (Reference A.15). For conservatism, 200 lbm of latent debris was used for Salem Unit 1 and 2 Debris Generation Calculation.

3i.3) A summary of the foreign material exclusion programmatic controls in place to control the introduction of foreign material into the containment.

Salem has procedures in place to control the introduction of foreign material inside containment.

Procedure MA-AA-716-008 (Reference A.40) provides overall requirements and guidance to prevent and control introduction of foreign materials into structures, systems, and components. This procedure also controls investigation and recovery actions when FME integrity is lost or unexpected foreign material is discovered.

All containment entries during Modes 1 through 4 are done in accordance with the operations procedure SC.SA-ST.ZZ-0001(Q) (Reference A.33). This procedure requires that all material taken into containment is either installed or removed upon exit. The final disposition of the material is documented in the FME area accountability log. The procedure addresses minimizing the material left unsecured and unattended while working in the containment building.

A containment walkdown is performed at the beginning and end of each outage in accordance with procedure S1(2).OP-PT.CAN-0001 (Q) (Reference A.34). One of the requirements of the procedure is to check the areas for foreign material, large accumulation of dirt, dust, lint and paint chips, and loose paint/coatings.

Procedure S1(2).OP-ST.SJ-0011(Q) (Reference A.35) is performed every outage to visually inspect the containment sump to verify that no FME exists in the sump and that sump components (trash racks, screens, etc.) show no evidence of structural distress or corrosion. The front and back strainer pockets are visually inspected to ensure they are clean, have no visible gaps greater than the criteria specified, and are in good material condition. Also, refueling canal drains are verified to be unobstructed and that there is no potential debris sources in the refueling canal area that could obstruct the drains.

All the plant modifications are controlled through the design change process procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37).

These procedures ensure that the plant modifications do not have a negative impact on the existing plant components.

As part of the newly installed containment sump strainers, additional programmatic controls were established through these modification control procedures to ensure that potential sources of debris that may be introduced into containment are assessed for adverse effects on the ECCS and Containment Spray System recirculation functions. These programmatic controls include requirements related to coatings, containment housekeeping, and materiel condition.

3i.4) A description of how permanent plant changes inside containment are programmatically controlled so as to not change the analytical assumptions and numerical inputs of the licensee analyses supporting the conclusion that the reactor plant remains in compliance with 10 CFR 50.46 and related regulatory requirements.

Salem Unit 1 and 2 have configuration control procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37) in place that require a review of all modifications to ensure that they do not have a negative impact on the plant design basis.

As part of the newly installed containment strainers, these design procedures have been revised to enhance the controls for introducing material in the containment. These procedures require that engineering changes be evaluated for system interactions. As part of the evaluation, there is a requirement to consider any potential adverse effect with regard to debris sources and/or debris transport paths associated with the containment sump. Specifically, it requires the review of the following:

- Insulation inside containment
- Coatings inside containment
- Structural changes (i.e., choke points) in containment
- Inactive volumes in containment
- Labels inside containment
- Addition of materials inside containment that may produce chemical effects in the post-LOCA flood pool/environment. It specifically prohibits the introduction of aluminum inside containment unless an evaluation is performed to assess the impact on the containment sump head loss.

3i.5) A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.
If any of the following suggested design and operational refinements given in the guidance report (guidance report, Section 5) and SE (SE, Section 5.1) were used, summarize the application of the refinements.

All temporary changes are performed in accordance with procedure CC-AA-112 (Reference A.42). This procedure requires a review of the temporary modification impact on the plant systems in accordance with procedures CC-AA-102 (References 15) and CC-AA-102-1001 (Reference A.37) to ensure that potential sources of debris that may be introduced into containment are assessed for adverse effects on the ECCS and CSS recirculation functions. These programmatic controls include requirements related to coatings, containment housekeeping, materiel condition, and modifications. The procedure revisions were issued on December 18, 2007.

10CFR50.65 (a)(4) requires that licensee assess and manage the increase in risk that may result from proposed maintenance activities. The potential increase in risk is assessed in accordance with SC.OM-AP.ZZ-0001 (Reference 52) and OP-AA-101-112-1002 (Reference 53). Critical to managing the increase in risk is to ensure that maintenance is performed in accordance with approved procedures.

NEI 04-07 Section 5 states the following:

"In addition to analytical refinements, licensees may choose to consider administrative control refinements, design refinements, or a combination of administrative control and design refinements, to enhance post-accident sump performance. This section describes some of these refinements that are generically applicable to all PWRs. Licensees may identify additional design or operational refinements that are applicable to their specific plant."

The following sections provide information associated with the items discussed in NEI 04-7 Section 5 as they pertain to the Salem Units.

A. Housekeeping and FME Programs:

   Salem has procedures in place to control the introduction of foreign material inside containment.

   Procedure MA-AA-716-008 (Reference A.40) provides overall necessary requirements and guidance to prevent and control introduction of foreign materials into structures, systems, and components. This procedure also controls investigation and recovery actions when FME integrity is lost or unexpected foreign material is discovered.

All containment entries during Modes 1 through 4 are done in accordance with the Operations procedure SC.SA-ST.ZZ-0001(Q) (Reference A.33). This procedure requires that all material taken into containment is either installed or removed upon exit. The final disposition of the material is documented in the FME area accountability log. Due to the possibility of an emergency exit, the procedure requires minimizing the material left unsecured and unattended while working in the containment building.

A containment walkdown is performed at the beginning and end of each outage in accordance with procedure S1(2).OP-PT.CAN-0001 (Q) (Reference A.34). One of the requirements of the procedure is to check the areas for foreign material, large accumulation of dirt, dust, lint and paint chips, loose paint/coatings.

Procedure S1(2).OP-ST.SJ-0011(Q) (Reference A.35) is performed every outage to conduct a visual inspection of the containment sump to verify that the subsystem suction inlets are not restricted by debris and that sump components (trash racks, screens, etc.) show no evidence of structural distress or corrosion. This inspection includes review of the ECCS containment sump and sump screens for damage and debris. The front and back strainer pockets are visually inspected to ensure they are clean, no visible gaps greater than the criteria specified, and are in good material condition. Also, refueling canal drains are verified to be unobstructed and that there is no potential debris sources in the refueling canal area that could obstruct the drains.

At Salem Units, all the plant modifications are controlled through the design change process procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference a.37). These procedures ensure that the plant modifications do not a negative impact on the existing plant components.

As part of the newly installed containment sump strainers, Salem has provided additional programmatic controls through procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37) to ensure that potential sources of debris that may be introduced into containment will be assessed for adverse effects on the ECCS and Containment Spray System recirculation functions. These programmatic controls include requirements related to coatings, containment housekeeping, materiel condition, and modifications.

B. Change-out of insulation

At Salem Units all calcium silicate insulation within the ZOI and Min-K insulation were replaced (Reference A.29 and A.30) wherever feasible. Also, the Salem procedures (CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37) have been enhanced to provide additional programmatic controls to ensure that potential sources of debris that may be introduced into containment will be assessed for adverse effects on the ECCS and Containment Spray System recirculation functions.

C. Modify or improve coatings program

The majority of coatings at Salem Units are qualified coatings. The amount of unqualified coatings is contained under item 3h.2.

During every refueling outage, PSEG performs containment walkdown to observe the conditions of protective coatings installed on concrete and steel substrates. PSEG follows the guidance of ASTM D5163 (Reference A.39).

Salem procedures CC-AA-102 (Reference A.36) and CC-AA-102-1001 (Reference A.37) have been enhanced to provide additional programmatic controls to ensure that controls related to coatings are assessed for adverse effects on the ECCS and CSS recirculation functions.

As part of the recently installed containment sump strainers, Salem has issued a new coating condition monitoring program (Reference A.66). It provides guidance for the engineering department to conduct assessments of the conditions of the containment coatings during refueling outages. It incorporates the practices of ASTM D5163 (Reference A.39) and includes the adhesion test procedure outlined in EPRI Report 1014883 Section 4 (Reference A.61).

D. Floor Obstruction Design Considerations

Debris interceptors have been installed in front of the strainer modules to help reduce total debris movement toward the containment sump. The debris interceptor is made of grating with bearing bars on 15/16 inch centers and cross bars on 4 inch centers. Attached to the back of the grating is perforated plate with 1/8 inch diameter perforations.

E. Screen Modifications

Passive strainers have been installed at the Salem Units. The original containment sump strainer area for each Salem Unit was approximately 85 ft^2. The new ECCS containment sump strainer modules installed at Salem Unit 1 and 2 have a surface area of 4,854 ft^2 and 4,656 ft^2 respectively. The new surface area was based on debris load and chemicals precipitates, as well as plant layout. In addition to providing a significant increase in strainer surface area, the new design incorporates a reduction in strainer hole size from 1/8 inch nominal (original strainer) to 1/12 inch nominal (new strainer).

3i.6) Recent or planned insulation change-outs in the containment which will reduce the debris burden at the sump strainers

At Salem Unit 1 and 2, all the calcium silicate insulation within the ZOI has been replaced (Reference A.29 and A.30). Min-K insulation was replaced with reflective metallic insulation wherever possible. In some cases NUKON insulation was used due to accessibility concerns. In all cases, the added NUKON and the remaining Min-K insulation were accounted for in the Debris Generation Calculation (Reference A.1).

During the Salem Unit 2 Spring 2008 refueling outage, the SGs are planned for replacement. The existing SGs are insulated with NUKON insulation. The replacement SG will be insulated with Transco RMI. PSEG has received approval of an extension for the insulation replacement on the Unit 2 steam generator (Reference A.26).

3i.7) Any actions taken to modify existing insulation (e.g., jacketing or banding) to reduce the debris burden at the sump strainers

As stated in Response 3i.6, all calcium silicate insulation within ZOI and Min-K insulation wherever possible has been replaced. Also, the Salem Unit 2 steam generator insulation will be replaced during the steam generator replacement. Other than these replacements, PSEG has determined that no additional modification to the existing insulation is necessary to reduce debris burden at the sump strainers.

3i.8) Modifications to equipment or systems conducted to reduce the debris burden at the sump strainers

PSEG has not made any modifications to equipment or system to reduce the debris burden at the sump strainers.

3i.9) Actions taken to modify or improve the containment coatings program

The existing Salem containment coatings program (Reference A.28) includes the specification of materials, surface preparation, application, and inspection procedures.

During every refueling outage, PSEG performs containment walkdown to observe the conditions of protective coatings installed on concrete and steel substrates. PSEG follows the guidance of ASTM D5163 (Reference A.39).

As part of the newly installed containment sump strainers, Salem has issued a new coating condition monitoring program (Reference A.66). It provides guidance for the engineering department to conduct assessments of the conditions of the containment coatings during refueling outages. It incorporates the practices of ASTM D5163 (Reference A.39) and includes the adhesion test procedure outlined in EPRI Report 1014883 Section 4 (Reference A.61).

3j. Screen Modification Package
The objective of the screen modification package section is to provide a basic description of the sump screen modification.

3j.1) Provide a description of the major features of the sump screen design modification.

3j.2) Provide a list of any modifications, such as reroute of piping and other components, relocation of supports, addition of whip restraints and missile shields, etc., necessitated by the sump strainer modifications.

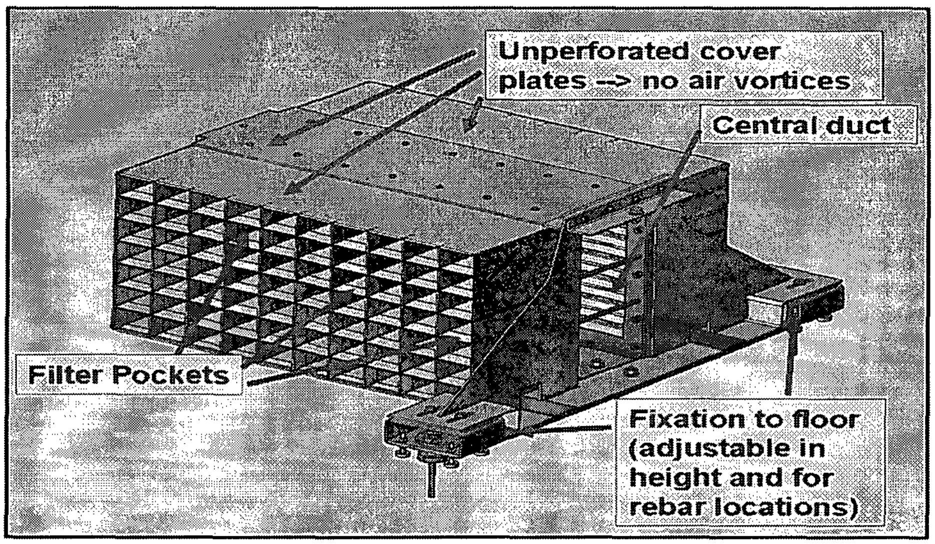
PSEG performed the physical changes necessary to bring Salem Unit 1 and 2 into full resolution with GL 2004-02. This involved removing the ECCS containment sump outer cage and inner screen and installing new ECCS containment sump strainer modules in each unit.

The sumps are located in the outer annulus area on elevation 78' of the Salem Unit 1 and Salem Unit 2 containment buildings. Each sump is surrounded by a concrete curb with the top of the curb at elevation 78' 9".

The inside of the sump is partitioned into two sides: the non-safety side that collects water from the trenches around the bioshield wall, and the ECCS side that takes water from the floor at elevation 78 feet to supply the RHR pumps during a LOCA.

The pre-GL 2004-02 design consisted of an outer cage made of 1 ¼ inch x 3/16 inch vertical grid bars on 1 3/16 inch centers for the walls and solid 3/16 inch plate for the top. The outer cage prevented large debris from blocking or damaging the inner screen. The inner screen covered the ECCS side of the sump. It was structured as a box frame that was covered with stainless steel mesh with 1/8 inch by 1/8 inch openings. The inner screen had a screen surface area of approximately 85 ft^2. In addition to the outer cage and inner screen, the top of the sump also had a 1/8 inch mesh partition between the non-safety side of the sump and the ECCS side.

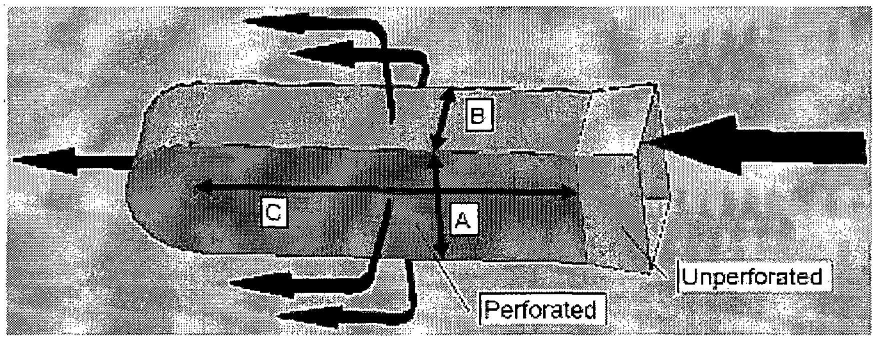
To accommodate the debris generated by a LOCA and transported to the sump, the surface area of the screen had to be significantly increased. A series of strainer modules were installed along the outer containment wall between the existing containment sump and the Pressure Relief Tank (PRT) to achieve the required total screen surface area,



Layout of a Standard Strainer Module

The strainer modules are passive strainers that were engineered, qualified, and manufactured by CCI. In order to maximize the surface area in a small footprint, each strainer module has pockets attached to the front and back of the module with a flow channel in the center.

The modules are either 10-pocket modules or 15-pocket modules. The 10-pocket modules are 10 pockets wide and 7 pockets high, whereas the 15-pocket modules are 15 pockets wide and 7 pockets high. The pockets (see sketch below) are made of stainless steel plate with 1/12 inch diameter holes. The smaller diameter holes are required to prevent potential damage/blockage of downstream components such as valves and pumps.



Layout of a Typical Strainer Pocket

The ECCS side of the sump is covered with a stainless steel enclosure made of 6 mm thick solid plate. The enclosure has an access panel that allows entry into the sump for maintenance and inspection. Inside the sump enclosure is a diffuser at the water inlet to help reduce turbulence.

There are two level transmitters located in each sump with a span of 204 inches. These level transmitters are three-stage transmitters such that the bottom stage is fully submerged in the sump, the top stage is completely outside the sump, and the middle stage overlaps the two.

Therefore, the top of the sump enclosure has sealing plates that fit around the level transmitters and/or conduit. The 1/8 inch mesh partition between the two sides of the sump was sealed with a solid plate to prevent communication between the two sides. This forces water from the non-safety side of the sump back up through the trenches, onto the floor at elevation 78' and through the new strainer modules. This tortuous path helps to allow debris to settle, limiting the amount transported to the sump.

The strainer modules are connected end-to-end and attached to the sump enclosure via a connection duct. The connection duct has internal vanes to reduce turbulence through the duct. The final result is a train of strainer modules that extends approximately a quarter of the way around the outer annulus and allows flow of water to the sump and the RHR pumps.

A 9 inch tall debris interceptor is bolted to the front feet of the strainer modules to prevent large debris from reaching the strainer pockets. The debris interceptor is made of grating with bearing bars on 15/16 inch centers and cross bars on 4 inch centers. Attached to the back of the grating is perforated plate with 1/8 inch diameter perforations. The top of the debris interceptor has an overhanging lip that keeps larger debris from lifting off the floor and flowing over the trash rack. At the end of the strainer train, the debris interceptor wraps around the side and extends to the containment liner to limit debris transport to the back of the strainers.

To support GL 2004-02, insulation was replaced inside the bioshield area and three out of the four bioshield doors were modified. By replacing the Calcium Silicate, Min-K and most of the NUKON insulation with RMI, the head loss across the screen and the chemical effects are greatly reduced. To prevent a holdup volume in the bioshield area, the bottom portion of three of the four bioshield doors were modified. Horizontal bars were added at no more than one foot centers so that large pieces of insulation would not block the flow of water to the sump.

Since all testing has not been completed for the GL 2004-02 requirements, the strainer modules and sump enclosure are not considered in full conformance. However, analysis was done with the new equipment to prove that the pre-GL 2004-02 design basis, which assumes the screen to be 50% blocked with debris, confirmed that the equipment is operable under the pre-GL 2004-02 design basis. Once testing is completed, and adequate NPSH available is validated, then the new strainer modules and sump enclosure will be in full conformance to the GL 2004-02 design basis. This will be completed by June 30, 2008.

3k. Sump Structural Analysis

The objective of the sump structural analysis section is to verify the structural adequacy of the sump strainer including seismic loads and loads due to differential pressure, missiles, and jet forces.

3k.1) Provide the information requested in GL 2004-02 Requested Information Item 2(d)(vii).

GL 2004-02 Requested Information Item 2(d)(vii)

Verification that the strength of the trash racks is adequate to protect the debris screens from missiles and other large debris. The submittal should also provide verification that the trash racks and sump screens are capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under flow conditions.

As discussed in section 3k.4, the strainers are not subject to missiles or high energy line breaks (HELB). The original design of the strainers accounted for the full post-LOCA debris load. The trash racks were installed in front of the strainers to reduce the debris load on the strainer, not for structural purposes, but for head loss purposes.

The 9 inch tall debris interceptor is bolted to the front feet of the strainer modules to minimize large debris from reaching the strainer pockets. The debris interceptor is made of standard floor grating with bearing bars on 15/16 inch centers and cross bars on 4 inch centers. Attached to the back of the grating is perforated plate with 1/8 inch diameter perforations.

The top of the debris interceptor has an overhanging lip that keeps larger debris from lifting off the floor and flowing over the trash rack. At the end of the strainer train, the debris interceptor wraps around the side and extends to the containment liner to limit debris transport to the back of the strainers.

The grating bearing bars are 1 ½ inch x 3/16 inch. With the longest span of ~6'-3 inch, the allowable load on the grating is 202 lb_f/ft^2, which is considerably higher than the loads imposed by the debris. During containment flooding, the resultant static pressure from 9 inch of water on the debris interceptor grating is well below the allowable loads in the extremely unlikely event that the entire length of the debris interceptor is completely blocked by debris until such time as the water level exceeds the grating height.

Since the debris interceptors are only 9 inch high and the strainers are fully submerged during recirculation operation (water level is approximately 2 feet-4 inch), the pressure differential across the debris interceptor is negligible. The attached perforated plate is bolted to the grating in three places. The perforated plate has been analyzed for deflection based on the maximum water velocity experienced at the trash rack. The maximum deflection was determined to be less than 1/8 inch, which is acceptable.

The debris interceptor is securely fastened to the base of the strainer frame by bolts. The analysis of the bolts is documented in VTD 900501 "Structural Analysis of Strainer and Support Structure" (Reference A.55). According to the calculation, there are no additional loads due to the attached curb to the strainer feet. Since both sides of the debris interceptor are flooded at recirculation operation, there is negligible pressure difference acting on the grating.

Any additional load caused by debris is encompassed in the strainer module analysis. The dead weight, seismic and hydrodynamic influence are also covered by the strainer module analysis. Further discussion regarding the analysis of loads on the strainers is provided in item 3k.2.

3k.2) Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.

__Design Conditions__

Minimum sump water temperature during recirculation	50 °F = 10.0 °C
Maximum sump water temperature during recirculation	264 °F = 128.3 °C
Maximum containment air temperature	264 °F = 128.3 °C

The maximum pressure difference across the strainers used in the static analysis is based on the allowable head loss at 190°F (87.8 °C). This pressure difference is converted to the minimum sump water temperature of 50 °F (10.0 °C) based on the viscosity change.

Allowable head loss at 190°F (87.8 °C) 3.15 ft
Kinematic viscosity of water at 87.8 °C $\upsilon_1 = 3.322 \cdot 10^{-7}$ m^2/s
at 10.0 °C $\upsilon_2 = 1.307 \cdot 10^{-6}$ m^2/s
Maximum head loss $dH = 3.15\ ft \cdot \upsilon_2/\upsilon_1 = 12.39\ ft = 3.776\ m$
A pressure difference of 13.12 ft (4 m) is used for the mechanical design.
Maximum pressure difference $dP = 5.8\ psi = 0.04\ MPa$
Design life 40 years stand-by life
2880 hours operating life time after LOCA

Weight of Structure

Weight of modules (10 pockets long):

Type	Number of Pockets	Mass [kg]	Mass [lb]
Modules without cartridges	10	160	353
1 cassette	10	17.5	39
14 cassette	10	245	540
Total module	10	**405**	893

Weight of modules (15 pockets long):

Type	Number of Pockets	Mass [kg]	Mass [lb]
Modules without cartridges	15	200	441
1 cassette	15	24	53
14 cassette	15	336	741
Total module	15	**536**	1182

Weight of supporting structure:
The density 7900 kg/m^3 (493.2 lb/ft^3) is used to calculate the weight of the supporting structure.
An additional weight of 5% to the weight of modules is considered. (Weight of bolts, sealing plates, simplification of the model) 536 kg x 1.05 = 563 kg

Weight of Debris

The following table was used for the original design inputs.

Debris Unit 2	Volume [ft^3]	Density [kg/m^3]	Mass [kg]	[lb]
Nukon Fiber	600	38.4	652.4	1438
Kaowool Fiber	600	48.1	817.2	1802
Reflective Metal Insulation	0.2502	7850	55.6	123
Qualified	25.5	1506	1087.5	2397
Unqualified Coatings	0.5	1506	21.3	47
Latent Particulates	1.01	2701	7702	170
Latent Fiber	0.33	1500	14.0	31
Total Mass			2725.3	6008
per Module (23)			118.5	261
per Cassette			**16.9**	37

The table below represents the revised combined debris weight based on S-C-CAN-MDS-0445 Rev. 2. The debris weight is bounded by the original weight calculation making it conservative.

Debris Unit 2	Volume [ft^3]	Density [kg/m^3]	Mass [kg]	[lb]
Nukon Fiber	23.3	38.44	25.4	55.9
Kaowool Fiber	35	128.15	127.0	280
Generic Fiberglass	47	96.11	127.9	282
Reflective Metal Insulation	1.6	7850	361.8	798
MRI (Pressurizer, Piping, RC Pumps)	0.95	7850	211.2	466
Qualified & Unqualified Coatings	13.1	2,681.49	994.7	2193
Latent Particulates	1.00	2,681.49	75.9	167.4
Latent Fiber	12.5	38.44	13.6	30
Min-K	24.5	256.3	177.8	392
Permanent Lead Shield Blanket	1	1,385.60	39.2	86.5
Total Mass			2154.5	4749.9
per Module (23)			93.7	207
per Cassette (7)			**13.4**	30

Pressure

The strainer is not a pressure retaining part and is therefore not subjected to any pressure transients or hydrostatic pressure during normal operation of the plant. If the strainer areas are covered with debris and the pumps are in use, then the following external pressures will act on the strainer.

ΔP=0.04 MPa at 15°C
ΔP=0.01 MPa at 87.8 °C and above

Hydrodynamic Water Masses

The calculation model represents two halves of a long strainer. The dimensions of one strainer are used to determine the hydrodynamic water masses. In the first step, the effects of the wall and the perforated sheets are minimal.

Coordinate directions:

X- horizontal, longitudinal direction
Y- horizontal, transverse direction
Z- vertical

Module height $h_m := 0.603\,m$ Module width $w_m := 1.122\,m$ Module length $l_m := 1.804\,m$

Duct height $h_d := 0.603\,m$ Duct width $w_d := 0.30\,m$

Density of steel $\rho_s := 7900\,\frac{kg}{m^3}$ Density of water $\rho_w := 996\,\frac{kg}{m^3}$

Steel mass of module $m_{Steel} := 536\,kg$ (used to calculate the volume displaced by the steel)

Included Water Mass

$$mi_y := \left(h_m \cdot w_m \cdot l_m - \frac{m_{Steel}}{\rho_s}\right) \cdot \rho_w \qquad mi_y = 1148kg$$

$$mi_x := \left[\left(h_m \cdot w_m \cdot l_m\right) - \left(h_d \cdot w_d \cdot l_m\right) - \frac{m_{Steel}}{\rho_s}\right] \cdot \rho_w \qquad mi_x = 823kg$$

(In x-direction the water included in the duct is not considered, because the duct has open ends at both sides)

$$mi_z := mi_y \qquad mi_z = 1148kg$$

Hydrodynamic Water Mass

See Reference A.64. The factor f1 versus ratio a/b is given in this reference. Hydrodynamic mass is given per Salem Unit length for long bodies with rectangular cross section

Y-direction $a := \frac{h_m}{2}$ $b := \frac{w_m}{2}$ $\frac{a}{b} = 0.537$

$f_1 = 1.686$ for $\frac{a}{b} = 0.537$ $f_2 := 1.0$

$mh_y := f_1 \cdot \pi \cdot \rho_w \cdot a^2 \cdot l_m \cdot f_2$ $mh_y = 865\text{kg}$

X-direction $a := \sqrt{w_m \cdot h_m}$ $b := l_m \cdot 11$ $\frac{b}{a} = 24.125$

$f_1 := 0.1$ (for b/a≈10) $f_2 := 1.0$

$mh_x := f_1 \cdot \rho_w \cdot a^2 \cdot l_m \cdot f_2$ $mh_x = 122\text{kg}$

Z-direction $a := \frac{w_m}{2}$ $b := \frac{h_m}{2}$ $\frac{a}{b} = 1.861$

$f_1 = 1.381$ for $\frac{a}{b} = 1.861$ $f_2 := 1.0$

$mh_z := f_1 \cdot \pi \cdot \rho_w \cdot a^2 \cdot l_m \cdot f_2$ $mh_z = 2453\text{kg}$

Total Water Mass

$m_x := mi_x + mh_x$ $m_x = 945\text{kg}$

$m_y := mi_y + mh_y$ $m_y = 2013\text{kg}$

$m_z := mi_z + mh_z$ $m_z = 3601\text{kg}$

Applied Water Mass

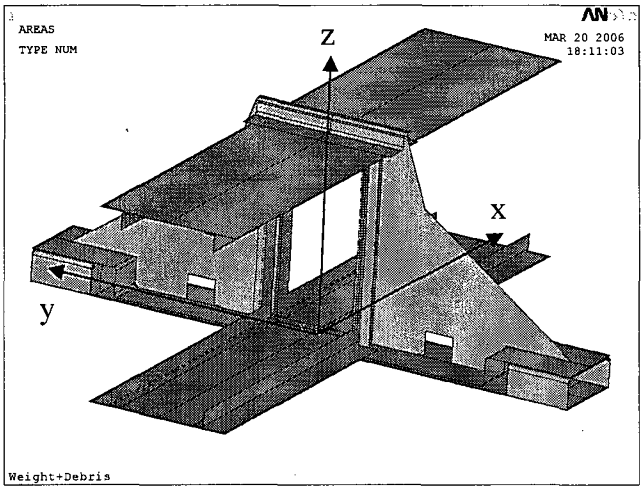
The value of the water mass is strongly affected by two influencing variables:

- Nearness to a wall / gap to the floor
- Perforated sheet

The strainer modules are located close to the basement and near the longitudinal wall. The water mass is accelerated by the wall or the floor. The inertia forces acting on the water are transferred directly through the water into the ground / wall and, therefore, no forces are exerted on the structure of the strainer. The strainers are not compact bodies, but mainly made of perforated plates. Therefore, for horizontal movements, only a portion of the surrounding water is accelerated, the rest "slips" through the perforation.

Direction	Wall / Basement f1	Perforated sheet f2
x	1	1
y	0.6	0.6
z	0	0.6

Applied Water Mass:
$mx = f_1 \cdot f_2 \cdot m_x = 950$ kg
$my = f_1 \cdot f_2 \cdot m_y = 725$ kg
$mz = f_1 \cdot f_2 \cdot m_z = 0$ kg



Faceplate at the end of the row

The hydrodynamic mass calculated above is applied in the spectrum analysis for Operating Basis Earthquake (OBE) and Design Basis Earthquake (DBE) of the strainer module. The mass causes lower natural frequencies and higher spectral accelerations. Because the hydrodynamic mass is large compared to the steel mass, the inertia loads acting on the strainer are higher. The loads due to water sloshing are not considered.

Temperature

Due to the design of the strainers, there are no significant temperature stresses. The specified temperatures are used only for evaluating the material properties.

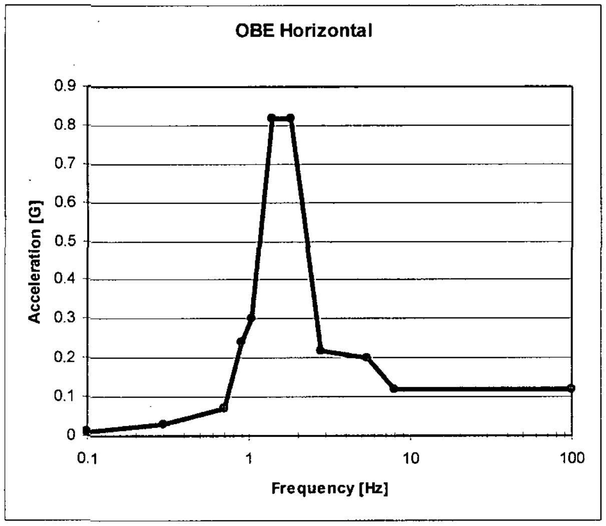
Earthquake

The strainers are Seismic Class 1 structures.

The response spectra are given in Attachment C of PSEG Specification No. S-C-CAN-MDS-0445. The damping values are 0.5% for OBE and 1% for DBE.

For the Spectrum analysis a simplified response spectra is used:

Table 0-2 Seismic Accelerations OBE



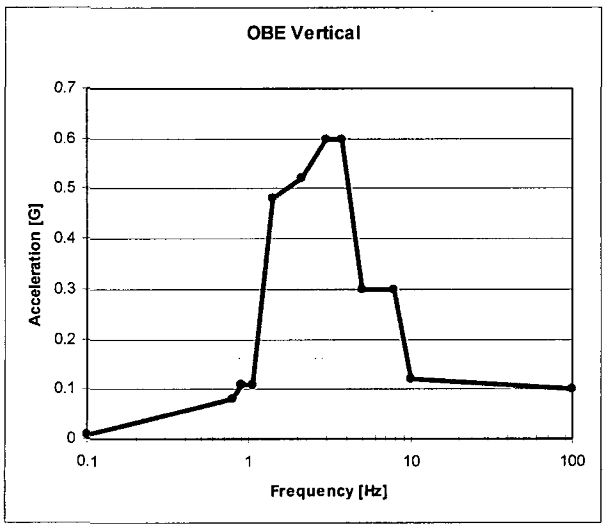
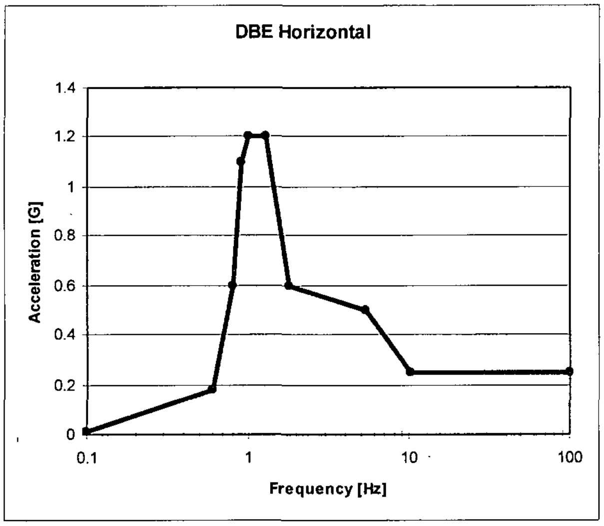
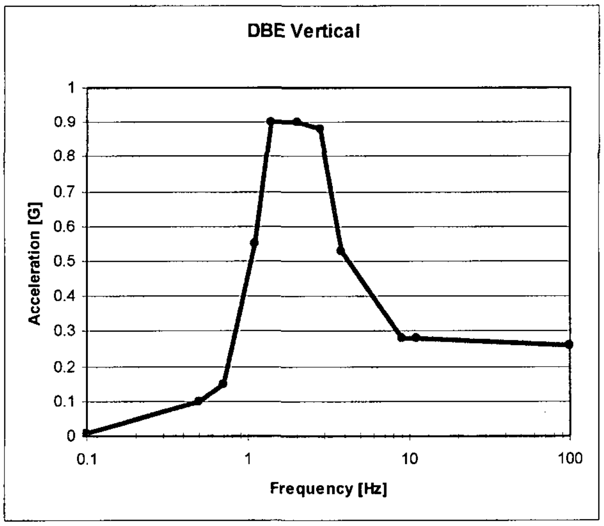


Table 0-3 Seismic Accelerations DBE





The resultant effects for both horizontal and vertical earthquake loads are determined by combining the individual effects by the square root of the sum of the squares method.

Load Combinations

The following table shows the event combinations that are considered.

Table 0-4 Load Combinations

Load comb. No.	Temperature (°F)	Temperature (°C)	Load Combination	Loading Category
1	263	128.3	W (pool dry)	Design / Service Limit A
2	263	128.3	W + OBE (pool dry)	Service Limit B
3	263	128.3	W + DBE (pool dry)	Service Limit C
4	263	128.3	$W + W_D + W_W$ + OBE (pool filled)	Service Limit B
5	50	10.0	$W + W_D + W_W + \Delta P$ (0.04 MPa)+ DBE (pool filled)	Service Limit C
6	263	128.3	$W + W_D + W_W + \Delta P$ (0.01 MPa)+ DBE (pool filled)	Service Limit C

The pressure difference at the high temperature is much lower, see 3SA_096_020_R7, chapter 0 which is documented in PSEG VTD 900501 (Reference A.55).

Loads:
W Weight of strainers, supporting structure, channels
W_D Weight of Debris
W_W Hydrodynamic Water Mass and Included Water Mass (occurs only with OBE and DBE)
ΔP Pressure difference across strainers
OBE Operating Basis Earthquake
DBE Design Basis Earthquake

Thermal expansion does not cause significant stresses, for two reasons:

- There are no temperature differences within the steel structure
- Sliding joints are provided between ducts and supports, so that different expansion of steel structure and concrete floor are compensated.

The temperatures are considered for the stress limits.

For the load combinations 4, 5 and 6, hydrodynamic masses are considered. The pockets are assumed to be full of water. Additional mass is conservatively considered for the debris weight (W_D).

Design Codes utilized in this evaluation are as follows

1. PSEG Nuclear LLC, Spec. No. S-C-CAN-MDS-0445, Salem Generating Station Containment Sump Strainers, Detailed Technical and Procurement Specification
2. PSEG Nuclear LLC, General Spec. No. 01-5000, Purchasing Department, Supply Chain Management, General Terms And Conditions For Furnishing Labor And Material On A Lump Sum, Salem Unit Price Or Cost Plus Basis

3. PSEG Nuclear, "Parameters for Strainer Design" dated July 18, 2005
4. 2004 ASME Boiler and Pressure Vessel Code, Section NF; Supports
5. 2004 ASME Boiler and Pressure Vessel Code, Section II; Part D – Properties (Metric)
6. ASME B31.1-2004, Power Piping
7. HILTI, Kwik Bolt 3, 2005 Product Technical Guide Supplement.
8. AISC, Manual of Steel Construction, Sixth Edition
9. T. Kirk Patton, Tables for Hydrodynamic Mass Factors for Translational Motion
10. Program ANSYS, Rev. 10.0
    Computer: PC, Windows XP Professional
    Author(s): ANSYS Inc., Houston, PA, USA
    Documentations: 4 Vol. User's Manuals

3k.3) Summarize the structural qualification results and design margins for the various components of the sump strainer structural assembly.

The values in the following tables summarize the values given in 3SA_096_020_R7, which is documented in PSEG VTD 900501 (Reference A.55). To identify the design margin, subtract the value in the Utilization columns from 100%.

Salem Nuclear Generating Station Units 1 and 2
Docket Nos 50-272 and 50-311
Generic Letter 2004-02
Supplemental Response for Salem

Component	Stress Type	Part	Chapter	Stresses									Material	Utilization			
				σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear	
Module Structure	Plate and Shell	Base Plate Bottom	5.3.7.1	111.0 MPa 16099 psi	<	172.5 MPa 25019 psi	137.0 MPa 19870 psi	<	258.8 MPa 37536 psi				304L	64.3%	52.9%	-	
		Base Plate Top	5.3.7.2	154.0 MPa 22336 psi	<	172.5 MPa 25019 psi	230.0 MPa 33359 psi	<	258.8 MPa 37536 psi				304L	89.3%	88.9%	-	
		Duct Plate "Bottom"	5.3.7.3	39.0 MPa 5656 psi	<	172.5 MPa 25019 psi	144.0 MPa 20885 psi	<	258.8 MPa 37536 psi				304L	22.6%	55.6%	-	
		Duct Plate "Top"	5.3.7.4	68.0 MPa 9863 psi	<	172.5 MPa 25019 psi	97.0 MPa 14069 psi	<	258.8 MPa 37536 psi				304L	39.4%	37.5%	-	
		Frame	5.3.7.5	136.5 MPa 19798 psi	<	172.5 MPa 25019 psi	230.0 MPa 33359 psi	<	258.8 MPa 37536 psi				304L	79.1%	88.9%	-	
		L-Holder / Flange	5.3.7.6			172.5 MPa 25019 psi	83.0 MPa 12038 psi	<	258.8 MPa 37536 psi				304L	-	32.1%	-	
		L-Profile	5.3.7.7	158.0 MPa 22916 psi	<	172.5 MPa 25019 psi	159.0 MPa 23061 psi	<	258.8 MPa 37536 psi				304L	91.6%	61.4%	-	
		Socket	5.3.7.8	157.0 MPa 22771 psi	<	172.5 MPa 25019 psi	202.0 MPa 29298 psi	<	258.8 MPa 37536 psi				304L	91.0%	78.1%	-	
		Trapezoid	5.3.7.9	170.0 MPa 24656 psi	<	172.5 MPa 25019 psi	202.0 MPa 29298 psi	<	258.8 MPa 37536 psi				304L	98.6%	78.1%	-	
				f_t		F_{tb}	f_v		F_{vb}					tension	shear	combined	
	Bolts	Frame and duct plate top	5.3.7.11	9.4 MPa 1370 psi	<	194.1 MPa 28152 psi	58.4 MPa 8470 psi	<	80.1 MPa 11618 psi				B8 Class 1	4.9%	72.9%	53.4%	
		Frame and duct plate bottom	5.3.7.11	7.1 MPa 1023 psi	<	194.1 MPa 28152 psi	62.0 MPa 8998 psi	<	80.1 MPa 11618 psi				B8 Class 1	3.6%	77.5%	60.1%	
		Duct plate top and I-holder	5.3.7.11	1.0 MPa 142 psi	<	194.1 MPa 28152 psi	4.9 MPa 711 psi	<	80.1 MPa 11618 psi				B8 Class 1	0.5%	6.1%	0.4%	
		Duct plate bottom and base plate top	5.3.7.11	0.2 MPa 32 psi	<	194.1 MPa 28152 psi	50.0 MPa 7245 psi	<	80.1 MPa 11618 psi				B8 Class 1	0.1%	62.4%	38.9%	
		L-holder and trapez	5.3.7.11	7.2 MPa 1046 psi	<	194.1 MPa 28152 psi	33.5 MPa 4859 psi	<	80.1 MPa 11618 psi				B8 Class 1	3.7%	41.8%	17.6%	
		L-profile and frame	5.3.7.11	15.7 MPa 2274 psi	<	194.1 MPa 28152 psi	56.0 MPa 8115 psi	<	80.1 MPa 11618 psi				B8 Class 1	8.1%	69.9%	49.4%	
		Socket and base plate top	5.3.7.11	5.0 MPa 722 psi	<	284.5 MPa 41263 psi	94.1 MPa 13648 psi	<	117.5 MPa 17042 psi				B8M Class 2	1.8%	80.1%	64.2%	
				T		T_A	S		S_A					tension	shear	combined	
	Anchor Bolts	5/8-in KB III	5.3.7.11	4.1 kN 922 lbf	<	7.3 kN 1641 lbf	8.8 kN 1978 lbf	<	14.5 kN 3260 lbf					56.2%	60.7%	81.7%	
				f_a		F_a								f_a/F_a			
	Buckling	Support Rod	5.3.7.10	22.6 MPa 3283 psi	<	59.9 MPa 8683 psi							304L	37.8%			
		Leveling Screws	5.3.7.11	79.5 MPa 11528 psi	<	85.3 MPa 12371 psi							B8 Class 1	93.2%			
				f_a		F_a	f_{bx}		F_{bx}	f_{by}		F_{by}		axial	bending 1	bending 2	combined
	Linear Type Supports	Support Rod	5.3.7.10	22.6 MPa 3283 psi	<	59.9 MPa 8683 psi	25.7 MPa 3721 psi	<	113.4 MPa 16449 psi	10.3 MPa 1488 psi	<	113.4 MPa 16449 psi	304L	37.8%	22.6%	9.0%	69.5%

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Component	Stress Type	Part	Chapter	Stresses									Material	Utilization		
				σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$	τ		Shear		mem	bend	shear
Standard Cartridges	Plate and Shell	Perforated Sheets	6.1.4	120.0 MPa 17405 psi	<	199.5 MPa 28935 psi	180.0 MPa 26107 psi	<	299.3 MPa 43410 psi				304	60.2%	60.1%	-
		Unperforated Sheets	6.1.4	40.0 MPa 5802 psi	<	199.5 MPa 28935 psi	110.0 MPa 15954 psi	<	299.3 MPa 43410 psi				304	20.1%	36.8%	-
		Perforated Sheets Pockets	6.2.2.1			199.5 MPa 28935 psi	144.0 MPa 20885 psi	<	299.3 MPa 43410 psi				304	-	48.1%	-
		Unperforated Sheets Pockets	6.2.2.1			199.5 MPa 28935 psi	110.0 MPa 15954 psi	<	299.3 MPa 43410 psi				304	-	36.8%	-
		Locking Tabs	6.3	83.3 MPa 12082 psi	<	199.5 MPa 28935 psi				10.0 MPa 1450 psi	<	124.2 MPa 18014 psi	304	41.8%	-	8.1%
Connection Duct Link	Plate and Shell			σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear
		Wall	7.	2.1 MPa 305 psi	<	172.5 MPa 25019 psi	177.0 MPa 25672 psi	<	258.8 MPa 37536 psi				304L	1.2%	68.4%	-
		Bottom / cover	7.			172.5 MPa 25019 psi	106.0 MPa 15374 psi	<	258.8 MPa 37536 psi				304L	-	41.0%	-
		Connection duct link support	Attachment C			172.5 MPa 25019 psi	170.0 MPa 24656 psi	<	258.8 MPa 37536 psi				304L	-	65.7%	-
	Bolts			f_t		F_{tb}	f_v		F_{vb}					tension	shear	combined
		Wall and bottom / cover	7.	16.6 MPa 2408 psi	<	140.5 MPa 20378 psi	23.0 MPa 3336 psi	<	58.0 MPa 8412 psi				B8 Class 1	11.8%	39.7%	17.1%
		Wall Parts	7.			140.5 MPa 20378 psi	16.7 MPa 2422 psi	<	58.0 MPa 8412 psi				B8 Class 1	-	28.8%	8.3%
		Support and Duct	Attachment C	3.0 MPa 435 psi	<	282.3 MPa 40944 psi	99.4 MPa 14417 psi	<	116.6 MPa 16911 psi				B8M Class 2	1.1%	85.2%	72.7%
	Anchor Bolts			T		T_A	S		S_A					tension	shear	combined
		5/8-in KB III	Attachment C	0.0 kN 0 lbf	<	7.3 kN 1641 lbf	7.4 kN 1668 lbf	<	14.5 kN 3260 lbf					-	51.2%	32.7%
Guide Plates	Plate and Shell			σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear
		Plates conditions number 1	8.	32.0 MPa 4641 psi	<	172.5 MPa 25019 psi	90.0 MPa 13053 psi	<	258.8 MPa 37536 psi				304L	18.6%	34.8%	-
		Plates conditions number 2	8.	32.0 MPa 4641 psi	<	172.5 MPa 25019 psi	60.0 MPa 8702 psi	<	258.8 MPa 37536 psi				304L	18.6%	23.2%	-
	Bolts			f_t		F_{tb}	f_v		F_{vb}					tension	shear	combined
		Plates conditions number 1	8.	0.0 MPa 0 psi	<	175.7 MPa 25483 psi	10.1 MPa 1465 psi	<	72.5 MPa 10515 psi				B8 Class 1	-	13.9%	1.9%
		Plates conditions number 2	8.	6.8 MPa 986 psi	<	175.7 MPa 25483 psi	8.5 MPa 1227 psi	<	72.5 MPa 10515 psi				B8 Class 1	3.9%	11.7%	1.5%
End Plate and Angle Plate	Plate and Shell			σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear
		Plates	9	85.9 MPa 12459 psi	<	172.5 MPa 25019 psi	245.0 MPa 35534 psi	<	258.8 MPa 37536 psi				304L	49.8%	94.7%	-
Sealing Plates	Plate and Shell			σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear
		Plates	10	0.0 MPa 0 psi	<	172.5 MPa 25019 psi	202.0 MPa 29298 psi	<	258.8 MPa 37536 psi				304L	-	78.1%	-

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Component	Stress Type	Part	Chapter	Stresses									Material	Utilization			
				σ_m		P_m	$\sigma_m + \sigma_b$		$P_m + P_b$					mem	bend	shear	
Suction Box	Plate and Shell	U-Profile	11.3	60.0 MPa 8702 psi	<	207.0 MPa 30023 psi	220.0 MPa 31908 psi	<	310.5 MPa 45034 psi				304	29.0%	70.9%	-	
		L-Profile	11.4	45.0 MPa 6527 psi	<	207.0 MPa 30023 psi	127.0 MPa 18420 psi	<	310.5 MPa 45034 psi				304	21.7%	40.9%	-	
		Steel Sheet	11.5	36.4 MPa 5279 psi	<	207.0 MPa 30023 psi	162.0 MPa 23496 psi	<	310.5 MPa 45034 psi				304	17.6%	52.2%	-	
		Door	11.6	148.5 MPa 21538 psi	<	207.0 MPa 30023 psi	250.0 MPa 36259 psi	<	310.5 MPa 45034 psi				304	71.7%	80.5%	-	
		Diffuser	11.8	0.0 MPa 0 psi	<	199.5 MPa 28935 psi	58.7 MPa 8508 psi	<	299.3 MPa 43410 psi				304	-	19.6%	-	
		Gauge Cover (perforated)	11.9.1.3	74.4 MPa 10791 psi	<	207.0 MPa 30023 psi	74.4 MPa 10791 psi	<	310.5 MPa 45034 psi				304	35.9%	24.0%	-	
		Gauge Cover (non perforated)	11.9.1.3	40.0 MPa 5802 psi	<	207.0 MPa 30023 psi	40.0 MPa 5802 psi	<	310.5 MPa 45034 psi				304	19.3%	12.9%	-	
		Upper Lateral Support	11.9.2.3	31.0 MPa 4496 psi	<	207.0 MPa 30023 psi	31.0 MPa 4496 psi	<	310.5 MPa 45034 psi				304	15.0%	10.0%	-	
		Lower Vertical Support	11.9.3.1	56.0 MPa 8122 psi	<	207.0 MPa 30023 psi	56.0 MPa 8122 psi	<	310.5 MPa 45034 psi				304	27.1%	18.0%	-	
		Level Instrument Bracket	11.10			199.5 MPa 28935 psi	182.0 MPa 26397 psi	<	299.3 MPa 43410 psi				304	-	60.8%	-	
				f_t		F_{tb}	f_v		F_{vb}					tension	shear	combined	
	Bolts	U-Profile	11.3.1	7.9 MPa 1150 psi	<	284.5 MPa 41263 psi	106.0 MPa 15374 psi	<	117.5 MPa 17042 psi				B8M Class 2	2.8%	90.2%	81.5%	
		L-Profile	11.4.1	43.7 MPa 6344 psi	<	284.5 MPa 41263 psi	57.5 MPa 8340 psi	<	117.5 MPa 17042 psi				B8M Class 2	15.4%	48.9%	26.3%	
		Steel Sheet	11.5.1	61.8 MPa 8959 psi	<	284.5 MPa 41263 psi	12.6 MPa 1833 psi	<	117.5 MPa 17042 psi				B8M Class 2	21.7%	10.8%	5.9%	
		Door	11.6.1	77.1 MPa 11187 psi	<	284.5 MPa 41263 psi	69.5 MPa 10080 psi	<	117.5 MPa 17042 psi				B8M Class 2	27.1%	59.1%	42.3%	
		Beam Supports B)	11.7.2	0.0 MPa 0 psi	<	284.5 MPa 41263 psi	93.2 MPa 13518 psi	<	117.5 MPa 17042 psi				B8M Class 2	-	79.3%	62.9%	
		Diffuser	11.8	0.0 MPa 0 psi	<	175.7 MPa 25483 psi	28.1 MPa 4076 psi	<	72.5 MPa 10515 psi				B8 Class 1	-	38.8%	15.0%	
		Gauge Cover	11.9.1.3	4.2 MPa 609 psi	<	194.1 MPa 28152 psi	24.2 MPa 3510 psi	<	80.1 MPa 11618 psi				B8 Class 1	2.2%	30.2%	9.2%	
				T		T_A	S		S_A					tension	shear	combined	
	Anchor Bolts	5/8-in KB III	11.2.1	1.3 kN 299 lbf	<	7.3 kN 1641 lbf	6.1 kN 1371 lbf	<	14.5 kN 3260 lbf					18.2%	42.1%	29.5%	
				f_a		F_a								f_a/F_a			
	Buckling	Beam Support	11.7.1.3.5	27.4 MPa 3974 psi	<	75.0 MPa 10878 psi								36.5%			
				f_a		F_a	f_b		F_b	τ		Shear		axial	bending	shear	
	Linear Type Supports	Beam Supports (-Earthquake)	11.7.1.3.4	21.3 MPa 3089 psi	<	186.3 MPa 27021 psi	156.8 MPa 22742 psi	<	186.3 MPa 27021 psi	17.3 MPa 2509 psi	<	79.8 MPa 11574 psi		11.4%	84.2%	21.7%	
		Beam Supports (-Earthquake)	11.7.1.3.5	27.4 MPa 3980 psi	<	75.0 MPa 10878 psi	184.9 MPa 26817 psi	<	186.3 MPa 27021 psi	18.6 MPa 2698 psi	<	79.8 MPa 11574 psi		36.6%	99.2%	23.3%	

3k.4) Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable).

The new strainer configuration is not exposed to dynamic effects such as pipe whip, jet impingement, and missiles associated with high-energy line breaks. According to the Salem UFSAR, the bioshield wall and refueling floor serve as barriers between the reactor coolant loops and the containment liner. The UFSAR states the following:

"The 3 feet thick wall, which extends from Elevation 81 feet to 130 feet, acts as a barrier between the containment liner and the sources of jet forces, pipe whip, and missiles associated with a failure of the RCS. All "essential components" (safety-related components in the containment which are required for operation during an accident) are located behind these missile barriers and therefore, are not subject to damage resulting from the dynamic effects associated with a LOCA."

The new strainer modules are located between the bioshield wall and the containment liner and, therefore, are not exposed to a direct impact of an RCS failure. However, the effect of a high energy line break (HELB) on the strainer modules was re-examined for the RHR injection lines, safety injection lines and the charging lines, which are located in the area of the strainer modules before penetrating the bioshield wall.

Each RHR injection line located in containment consists of two check valves inside the bioshield wall. This double isolation reduces the possibility that a HELB would occur outside the bioshield wall since the Reactor Coolant pressure boundary is inside the bioshield.

Each cold leg safety injection line consists of two check valves; one inside and one outside the bioshield wall. In the case that the check valve inside the bioshield should fail, it is possible to have a HELB outside the bioshield.

At this location, the safety injection lines are 2" in diameter. According to Reference 3, the worst case ZOI is 28.6 times the diameter of the pipe. In Salem's case, the ZOI would be a sphere with a radius of 57.2" (4.77'). This is the requirement for MRI with standard bands and is based on Air Jet Impact Tests (AJIT) performed by BWROG.

The MRI is made of a 0.032 inch stainless steel sheath with stainless steel reflective foils. The AJIT tests that were performed on MRI indicated that the air jet did not directly penetrate the stainless-steel sheaths; rather, the sheaths disassembled at the seams, similar to rivet failures. The results showed that the failure of the MRI was due to the seams being in direct alignment with the jet.

At the Salem Unit 1 and 2, the new strainer modules and sump enclosure are not located within the ZOI of the safety injection lines. Additionally, compared to the MRI, the strainer modules and sump enclosure are significantly more robust. The strainer modules have pockets that are 1.5 mm thick or ~ 0.059 inch, which is considerably larger that the thickness of the MRI. The stainless steel sump enclosure is made of 6 mm thick solid plate (0.236 inch), which is more than seven times the thickness of the MRI that was tested.

The support structures for the modules and the enclosure are 6 mm thick and the entire configuration is a bolted assembly. The strainers are far sturdier than MRI. Because the strainer modules are not within the ZOI, they are not affected due to a HELB in the cold leg safety injection lines. The hot leg safety injection lines are not a concern since hot leg recirculation occurs 14 hours after the LOCA and by that time the RCS would be depressurized.

The charging safety injection lines consist of a single check valve outside the bioshield and four check valves in each line inside the bioshield. In the case where one of the four check valves inside the bioshield should fail, it is possible to have a HELB outside the bioshield.

Most of the charging safety injection lines are located on the other side of the elevator shaft from the strainer modules and therefore a break at this location would not affect the strainer modules. Of the lines that are closer to the strainer modules, the diameter is only 1 ½ inch. Using the methodology above, the strainer modules would have to be within 25 ½ inches of the break. Since the strainer modules are not within this ZOI, then a HELB in the charging safety injection lines will not affect the integrity of the strainer modules

The location of the check valves in the RHR, safety injection, and charging lines are located as close as possible to the reactor coolant loop connections, thereby shortening the reactor coolant pressure boundary and minimizing pipe whip. All RHR lines penetrating the bioshield have been anchored to the bioshield wall to prevent reactor coolant pipe rupture forces from being transferred to the containment through the RHR branches.

3k.5) If a backflushing strategy is credited, provide a summary statement regarding the sump strainer structural analysis considering reverse flow.

PSEG did not credit back flushing strategy in the containment strainer design.

3l. Upstream Effects

The objective of the upstream effects assessment is to evaluate the flowpaths upstream of the containment sump for holdup of inventory which could reduce flow to and possibly starve the sump.

3l.1) Provide a summary of the upstream effects evaluation including the information requested in GL 2004-02 Requested Information Item 2(d)(iv).

GL 2004-02 Requested Information Item 2(d)(iv)
The basis for concluding that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

3l.2) Summarize the evaluation of the flow paths from the postulated break locations and containment spray washdown to identify potential choke points in the flow field upstream of the sump.

3l.3) Summarize measures taken to mitigate potential choke points.

3l.4) Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.

3l.5) Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.

Following is response to Items 3l.1, 3l.2, 3l.3, 3l.4, and 3l.5

As part of the minimum flood level and debris transport calculations performed in accordance with the NEI Guidance and its associated NRC SER documents (References 2 and 3), flowpaths were identified for returning water to the recirculation sump strainer, and possible holdup locations were considered. The flowpaths were modeled in a CFD analysis as part of the transport calculation (Reference A.2).

According to this calculation, there is one primary flowpath from the postulated break locations. The primary flowpath has water flowing from the break inside the bioshield, out through the bioshield doors and down the stairwells to the outer annulus at 78'. A possible choke point for this flowpath is blockage of the bioshield doors.

A secondary flowpath includes containment spray washdown flow through openings outside the bioshield area such as stairways, and gratings. A possible choke point for this flowpath is the lower portion of the refueling cavity drain.

The Minimum Containment Flood Level calculation (Reference A.21), accounts for holdup volumes (Refer to section 3g.8 of this supplemental Response for further details).

Note that in the minimum containment flood level calculation, the refueling cavity only assumed that the upper cavity would be a holdup volume as the lower cavity has a 6 inch opening that allows the water to drain. Blockage of this opening by debris is possible; however, it is not the limiting case of ECCS inventory hold up.

The Salem refueling cavity volume is approximately 6,550 ft^3 (Reference A.10). The refueling cavity is only filled by containment spray (no break flow fills the refuel cavity).

The Salem reactor cavity volume is approximately 10,400 ft^3 (Reference A.10). The reactor cavity can be filled directly by a break at the reactor vessel nozzle, or by overflow from the containment sump volume once the level in the containment reaches the 81 feet 9 inches level (which is above the minimum level required for recirculation operation of 80 feet 10 inches).

A break in the RCS piping at the steam generators would potentially block the reactor cavity drain. However, this break will not result in immediate filling of the reactor cavity. For this type of break, it is possible for a piece of debris to be blown up between the SGs and the enclosure wall and land on the refueling cavity drain on elevation 130'. With the drain blocked, any of the containment spray discharge falling into the refueling cavity would be lost to the recirculation pool inventory.

Conversely, a break at the reactor nozzle that leads to direct filling of the reactor cavity will not generate the amount of debris needed to block the refueling cavity drain.

Therefore, the concurrent use of both of these hold up volumes for determining minimum flood level for switchover to recirculation operation is not credible at Salem Unit 1 and 2. Because the reactor cavity has the largest volume, the reactor cavity is considered the limiting case for ECCS inventory hold up for both Salem Unit 1 and 2.

With the above entrapped water, the minimum flood level is determined to be adequate to support ECCS switchover to recirculation.

To prevent personnel access during plant operation and reduce exposure to high radiation areas, the entrance to the Salem Generating Station inner annulus (bioshield) is restricted. This is accomplished with locked closed wire mesh and folding gates located at the stairwells leading up from the outer annulus to the inner annulus (each Salem Unit has four stairwells). Following a LOCA, water from the break will flow from the inner annulus through these stairwells into the outer annulus area of the containment, where the containment sump is located.

To ensure that water does not get trapped inside the inner annulus in the event of a LOCA, gates in three of the four-bioshield stairwells in each Unit have been modified. The folding gates have been removed at Unit 1 and locked open in Unit 2. The door/gate nearest to the strainer module was not modified in either Salem Unit because blockage of these doorways would result in a more tortuous path for debris, thus potentially reducing the overall debris transport.

The new strainer configuration includes a debris interceptor that is attached to the front feet of each strainer module. The debris interceptor consists of grating with perforated plate bolted to the back of the grating. This debris interceptor is modeled in the debris transport calculation as a piece of solid plate that is approximately 9 inch high.

Additionally, the sump pit is surrounded by a 9 inch high curb. Neither the debris interceptor nor the sump curb creates holdup volumes as they are located in the outer annulus area. At switchover to recirculation operation all curbs and debris interceptors in the annulus area are fully flooded by the sump pool.

As previously discussed, the curb at the reactor cavity is at elevation 81 feet 9 inch, which is above the minimum water level required for switchover to recirculation operation. Therefore, water already on the containment floor will not flow into the reactor pit prior to switchover. The minimum flood level calculation, however, assumes that the reactor cavity fills at the start of the LOCA before water begins spilling on the containment floor. With this holdup volume, there is still adequate water to support switchover to recirculation operation.

3m Downstream Evaluation – Components and Systems

3m.1) Provide the information requested in GL 04-02 Requested Information Item 2.(d)(v) and 2.(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the sump.

GL 2004-02 Requested Information Item 2(d)(v)
The basis for concluding that inadequate core or containment cooling would not result due to debris blockage at flow restrictions in the ECCS and CSS flowpaths downstream of the sump screen, (e.g., a HPSI throttle valve, pump bearings and seals, fuel assembly inlet debris screen, or containment spray nozzles). The discussion should consider the adequacy of the sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

As a result of GL 2004-02 (Reference 1) new containment sump screens are installed at Salem Generating Station. Specification S-C-CAN-MDS-0445 (Reference A.22) specifies that these screens shall have 100% retention of particles greater than 1/12 inch. These screens have round holes with nominal diameters of 1/12 inch (2.1 mm) per CCI report 680/41273 (Reference A.23). After installation, these screens were inspected using site procedure S2.OP-ST.SJ-0011(Q) – Revision 5 (Reference A.24) to verify that screen fit-up was within 1.5 mm (0.060 inch) and that no local opening was greater than 2.5 mm (0.100 inch). Through this combination of design information and inspections, it is concluded that the maximum hole size in the strainers is 2.5 mm.

The susceptibility of the ECCS equipment required to pass debris-laden fluid during the recirculation phase after a postulated accident was evaluated to function as required. This evaluation was performed in Calculation S-C-RHR-MEE-1883, Revision 1 (Reference A.25). This evaluation determined the ECCS equipment that would be in the post-accident recirculation path and reviewed the dimensions of close-tolerances in this ECCS equipment against the acceptance criteria up to two (2) times the screen hole size.

The gaps in the bushings and wear rings of the ECCS pumps were determined to have clearances less than 1.1 times the screen hole size.

SI throttling valves, RHR pump mechanical seal heat exchangers and SI stop valve were determined to have a minimum opening of between 1.7 and 2 times the screen openings. These components were reviewed for the effect of wear on their performance using the methodology described in section 3m.3. Since these openings are greater than 1.7 times the screen opening, blockage is not a concern.

3m.2) ***<u>GL2004-02 Requested Information Item 2(d)(vi)</u>***
Verification that the close-tolerance sub-compartments in pumps, valves and other ECCS and CSS components are not susceptible to plugging or excessive wear due to extended post-accident operation with debris-laden fluids.

Blockage of components is addressed previously in section 3m.1. The long-term wear calculation (Reference A.18) addresses wear in close tolerance components. It also includes instrument lines, relief valves, piston check valves and post accident sampling system components for the potential for blockage due to debris.

The downstream effects calculation is not complete. PSEG has submitted and received an approval for an extension request for completion of this evaluation by June 30, 2008 (Reference A.27).

3m.3) If NRC-approved methods were used (e.g., WCAP-16406-P with accompanying NRC SE), briefly summarize the application of the methods. Indicate where the approved methods were not used or exceptions were taken, and summarize the evaluation of those areas.

The methods of WCAP-16406-P were used with the guidance of the SER to the WCAP and clarifications described during the October 2007 training teleconference. Calculation S-C-RHR-MDC-2089, Revision 1 used more detailed methods where additional quantification was required. Noteworthy differences between S-C-RHR-MDC-2089, Revision 1 and WCAP-16406-P, dated August 2007 (References A.18 and 27, respectively) are described below.

Section 5 of WCAP-16406-P (Reference 27) describes a methodology for calculating debris depletion over time. The WCAP also provides values of depletion coefficients by way of example. The WCAP does not provide specific depletion coefficients. Based on flow rates, volumes and settling velocities at Salem Generating Station, plant specific depletion coefficients were calculated. These depletion coefficients also credited filtration of particulates as well as fibers on the sump screen where such filtration is supported by plant specific testing.

WCAP-16406-P, Revision 1 (Reference 27) provides information on size distribution and settling fraction of coatings. It states that qualified coatings fail as 10 micron particles. This is conservative for pressure drop calculations, but not for downstream calculations. The Salem Unit 1 and 2 specific evaluation used a larger size particle based on vendor information about size of pigments in the coatings, resulting in a more conservative higher calculated wear.

WCAP-16406-P (Reference 27) assumes that unqualified coatings larger than 100 microns will settle. The Salem Unit 1 and 2 calculation uses an empirical correlation for friction factor that does not assume a constantly decreasing laminar friction factor and benchmarks the resulting settling size against NRC-sponsored settling tests documented in NUREG/CR-6916 (Reference 19). Because the paint chips were all assumed to settle with the widest cross section perpendicular to the direction of settling, the calculation showed a larger settling size for a given paint chip and settling velocity. This results in a conservative, benchmarked, plant-specific settling size for particulates.

A pump curve (after wear) is calculated for each Salem ECCS pump rather than utilizing WCAP-16406-P (Reference 27) Figure 8.1-3, which is based on a single stage pump with a particular specific speed. It does not bound the calculated wear effect for multi-stage high head, low flow pumps like the High Pressure Safety Injection pump. A more conservative method is used in S-C-RHR-MDC-2089, Revision 1 (Reference A.18). The worn pump curve is evaluated against system requirements to assure that adequate core cooling will be maintained in the recirculation phase after a postulated LOCA.

WCAP-16406-P (Reference 27), Appendix O, Section 2.3 recommends an assumed friction factor of 0.01 to maximize wear. During the performance of the calculation, it was found that the rate of wear, measured as gap increase, would be maximum when the combination of parameters, friction factor times bearing length divided by clearance, was set equal to 2/3. Since this can be demonstrated mathematically it is no longer necessary to make an assumption about the friction factor in order to maximize the wear.

WCAP-16406-P (Reference 27) does not explicitly address seal leakage. PSEG interprets Sections 7.2 and 8.1.3 of WCAP-16406-P and its associated SER to state that if debris laden fluid is piped from the recirculation stream to flush a pump's seal then the primary seal would fail as a direct consequence of the postulated LOCA. This would constitute a common mode failure mechanism. Conversely, if fluid from the recirculation stream is not piped to a pump's seal then there is no credible source of debris to fill the seal chamber and the primary pump seal is not assumed to fail as a direct consequence of the postulated LOCA. Such seals would still be subject to a postulated random failure of the pressure boundary as a moderate or high-energy line break. The leakage rate through a pump seal for one-half hour after a postulated primary seal failure was calculated. This calculation included the effects of wear on the components in the seals that would remain intact after a primary seal failure.

Rounding the inlet to an orifice in conjunction with increasing the orifice diameter decreases the flow resistance more than just increasing the diameter. In order to account for the effects of rounding the inlet of an orifice by debris Section 8.4 of WCAP-16406-P, Revision 1 (Reference 27) recommends a formula taken from the first edition of Idelchik's "Handbook of Hydraulic Resistance". The first edition, translated from Russian in the 1960's has been updated and the corresponding formula from the third edition of Idelchik's "Handbook of Hydraulic Resistance" (Reference 30) was used.

3m.4) Provide a summary and conclusions of downstream evaluations.

The ECCS components and systems that are required to operate and pass debris-laden fluid during the recirculation phase of recovery from a postulated LOCA have been identified. These ECCS components have been evaluated for blockage and wear from debris that would pass through the new containment sump screens. The ECCS equipment at Salem Generating Station will remain capable of passing sufficient flow to the reactor to adequately cool the core during the recirculation phase of a postulated LOCA.

The downstream effects and in-vessel evaluations have not been completed. PSEG has submitted and received an approval for an extension request for this item by June 30, 2008 (Reference A.27). Upon completion of the evaluations, the information will be submitted to NRC.

3n Downstream Effects - Fuel and Vessel

3n.1) Show that the in-vessel effects evaluation is consistent with, or bounded by, the industry generic guidance (WCAP-16793), as modified by NRC staff comments on that document. Briefly summarize the application of the methods. Indicate where the WCAP methods were not used or exceptions were taken, and summarize the evaluation of those areas.

The in-vessel chemical effects analysis for Salem Generating Station is being documented in Calculation 2007-20560 (Reference A.13). This calculation is currently being generated and PSEG has obtained an extension approval from the NRC for completion by June 30, 2008 (Reference A.27).

This calculation is based on guidance from the "Draft NRC Staff Review Guidance for Evaluation of Downstream Effects of Debris Ingress into the PWR RCS on Long Term Core Cooling Following a LOCA" (Reference 29) and from WCAP-16793-NP (Reference 28).

WCAP-16793-NP (Reference 28) shows that for all PWR designs, adequate flow to satisfy the long term cooling requirements is available even when the potential for debris blockage of the core is considered. However, the document suggests that plant specific analyses of the fuel chemical deposition issue be performed.

Calculation 2007-20560 (Reference A.13) will address material deposition on the fuel rods that may interfere with the transfer of heat to the coolant and result in excessive fuel cladding temperatures using plant specific conditions and the methodology recommended in WCAP-16793-NP (Reference 28) and Option 2 from the Additional Guidance for Modeling Post-LOCA Core Deposition which is contained in the enclosure to PWROG letter OG-07-534 (Reference 31).

The primary mode of deposition is boiling in the core. The plate-out of the chemicals that are introduced into the containment sump as a result of a LOCA in the containment building was analyzed. These chemicals are from materials that are in the reactor coolant and containment (i.e., aluminum, insulation, and concrete) that dissolve, and are added to the recirculating water in the sump. The calculation also addresses the potential for fiber, which bypasses the sump strainer to deposit on the fuel rods.

Calculation 2007-20560 (Reference A.13) will determine thickness of the material deposited on the fuel cladding. It is anticipated that the thickness will be below the recommended limit of 50 mils provided in WCAP-16793-NP (Reference 28). Also, the maximum temperature of the fuel cladding over the 30 days following the LOCA will be calculated. It is anticipated that this temperature will be blow the recommended limit of 800°F provided in WCAP-16793-NP (Reference 28).

3o Chemical Effects

3o.1) Provide a summary of evaluation results that show that chemical precipitates formed in the post-LOCA containment environment, either by themselves or combined with debris, do not deposit at the sump screen to the extent that an unacceptable head loss results, or deposit downstream of the sump screen to the extent that long-term core cooling is unacceptably impeded.

The in-vessel chemical effects analysis is described in the response to Item n.1. The head loss evaluation will be generated upon completion of the chemical testing at CCI facility. PSEG received NRC approval for an extension request for completion of the chemical head loss tests and incorporation of the head loss test results into the strainer head loss and NPSH calculations by June 30, 2008.

3o.2) Content guidance for chemical effects is provided in Enclosure 3 to a letter from the NRC to NEI dated September 27, 2007 (ADAMS Accession No. ML0726007425).

Responses to the content guidance in Enclosure 3 to a letter from the NRC to NEI dated September 27, 2007 (ADAMS Accession No. ML0726007425) are provided in the following subsections (o.1.x).

3o.1.1d(i) ***Sufficient 'Clean' Strainer Area*****: Those licensees performing a simplified chemical effects analysis should justify the use of this simplified approach by providing the amount of debris determined to reach the strainer, the amount of bare strainer area and how it was determined, and any additional information that is needed to show why a more detailed chemical effects analysis is not needed.**

Salem Generating Station is not performing a simplified chemical effects analysis.

The quantity of chemicals (aluminum, calcium, and silicon) dissolved in the post-LOCA sump pool and precipitates generated are determined using WCAP-16530-NP (Reference 24). The dissolved chemical and precipitate quantities are then provided to the screen vendor, CCI, so that prototypical chemical effects head loss tests can be performed.

3o.1.2d(i) ***Debris Bed Formation*: Licensees should discuss why the debris from the break location selected for plant-specific head loss testing with chemical precipitate yields the maximum head loss. For example, plant X has break location 1 that would produce maximum head loss without consideration of chemical effects. However, break location 2, with chemical effects considered, produces greater head loss than break location 1. Therefore, the debris for head loss testing with chemical effects was based on break location 2.**

The debris quantities provided to the screen vendor for head loss testing are based on the break, which results in the greatest quantity of debris detrimental to head loss (fiber, particulate, and Min-K) at the strainer. The limiting breaks for Salem Unit 1 and 2 have more (or an equivalent amount of) NUKON, Kaowool, generic fiberglass, Min-K and coatings than any other modeled break. Break selection criteria are discussed in detail in the response to Item 3a.

The maximum 30-day dissolved chemical quantities (aluminum, calcium, and silicon) for Salem Unit 1 and 2 were also provided to the screen vendor for head loss testing. The maximum dissolved chemical quantity is based on the break that generates the most debris, which can lead to chemical precipitates (NUKON, Kaowool, generic fiberglass, and Min-K). The dissolved chemical quantities are determined in the chemical effects analysis (Reference A.4), which uses the WCAP-16530-NP (Reference 24) methodology. Inputs to the chemical effects analysis are described in more detail in the response to Item o.1.3d(i).

Thus, the worst-case debris load and dissolved chemical quantities are provided to the screen vendor for chemical effects head loss testing. Note that testing will be performed individually for each Salem Unit and therefore debris loads and dissolved chemical quantities are provided individually for each Salem Unit.

3o.1.3d(i) ***Plant Specific Materials and Buffers:* Licensees should provide their assumptions (and basis for the assumptions) used to determine chemical effects loading: pH range, temperature profile, duration of containment spray, and materials expected to contribute to chemical effects.**

The chemical effects analysis for Salem Unit 1 and 2 is documented in Calculation VTD 900984 (Reference A.4). This calculation determined both the quantity of chemicals which are dissolved in the post-LOCA sump as well as the predicted quantity of precipitate present in the post-LOCA sump using the methodology (and spreadsheet) outlined in WCAP-16530-NP (Reference 24).

Descriptions of the primary inputs to the chemical effects analysis are provided in the following paragraphs. Salem Unit 1 and 2 are similar, and therefore all inputs apply to both Salem Units unless otherwise specified.

The materials in containment which are exposed to the sump pool and containment spray in the post-LOCA environment and which, when dissolved, may lead to precipitates in the post-LOCA sump pool are: NUKON, Kaowool, generic fiberglass, Min-K, latent debris, exposed aluminum metal, aluminum paint, and exposed concrete. This is consistent with the guidance in WCAP-16530-NP (Reference 24).

All LOCA generated debris (NUKON, Kaowool, generic fiberglass, Min-K, and latent debris) is modeled as being submerged in the sump pool. NUKON and generic fiberglass release significant amounts of calcium and silicon, and a smaller amount of aluminum. Kaowool releases a significant amount of silicon and aluminum while Min-K releases only silicon.

Latent debris is modeled as 85% particulate concrete and 15% fiberglass, and it releases calcium, silicon, and aluminum. The debris quantities are taken from the debris generation calculation (Reference A.1) for Salem Generating Station. The limiting breaks for both Salem Unit 1 and Salem Unit 2 have the largest quantity of each debris type and therefore the maximum debris quantities are used in the chemical effects analysis. This results in the most conservative calcium, silicon, and aluminum releases in the post-LOCA sump pool.

The following equipment in containment contains exposed aluminum metal: source, intermediate, and power neutron flux monitoring system detectors, control rod drive mechanism connectors, NSSS (Nuclear Steam Supply System), flux mapping drive system, miscellaneous valves, and aluminum carabiners. In the chemical effects analysis, aluminum metal is modeled as submerged or non-submerged. The submerged aluminum metal in containment has a surface area of 8.6 ft^2 and a mass of 23 lbm, which is conservatively increased to 9.5 ft^2 and 25 lbm (10% margin) for the chemical effects analysis. The non-submerged aluminum metal (excluding paint) in containment has a surface area of 489.2 ft^2 and a mass of 1146 lbm.

Aluminum paint in containment is accounted for separate from aluminum metal in the chemical effects analysis. The total quantity of aluminum paint in containment is 5000 ft^2, of which 500 ft^2 (2.6 lbm) is submerged and 4500 ft^2 (23.7 lbm) is non-submerged.

Exposed concrete is concrete which is uncoated, coated with unqualified coating, or coated with qualified coating within the break ZOI. This concrete is subject to dissolution in the post-LOCA environment. The total quantity of exposed concrete in containment is 3592 ft^2, of which 983 ft^2 is submerged and 2609 ft^2 is non-submerged. The submerged exposed concrete is all within the break ZOI.

The quantity of debris, aluminum, and concrete which dissolves is dependent upon the characteristics of both the post-LOCA sump pool and the containment spray. The sump pool properties are used to determine dissolution of submerged materials and the spray properties are used to determine dissolution of non-submerged materials. The properties of the sump pool and spray which are most important are: the sump pool volume, the sump water and containment atmosphere temperature profiles, the sump and spray pH profiles and the spray duration during the injection phase.

The maximum sump pool volume is conservatively used in the chemical effects analysis since it results in the greatest quantity of dissolved material since the material dissolution rate is dependent on the concentration of material already dissolved in the sump pool per the WCAP-16530-NP methodology (i.e., more material dissolves when the material concentration in the sump pool is lower). The maximum sump pool volume is determined in Calculation S-C-A900-MDC-0082 (Reference A.10) to be 464,300 gallons.

The sump water and the containment atmosphere temperature profiles are taken from WCAP-16503-NP (Reference A.5). The analyses in WCAP-16503-NP (Reference A.5) are performed using assumptions, which maximize the global containment pressure and temperature response to design-basis mass and energy release events. The sump water temperature response for all Salem Unit 1 and 2 scenarios modeled in WCAP-16503-NP (Reference A.5) were compared to determine the most limiting scenario. The most limiting (highest sump water temperature) scenario identified is for the case with the Salem Unit 2 RSG and a DEPS break with minimum safeguards and no recirculation containment spray. This scenario also results in the most limiting containment atmosphere temperature profile. The containment atmosphere and sump water temperature profiles are provided in Table A.6.3-6 and Figures A.6.3-5 and A.6.3-6 of the WCAP, respectively. The figures are repeated below.

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Supplemental Response for Salem

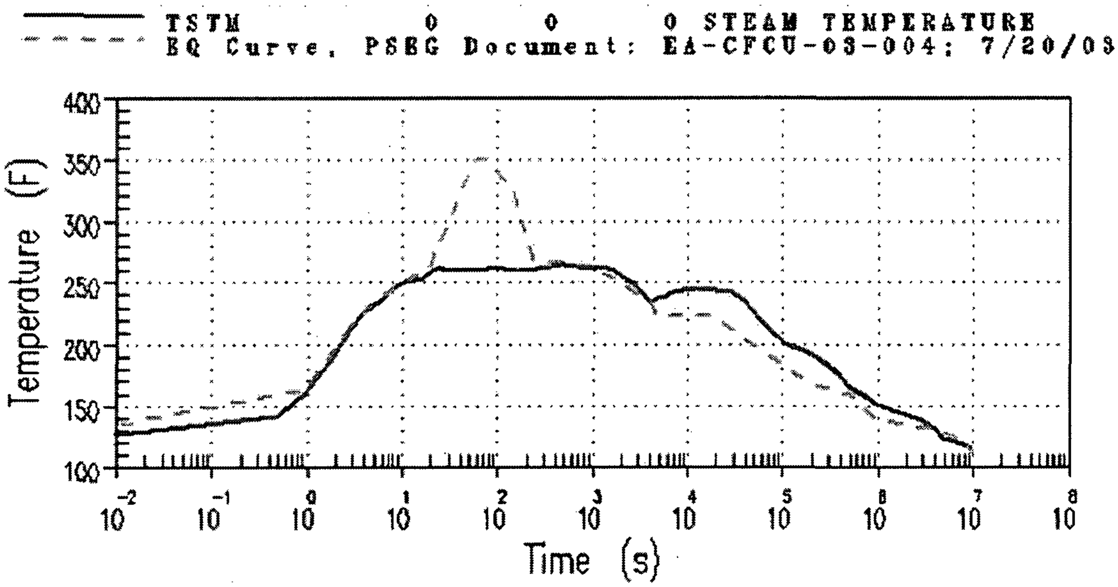

Figure A.6.3-5 Containment Temperature – Double-ended Pump Suction Break with Minimum Safeguards for Salem Unit 2 without Recirculation Spray

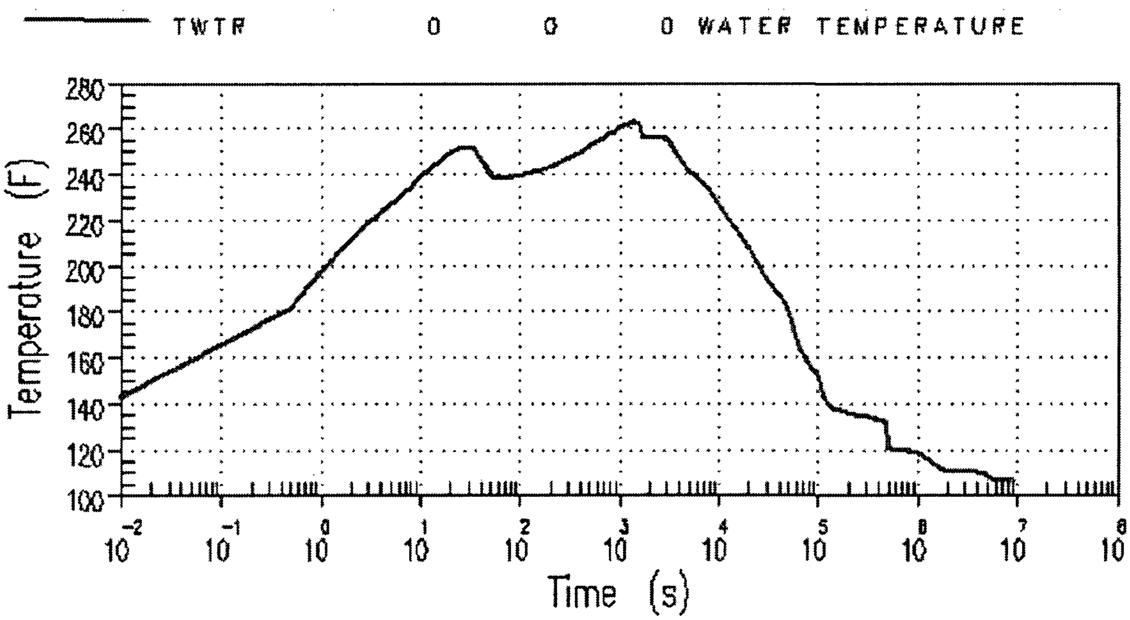

Figure A.6.3-6 Containment Sump Temperature – Double-ended Pump Suction Break with Minimum Safeguards for Salem Unit 2 without Recirculation Spray

The sump and spray pH profiles used in the chemical effects analysis are based on calculation S-C-SJ-MDC-2092 (Reference A.11) and §6.2.3.4.1 of the UFSAR. Per calculation S-C-SJ-MDC-2092 (Reference A.11), the sump pH is 8.4 or greater from 1 hr to 30 days post-LOCA. This pH is applicable to both the sump and spray following the injection phase. Per §6.2.3.4.1 of the UFSAR, the duration of safety injection is 48 minutes, and the spray pH during this time is between 8.5 and 10.0.

The buffer, which is sodium hydroxide (NaOH), is introduced to the containment via the containment spray system. Since higher pH values result in greater aluminum dissolution, both the sump and the spray are modeled with a pH of 10.0 for the first 48 minutes post-LOCA. Following the injection phase (t > 48 minutes), the sump and spray pH are both 8.4.

The event mission time also impacts the quantity of material, which will dissolve. Per Calculation S-C-SJ-MEE-1978 (Reference A.12), the post-LOCA mission time is 30 days. Therefore, the chemical quantities dissolved in the sump and the predicted precipitate quantities are based on 30-day event duration. Containment spray is conservatively modeled as remaining on for 30 days post-LOCA, which maximizes dissolution of non-submerged materials.

3o.1.4d(i) *Approach to Determine Chemical Source Term (Decision Point)*: Licensees should identify the vendor who performed plant-specific chemical effects testing.

The screen vendor, CCI, is performing a plant specific chemical effect testing.

3o.1.5) *Separate Effects Decision (Decision Point)*: State which method of addressing plant-specific chemical effects is used.

The WCAP-16530-NP (Reference 24) methodology is used to determine the quantity of chemicals, which dissolved in the post-LOCA sump for Salem Unit 1 and 2.

3o.1.6d(i) *AECL Model*: Since the NRC staff is not currently aware of the testing approach, the NRC staff expects licensees using it to provide a detailed discussion of the chemical effects evaluation process along with head loss test results.

The AECL method is not used by PSEG.

3o.1.6d(ii) *AECL Model*: Licensees should provide the chemical identities and amounts of predicted plant-specific precipitates.

The AECL method is not used by PSEG.

3o.1.7d(i) *WCAP Base Model*: For licensees proceeding from block 7 to diamond 10 in the Figure 1 flow chart [in Enclosure 3 to a letter from the NRC to NEI dated September 27, 2007 (ADAMS Accession No. ML0726007425)], justify any deviations from the WCAP base model spreadsheet (i.e., any plant specific refinements) and describe how any exceptions to the base model spreadsheet affected the amount of chemical precipitate predicted.

The base model spreadsheet was originally issued in February 2006, as part of WCAP-16530-NP (Reference 24). Following the initial issuance, errors were discovered in the spreadsheet as described in letter WOG-06-102 (Reference 24.3) and a revised spreadsheet was issued on March 17, 2006, via letter WOG-06-103 (Reference 24.4). Additional errors in the spreadsheet were discovered and were described in letter OG-06-232 (Reference 24.5).

These errors were corrected, and a revised spreadsheet was issued on August 7, 2006, via letter OG-06-255 (Reference 24.6). Following this issuance of the spreadsheet, one additional error in the spreadsheet was discovered as described in letter OG-06-273 (Reference 24.7), dated August 28, 2006. However, no revision to the WCAP spreadsheet was issued following the issuance of letter OG-06-273.

The spreadsheet used in calculation VTD 900984 (Reference A.4) is based on that issued via letter OG-06-255 (Reference 24.6); however, the spreadsheet was modified to address the error described in Letter OG-06-273 (Reference 24.7). The error correction involved changing a cell reference in several worksheets as is described in letter OG-06-273 (Reference 24.7). Letter OG-06-273 (Reference 24.7) states that this error only impacts plants, which use TSP for a buffer. Since Salem Unit 1 and 2 utilize a sodium hydroxide buffer, this error and its associated correction do not impact the Salem Unit 1 and 2 results.

In addition, sheets were added to the WCAP-16530-NP (Reference 24) spreadsheet to explicitly address aluminum paint and particulate concrete separately from aluminum metal and exposed concrete. These sheets were added since the WCAP-16530-NP (Reference 24) spreadsheet modeled the dissolution of aluminum metal and exposed concrete as a function of surface area, not thickness.

Hence, dissolution of aluminum metal and exposed concrete continues throughout the duration of the event based on the implicit assumption that there is an unlimited quantity of each material. Given the limited thickness/quantity of aluminum paint and limited mass of particulate concrete, the assumption of indefinite dissolution was not appropriate for these two materials.

Therefore, separate sheets were added such that dissolution of aluminum paint and particulate concrete continued only to the point at which all aluminum paint and particulate concrete was dissolved.

Other than the modifications mentioned above, no other changes to the WCAP base model spreadsheet were made in the Salem Unit 1 and 2 chemical effects analysis. Also, no plant-specific refinements were incorporated into the WCAP base model spreadsheet.

3o.1.7d(ii) *__WCAP Base Model__*: List the type (e.g., AlOOH) and amount of predicted plant-specific precipitates.

The maximum quantities of dissolved chemicals and generated precipitates in the post-LOCA sump are determined in Calculation VTD 900984 (Reference A.4) and are repeated below. These are the basis for the quantities given to the screen vendor, CCI, for the original chemical effects head loss testing. Note that the values presented in the table below are the quantities of chemicals, which dissolve in the post-LOCA sump over 30 days following a LOCA.

Table 3o-1: Maximum Dissolved Chemicals

Chemical	Salem Unit 1	Salem Unit 2
Aluminum	44.3 kg as Al	42.0 kg as Al
Silica	167.0 kg as SiO_2	123.5 kg as SiO_2
Calcium	20.7 kg as Ca	12.2 kg as Ca

In addition to the dissolved chemical quantities, the chemical effects analysis also predicts the quantity of precipitate, which will form over 30 days following a LOCA due to the dissolved chemicals. These quantities are provided in the table below and will be used in future chemical effects head loss testing.

Table 3o-2: Maximum Precipitates

Chemical	Salem Unit 1	Salem Unit 2
Sodium Aluminum Silicate, $NaAlSi_3O_8$	242.8 kg	179.6 kg
Aluminum Oxyhydroxide, AlOOH	42.9 kg	52.2 kg
Calcium Phosphate, $Ca_3(PO_4)_2$	0.0 kg	0.0 kg

3o.1.8) *WCAP Refinements*: State whether refinements to WCAP-16530-NP were utilized in the chemical effects analysis.

The Salem Unit 1 and 2 chemical effects analysis, calculation VTD 900984 (Reference A.4), did not utilize any of the refinements described in WCAP-16785-NP (Reference 25).

3o.1.9d(i) *Solubility of Phosphates, Silicates and Al Alloys*: Licensees should clearly identify any refinements (plant-specific inputs) to the base WCAP-16530 model and justify why the plant-specific refinement is valid.

The Salem Unit 1 and 2 chemical effects analysis, calculation VTD 900984 (Reference A.4), did not utilize any of the refinements described in WCAP-16785-NP (Reference 25).

3o.1.9d(ii) *Solubility of Phosphates, Silicates and Al Alloys*: For crediting inhibition of aluminum that is not submerged, licensees should provide the substantiation for the following: (1) the threshold concentration of silica or phosphate needed to passivate aluminum, (2) the time needed to reach a phosphate or silicate level in the pool that would result in aluminum passivation, and (3) the amount of containment spray time (following the achieved threshold of chemicals) before aluminum that is sprayed is assumed to be passivated.

The Salem Unit 1 and 2 chemical effects analysis, calculation VTD 900984 (Reference A.4), did not utilize any of the refinements described in WCAP-16785-NP (Reference 25). Specifically, the analysis does not model aluminum passivation.

3o.1.9d(iii) ***Solubility of Phosphates, Silicates and Al Alloys*****: For any attempts to credit solubility (including performing integrated testing), licensees should provide the technical basis that supports extrapolating solubility test data to plant-specific conditions. In addition, licensees should indicate why the overall chemical effects evaluation remains conservative when crediting solubility given that small amount of chemical precipitate can produce significant increases in head loss.**

The Salem Unit 1 and 2 chemical effects analysis, calculation VTD 900984 (Reference A.4), did not utilize any of the refinements described in WCAP-16785-NP (Reference 25). Specifically, the analysis does not credit solubility of phosphates, silicates, or aluminum alloys.

3o.1.9d(iv) ***Solubility of Phosphates, Silicates and Al Alloys*****: Licensees should list the type (e.g., AlOOH) and amount of predicted plant specific precipitates.**

The Salem Unit 1 and 2 chemical effects analysis, calculation VTD 900984 (Reference A.4), did not utilize any of the refinements described in WCAP-16785-NP (Reference 25). The type and amount of predicted plant precipitates based on WCAP-16530-NP analysis are provided in the response to Item 3o.1.7d(ii).

3o1.10d ***Precipitate Generation (Decision Point)*****:**
State whether precipitates are formed by chemical injection into a flowing test loop or whether the precipitates are formed in a separate mixing tank.

In previous testing, precipitate was formed by chemical injection. However, for future testing, precipitate generation will be performed in a separate mixing tank per Westinghouse's WCAP-16530-NP Rev. 0.

3o1.11d(i) ***Chemical Injection into the Loop*****:**
Licensees should provide the one-hour settled volume (e.g., 80 ml of 100 ml solution remained cloudy) for precipitate prepared with the same sequence as with the plant-specific, in-situ chemical injection.

The planned Salem testing will use precipitate generation outside the loop in accordance with Westinghouse WCAP 16530-NP. No chemicals will be injected into the test loop.

3o1.11d(ii) *Chemical Injection into the Loop*:
For plant-specific testing, the licensee should provide the amount of injected chemicals (e.g., aluminum), the percentage that precipitates, and the percentage that remains dissolved during testing.

The planned Salem testing will use precipitate generation outside the loop in accordance with Westinghouse WCAP 16530-NP. No chemicals will be injected into the test loop.

3o1.11d(iii) *Chemical Injection into the Loop*:
Licensees should indicate the amount of precipitate that was added to the test for the head loss of record (i.e., 100 percent 140 percent).

The planned Salem testing will use precipitate generation outside the loop in accordance with Westinghouse WCAP 16530-NP. No chemicals will be injected into the test loop. Salem plans to add 150% of the chemical precipitate to the loop.

3o1.12d(i) *Pre-Mix in Tank*:
Licensees should discuss any exceptions taken to the procedure recommended for surrogate precipitate formation in WCAP-16530.

No deviations are expected. However, any deviations will be documented in the test report.

3o1.13d(i) *Technical Approach to Debris Transport (Decision Point)*:
State whether near-field settlement is credited or not.

CCI introduces debris close to the strainer module. Therefore, CCI does not credit near-field settlement integrally in the head loss testing. Although some limited amount of debris cannot be prevented from settling directly in front of the strainer (especially if not all debris fits into the pockets), there is no CCI strategy to credit near-field settling. Additionally, settling which does occur during planned testing will be re-suspended using agitation in the test loop.

3o1.14d(i) *Integrated Head Loss Test with Near-Field Settlement Credit*:
Licensees should provide the one-hour or two-hour precipitate settlement values measured within 24 hours of head loss testing.

Not applicable

3o1.14d(ii) *Integrated Head Loss Test with Near-Field Settlement Credit*: Licensees should provide a best estimate of the amount of surrogate chemical debris that settles away from the strainer during the test.

Not applicable

3o1.15d(i) *Head Loss Testing Without Near Field Settlement Credit*: Licensees should provide an estimate of the amount of debris and precipitate that remains on the tank/flume floor at the conclusion of the test and justify why the settlement is acceptable.

The final chemical and non-chemical head loss testing has not been completed. PSEG has submitted and received an approval for an extension request by June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

3o1.15d(ii) *Head Loss Testing Without Near Field Settlement Credit*: Licensees should provide the one-hour or two-hour precipitate settlement values measured and the timing of the measurement relative to the start of head loss testing (e.g., within 24 hours).

The final chemical and non-chemical head loss testing has not been completed. PSEG has submitted and received an approval for an extension request by June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

3o1.16d(i) *Test Termination Criteria*: Provide the test termination criteria.

After the precipitate addition, testing continues until the head loss stabilizes within the range of -1% to 1% change for 60 continuous minutes.

3o1.17d(i) *Data Analysis*: Licensees should provide a copy of the pressure drop curve(s) as a function of time for the testing of record.

The final chemical and non-chemical head loss testing has not been completed. PSEG has submitted and received an approval for an extension request by June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

3o1.17d(ii) ***Data Analysis*****:**
Licensees should explain any extrapolation methods used for data analysis.

During previous testing chemical injection was made into the test loop and precipitate formed in situ. Head loss extrapolation was achieved by plotting the data points acquired during testing and extrapolating the plot line to the required 30-day time period.

During future testing, precipitates are planned to be added directly to the test loop and test length will be based on loop turnover equivalent to the 30-day containment turn over.

3o1.18d ***Integral Generation (Alion)*****:**

Salem does not utilize the Alion methodology. Therefore, this question is not applicable to Salem.

3o1.19c(i) ***Tank Scaling / Bed Formation*****:**
Explain how scaling factors for the test facilities are representative or conservative relative to plant-specific values.

The scaling factor is derived as the ratio of the plant screen surface, reduced conservatively by the sacrificial area due to stickers, etc., to the test screen surface. This scaling ratio is used for reducing the flow rate and the amounts of debris and chemical precipitates. Together with the geometric similarity, the testing is prototypical.

As described in Section 3o1.19c (ii), the test configuration for Salem is a representative slice of the whole train of modules with proper representation of the two-sided cartridges, the space in front of the module, the flow space above the module, and the space behind the module including the simulation of the containment wall. Together with the scaled flow rate and debris amounts, the debris bed formation is expected to be representative of the plant.

3o1.19c(ii) ***Tank Scaling / Bed Formation*****:**
Explain how bed formation is representative of that expected for the size of materials and debris that is formed in the plant specific evaluation.

The test configuration for Salem is a slice of the whole train of modules, with proper representation of the two-sided cartridges, the space in front of the module, the flow space above the module, and the space behind the module including the simulation of the containment wall. Together with the scaled flow rate and debris amounts, the debris bed formation is expected to be representative of the plant.

3o1.20d ***Tank Transport*****:**
Explain how the transport of chemicals and debris in the testing facility is representative or conservative with regard to the expected flow and transport in the plant-specific conditions.

The spaces before, above and behind the strainer module are representative of the plant (see Attachment 1 section 3o1.19c(ii)), and the flow rate is representative, therefore, the transport of chemicals and debris is also expected to be representative.

Additionally, debris which settles in the test flume is agitated into suspension again using one of two methods: a paddle style stick to "sweep" the debris off the floor or a water blast created from a propeller style drill bit and drill. This test loop agitation helps ensure all debris is transported.

3o1.21d(i) ***30-Day Integrated Head Loss Test*****:**
Licensees should provide the plant-specific test conditions and the basis for why these test conditions and test results provide for a conservative chemical effects evaluation.

It has been determined that the NPSH critical time point is the beginning of the recirculation phase, where the sump temperature is high, and therefore the influence of the vapor pressure makes the NPSH margin minimal. After an extended period of 30 days, temperatures are near ambient and the NPSH margin is substantially higher.

The critical time remains with the beginning of the recirculation phase, which is simulated by the test duration. The chemical precipitates are calculated for a 30 days accumulated amount and added all in the first day of the test.

In future testing, chemical precipitates will be prepared per the WCAP method using an external precipitate generator. During this upcoming testing PSEG plans to increase the chemical precipitate loading to 150% of the total amount of precipitate specified for the plant to add conservatism.

3o1.21d(ii) ***30-Day Integrated Head Loss Test*:**
Licensees should provide a copy of the pressure drop curve(s) as a function of time for the testing of record.

The Salem head loss chemical testing has not been completed. PSEG has submitted and received an NRC approval for an extension request for completion until June 30, 2008 (Reference A.27). The pressure curve will be determined during upcoming chemical effect testing. The testing will be done based on a 30-day equivalent loop versus containment turnover.

3o1.22d(i) ***Data Analysis Bump Up Factor*:**
Licensees should provide the details and the technical basis that show why the bump-up factor from the particular debris bed in the test is appropriate for application to other debris beds.

CCI does not use bump-up factors to determine head losses.

3p. Licensing Basis
The objective of the licensing basis section is to provide information regarding any changes to the plant licensing basis due to the sump evaluation or plant modifications.
Provide the information requested in GL 04-02 Requested Information Item 2.(e) regarding changes to the plant licensing basis. The effective date for changes to the licensing basis should be specified. This date should correspond to that specified in the 10 CFR 50.59 evaluation for the change to the licensing basis.
GL 2004-02 Requested Information Item 2(e)
A general description of planned schedule for any changes to the plant licensing bases resulting from any analysis or plant modifications made to ensure compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. Any licensing actions or exemption requests needed to support changes to the plant licensing basis should be included.

PSEG submitted a Licensing Basis Change on August 15, 2007 to revise the licensing basis for the Net Positive Suction Head available (NPSHa) methodology for the ECCS and CS System pumps as described in the Appendix 3A of the Salem Updated Final Safety Evaluation Report (UFSAR). The NRC approved the request on November 15, 2007 (Reference A.8).

The design basis information documented in the UFSAR is planned for revision in two phases. The first update, which has already been completed, was required to support the physical changes made to the plants. It addressed the installation of new sump enclosure, strainer modules, and the new level switches. The water elevation was revised for cold leg recirculation to maximize the height of the strainer, and to ensure complete submergence at the time of switchover. Since the new level instruments have a smaller uncertainty than the sump level transmitters, the existing setpoint is maintained. This required changes to Sections 6.2.2 "Containment Heat Removal Systems" and 6.3.2 "System Design"

The final head loss testing including chemicals at the vendor facility has not been completed. PSEG has submitted and received an NRC approval for an extension request for completion and evaluation of the final chemical head loss tests performed by CCI by June 30, 2008 (Reference A.27).

Upon completion of the chemical testing, the UFSAR will be updated again to describe the remaining information associated with the chemical testing and the associated evaluations. After the head loss values are determined from the chemical testing, the NPSHa values will be updated in the UFSAR.

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GL 2004-02 RAI Response

On February 9, 2006, the Commission issued a Request for Additional Information (RAI) to the Salem site to be answered within 60 days (Reference A.70).

On January 4, 2007, the Commission issued a letter stating that it would allow licensees to include the RAI response in the final GL response for closure of all of the GSI-191 issues no later than December 31, 2007 (Reference 33).

On November 30, 2007 the Commission issued a letter extending the submission of GL response for closure of all of the GSI-191 issues no later than February 29, 2007 (Reference 34).

Following are the responses to the RAIs issued PSEG for Salem Units

1. (Not applicable).

2 Identify the amounts (i.e., surface area) of the following materials that are:
(a) submerged in the containment pool following a loss-of-coolant accident (LOCA),
(b) in the containment spray zone following a LOCA:
- aluminum, - zinc (from galvanized steel and from inorganic zinc coatings)
- copper, carbon steel not coated, uncoated concrete
Compare the amounts of these materials in the submerged and spray zones at your plant relative to the scaled amounts of these materials used in the Nuclear Regulatory Commission (NRC) nuclear industry jointly-sponsored Integrated Chemical Effects Tests (ICET) (e.g., 5x the amount of uncoated carbon steel assumed for the ICETs).

The surface area of submerged and sprayed aluminum (both paint and metal) as well as the surface area of submerged and sprayed exposed concrete is provided below. In addition, the quantity of particulate concrete (i.e. latent particulate debris) is included.

	Submerged Quantity	Sprayed Quantity
Aluminum Metal	9.5 ft^2	489.2 ft^2
Aluminum Paint	500 ft^2	4500 ft^2
Exposed Concrete	983 ft^2	2609 ft^2
Particulate Concrete	170 lbm	0 lbm

Zinc, copper, and uncoated carbon steel are not addressed in the Salem Generating Station chemical effects analysis (Reference A.4) since they would not significantly contribute to precipitate formation in the post-LOCA environment, consistent with WCAP-16530-NP (Reference 24).

The dissolution tests documented in WCAP-16530-NP demonstrated that very little zinc and iron dissolved when exposed to conditions similar to those, which could be expected in a post-LOCA containment. Investigations with copper were not performed by Westinghouse since copper has a very similar corrosion resistance to uncoated carbon steel and galvanized steel per Section 5.1.2 of WCAP-16530-NP (Reference 24).

Calculation VTD 900984 (Reference A.4) contains a comparison of the amount of material submerged versus sprayed (non-submerged) at Salem Generating Station to that used in ICET #1, which is the ICET most representative of Salem Generating Station. This comparison is included in the table below.

Material	ICET #1		Salem		Ratio of Salem to ICET #1	
	Submerged	Sprayed	Submerged	Sprayed	Submerged	Sprayed
Aluminum Metal	5%	95%	1.9%	98.1%	0.38	1.03
Aluminum Paint	N/A	N/A	10.0%	90.0%	N/A	N/A
Exposed Concrete	34%	64%	27.4%	72.6%	0.81	1.13
Particulate Concrete	100%	0%	100%	0%	1.0	1.0

3 **Identify the amount (surface area) and material (e.g., aluminum) for any scaffolding stored in containment. Indicate the amount, if any that would be submerged in the containment pool following a LOCA. Clarify if scaffolding material was included in the response to Question 2.**

There is no aluminum scaffolding permanently stored inside Containment.

The scaffold inside the Containment is made of steel material. All the permanent scaffolding stored inside the Salem Unit 1 and 2 Containment is specified on Drawing 605772 (Reference A.38). The drawing has a note that states "The aluminum planks may be stored only during outages and shall be removed prior to containment closures".

4 **Provide the type and amount of any metallic paints or non-stainless steel insulation jacketing (not included in the response to Question 2) that would be either submerged or subjected to containment spray.**

There is no non-stainless steel insulation jacketing in the Salem Unit 1 and 2 containments. The quantity of metallic paint in the Salem Unit 1 and 2 containments is provided in the response to RAI #2.

5 **Provide the expected containment pool pH during the emergency core cooling system (ECCS) recirculation mission time following a LOCA at the beginning of the fuel cycle and at the end of the fuel cycle. Identify any key assumptions.**

The sump water pH following the ECCS recirculation phase is as follows during the mission time (up to 30 days):

The containment sump pH is much higher at end of cycle (Reference A.58) than the 8.4 value documented in Calculation S-C-SJ-MDC-2092, Rev. 0 for the beginning of Fuel Cycle

Key Assumptions/Inputs are as shown below (S-C-SJ-MDC-2092, Rev. 0, Methodology and Assumptions Sections). These predict lower sump water pH.

A. No credit for CsOH production from the fission product is taken.
B. Hydrogen ion (H^+) production from radiolysis of water and cable is included in the analysis. Beta shielding factor of 10 was assumed.
C. Aerosol source term fraction in sump water is assumed to be 0.8.

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6 **For the ICET environment that is the most similar to your plant conditions, compare the expected containment pool conditions to the ICET conditions for the following items: boron concentration, buffering agent concentration, and pH. Identify any other significant differences between the ICET environment and the expected plant-specific environment.**

A comparison of the ICET number 1 conditions to the conditions expected in the post-LOCA Salem Unit 1 and 2 sump pool is provided in calculation VTD 900984 (Reference A.4) and is repeated below. The Salem parameters presented result in the maximum mass of precipitate.

Parameter	Test #1 Data Report	Salem Unit 1 and 2	Units
Duration of Test	30	30	Days
Temperature	140	111 to 265	°F
Boron Concentration	2800	2440	mg/L
Spray Duration	4	720	hours
Maximum spray pH	12	10	
Target solution pH	10	8.4	
Buffer	NaOH	NaOH	
Buffer Concentration	As needed	30	Wt%
NaOH Injection with spray	30	48	minutes
pH Range at 25°C	9.4 to 10.0	8.4	

7 **For a large-break LOCA (LBLOCA), provide the time until ECCS external recirculation initiation and the associated pool temperature and pool volume. Provide estimated pool temperature and pool volume 24 hours after a LBLOCA. Identify the assumptions used for these estimates.**

The LBLOCA (pump suction line double-ended break with minimum safeguards (failure of a complete train) data are shown below:

The ECCS recirculation initiation time:

- Salem Unit 1 1,748 seconds (WCAP-16503-NP, Rev. 3, Table 6.3-1)
- Salem Unit 2 1,748 seconds (WCAP-16503-NP, Rev. 3, Table 6.3-2)
- Salem Unit 2 (RSG) 1,748 seconds (WCAP-16503-NP, Rev. 3, Table A.6.3-2)

Sump temperature:

- Salem Unit 1 249°F @ 1,748 seconds (WCAP-16503-NP, Rev. 3, Table 6.3-4)
- Salem Unit 2 252°F @ 1,748 seconds (WCAP-16503-NP, Rev. 3, Table 6.3-6)
- Salem Unit 2 (RSG) 258°F @ 1,748 seconds (WCAP-16503-NP, Rev. 3, Table A6.3-6)

- Salem Unit 1 136°F @ 24 hours (WCAP-16503-NP, Rev. 3, Table 6.3-4)
- Salem Unit 2 136°F @ 24 hours (WCAP-16503-NP, Rev. 3, Table 6.3-6)
- Salem Unit 2 (RSG) 156°F @ 24 hours (WCAP-16503-NP, Rev. 3, Table A6.3-6)

Sump Volume after recirculation (i.e., after 1,748 seconds):

- Salem Unit 1 and 2 456,000 gal (basis provided below)
- Salem Unit 2 (RSG) 459,000 gal (basis provided below)

Note: RSG = Replacement Steam Generator.

During the Salem Unit 2 refueling outage in Spring 2008 the SG will be replaced. The values shown above with (RSG) are for Salem Unit 2 after the steam generator replacement.

The above data are based on the following assumptions:

a) Loss of one ECCS train is assumed.
b) The cooling water temperature for the duration of accident remains at the maximum value, 93°F.
c) Recirculation sprays are not used.
d) Containment fan coolers are used.
e) One RHR and one CCW heat exchanger are used.
f) The total sump volume after the initiation of the recirculation phase is estimated based on minimum usable volumes in accumulators (6,200 gallons per accumulator per UFSAR Table 6.3-2), minimum usable volume in RWST (364,500 gallons per UFSAR Table 6.3-4), nominal volume in Boron Injection Tank (900 gallons per UFSAR Table 6.3-3), and RCS liquid volume (11,892 ft^3 per page 8 of S-C-A900-MDC-0082, Rev. 4A) reduced by water retained in

vessel and piping (3,036 ft^3 per page 8 of S-C-A900-MDC-0082, Rev. 4A). It should be noted that the Boron Injection Tank is not utilized for storing boron and is assumed to be filled with water acting just like a pipe. The replacement steam generator volume is 3,000 gallons more than the existing Salem Unit 2 steam generator volume, thus, Salem Unit 2 with RSG sump volume is 3,000 gallons more than Salem Unit 2 with existing steam generators. This estimate neglects less significant terms such as steam in the containment atmosphere, water film on heat sinks, etc.

g) RWST water temperature is 100°F.

8 **Discuss your overall strategy to evaluate potential chemical effects including demonstrating that, with chemical effects considered, there is sufficient net positive suction head (NPSH) margin available during the ECCS mission time. Provide an estimated date with milestones for the completion of all chemical effects evaluations.**

Salem has performed a detailed analysis in accordance with WCAP 16530-NP as discussed in detail in Attachment 1 Section 3o of this response.

Salem has previously performed some chemical testing in the MFTL at the vendor facility. These tests showed that the head loss was within the acceptable limits. These tests are being repeated to use a more prototypical test configuration and to resolve some concerns from the NRC regarding testing methodology. This configuration is designed to provide a highly representative post-accident sump environment and sump strainer challenge for Salem Unit 1 and 2.

Salem Unit 1 and 2 testing will be performed at the vendor facility (CCI) in a MFTL using Salem representative precipitates postulated strainer debris loading, and chemicals. The testing is not completed. PSEG has submitted and received an approval for an extension request until June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

9 **Identify, if applicable, any plans to remove certain materials from the containment building and/or to make a change from the existing chemicals that buffer containment pool pH following a LOCA.**

At Salem Unit 1 and 2, the calcium silicate insulation has been removed from the zone of influence. Also, Min-K insulation was replaced with Transco RMI wherever possible. Based on the analyses performed, PSEG does not plan to change the existing sodium hydroxide buffer solution.

10 **If bench-top testing is being used to inform plant-specific head loss testing, indicate how the bench-top test parameters (e.g., buffering agent concentrations, pH, materials, etc.) compare to your plant conditions. Describe your plans for addressing uncertainties related to head loss from chemical effects including, but not limited to, use of chemical surrogates, scaling of sample size and test durations. Discuss how it will be determined that allowances made for chemical effects are conservative.**

In previous testing, CCI used bench-top test results to identify the quantity and quality of chemical precipitate generated during actual testing. The future tests will use the full WCAP 16530-NP methodology for external loop precipitate generation. Bench-top testing is not necessary during this testing other than to establish the precipitate settling rate.

11 **Provide a detailed description of any testing that has been or will be performed as part of a plant-specific chemical effects assessment. Identify the vendor, if applicable, that will be performing the testing. Identify the environment (e.g., borated water at pH 9, deionized water, tap water) and test temperature for any plant-specific head loss or transport tests. Discuss how any differences between these test environments and your plant containment pool conditions could affect the behavior of chemical surrogates. Discuss the criteria that will be used to demonstrate that chemical surrogates produced for testing (e.g., head loss, flume) behave in a similar manner physically and chemically as in the ICET environment and plant containment pool environment.**

<u>Previous Testing:</u>
In December 2006, CCI performed its first chemical effects assessment of Salem's replacement ECCS strainers. CCI tested three different debris loads during the tests: Case 1a, Case 1b, and Case 2.

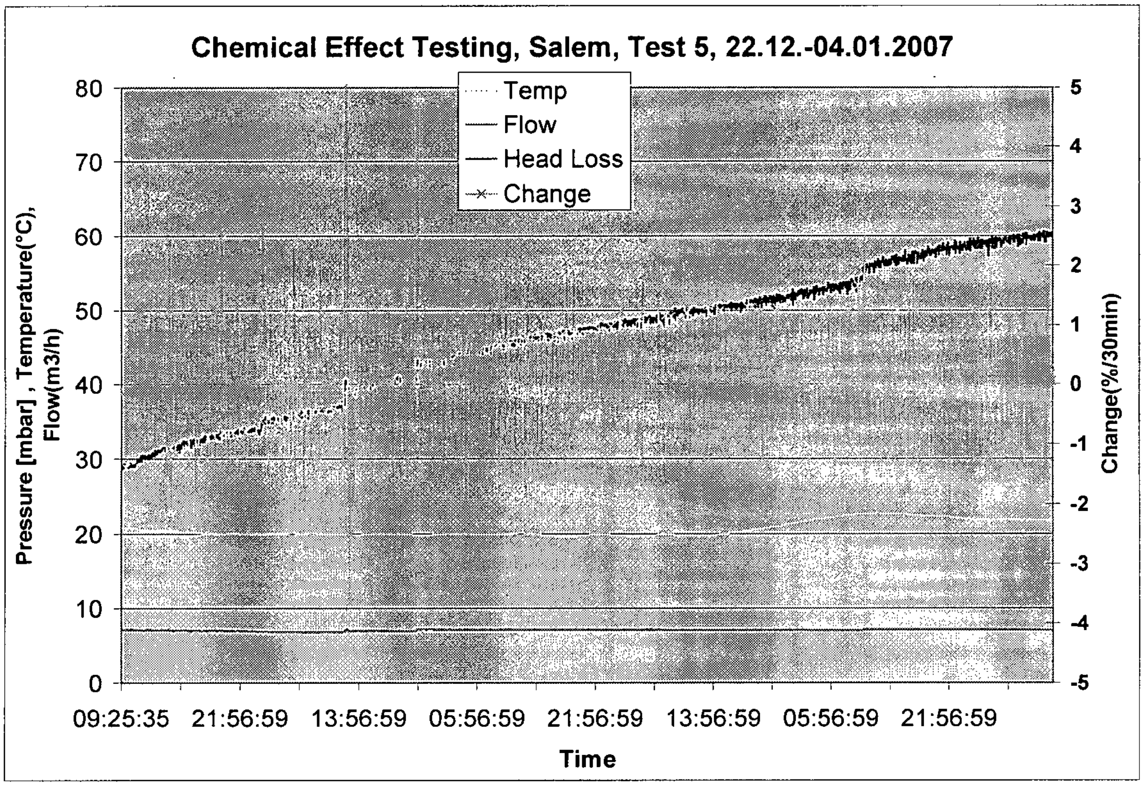
Case 1a was for Salem Unit 1 with NUKON on SG s. Case 1b was for Salem Unit 1 with the NUKON on SG replaced with RMI. Case 2 was for Salem Unit 2. First, chemical bench tests were performed to identify the quantity and quality, including particle size, filterability and settling rates of the precipitate, which would be generated in the actual tests. Chemical assays of the injected chemicals were also performed.

The head loss tests were performed by first filling the MFTL with tap water and borating the loop water. The pH was then checked to be in the 4.5 to 5.5 range and then the debris bed was built. The chemical constituents were then added to generate precipitates in steps of 40%, +30%, +30%, +20%, +20% resulting in ~140% of the total amount of chemical precipitates present in the loop. The loop pH and water temperature are measured throughout the chemical addition process. The pH was maintained at or below 8.4 for 100% or more chemicals. A grab sample was then taken to measure for suspended solids as well as dissolved boron, aluminium, calcium and silica. The extremes for observed water temperature during all testing were: low (12 °C) and high (24°C).

The scaling factors for these tests were 162.5 and 155.1 for Salem Unit 1 and 2 respectively. The flow rates for the tests were scaled from 9000 gpm (two trains) and 5110 gpm (one train) for both Salem Unit 1 and Salem Unit 2.

Test 5 in particular was based on the Case 2 debris load. The test ran for 2 days at 9000 gpm equivalent and demonstrated a peak of 78 mbar. Starting on the 3rd day, the flow was adjusted to the 5110 gpm equivalent and head loss was measured at 28.3 mbar. The loop was left running for the next 13 days and it demonstrated a continuous increase in head loss. The stabilization criterion of 2 periods with 1% per 30 min was fulfilled after planned test duration; however, the head loss rose up and doubled in value over the extended time period. Additionally, the head loss value of 28.3 mbar after reducing the flow rate (to 5110 gpm equivalent) is greater than would be expected if the debris had accumulated at 5110 gpm since the debris accumulation was made with higher flow rate.

The results are plotted here:



Planned Testing:

In head loss testing planned to be performed during March 2008, the tests will be performed using the precipitate generation process described in WCAP 16530-NP and subsequent enclosures, and the associated NRC SER. Precipitates will be formed in an external precipitate generator and their settling rates will be evaluated prior to addition into the test loop. The testing will review head loss in both thin-bed and full load debris scenarios as well as chemical effects on head loss.

For the planned testing, the scaling factors will be 73 and 69.7 for Salem Unit 1 and 2 respectively. The flow rates are the same as previously conducted tests: scaled from 9,000 and 5,110 gpm for Salem Unit 1 and scaled from 9,000 gpm and 4,980 gpm for Salem Unit 2.

For the tests, both the coatings and latent debris particulate is planned to be modelled using stone flour (see Section 3h.4). Additionally, generic fiberglass fines (individual glass fibers which transport to the strainer surface) were modelled as NUKON fines. During the testing any debris, which does settle on the loop floor away from the strainer will be re-suspended via agitation.

12 For your plant-specific environment, provide the maximum projected head loss resulting from chemical effects (a) within the first day following a LOCA, and (b) during the entire ECCS recirculation mission time. If the response to this question will be based on testing that is either planned or in progress, provide an estimated date for providing this information to the NRC.

The response to the question will be completed after the testing is completed at the vendor facility. PSEG has submitted and received an approval for an extension request until June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

13 Results from the ICET #1 environment and the ICET #5 environment showed chemical products appeared to form as the test solution cooled from the constant 140 oF test temperature. Discuss how these results are being considered in your evaluation of chemical effects and downstream effects.

CCI will use the method described in the Westinghouse WCAP 16530-NP to generate chemical precipitates and provide head loss results for the plant.

However, CCI uses the results of viscosity measurements of the ICET tests to assess the influence of the chemicals onto the viscosity of pure water. The difference between viscosity of the ICET #1 solution and pure water is accounted for in the strainer head loss. In-vessel downstream effects are addressed using WCAP 16793-NP (Reference 28).

14 to 24 Not Applicable

25 **Describe how your coatings assessment was used to identify degraded qualified/acceptable coatings and determine the amount of debris that will result from these coatings. This should include how the assessment technique(s) demonstrates that qualified/acceptable coatings remain in compliance with plant licensing requirements for design basis accident (DBA) performance. If current examination techniques cannot demonstrate the coatings' ability to meet plant licensing requirements for DBA performance, licensees should describe an augmented testing and inspection program that provides assurance that the qualified/acceptable coatings continue to meet DBA performance requirements. Alternately, assume all containment coatings fail and describe the potential for this debris to transport to the sump.**

PSEG conducted walkdowns for evaluating debris sources inside the Salem Unit 1 and 2 containments during 2004 and 2005 as part of the resolution of GL 2004-02 (References 19 and 20). The walkdowns provided visual observation of the general condition of the qualified coatings applied to equipment, piping, and structures, and confirmed that the coating locations were in accordance with the design documents.

In addition, during each refueling outage engineering personnel walk through accessible areas of the containment, to observe the conditions of protective coatings installed on concrete and steel substrates. Degraded coatings are initially documented via the Notification process. Notifications are reviewed by engineering and plant branch managers and recommended for the proper level of attention. Work orders are generated from the notifications and prioritized by Station management. The person observing the coating conditions categorizes in the notification text whether the observed degraded condition should be immediately repaired in the current refueling outage, or tracked for future repairs or visual monitoring. Delaminating coatings are typically repaired by removing the delamination, and scraping back to a sound coating.

As part of the newly installed containment sump strainers, PSEG has issued a new coating condition monitoring program (Reference A.66). It provides guidance for the engineering department to conduct assessments of the conditions of the containment coatings during refueling outages. It incorporates the practices of ASTM D5163 (Reference A.39) and includes the adhesion test procedure outlined in EPRI Report 1014883 Section 4 (Reference A.61). It is supplemented with examination techniques to provide assurance that the coatings continue to meet DBA performance requirements.

The calculations for the sizing of the recently installed sump strainers incorporated the assumptions that all non-qualified coatings in containment failed and were transported to the strainers.

26 to 29 Not applicable

30 The NRC staff's safety evaluation (SE) on the NEI guidance report, NEI 04-07 addresses two distinct scenarios for formation of a fiber bed on the sump screen surface. For a thin bed case, the SE states that all coatings debris should be treated as particulate and assumes 100% transport to the sump screen. For the case in which no thin bed is formed, the staff's SE states that the coatings debris should be sized based on plant-specific analyses for debris generated from within the zone of influence (ZOI) and from outside the ZOI, or that a default chip size equivalent to the area of the sump screen openings should be used (Section 3.4.3.6). Describe how your coatings debris characteristics are modeled to account for your plant-specific fiber bed (i.e. thin bed or no thin bed). If your analysis considers both a thin bed and a non-thin bed case, discuss the coatings debris characteristics assumed for each case. If your analysis deviates from the coatings debris characteristics described in the staff-approved methodology, provide justification to support your assumptions.

Both the previously performed testing as well as upcoming tests includes head loss verification for both thin bed and full debris load cases. In both cases CCI has selected a conservative approach and modelled coating debris as particulate (reference response 3h.4). As previously described, smaller particulate has a greater impact on S_v so coating chips can be conservatively modelled using the stone flour described in section 3h.4. While the stone flour does have a higher density than coating debris, the stone flour remains acceptable because the test loop is agitated and particulate, which has settled, is put back into suspension. Additionally, Salem has adequate amounts of fiber to prevent chips from blocking significant amounts of holes. The Salem Unit 2 full fiber load results in approximately 0.5 inch uncompressed fiber debris bed and the Salem Unit 1 full fiber load results in an uncompressed fiber bed well over 1 inch.
Also, PSEG has not performed testing with paint chips, however, it is CCI's experience through numerous tests for different clients that head loss tests with stone flour in lieu of paint chips create higher head losses and as such is more conservative (Reference 67).

31 **Your submittal did not provide details regarding the characterization of latent debris found in your containment as outlined in the NRC SE. Please provide these details.**

The latent debris present at Salem Generating Station is discussed in detail in Attachment 1 Section 3d.

32 **How will your containment cleanliness and foreign material exclusion (FME) programs assure that latent debris in containment will be controlled and monitored to be maintained below the amounts and characterization assumed in the ECCS strainer design? In particular, what is planned for areas/components that are normally inaccessible or not normally cleaned (containment crane rails, cable trays, main steam/feedwater piping, tops of steam generators, etc.)?**

At the end of an outage, a formal containment closeout procedure S1(2).OP-PT.CAN-0001 (Q) (Reference A.34) is performed. The closeout is performed to ensure that loose materials are removed. The procedure specifically requires checking for foreign material such as tape, equipment labels, construction and maintenance debris (example rags, plastic bags, packaging, sawdust, etc.), temporary equipment (example scaffolding, ladders, insulation material, etc). Also, the walkdown requires checking for dirt, dust, lint, paint chip buildup, and loose paint/coatings on surfaces such as walls or floors in containment.

As part of containment closeout, each ECCS train containment sump and sump screens are inspected utilizing procedure S1(2).OP-ST.SJ-0011(Q) (Reference A.35) for damage and debris. Also, refueling canal drains are verified to be unobstructed and that there is no potential debris sources in the refueling canal area that could obstruct the drains.

In support of the Generic Letter 2004-02 evaluation, a Salem Unit 2 containment walkdown was performed to determine the amount of latent debris. The results showed that the amount to be 33 lbm (Reference A.15). For conservatism, 200 lbm latent debris was used for Salem Unit 1 and 2 Debris Generation Calculation and head loss testing.

Based on the information that there is a substantial margin between the assumed and as found latent debris and programmatic controls, PSEG does not plan to perform future walkdowns to determine the amount of latent debris.

33 Will latent debris sampling become an ongoing program?

See response to RAI question 32

34 You indicated that you would be evaluating downstream effects in accordance with WCAP 16406-P. The NRC is currently involved in discussions with the Westinghouse Owner's Group (WOG) to address questions/concerns regarding this WCAP on a generic basis, and some of these discussions may resolve issues related to your particular station. The following issues have the potential for generic resolution; however, if a generic resolution cannot be obtained, plant-specific resolution will be required. As such, formal RAIs will not be issued on these topics at this time, but may be needed in the future. It is expected that your final evaluation response will specifically address those portions of the WCAP used, their applicability, and exceptions taken to the WCAP. For your information, topics under ongoing discussion include:

a) Wear rates of pump-wetted materials and the effect of wear on component operation
b) Settling of debris in low flow areas downstream of the strainer or credit for filtering leading to a change in fluid composition
c) Volume of debris injected into the reactor vessel and core region
d) Debris types and properties
e) Contribution of in-vessel velocity profile to the formation of a debris bed or clog
f) Fluid and metal component temperature impact
g) Gravitational and temperature gradients
h) Debris and boron precipitation effects
i) ECCS injection paths
j) Core bypass design features
k) Radiation and chemical considerations
l) Debris adhesion to solid surfaces
m) Thermodynamic properties of coolant

Since there is no specific NRC question here, no response is provided.

35 **Your response to GL 2004-02 question (d) (viii) indicated that an active strainer design will not be used, but does not mention any consideration of any other active approaches (i.e., backflushing). Was an active approach considered as a potential strategy or backup for addressing any issues?**

PSEG did not utilize an active strainer approach to resolve the Generic Letter 2004-02 concerns. PSEG has not utilized the active strainer or back flushing approach in the resolution strategy.

36 **The NRC staff's SE discusses a systematic approach" to the break selection process where an initial break location is selected at a convenient location (such as the terminal end of the piping) and break locations would be evaluated at 5-feet intervals in order to evaluate all break locations. For each break location, all phases of the accident scenario are evaluated. It is not clear that you have applied such an approach. Please discuss the limiting break locations evaluated and how they were selected.**

While the SE discusses a "systematic approach" of investigating breaks at 5-feet increments, it also states that the "concept of equal increments is only a reminder to be systematic and thorough." For this calculation PSEG has selected breaks near large insulation targets, i.e. major equipment and walls, and have placed the breaks on the largest pipes in order to maximize the ZOI. Further discussion is provided in Attachment 1 section 3a of this response.

37 **You stated that SE values for destruction pressure and ZOI were applied for each debris type in their evaluations, except for Kaowool and Transco fiber. For Kaowool and Transco fiber, ZOI values were acquired from Table 4-1 of the Nuclear Energy Institute guidance report and a ZOI equivalent to that of unjacketed NUKON (17 D) was applied. Please discuss the evaluations that were performed to justify that the applied value is applicable for the Salem-specific insulation type.**

NUKON and Kaowool insulation are similar material types, with similar installations and have similar densities and it is therefore considered reasonable that they would have similar ZOIs.

However, due to the relatively large ZOI and postulated break diameters, the debris generation calculation conservatively considers damage to all Kaowool in the area of containment where the break occurs. This is discussed in greater detail in Attachment 1 Section 3b of this response. Transco fiber is not part of the Salem Unit 1 and 2 debris load.

38 **You stated that fibrous debris was characterized into four debris size categories based on the interpretation of the Boiling Water Reactor Owner's Group (BWROG) Air-Jet Impact Testing (AJIT) data. Please discuss the technical evaluations performed to conclude that this data is applicable for the Salem specific insulation types.**

For unjacketed NUKON and Kaowool fibrous debris generated from a 17D ZOI, the 4 category size distribution is no longer utilized, instead the SE recommended debris size distribution be used. For jacketed NUKON debris generated by an 8D ZOI, the AJIT data is used because the insulation/jacketing combination tested by the AJIT evaluation is representative of the jacketed NUKON present at Salem. A 4 size category size distribution is not used with an 8D ZOI. Further discussion of debris size distributions is contained in Attachment 1 section 3c of this response.

39 **Has debris settling upstream of the sump strainer (i.e., the near-field effect) been credited or will it be credited in testing used to support the sizing or analytical design basis of the proposed replacement strainers? In the case that settling was credited for either of these purposes, estimate the fraction of debris that settled and describe the analyses that were performed to correlate the scaled flow conditions and any surrogate debris in the test flume with the actual flow conditions and debris types in the plant's containment pool.**

CCI introduces debris close to the strainer module. Additionally, debris, which does settle on the test loop floor, is re-suspended via loop agitation. Therefore, CCI does not credit near-field settlement integrally in the head loss testing. Although some limited amounts of debris cannot be prevented from settling directly in front of the strainer (especially in cases where more debris than strainer pocket volume exists) there is no CCI strategy to credit near-field settling.

40 Are there any vents or other penetrations through the strainer control surface, which connect the volume internal to the strainer to the containment atmosphere above the containment minimum water level? In this case, dependent upon the containment pool height and strainer and sump geometries, the presence of the vent line or penetration could prevent a water seal over the entire strainer surface from ever forming; or else this seal could be lost once the head loss across the debris bed exceeds a certain criterion, such as the submergence depth of the vent line or penetration. According to Appendix A to Regulatory Guide 1.82, Revision 3, without a water seal across the entire strainer surface, the strainer should not be considered to be "fully submerged." Therefore, if applicable, explain what sump strainer failure criteria are being applied for the "vented sump" scenario described above.

See response to Attachment 1 section 3f.11.

41 What is the basis for concluding that the refueling cavity drain(s) would not become blocked with debris? What are the potential types and characteristics of debris that could reach these drains? In particular, could large pieces of debris be blown into the upper containment by pipe breaks occurring in the lower containment, and subsequently drop into the cavity? In the case that large pieces of debris could reach the cavity, are trash racks or interceptors present to prevent drain blockage? In the case that partial/total blockage of the drains might occur, do water hold-up calculations used in the computation of NPSH margin account for the lost or held-up water resulting from debris blockage?

Each Salem Unit has a 6 inch drain line from the lower refueling cavity. During normal operation the refueling canal drain flanges on the bottom of these drain lines are unbolted and swung out of position. These lines drain directly to the containment floor. Blockage of these drain lines would create a holdup volume, however, this blockage is not considered credible based on the following:

- Pipe breaks that result in sump recirculation are located either under the operating floor or within the pressurizer enclosure.
- No additional debris is generated due to exposure to containment spray.
- Any debris that would make it to the refueling cavity would have to be blown up by the break effluence through either grating or through narrow openings around the steam generators.
- Large pieces (4 inch and larger) do not easily pass through gratings. In addition, large pieces that enter the upper containment through openings

around the SG would have to be blown over the 10' high shield wall around the steam generators.

Therefore, large insulation debris pieces are not expected to end up in the refueling canal. As small debris pieces (such as small insulation pieces, latent debris, foreign materials, etc.) are not likely to be capable of blocking a 6 inch drain line, blockage of the 6 inch refueling canal drain line in the lower refueling cavity is not expected.

Further examination showed that for the purposes of minimum containment flood level, it is more conservative and realistic to assume the reactor cavity is a holdup volume rather than the refueling cavity. For Salem Unit 1 and 2, the refueling cavity volume is approximately 6,550 ft^3 (Reference A.10).
The reactor cavity volume is approximately 10,400 ft^3 (Reference A.10). The refueling cavity is only filled by containment spray (no LOCA fills the refueling cavity). The reactor cavity can be filled directly by a break at the reactor vessel nozzle, or by overflow from the containment sump volume once the water level in the containment reaches the 81 feet 9 inch level (which is above the minimum water level required for recirculation operation of 80 feet 10 inch).

If there is a break in the RCS piping at the steam generators, in order to block the refuel cavity drain, a piece of debris would have to be blown up between the SG and the enclosure wall and land on the refueling cavity drain on the 130 feet elevation. With the drain blocked, any of the containment spray discharge falling into the refueling cavity would be lost to the recirculation pool inventory. However, this break will not result in immediate filling of the reactor cavity. Conversely, the break at the reactor nozzle that leads to direct filling of the reactor cavity will not generate the debris that could block the refueling cavity drain.

Therefore, at Salem Unit 1 and 2, concurrent use of both of these hold up volumes for determining minimum flood level for switchover to recirculation operation is not credible. Since the reactor pit has the largest volume, then it is considered the limiting case for ECCS inventory hold up for both Salem Units at Salem Generating Station.

42 What is the minimum strainer submergence during the postulated LOCA? At the time that the re-circulation starts, most of the strainer surface is expected to be clean, and the strainer surface close to the pump suction line may experience higher fluid flow than the rest of the strainer. Has any analysis been done to evaluate the possibility of vortex formation close to the pump suction line and possible air ingestion into the ECCS pumps? In addition, has any analysis or test been performed to evaluate the possible accumulation of buoyant debris on top of the strainer, which may cause the formation of an air flow path directly through the strainer surface and reduce the effectiveness of the strainer?

In accordance with PSEG TODI 80080788-06 (Reference A.6) Minimum Water Submergence, the minimum expected water submergence after a LOCA is 3 inches.

The proof that no vortices occur for clean strainers, including the effects of non-uniformity of flow rates into individual modules along the train of modules, is provided in the CCI vortexing report 3SA-096.071 which is documented in PSEG VTD 901380 (Reference A.72). For more details see Attachment 1 section 3f.3. The tests that are the basis for this proof, have shown that buoyant debris disrupts air vortices and does not enhance them.

43 The September 2005 GL response indicated that your debris transport analysis included modeling of fibrous debris erosion. Please explain how you modeled erosion of debris.

Erosion of fibrous debris is described in Attachment 1 section 3e.1and 3e.2 of this response.

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Draft Audit Open Items

During the week of October 1, 2007 the NRC conducted a detailed audit of the Salem Unit 1 and 2 new containment sump design and its associated analyses, testing, modifications and evaluations. The draft audit open items are documented in Reference A.71. Following are the responses to the draft audit open items.

1. Aluminum Paint
The licensee's chemical effects analysis does not address the presence of large amounts of aluminum paint on the Salem Unit 2 steam generators. The licensee should address this material in its evaluations and/or testing.

The initial Salem chemical effects evaluation TODI 80080788-007 (Reference A.44) did not account for aluminum (Al) paint on the existing Salem Unit 2 steam generators, as they are scheduled for replacement during the Spring 2008 outage. The new SGs have no aluminum paint. However, this evaluation (Reference A.44) was revised to consider the aluminum in paint on the existing SG for a period of time until they are replaced. The evaluation concludes that the aluminum paint on the existing Salem Unit 2 SG is acceptable until their replacement during the 2R16 (spring 2008) refueling outage.

2. Chemical Effects Resolution
Because plant-specific chemical effects evaluations were in progress at the time of the onsite audit, chemical effects resolution in general was designated as an open item. The licensee needs to complete plant-specific chemical effects evaluations and integrated head loss tests.

The final chemical and non-chemical head loss testing has not been completed. PSEG has submitted and received an approval for an extension request until June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

3. **Downstream Effects for Components and Systems Incomplete**
The downstream effects analysis for components and systems was in progress but incomplete. Examples of specific items which were incomplete were evaluation of the charging pump start/stop operations and charging system evaluation, validation of safety injection pump and charging pump mission times, and general validation of critical inputs to the downstream effects analyses. The licensee needs to complete the analysis for downstream effects for components and systems.

The downstream effects and in-vessel evaluations have not been completed. PSEG has submitted and received an approval for an extension request for this item until June 30, 2008 (Reference A.27). Upon completion of the evaluations, the information will be submitted to the NRC.

4. **Downstream Effects for Fuel and Vessel**
The licensee analysis of downstream effects for the fuel and vessel was in draft and will be re-evaluated in accordance with WCAP 16793 "Evaluation of Long-term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid, Revision 0." The licensee needs to complete the analysis for downstream effects for the fuel and vessel.

The downstream effects and in-vessel evaluations have not been completed. PSEG has submitted and received an approval for an extension request for this item until June 30, 2008 (Reference A.27). Upon completion of the evaluations, the information will be submitted to NRC.

5. **Use of an 8 Pipe Diameter (8D) Zone of Influence (ZOI) for Steel Jacketed NUKON**
The licensee used an 8D ZOI for steel jacketed NUKON fibrous insulation based on a Westinghouse (WCAP) test report which the licensee did not possess and therefore was unavailable for audit team review. The licensee needs to provide the NRC an opportunity to review this test report.

The design at Salem Unit 2 utilized WCAP 16710-P "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON® Insulation for Wolf Creek and Callaway Nuclear Operating Plants" thus reducing the ZOI to 8D instead of 17D.

6 Preparation of Fibrous Debris for Head Loss Tests Not Prototypical
In the head loss tests conducted by the licensee before the onsite audit week, the fibrous debris was prepared in such a significantly coarse manner that a major fraction of it settled in front of the test strainers and loaded the strainer test pockets in a gravitationally-skewed manner. However, licensee documentation showed that the fibrous debris accumulating on the sump strainer would consist mainly of readily transported suspended and generally independent fibers. Therefore, the preparation of fibrous debris for the head loss tests was not prototypical and, as a result, tended to preclude the formation of a fibrous debris "thin bed" in the test strainers. The licensee's conclusion that a thin bed would not form on the sump strainer may therefore be in error. The licensee should evaluate this issue for its impact on plant testing.

PSEG had telecon on October 17, 2007, with the NRC to discuss the concern and received clarifications. Debris samples similar to the debris used in MFTL testing prepared by CCI were provided to NRC for review. The following is a comparison of the CCI fibrous debris preparation with the NUREG CR-6917 METHOD.

A. Objective

To separate NUKON fiber insulation blankets into a homogenous, single-fiber slurry for use in bypass and thin bed effect testing on ECCS strainers.

B. Methods Explained

NUREG CR-6917 describes preparing NUKON by first subjecting the NUKON to a 12 to 14 hour heat treating process on a 600°F hot plate. The blanket is then shredded through a wood chipper. Next either 25 or 12.5 grams NUKON are then weighed out and added to 1000 mL or 500 mL water, respectively, and shredded in a commercial blender for a range of 3 to 10 minutes.

CCI Method per Salem Test Specification Q.003.84805:

- The fibers will be freed from the jacketing (if jacketed). Then the fibers will be baked by placing them in an oven with a regulated temperature of 250°C (482°F) for 24 hours prior to testing. The baking is meant to simulate the exposure of fiber insulation in the plant to hot surfaces such as the steam generator, pressurizer, and piping.

- The fibers will be hand cut in pieces of approx. 50 x 50 mm.
- The dry material gets weighed
- The fibers get split in batches of 3 to 4 dm^3 (0.1 to 0.14 ft^3)
- Each batch gets soaked in 2 l of water (½ gal) until saturated
- Their adherence will be decomposed by a high pressure water jet with a capacity of 100 bar and with the jet at a distance of ± 0.05 m to the water surface for a duration of approximately 4 min for each batch.
- It will be ensured by visual means that the insulation is decomposed in the water in fine pieces with no clumps of fibers remaining intact and individual fiber pieces smaller than 8 mm.
- Several batches can be mixed together to a main batch (portion) according to the test description.

In the past, CCI has also separated NUKON by using the same high-pressure water jet to force the NUKON through a 12mm x 12mm mesh screen. The resulting slurry had the same characteristics as the slurry prepared in the bucket only.

Figure 1. Baked Blankets and Strips

Figure 2. 5 cm x 5 cm Pieces

C. Results Comparison:

Figure 3-2 from NUREG CR-6885, shows the prepared NUKON characteristics. This NUREG document describes preparing the NUKON slurry by first using a leaf shredder to shred the NUKON blankets. The NUKON is then heated to >90^{O}C and stirred for 5 minutes using a kitchen blender (slurry concentration is unknown).

Figure 3-2. BP NUKON™.

Figure 3 Blender Processed NUKON

The figure below displays the NUKON properties of a slurry prepared per the CCI preparation method.

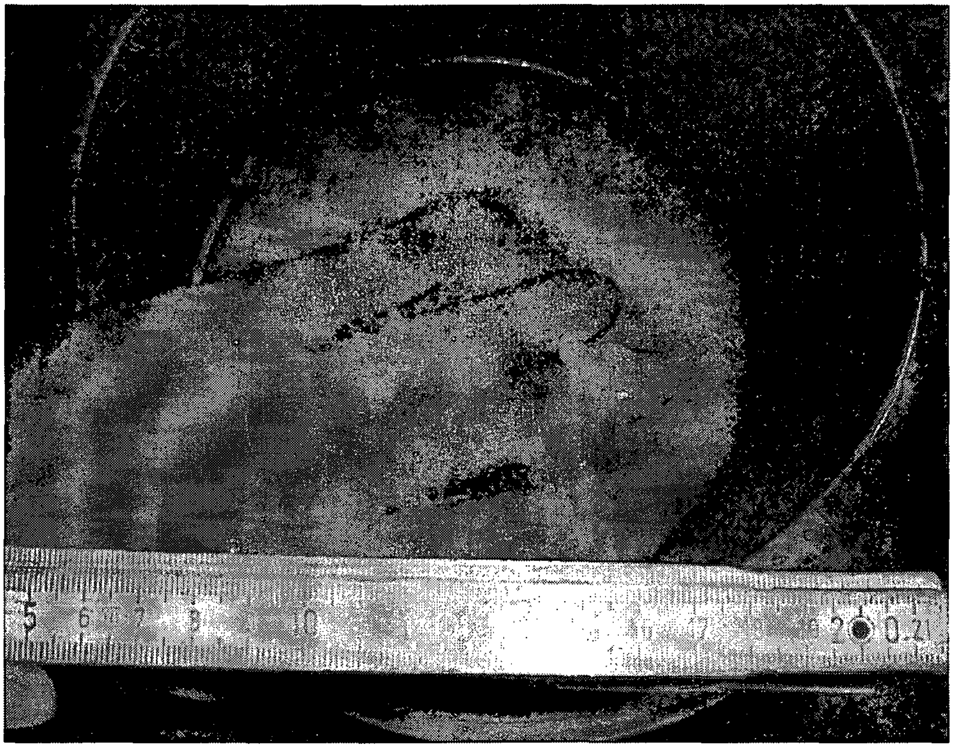

Figure 4. CCI Method Prepared Debris

Below, Figure 5 and Figure 6 are from the thin bed testing performed in October 2005 for Salem. The photos were taken after the test conclusion and all water had been drained from the test loop. As can be seen in Figure 6 the drain down process causes some small areas in the debris bed to fall off the top and side strainer surfaces. These open areas do not exist during testing.

Additionally, to confirm the small open areas were not present during testing we can refer to the thin bed test results detailed in VTD 901000 (Reference A.65). The results show a rise in head loss as the flow rate is increased and then a slow reduction in head loss as the flow rate decreases. The test results are outlined in Table 1 and Diagram 1 below:

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Test step #	**Time [hh.mm]**	**Flow Temp [°C]**	**Pool Temp [°C]**	**Flow rate [m^3/h]**	**Δp [mbar]**	**Δp** U-tube **[mmWC]**	**Remarks**
16	11:14	12.3	12.4	47.6	78.4	-	
17	11:38	12.4	12.5	56.9	81.7	-	
18	12:11	12.7	12.8	66.7	82.9	-	
19	12:48	12.8	12.9	47.6	71.1	-	
20	13:20	12.9	13.0	33.4	57.8	-	

Table 1

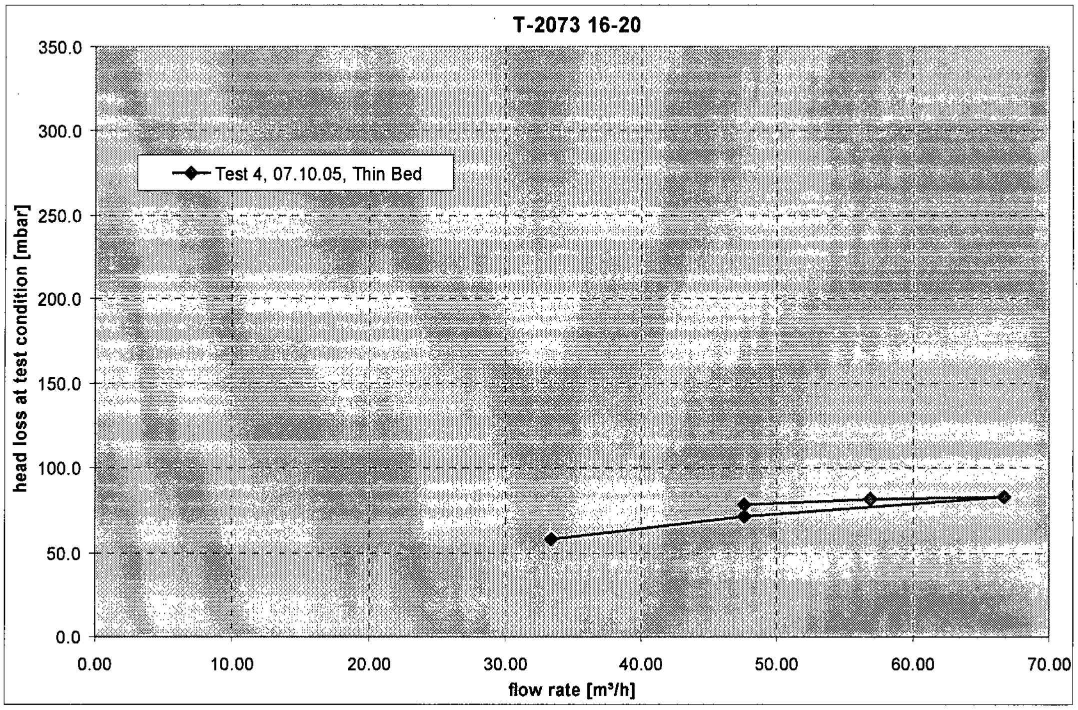


Diagram 1

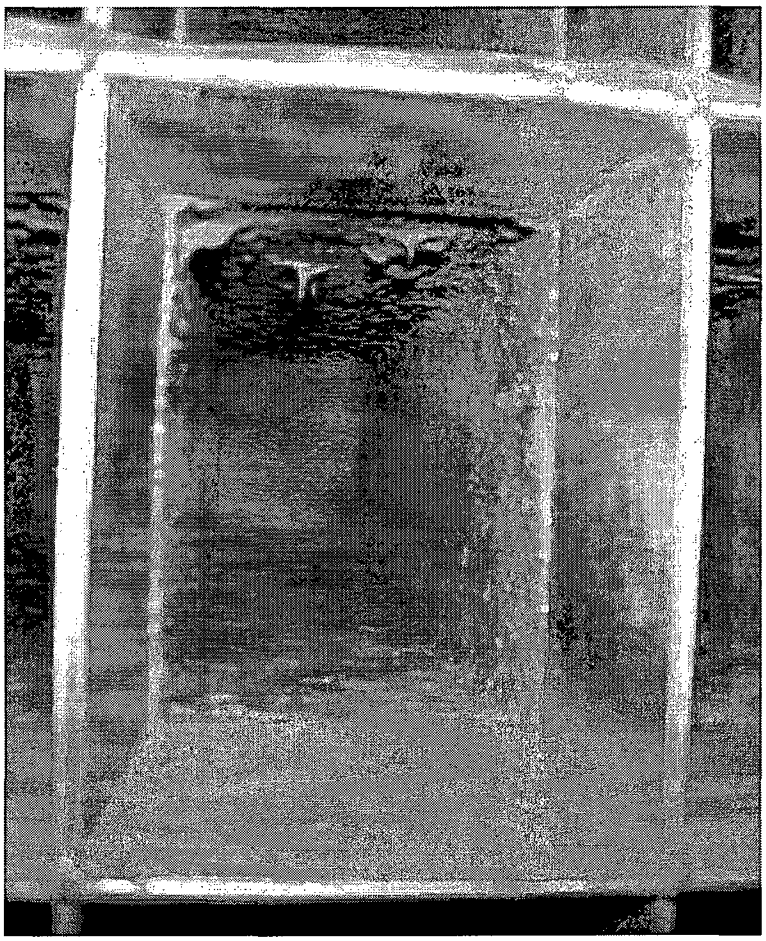
These results show that the screen does not exhibit thin bed behavior.

Figures 5 and 6, when combined with the test results demonstrate adherence to Criterion 1 through 5 (in particular Criterion 2) in section 3.1.1 of NUREG CR-6917. The Criterion are listed here:

- Material should form a complete debris bed on the specified metal screen or perforated plate.

- Debris beds should be uniformly thick and internally as homogeneous as possible in the radial direction.
- Uniform debris beds should be formed over the range of debris loadings specified by the NRC proposed test matrix provided as part of NUREG CR-6917.
- The debris beds generated for a given composition and target debris loading should yield repeatable physical and performance characteristics.
- The debris beds should meet NRC specifications for debris bed composition and criteria for head loss measurements (e.g., formed at specified bed formation velocity and temperature).

Figure 5



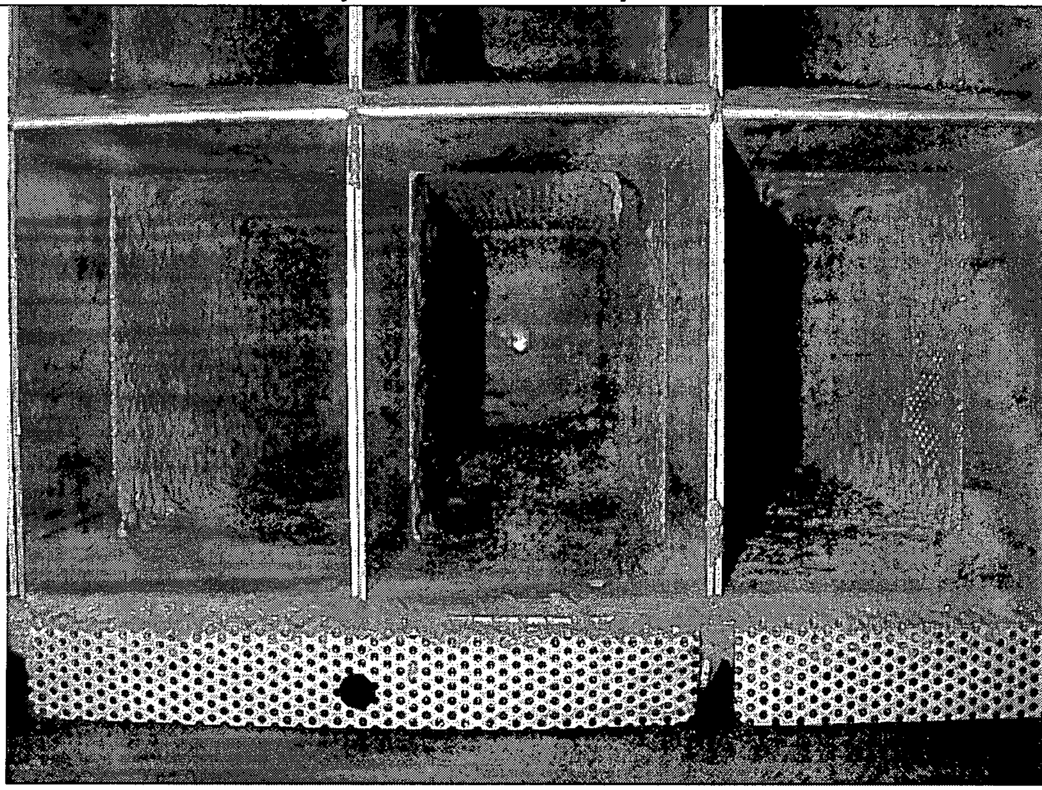


Figure 6.

D. CCI's Findings

Our testing has determined the following:

1) All NUKON fibers will eventually settle in a zero turbulence environment as described in Figure 7 below. Figure 7 shows a sample 12.5 gram NUKON/500 mL water slurry prepared using the method described in NUREG CR-6917. The slurry in the photo has been undisturbed for approximately 36 hours and no fibers remain in suspension.

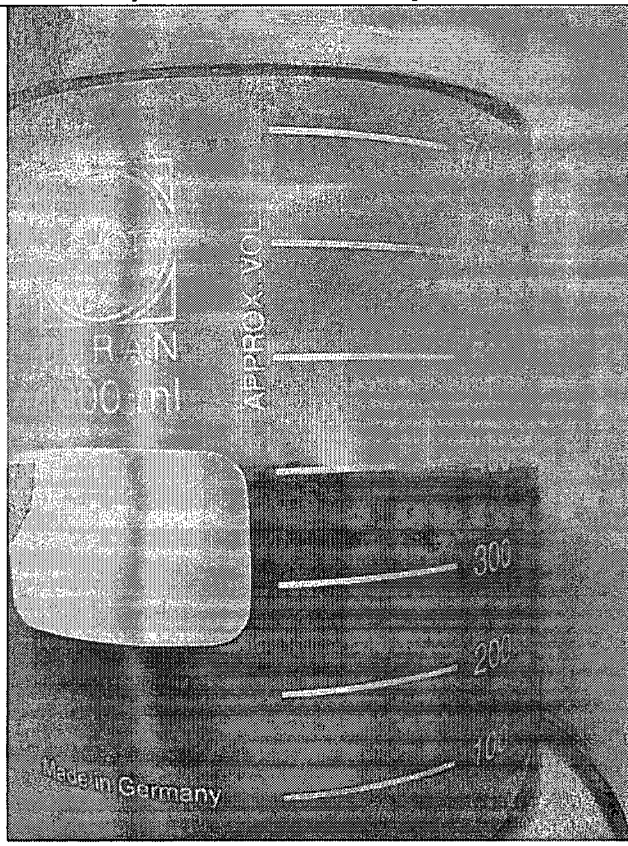


Figure 7.

2) There are 2 methods for improving likeliness of a true single fiber NUKON slurry when introducing fibers into the test loop
   a. Agitate the fibers prior to adding. CCI does this by operating a propeller style blade powered by a drill in each bucket prior to adding to the test loop.
   b. The most influential variable – a low NUKON concentration in the NUKON/water slurry. We have found that no matter how small or finely separated the fibers are if the NUKON concentration in the water is too high clumps will form. To achieve as close to single fiber slurries as possible in thin bed tests, CCI typically uses approximately 110g NUKON per between 10 to 30 L water.

E. Conclusion

Based on the behaviors of the NUKON slurry in both the NUREG and CCI described preparation methods the CCI method satisfies the criterion described in Section 3.1.1 of NUREG CR-6917.

F. Additional In-Loop Underwater Photos:

These photos were made during non-QA testing performed December 11 and 12, 2007. The photos were taken after 900 grams of NUKON (approximately 0.166 inch thick bed) and 1 kg of stone flour were added to the loop. Sufficient time was allowed for the particulate to filter from the water for photo clarity. The photos clearly demonstrated that a thin bed would not form.

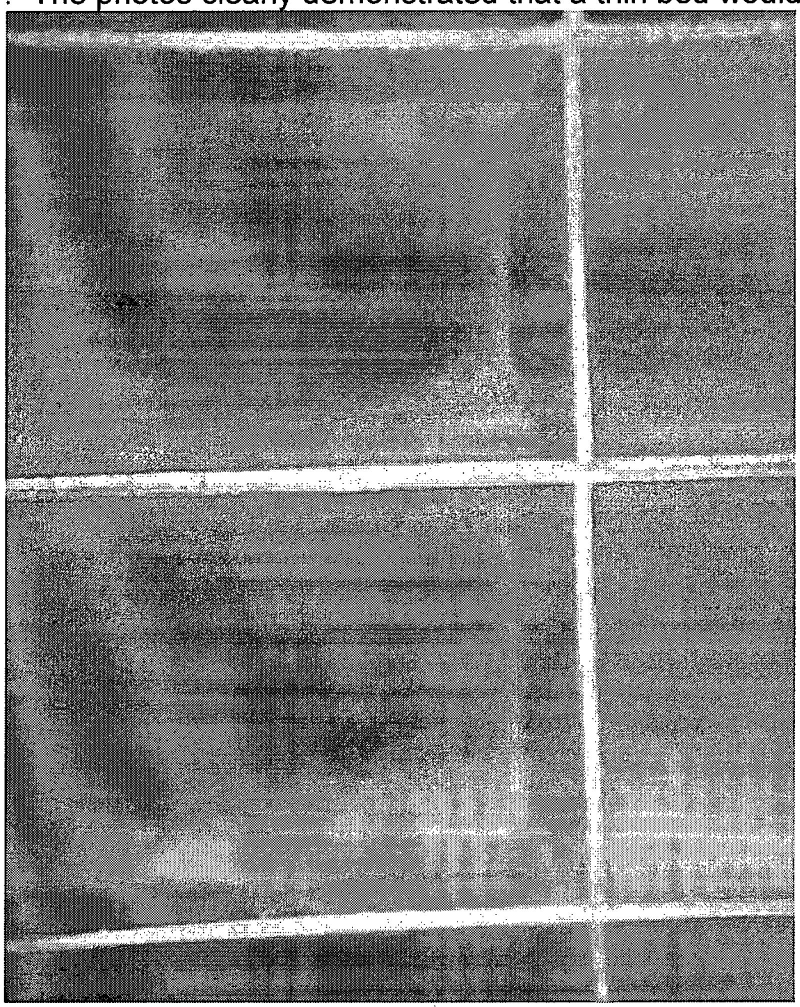


Figure 8 - Front-mid strainer

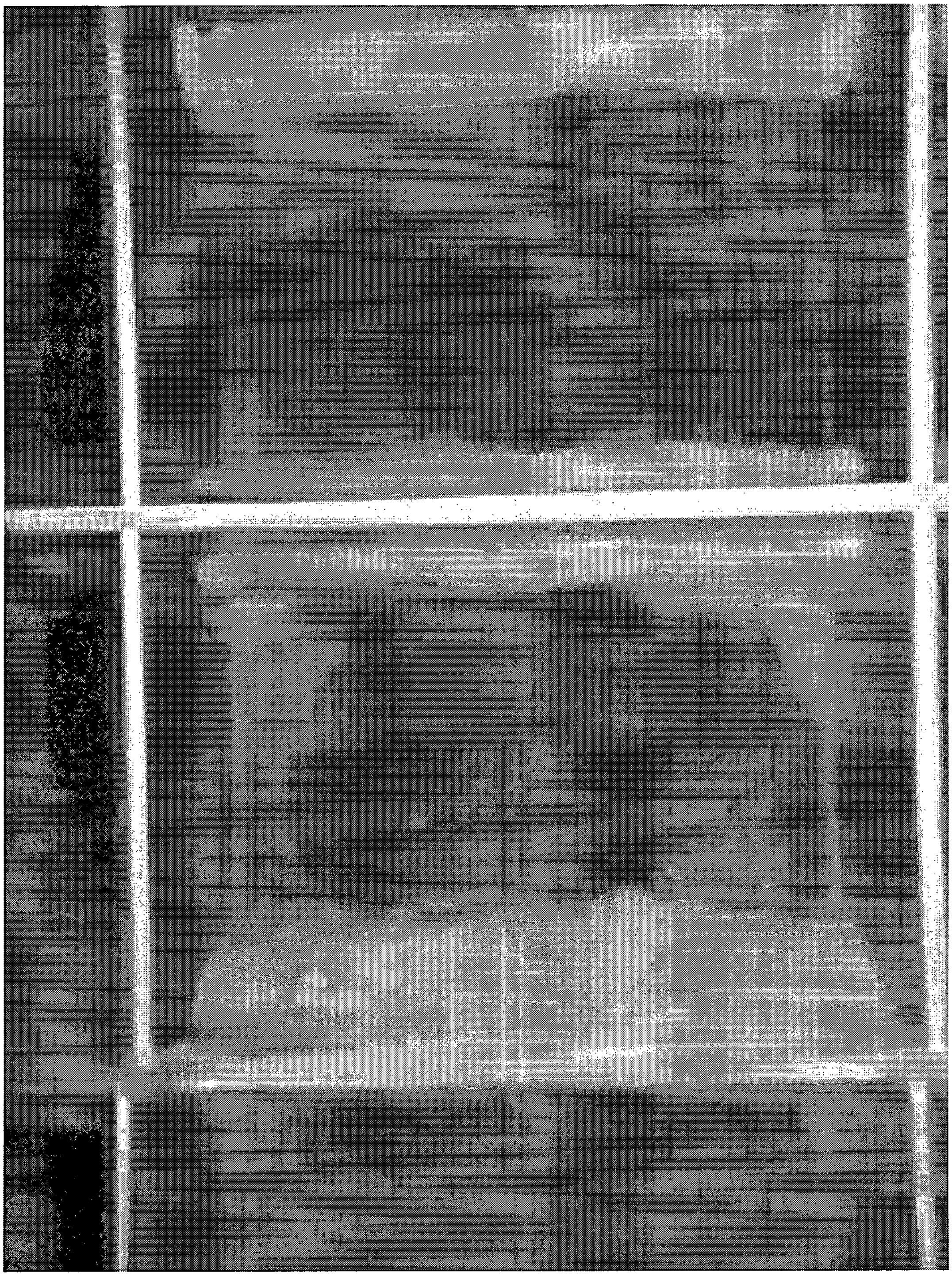


Figure 9 - Rear-mid Strainer Pockets

7. Certain Water Holdup Calculation Omitted from Latest Revision to the Minimum Sump Water Level Calculation

The technical evaluation for steam generator nozzle break loss-of-coolant accidents (LOCAs) capable of filling the lower refueling cavity by blocking the drain line with debris and preventing the lower refueling cavity from draining (and thereby decreasing sump water volume) was omitted from the licensee's latest revision to the minimum sump water level calculation. This evaluation explained that although significant from a holdup perspective, LOCAs from this set of breaks are mutually exclusive from, and less severe than, reactor vessel nozzle breaks that directly fill the reactor pit but have no potential to block the lower refueling cavity drain line nor fill the lower refueling cavity. The licensee should revise the latest minimum sump water level calculation to include the previous technical evaluation from an earlier version of the minimum sump water level calculation.

The minimum flood level calculation was revised to include the analysis documented in the previous revision (0IR0) of the calculation that considered the entire refuel cavity as a holdup volume.

This analysis was not used in revision 0 of the calculation since it was determined that it was not credible to assume both the refuel cavity and the reactor cavity volumes were lost to the sump pool from a LOCA. The reactor cavity was determined to be the limiting case ECCS inventory holdup as described below.

For Salem, the refuel cavity volume is approximately 6,550 ft^3 (Reference A.10). The reactor cavity volume is approximately 10,400 ft^3 (Reference A.10). The refuel cavity is only filled by containment spray (no break flow fills the refuel cavity). The reactor cavity can be filled directly by a break at the reactor vessel nozzle, or by overflow from the containment sump volume once the level in the containment reaches the 81 feet 9 inch level which is above the minimum level required for recirculation operation of 80 feet 10 inch.

If there is a break in the RCS piping at the steam generators, in order to block the refuel cavity drain, a piece of debris would have to be blown up between the SG and the enclosure wall then land on the refuel cavity drain on the 130 foot elevation.

With the drain blocked, any of the containment spray discharge falling into the refuel cavity would be lost to the recirculation pool inventory. However, this break will not result in immediate filling of the reactor cavity. Conversely, the break at the reactor nozzle that leads to direct filling of the reactor cavity will not generate the debris that could block the refuel cavity drain.

Therefore, at Salem concurrent use of both of these hold up volumes for determining minimum flood level for switchover to recirculation operation is not credible. Since the reactor cavity has the largest volume, it is considered the limiting case for ECCS inventory hold up at Salem Unit 1 and 2.

For historical purposes, revision 0IR0 is now included as Attachment J to calculation S-C-CAN-MDC-2061 (Reference A.21), Minimum Containment Flood Level, Revision 1.

8 **Final Chemical and Non-chemical Integrated Head Loss Testing not Performed**
The licensee needs to perform the final chemical and non-chemical head loss testing and then calculate strainer head loss. Net-positive suction head (NPSH) margin for the emergency core cooling systems (ECCS) pumps can then be calculated.

The final chemical and non-chemical head loss testing has not been completed. PSEG has submitted and received an approval for an extension request until June 30, 2008 (Reference A.27). Upon completion of testing and associated calculations, the information will be submitted to NRC.

9 **Licensee NPSH Calculations Credit Containment Partial Air Pressure Without an Approved License Amendment Request (LAR)**
Licensee calculations include credit for the contribution of partial containment air pressure to NPSH, but the NRC has not yet approved the licensee's LAR requesting approval for this credit. The licensee needs to receive the NRC-approved LAR or remove the credit for air pressure-difference contribution to NPSH.

PSEG submitted a LAR to revise the licensing basis for the NPSHa for ECCS and Containment Heat Removal System pumps as described in the Appendix 3A of the Salem UFSAR The NRC approved the LAR on November 15, 2007 (Reference A.9).

10 Spray Droplet Water Holdup Calculation Omitted from Latest Revision to the Minimum Sump Water Level Calculation
The technical evaluation for the spray droplet holdup mechanism was omitted from the licensee's latest revision to the minimum sump water level calculation. The licensee needs to revise the minimum sump water level calculation to include the technical evaluation of spray droplet holdup in the containment atmosphere.

The minimum flood level calculation was revised to include containment spray water droplets that would not contribute to the water level until the droplets fell to the sump pool. This analysis utilized the terminal velocities of droplets and the falling distance from the highest spray ring elevation to the containment floor.

During the time it takes for the water droplets to fall (approximately 15 seconds, worst case), the volume of water suspended in the atmosphere is about 175 ft^3. This translates to a reduction in the sump level of approximately 0.31 inches.

This analysis is included as Attachment K to calculation S-C-CAN-MDC-2061 (Reference A.21), Minimum Containment Flood Level, Revision 1.

11 Inadequate Technical Basis for Maximum Flow Rates for RHR Pumps
The licensee needs to develop an adequate technical basis for the maximum flow rates for the RHR pumps for cold leg and hot leg injection, and spray operation in limiting single-pump operation.

Calculation S-C-RHR-MDC-1711 (Reference A.41) provides the ECCS sump performance based on the following maximum RHR pump flow rate (single pump in operation) in the recirculation mode.

Mode	Salem Unit 1	Salem Unit 2	Basis
Cold Leg Recirculation (w/o Sprays)	5,110 gpm	4,900 gpm	Salem Unit 1 – Note 1 Salem Unit 2 – Note 2
Hot Leg Recirculation	4,980 gpm	4,980 gpm	Note 3
Cold Leg Recirculation with Sprays	4,850 gpm	4,850 gpm	Note 4

Notes:

1. The calculated flow is for one RHR pump line-up that feeds all four cold legs (two by normal paths and also through loop path and all four charging/SI pumps). This condition is explained further with an example below. The hydraulic analysis (Calculation number FSE/SS-PSE/PNJ-2017) was performed by Westinghouse.

   During normal LOCA recirculation lineup (without sprays) the 11 RHR pump feeds 11 and 13 Cold legs and 2 SI pumps and 12 RHR pump feeds 12 and 14 Cold leg and 2 charging pumps.

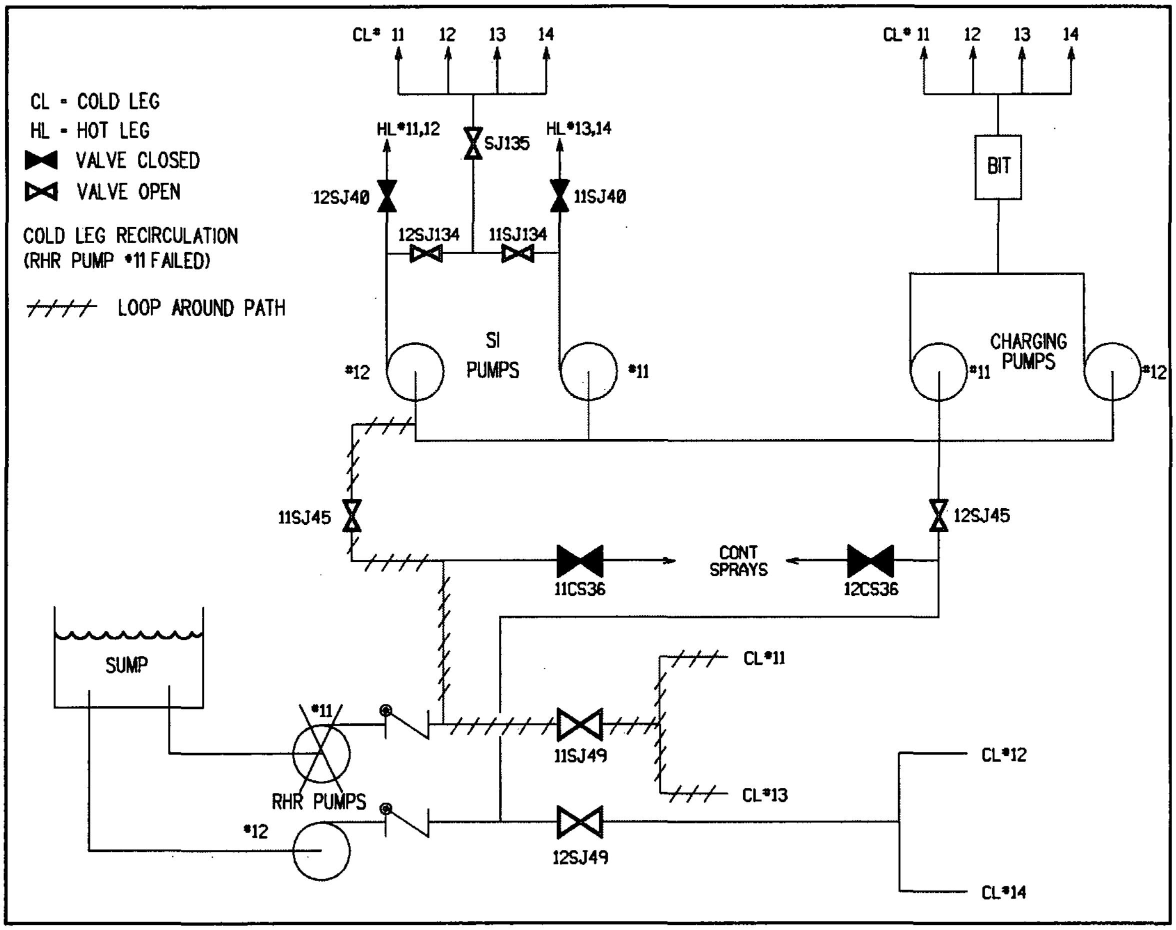
   Following loss of one operating RHR pump (example #11 RHR pump) the 12 RHR pump would supply to 12 and 14 cold legs and charging pumps (as previously discussed). In addition a loop around would occur due to the failed RHR pump. The loop around flow path would be, as shown in Figure 1 (below). This configuration results in maximum flow per pump.

2. The calculated flow path for Salem Unit 2 is similar to Salem Unit 1 (as discussed above in Note 1). The hydraulic analysis (Calculation number FSE/SS-PSE-1828 and FSE/SS-PSE/PNJ-2017) was performed by Westinghouse.

3. 4,300 gpm per pump is the maximum estimated RHR pump flow with four ECCS pumps (two Charging and two SI) in hot leg recirculation alignment (Westinghouse letter PSE-06-24 dated March 2, 2006, (Reference A.56), and calculation FSE/SS-PSE/PNJ-2056. A conservative value of 4980 gpm is used in the NPSH analysis that exceeds the value computed in the hydraulic analysis.

4. In this mode one RHR pump is aligned to two RCS cold legs and two SI pumps. The other pump is aligned to containment sprays and two charging pumps. Assuming failure of the RHR pump aligned to containment sprays, the calculated flow through the operating RHR pump is <=4,850 gpm (FSE/SS-PSE/PNJ-2017, page 14). The failure of the RHR pump aligned to RCS cold legs is bounded by the above failure (FSE/SS-PSE/PNJ-2017, page 13).

Figure 1 Salem Unit 1 Cold Leg Recirculation (w/o Containment Spray)



12 **Salem has water in its sumps during the operating cycle. This condition has a potential for biological growth, necessitating clean-up during each outage. This item needs to be addressed by PSEG in its sump analysis. Provide with documentation, which describes the PSEG analysis of this issue?**

The ECCS containment sump at Salem Unit 1 and 2 is filled with water during the normal operating mode. The concern is that stagnant water in the containment sump would result in biological growth, which has a potential to impact the operation of containment sump during recirculation phase of the LOCA.

A containment sump inspection was performed at Salem Unit 2 in 2003 to determine if there is any biological growth. This inspection showed substantial amount of algae in the sump. At that time the sump was thoroughly cleaned.

Subsequently at Salem Unit 1 and 2 work orders were created for thorough inspection of the containment sump during every refueling outage and the cleaning of any algae growth. These subsequent inspections show a very thin film of algae. Salem Unit 1 inspections were performed on June 4, 2004, November 9, 2005, and April 15, 2007 and the next inspection is scheduled for upcoming 1R19 refueling outage (Fall 2008).

Salem Unit 2 inspections were performed on November 11, 2003, May 6, 2005, and November 11, 2006, and the next inspection is scheduled for upcoming 2R16 refueling outage (Spring 2008).

This thin film of algae on the water surface will breakdown during a LOCA condition. The small mass of algae will be negligible relative to the other debris generated. Therefore, the algae are not expected to cause downstream concerns or reduction in sump performance.

References

General References

1. NRC Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents for Pressurized-Water Reactors," dated September 13, 2004.

2. Nuclear Energy Institute (NEI) document NEI 04-07 Revision 0, December 2004, "Pressurized Water Reactor Sump Performance Evaluation Methodology."

3. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Nuclear Energy Institute Guidance Report (Proposed Document Number NEI 04-07), "Pressurized Water Reactor Sump Performance Evaluation Methodology," Issued December 6, 2004.

4. Regulatory Guide 1.82, "Water Sources for Long Term Recirculation Cooling Following a Loss of Coolant Accident," Revision 3, November 2003.

5. NUREG-0800, "U.S. Nuclear Regulatory Commission Standard Review Plan," Section 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," Revision 1, July 1981.

6. NUREG/CR-2791, "Methodology for Evaluation of Insulation Debris Effects, Containment Emergency Sump Performance Unresolved Safety Issue A-43," Issued September 1982.

7. NUREG/CR-3616, "Transport and Screen Blockage Characteristics of Reflective Metallic Insulation Materials," January 1984.

8. NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris, Final Report," Issued October 1995.

9. NUREG/CR-6369, "Drywell Debris Transport Study, Final Report," Volume 1, Issued September 1999.

10. NUREG/CR-6369, "Drywell Debris Transport Study: Experimental Work, Final Report," Volume 2, Issued September 1999.

11. NUREG/CR-6369, "Drywell Debris Transport Study: Computational Work, Final Report," Volume 3, Issued September 1999.

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12. NUREG/CR-6762, Volume 1, "GSI-191 Technical Assessment: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance," Issued August 2002.

13. NUREG/CR-6762, Volume 2, "GSI-191 Technical Assessment: Summary and Analysis of U.S. Pressurized Water Reactor Industry Survey Responses and Responses to GL 97-04," Issued August 2002.

14. NUREG/CR-6762, Volume 3, "GSI-191 Technical Assessment: Development of Debris Generation Quantities in Support of the Parametric Evaluation," Issued August 2002.

15. NUREG/CR-6762, Volume 4, "GSI-191 Technical Assessment: Development of Debris Transport Fractions in Support of the Parametric Evaluation," Issued August 2002.

16. NUREG/CR-6772, "GSI-191: Separate Effects Characterization of Debris Transport in Water," Issued August 2002.

17. NUREG/CR-6773, "GSI-191: Integrated Debris-Transport Tests in Water Using Simulated Containment Floor Geometries," Issued December 2002.

18. NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," Issued February 2003.

19. NUREG/CR-6916, "Hydraulic Transport of Coating Debris, A Subtask of GSI-191," Issued December 2006.

20. Nuclear Energy Institute (NEI) Document 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," Revision 1.

21. Westinghouse Technical Bulletin, TB-06-15, "Unqualified Service Level 1 Coatings on Equipment in Containment," Dated September 28, 2006.

22. WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA-Qualified / Acceptable Coatings," Revision 0, dated June 2006.

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23. C.D.I. Report 96-06, "Air Jet Impact Testing of Fibrous and Reflective Metallic Insulation," Revision A, included in Volume 3 of General Electric Document NEDO-32686-A, "Utility Resolution Guide for ECCS Suction Strainer Blockage."

24. WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," Revision 0, dated February 2006, supplemented by the following Letters:

    24.1 Letter OG-06-387, "Responses to the NRC Request for Additional Information (RAI) on WCAP-16530, "Evaluation of Chemical Effects in Containment Sump Fluids to Support GSI-191," Dated November 21, 2006.

    24.2 Letter OG-07-129, "Responses to the NRC Second Set of Requests for Additional Information (RAI's) on WCAP-16530, "Evaluation of Chemical Effects in Containment Sump Fluids to Support GSI-191," Dated April 3, 2007.

    24.3 Letter WOG-06-102, "Distribution of Errata to WCAP-16530-NP, "Method for Evaluating Post-Accident Chemical Effects in Containment Sump Fluids" (PA-SEE-0275)," Dated March 17, 2006.

    24.4 Letter WOG-06-103, "Distribution of WCAP-16530-NP, " Method for Evaluating Post-Accident Chemical Effects in Containment Sump Fluids" (PA-SEE-0275)," Dated March 17, 2006.

    24.5 Letter OG-06-232, "PWR Owners Group Letter Regarding Additional Error Corrections to WCAP-16530-NP (PA-SEE-0275)," Dated June 17, 2006.

    24.6 Letter OG-06-255, "PWR Owners Group Letter Releasing Revised Chemical Model Spreadsheet From WCAP-16530-NP (PA-SEE-0275)," Dated August 7, 2006.

    24.7 Letter OG-06-273, "PWR Owners Group Method Description of Error Discovered August 16, 2006 in Revised Chemical Model Spreadsheet (PA-SEE-0275)," Dated August 28, 2006.

    24.8 Letter OG-07-408, "Responses to NRC Requests for Clarification Regarding WCAP-16530, "Evaluation of Chemical Effects in Containment Sump Fluids to Support GSI-191 (PA-SEE-0275)," Dated September 12, 2007.

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24.9 Final Safety Evaluation by the Office of Nuclear Reactor Regulation Topical Report WCAP-16530-NP "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," Pressurized Water Reactor Owners' Group Project No. 694, Adams Accession No. ML073520891, issued December 21, 2007.

25. WCAP-16785-NP, "Evaluation of Additional Inputs to the WCAP-16530-NP Chemical Model," Revision 0, Dated May 2007.

26. WCAP-16710-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON Insulation for Wolf Creek and Callaway Nuclear Operating Plants," Revision 0, dated October 2007.

27. WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," Revision 1, dated August 2007.

28. WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 0, Dated May 2007.

29. Draft NRC Staff Guidance for Evaluation of Downstream Effects of Debris Ingress into PWR RCS on Long Term Cooling Following a LOCA, dated November 22, 2005. ADAMS Accession No. ML053200277.

30. Idelchik, I. E., "Handbook of Hydraulic Resistance", Third Edition, 1994.

31. Letter OG-07-534, "Transmittal of Additional Guidance for Modeling Post-LOCA Core Deposition with LOCADM Document for WCAP-16793-NP (PA-SEE-0312)," Dated December 14, 2007.

32. WCAP 16727-NP "Evaluation of Jet Impingement and High Temperature Soak Tests of Lead Blankets For Use Inside Containment of Westinghouse Pressurized Water Reactors" (Note to SandL: Added this reference)

33. Letter from NRC to Holders of Licenses for Pressurized-Water Reactors: "Alternative Approach for Responding to The Nuclear Regulatory Commission Request for Additional Information Letter Regarding Generic letter 2004-02," dated January 4, 2007.

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34. Letter from NRC To Mr. Anthony R. Pietrangelo (Nuclear Energy Institute): "Supplemental Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated November 30, 2007

Salem Specific References

A.1 Calculation S-C-RHR-MDC-2039, "Debris Generation Due to LOCA within Containment for Resolution of GSI-191," Revision 1, Dated January 21, 2008.

A.2 Calculation S-C-RHR-MDC-2056, "Post-LOCA Debris Transport to Containment Sump for Resolution of GSI-191," Revision 1, Dated November 14, 2007

A.3 Calculation S-C-CAN-MDC-2144, "Minimum Containment Air Pressure Prior to a LOCA," Revision 0, Dated September 19, 2007.

A.4 VTD 900984 "Post-LOCA Chemical Effects Analysis in Support of GSI-191," , 2006. Revision 2 Dated January 30, 2008 (SandL Calculation 2006-07720, Rev. 1)

A.5 WCAP-16503-NP, "Salem Unit 1 and Salem Unit 2 Containment Response to LOCA and MSLB for Containment Fan Cooler Salem Unit Margin Recovery Project," Revision 3, Dated February 2007.

A.6 TODI 80080788-006, "Documentation of Minimum Strainer Water Submergence for Containment Sump Project," Dated October 29, 2007.

A.7 Evaluation S-C-CAN-MEE-1896, "Input to Procurement Specification S-C-CAN-MDS-0445," Revision 1, Dated September 20, 2007.

A.8 Letter No. LR-N07-0156 from PSEG to USNRC, Subject: License Amendment Request LAR S07-05 Revision to Licensing Basis – NPSH Methodology for ECCS Pumps, Dated August 15, 2007.

A.9 Letter from USNRC to PSEG, Subject: Salem Nuclear Generating Station, Salem Unit Nos. 1 and 2, Issuance of Amendments Re: Revision to Licensing Basis – Net Positive Suction Head Methodology for Emergency Core Cooling Systems Pumps (TAC Nos. MD6353 and MD6354), Dated November 15, 2007.

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A.10 Calculation S-C-A900-MDC-0082, "Containment Volume vs. Flood Level Analysis," Revision 2, Dated February 7, 2003.

A.11 Calculation S-C-SJ-MDC-2092, "Design Basis pH Calculation of Salem Generating Station," Revision 0, Dated December 14, 2005.

A.12 Evaluation S-C-SJ-MEE-1978, "Required Mission Times for Salem ECCS Pumps During Recirculation Phase," Revision 0, Dated March 22, 2006.

A.13 Calculation 2007-20560 "Post LOCA Fuel Deposition Analysis in Support of GSI-191 " Revision 0 (Note: This calculation is not completed as yet)

A.14 TODI 80080788-004, "Design Clarifications for Containment Sump Project," Dated June 14, 2007.

A.15 Calculation S-2-CAN-MDC-2076, "Calculation for Latent Debris (Dust and Lint) Determination for Salem Unit 2 Containment for Resolution of GSI-191," Revision 0IR0, Dated March 6, 2006.

A.16 VTD 901212 "Walkdown Report for Evaluating Debris Sources Inside Salem Unit 1 Containment for Resolution of GSI-191," Revision 0 (SandL Report 2004-03483)

A.17 VTD 901213 "Walkdown Report for Evaluating Debris Sources Inside Salem Unit 2 Containment for Resolution of GSI-191," Revision 0 (SandL Report 2005-05960)

A.18 Calculation S-C-RHR-MDC-2089, "Long Term Wear Effects Evaluation in Support of Resolution of GSI-191," (Note: This calculation is not completed as yet)

A.19 Fauske and Associates, Inc. Report FAI/07-24, Revision 1, "Test Report for Containment Sumps Project."

A.20 TODI 80080788-005, "Documentation of Insulation for Containment Sump Project," Dated September 27, 2007.

A.21 S-C-CAN-MDC-2061, "Minimum Containment Flood Level," Revision 1, Dated October 15, 2007

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A.22 S-C-CAN-MDS-0445, "Salem Generating Station Containment Sump Strainer," Revision 2, Dated November 15, 2007.

A.23 Vendor Technical Document VTD-901096, CCI Report 680/41273, "Acceptability Criteria for Fabricated Hole Sizes," Revision 1, Dated February 28, 2007.

A.24 Salem Generating Station Procedure S2.OP-ST.SJ-0011 (Q), Revision 5, Dated October 27, 2006.

A.25 S-C-RHR-MEE-1883, "Downstream Phase 1," Revision 1, Dated June 14, 2006.

A.26 Salem Nuclear Generating Station Salem Unit 2 Approval of Generic Letter 2004-02 Extension Request (TAC No. MC4713) dated August 11, 2006

A.27 Letter from NRC to Mr. William Levis "Salem Nuclear Generating Station, Salem Units Nos. 1and 2 – Approval of Request for Extension of Completion Date for Generic Letter 2004-02 Corrective actions (TAC Nos. MC4712 and MC4713 dated December 21, 2007

A.28 NC.DE-TS.ZZ-6006 "Primary Containment Coatings", Revision 1 Dated October 6, 2003

A.29 DCP 80089513 Salem Unit 2 Design Change Package for GSI-191 Insulation Debris Reduction Revision 1

A.30 DCP 80090886 Salem Unit 1 Design Change Package for GSI-191 Insulation Debris Reduction Revision 1

A.31 DCP 80080787 Salem Unit 1 Design Change Package for Containment Sump Upgrades Revision 2

A.32 DCP 80080788 Salem Unit 2 Design Change Package for Containment Sump Upgrades Revision 4

A.33 SC.SA-ST.ZZ-0001(Q) "Salem Containment Entries In Modes 1 through 4, Revision 2 Dated January 20, 2005

A.34 S1(2).OP-PT.CAN-0001 (Q) "Containment Walkdown", Revision 15 Dated April 12, 2007

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A.35 S1(2).OP-ST.SJ-0011(Q) Emergency Core Cooling ECCS systems Containment Sump Modes 5-6, Revision 5 Dated April 12, 2007

A.36 Procedure CC-AA-102 Design Input and Configuration Change Impact Screening, Revision 14 Dated December 18, 2007

A.37 Procedure CC-AA-102-1001 Design Inputs and Impact Screening Implementation, Revision 1 Dated December 18, 2007

A.38 Drawing 605772 "Containment Scaffold Racks and Shielding Storage Boxes Salem Units 1 and 2", Revision 1 Dated December 6, 2002

A.39 ASTM D5163, "Standard Guide for Establishing Procedures to Monitor the Performance of Coating Service Level I Coating Systems in an Operating Nuclear Power Plant".

A.40 Procedure MA-AA-716-008 "Foreign Material Exclusion Program", Revision 2 Dated March 13, 2006

A.41 Calculation S-C-RHR-MDC-1711 "Available NPSH at RHR Pumps during Recirculation Modes", Revision 3 Dated October 27, 2006

A.42 Procedure CC-AA-112 "Temporary Configuration Changes", Revision 11 Dated December 14, 2006

A.43 VTD 901030 "Proof of Absence of Air Vortices Above Strainers," Revision 2, Dated January 28, 2008. (CCI Report 680/41 272 Rev 3 Dated November 15, 2007)

A.44 PSEG TODI 80080788-007 "Aluminum Paint for Containment Sump Project

A.45 Technical Specification 4.5.2.c.2 "Emergency Core Cooling Systems"

A.46 Drawing 207067, No. 1 Salem Unit – Reactor Containment Floor Plan El. 78'-0" and 81 feet-0, Revision 9

A.47 Drawing 207070, No. 2 Salem Unit – Reactor Containment Floor Plan El. 78'-0" and 81 feet-0, Revision 8

A.48 Drawing 201111, "No. 1 Salem Unit – Reactor Containment Slab at El. 78'-0" and El. 81 feet Plan," Sheet 1, Revision 7

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A.49 Drawing 201167, "No. 2 Salem Unit – Reactor Containment Slab at El. 78'-0" and El. 81 feet Plan," Sheet 1, Revision 7

A.50 Drawing 207068, "No. 1 Salem Unit – Reactor Containment Floor Plan El. 100'-0"," Revision 6

A.51 Drawing 207071, "No. 2 Salem Unit – Reactor Containment Floor Plan El. 100'-0"," Revision 5

A.52 Procedure SC.OM-AP.ZZ-0001, Shutdown Safety Management Program - Salem Annex, Revision 1 Dated May 16, 2006

A.53 Procedure OP-AA-101-112-1002 On-line Risk Assessment. Revision 2, Dated November 29, 2007

A.54 VTD 901357 "Comparison of Salem Steam Generator Insulation with Wolf Creek Insulation – Containment Sump Project

A.55 VTD 900501 Structural Analysis of Strainer and Support Structure Rev 3 (CCI calculation number 3 SA-096.020) Revision 3, Dated April 17, 2007

A.56 VTD 900519 Maximum Discharge Flows from Containment Sump during Alignment of two Maximum RHR pumps – Containment Sump Project (Westinghouse Letter PSE-06-24) Revision 1 Dated December 7, 2007

A.57 Technical Evaluation 80089191 Maximum Flow from Containment Sump to RHR Pumps

A.58 VTD 900442 Salem Unit 2 Sump pH Evaluation with RSGs Revision 1 Dated December 5, 2007

A.59 Calculation 6S1-2258 Hazards Analysis for Installing Permanent Lead Shielding (Inside Salem Unit 1 Containment) Revision 0 Dated December 12, 2006

A.60 Calculation 6S2-2249 Hazards Analysis for Installing Permanent Lead Shielding (Inside Salem Unit 2 Containment) Revision 0 Dated May 17, 2006

A.61 EPRI Report 1014883 "Plant Support Engineering: Adhesion Testing of Nuclear Service Level 1 Coatings" Dated August 2007

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A.62 Flow Resistance: A Design Guide for Engineers; Erwin Fried (General Electric Company), I.E.Idelchik (Industrial Research Institute, Moscow; Publishing Office: Taylor @ Francis Ltd.)

A.63 CCI Paint Particle Transport Test" Document No 680/41256 Rev. 0 (proprietary)

A.64 T. Kirk Patton, Tables of Hydrodynamic Mass Factors for Translational Motion

A.65 VTD 901000 Large Test Loop Filter Performance Specification and Test Report Revision 1 Dated October 25, 2006 (CCI Document No. Q.003.84.745 and 680/41128)

A.66 Procedure CC-SA-6006 "Monitoring the Performance of Service Level 1 coating Systems at the Salem Generating Station Salem Units 1 and 2

A.67 "Large Size Filter Performance Test" – Byron and Braidwood, Doc No 680/41134 Rev 3(Proprietary) and "Large Test Loop Filter Performance Report" – ANO Salem Unit 2, Doc No 680/41185 Rev 1 (Proprietary)

A.68 VTD 901214 Head Loss Calculation for Present Design 50% Blockage Salem Unit 2 (CCI Document 3SA-096.046)

A.69 VTD 901053 Head Loss Calculation for Present Design Salem Unit 1 (CCI Document 3SA-096.047)

A.70 Letter from NRC to Mr. William Levis: "Salem Nuclear Generating Station, Salem Units 1 and 2 Request for Additional Information Re: Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design-Basis Accidents at Pressurized-Water Reactors" (TAC Nos. MC4712 and MC4713)," dated February 9, 2006.

A.71 Letter from Michael L. Scott, Chief Safety Issue Resolution Branch Division of Safety Systems Office of the Nuclear Reactor Regulation to Harold Chernoff, Chief Plant Licensing Branch I-2 Division of Operating Reactor Licensing Office of the Nuclear Reactor Regulation "Salem Units 1 and 2 Draft open Items From the Staff Audit of Corrective Actions to Address Generic Letter 2004-02 (TAC Nos. MC4712 and MC4713), dated October 24, 2007.

A.72 Proof of Absence of Vortexing Above Modules for Clean Strainers (CCI Document 3SA-096.071)

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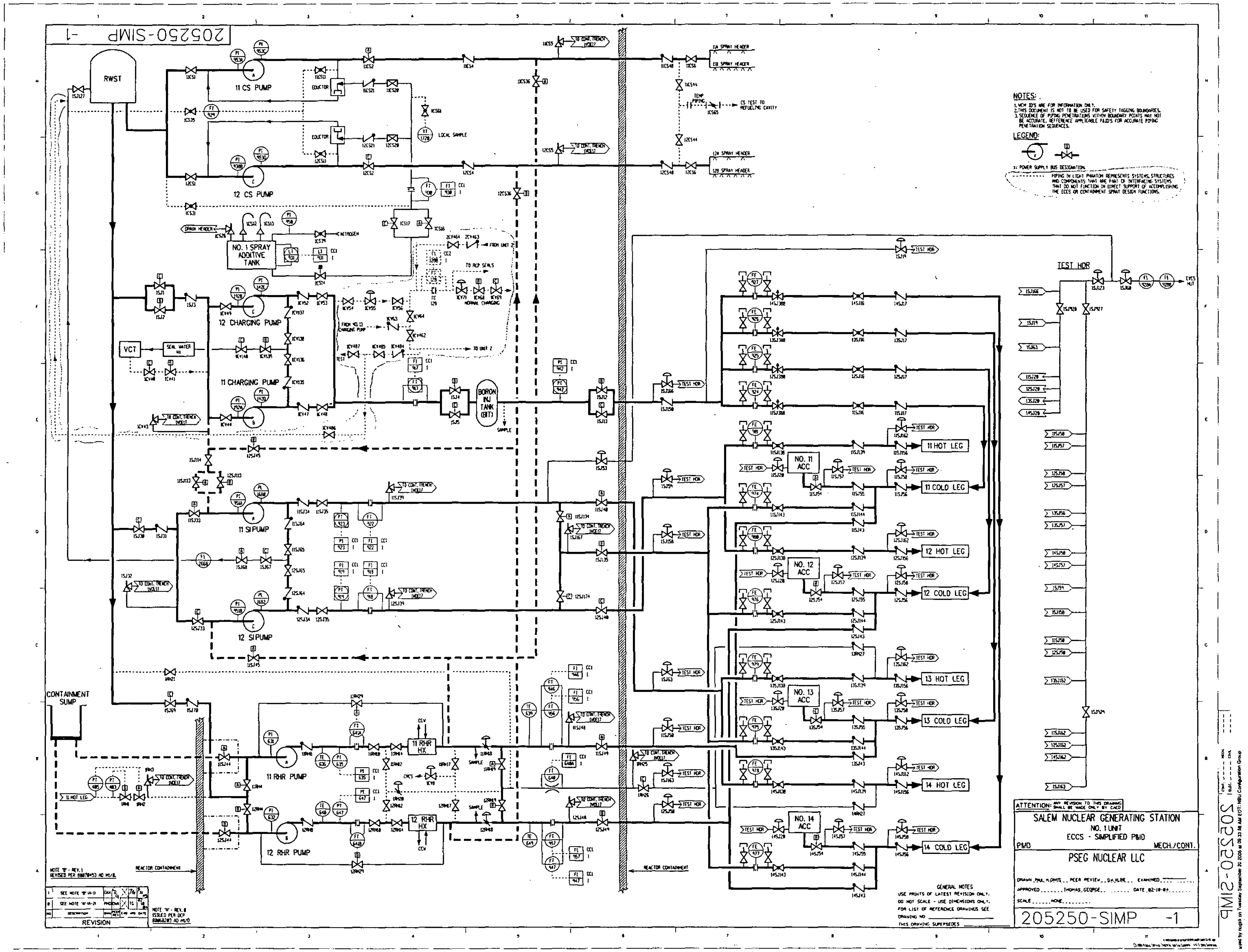
The following are simplified P&ID drawings associated with the ECCS and CSS are included in this Enclosure:

1. Drawing 205250-Simp No 1 Salem Unit ECCS Simplified P&ID, Revision 1 Dated September 21, 2005
2. Drawing 205350-Simp No 2 Salem Unit ECCS Simplified P&ID, Revision 4 Dated September 21, 2005
3. Drawing 205234-Simp No 1 Salem Unit Safety Injection Simplified P&ID, Revision 1 Dated June 16, 1999, Revision 1 Dated September 21, 2005
4. Drawing 205334-Simp No 2 Salem Unit Safety Injection Simplified P&ID, Revision 1 Dated February 5, 1999
5. Drawing 205235-Simp No 1 Salem Unit Containment Spray Simplified P&ID, Revision 0 Dated May 15, 1999
6. Drawing 205335-Simp No 2 Salem Unit Containment Spray Simplified P&ID, Revision 1 Dated February 5, 1999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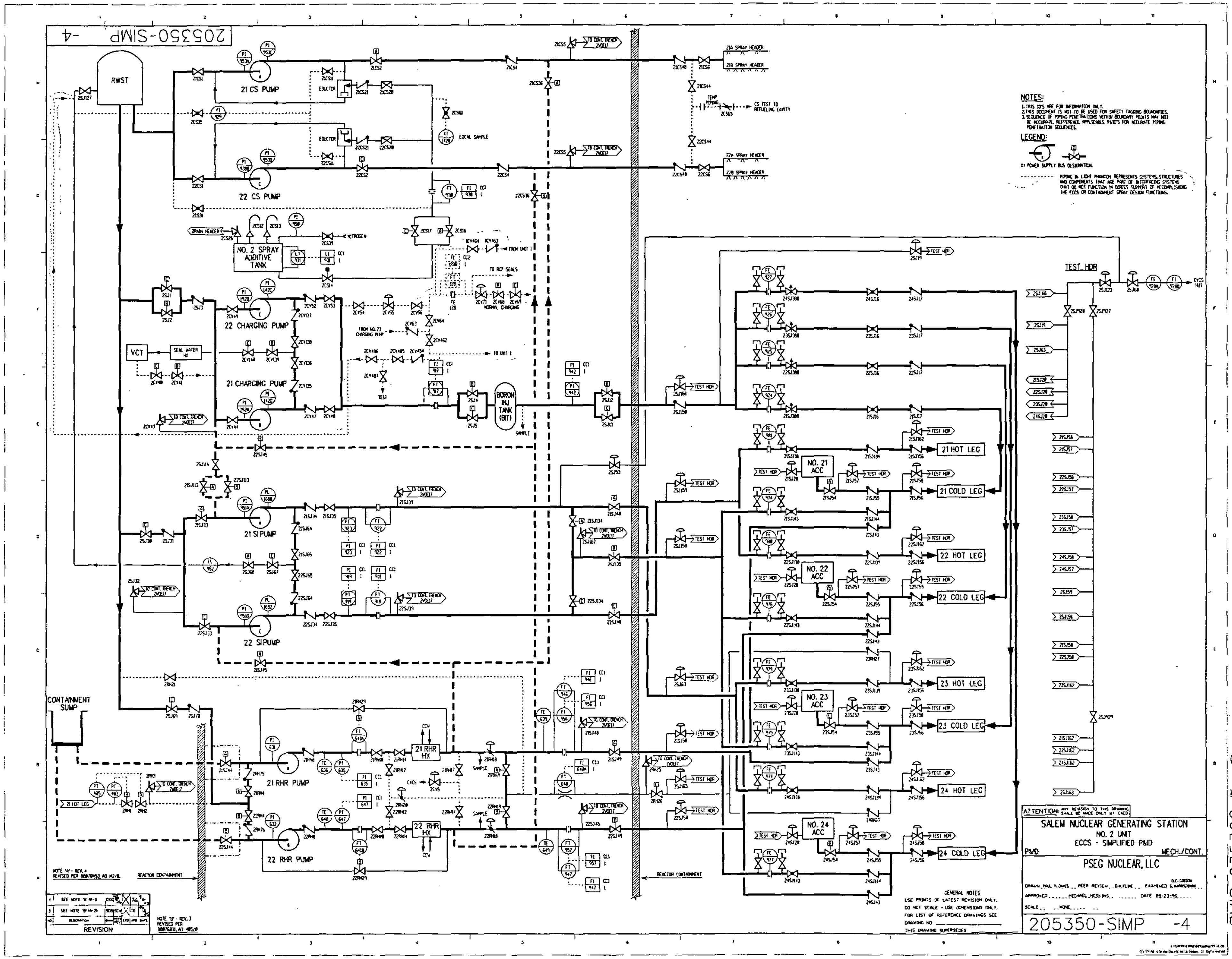
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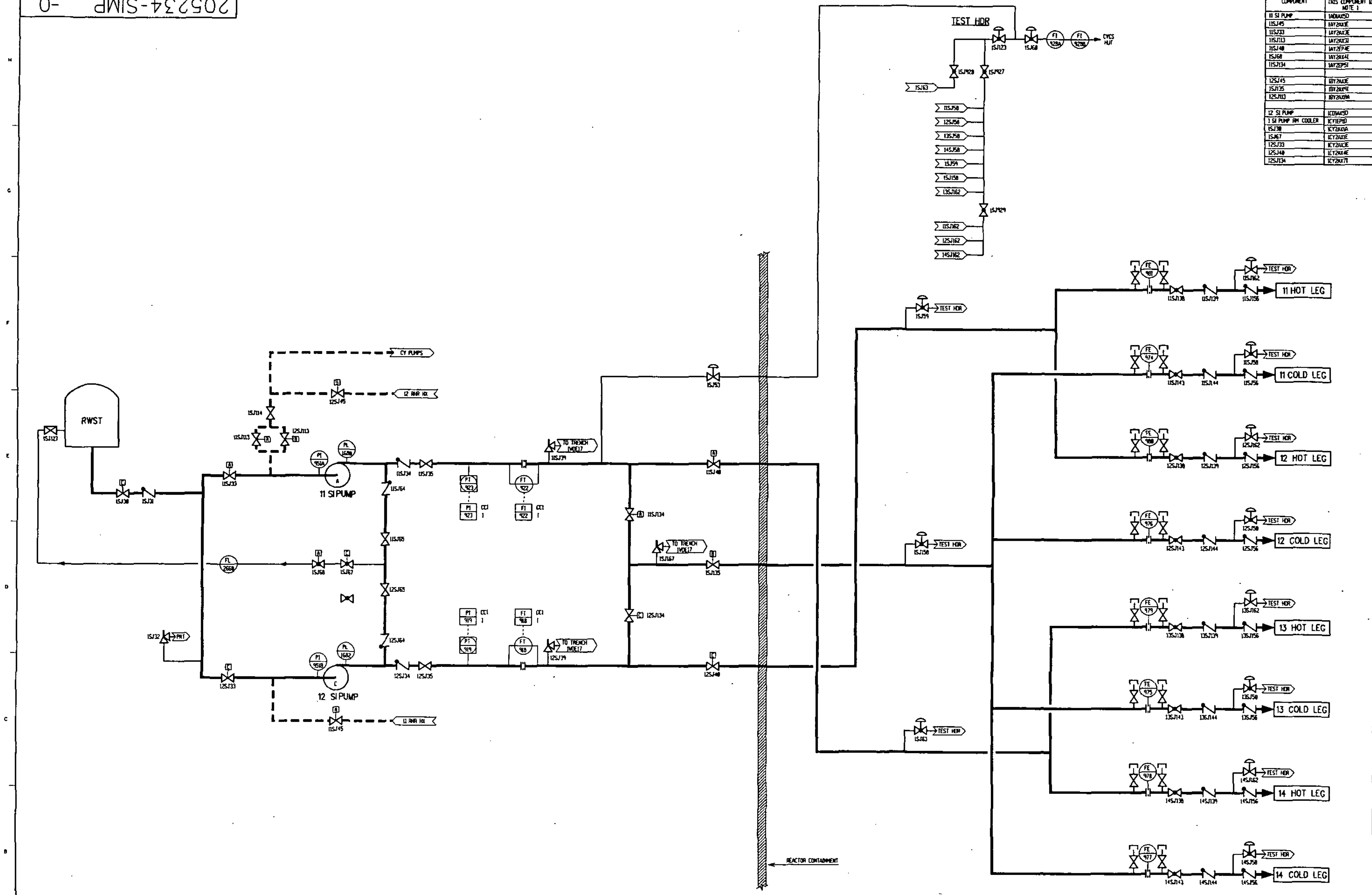

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11SJ40	1AY2EP4E
1SJ68	1AY2AX4I
11SJ134	1AY2EP5I
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1SJ135	1BY2AX9I
12SJ113	1BY2AX8A
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1SJ67	1CY2AX1E
12SJ33	1CY2AX3E
12SJ40	1CY2AX4E
12SJ134	1CY2AX7I

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NO. 1 UNIT
SAFETY INJECTION SIMPLIFIED P&ID

P&ID MECH./CONT.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NUCLEAR DEPARTMENT

DRAWN ______ PEER REVIEW ______ EXAMINED ______
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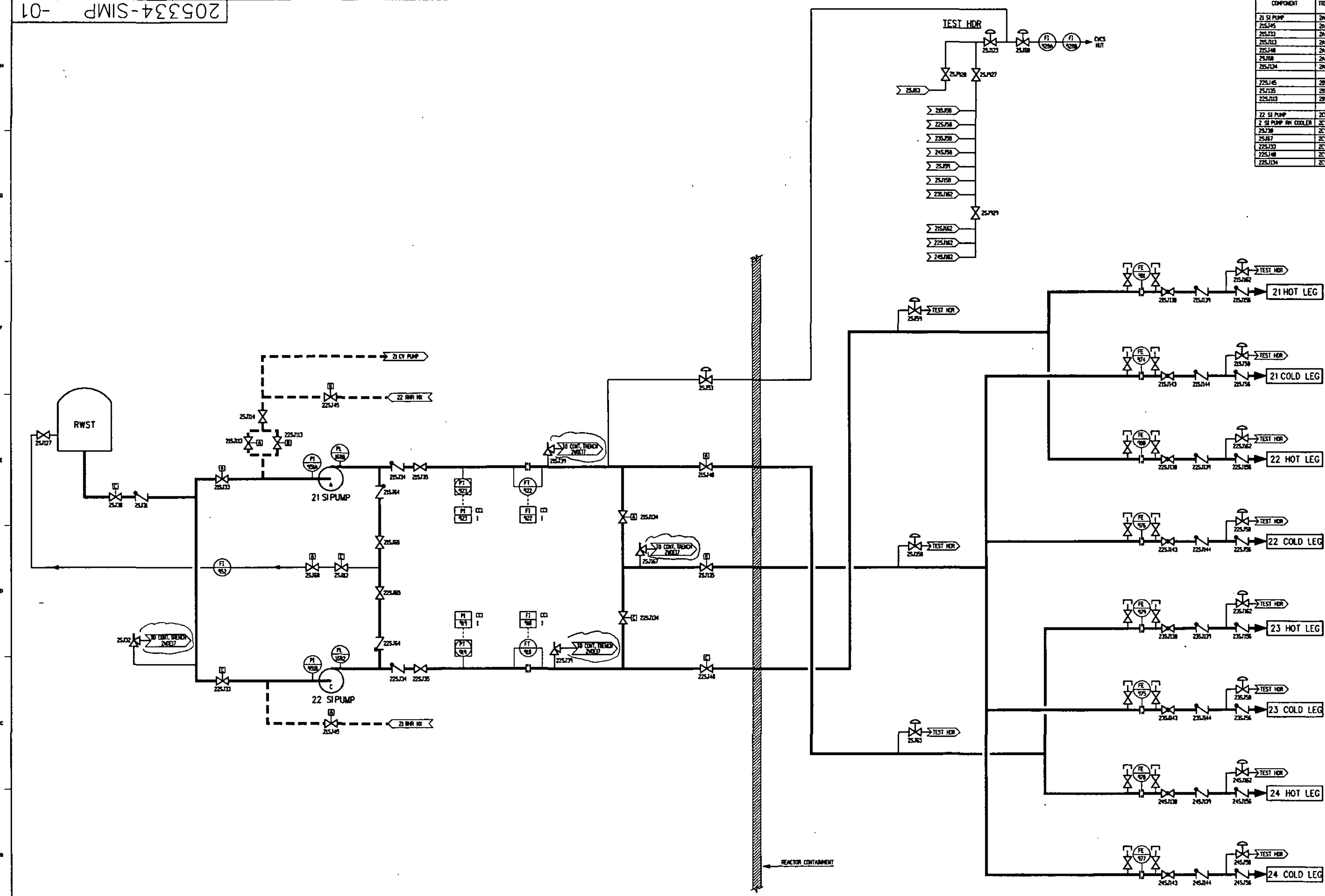

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22SJ33	2CY2AXCE
22SJ40	2CY2AX4E
22SJ134	2CY2AX71

NOTE "B" - REV.1
REVISED (4) OFF-PAGE CONN'S. (VARIOUS ZONES).
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1	SEE NOTE "B" (A-1)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0	SEE NOTE "A" (A-2)	PMD	DWC BB	JH POD	MH	[illegible]
NO	DESCRIPTION	DWN	PEER REV	EXAM	APVD	DATE

REVISION

NOTE "A" - REV.0
ORIGINAL ISSUE.
REVISION SUPERSEDES AND INCORPORATES
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LEGEND:
X= POWER SUPPLY BUS DESIGNATION

CAED ORIGINAL

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SALEM NUCLEAR GENERATING STATION
NO. 2 UNIT
SAFETY INJECTION SIMPLIFIED P&ID
P&ID MECH./CONT.

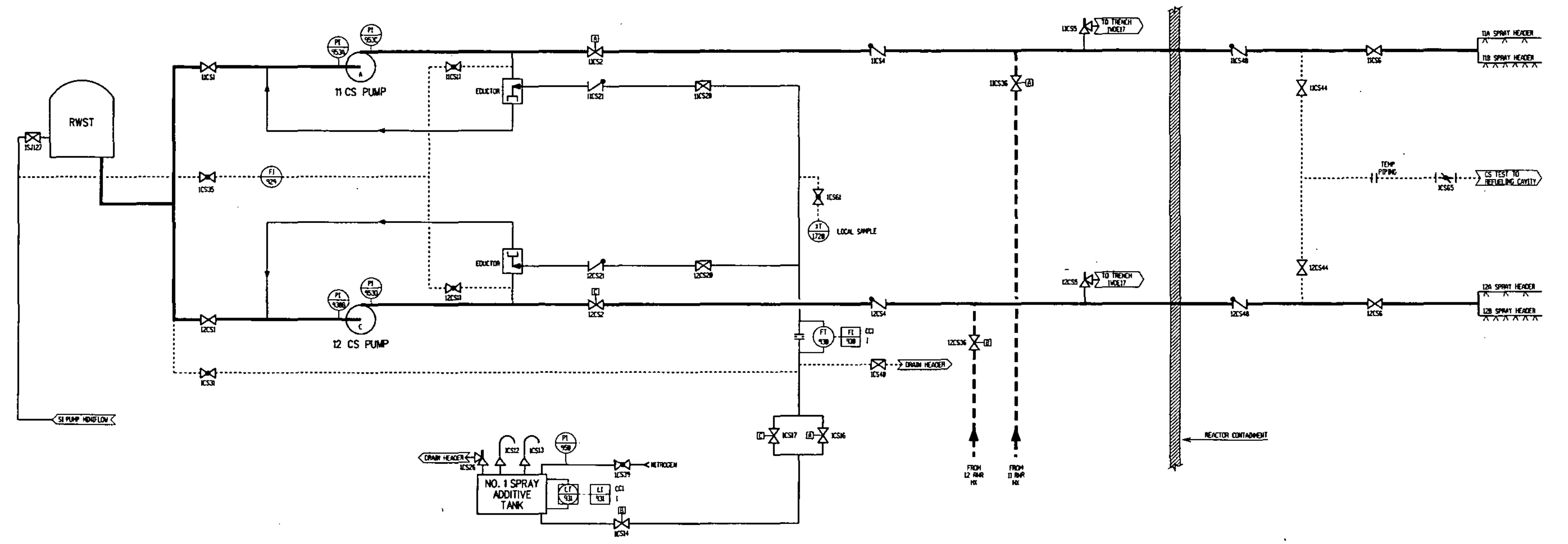
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NUCLEAR DEPARTMENT

DRAWN PAUL B. DAVIS PEER REVIEW [illegible] EXAMINED [illegible]
APPROVED MICHAEL MOSKDWR DATE 11-05-98
SCALE NONE

205334-SIMP -01

205235-SIMP -0

COMPONENT	TRIS COMPONENT ID NOTE 1
11 CS PUMP	1AOUAX20
11 CS PUMP RM COOLER	1AY1EP2G
1CS16	1AY2AX0A
11CS2	1AY2AX3A
11CS36	1AY2EP1D
1CS14	1BY2AX4A
12CS36	1BY2AX6E
12 CS PUMP	1CD1AX20
12 CS PUMP RM COOLER	1CY1EP2G
1CS17	1CY2AX2E
12CS2	1CY2AX21



NOTES:

1. TRIS ID'S ARE FOR INFORMATION ONLY.
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LEGEND:

X: POWER SUPPLY BUS DESIGNATION.

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NO. 1 UNIT
CONTAINMENT SPRAY SIMPLIFIED P&ID
P&ID MECH./CONT.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NUCLEAR DEPARTMENT

DRAWN PAUL H. DAVIS PEER REVIEW EXAMINED
APPROVED DATE 6-14-22
SCALE NONE

205235-SIMP -0

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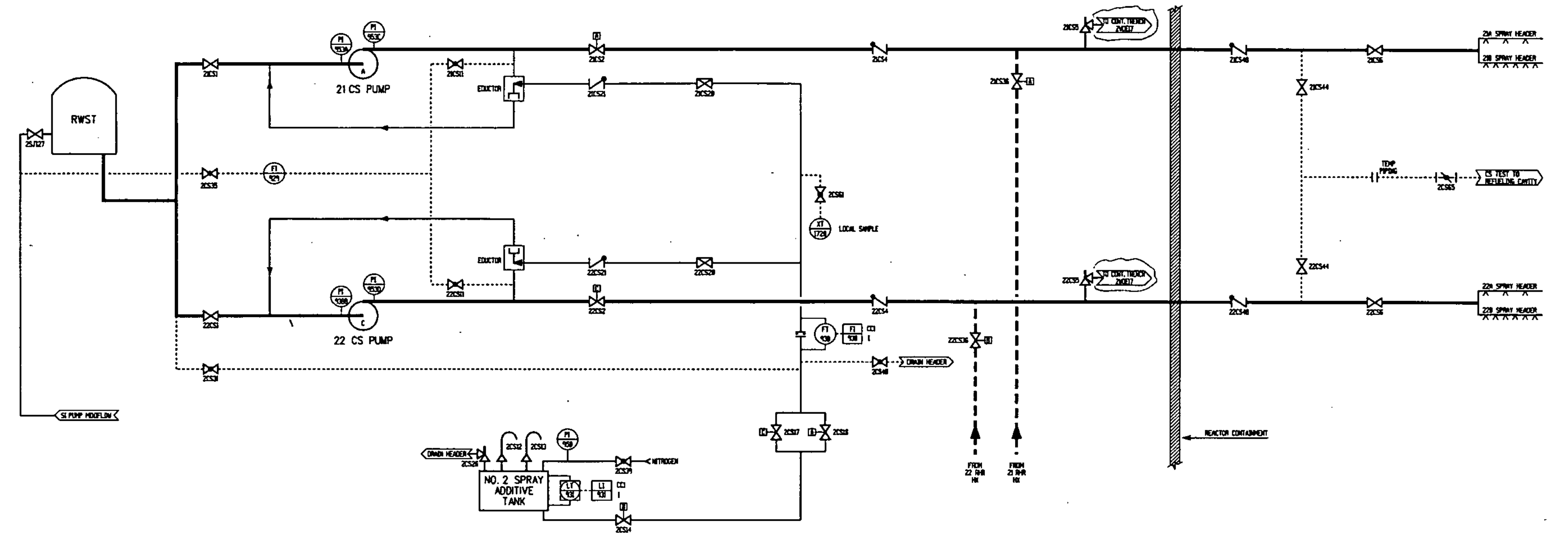
NOTE "A" - REV. 0
ORIGINAL ISSUE.
REVISION SUPERSEDES AND INCORPORATES 1EZ-1754 DOCUMENT ONLY CHANGE.

NO	DESCRIPTION				
0	SEE NOTE "A"				

REVISION

COMPONENT	TRIS COMPONENT ID NOTE 1
21 CS PUMP	2ADLAX2D
21 CS PUMP RM COOLER	2AY1EP26
2CS16	2AY2AX3A
21CS2	2AY2AX3A
21CS36	2AY2EP1E
2CS14	2BY2AX4A
22CS36	2BY2AX6E
22 CS PUMP	2CDIAX2D
22 CS PUMP RM COOLER	2CY1EP26
2CS17	2CY2AX2E
22CS2	2CY2AX21



NOTES:
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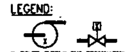
3. SEQUENCE OF PIPING PENETRATIONS WITHIN BOUNDARY POINTS MAY NOT BE ACCURATE. REFFERENCE APLICABLE P&ID'S FOR ACCURATE PIPING PENETRATION SEQUENCES.

LEGEND:



X= POWER SUPPLY BUS DESIGNATION.

NOTE "B" - REV. 1
REVISED: (2) OFF-PAGE CONN'S, E-8 & G-8L
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NO	DESCRIPTION	DRWN	PEER REV	EXMD	APPD	DATE
1	SEE NOTE "B" (A-1)	DLM				
0	SEE NOTE "A" (A-2)	PHD	DWK BB	JM POD	MH	

REVISION

NOTE "A" - REV. 0
ORIGINAL ISSUE.
REVISION SUPERSEDES AND INCORPORATES
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PUBLIC SERVICE ELECTRIC AND GAS COMPANY
NUCLEAR DEPARTMENT

DRAWN PAUL H. DAVIS PEER REVIEW D.K.K./B.B. EXAMINED J.M./P.F./O.D.
APPROVED MICHAEL HOSKINS DATE 12-20-96
SCALE NONE

205335-SIMP -01

205335-SIMP