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Director
Nuclear Regulatory Affairs

GL 2004-02

November 12, 2009

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

Subject: **Docket Nos. 50-361 and 50-362**
NRC Generic Letter 2004-02 Supplemental Response
San Onofre Nuclear Generating Station Units 2 and 3

References:

1. SCE to NRC October 30, 2008 Letter, Michael P. Short to Document Control Desk; Subject: Extension Request Related to Generic Letter 2004-02, San Onofre Nuclear Generating Station, Units 2 and 3

2. SCE to NRC February 27, 2008 Letter, Ross T. Ridenoure to Document Control Desk, Subject: NRC Generic Letter 2004-02, San Onofre Nuclear Generating Station, Units 2 and 3

3. SCE to NRC February 23, 2009 Letter, A. Edward Scherer to Document Control Desk, Subject: Response to Request for Additional Information, Generic Letter 2004-02, San Onofre Nuclear Generating Station, Units 2 and 3

Dear Sir or Madam:

By Reference 1, Southern California Edison (SCE) requested an extension of the completion date for Generic Letter (GL) 2004-02 closeout for San Onofre Nuclear Generating Station (SONGS) Units 2 and 3, consistent with the schedule discussion during an October 3, 2008 teleconference. SCE committed to complete a chemical effects retest program and identify any additional modifications by November 20, 2009. This letter provides the required supplemental response for SONGS Units 2 and 3. In summary, the retest program is complete and no additional plant modifications are required.

This response is formatted as follows:

1. Attachment 1 is an item-by-item response to the agreed-upon Content Guide, annotated and modified, as required, to reflect program changes subsequent to the February 27, 2008 supplemental response (Reference 2).

2. Attachment 2 is an item-by-item response to the list of open items produced during the 2006 NRC audit, annotated and modified, as required, to reflect program changes that were subsequent to the February 27, 2008 supplemental response (Reference 2).

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P.O. Box 128
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3. Attachment 3 is a matrix showing the SCE responses to Requests for Additional Information (RAI) received subsequent to the February 27, 2008 supplemental response (Reference 2), and referencing sections in Attachments 1 and 2 where the RAI responses are detailed.

4. Attachment 4 is a comprehensive list of references cited in Attachments 1, 2, and 3.

The following two commitments are applicable:

1. As discussed in this submittal in Attachment 1, Section 3.n.i; Attachment 2, Open Item 20; and Attachment 3, Item B.1, SCE plans to perform the necessary evaluations prescribed by Westinghouse topical report WCAP-16793-NP relative to potential fuel debris blockage, once the associated NRC Safety Evaluation (SE) is issued.

2. Reference 3 and this supplemental response credit the replacement of Units 2 and 3 steam generators. The Unit 2 replacement steam generators are being installed during the ongoing cycle 16 refueling outage. The Unit 3 replacement steam generators are scheduled to be installed during the fall 2010 cycle 16 refueling outage.

This supplemental response contains no other commitments.

If you have any questions or require any additional information, please contact Ms. Linda T. Conklin at (949) 368-9443

Sincerely,

Loyd Wright for

Attachments: as stated

cc: E. E. Collins, Regional Administrator, NRC Region IV
R. Hall, NRC Project Manager, San Onofre Units 2 and 3
G. G. Warnick, NRC Senior Resident Inspector, San Onofre Units 2 and 3

ATTACHMENT 1

CONTENT GUIDE SUPPLEMENTAL RESPONSE

Attachment 1

CONTENT GUIDE FOR GENERIC LETTER 2004-02 SUPPLEMENTAL RESPONSES

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 generic letter. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect that credit has been taken in the analysis and testing for the reduced mineral wool debris quantity associated with the pending replacement steam generators. The list of significant conservatisms has also been revised.

Southern California Edison (SCE) has completed the analyses and testing; and has completed the physical plant modifications for Units 2 & 3 associated with the replacement sump screens and ancillary insulation and barrier modifications described below, in order to ensure that the Emergency Core Cooling Systems (ECCS) and Containment Spray Systems (CSS) will function under debris loading conditions and will be in compliance with the GL 2004-02 Regulatory Requirements. Additionally, programmatic controls are in place to ensure compliance is maintained, as described in Section 3.i below.

The analyses and testing work performed credits the pending replacement steam generator projects for reduction of the mineral wool debris quantity, as the replacement steam generators are insulated with reflective metallic insulation. The Unit 2 steam generators will be replaced during the Unit 2 Cycle 16 refueling outage that commenced in September 2009, and the Unit 3 steam generators will be replaced during the Unit 3 Cycle 16 refueling outage that is currently scheduled to commence in October 2010.

Outside of the steam generator replacement, the primary physical plant modification consists of replacement of the screens on the circumference of the emergency sump pits with vertically oriented cylindrical "Top-Hat" screens filling the sump pits. This configuration provides approximately 976 square feet of screen area in each of the two separate trains in each unit; the old configuration provided only approximately 75 square feet per train.

Analyses and testing (including chemical effects) have been performed demonstrating that the as-installed replacement screens would provide sufficient NPSH margin throughout the post-LOCA mission duration. Downstream effects evaluations have been performed that conclude that there would be no detrimental effects due to debris that bypasses the replacement screens.

Ancillary modifications consist of replacement of Microtherm insulation with Reflective Metallic Insulation (RMI) on select piping within containment to minimize the Microtherm debris source term, and modification of the bioshield gates to preclude debris and water hold-up.

Significant conservatisms in the design are as follows:

1. Each of the two screens per generating unit is sized for 100% of the quantity of debris that is calculated to be transported to the sump.
2. The analyses and testing were performed assuming the High Pressure Safety Injection (HPSI), Containment Spray (CS), and Low Pressure Safety Injection (LPSI) pumps operate at run-out flow, rather than at the design operating point.
3. No credit for leak-before-break was taken in the SONGS GSI-191 evaluation.
4. The calculated minimum water level inside containment is based on the small-break LOCA, which results in a lower water level than a large-break LOCA, while the quantity of debris generated and transported to the sump is based on the large-break LOCA, which results in a higher quantity of debris being generated than the small break LOCA.
5. The Debris Generation calculation is based on the quantity of qualified coatings within a 5 L/D ZOI, rather than the 4 L/D ZOI afforded by WCAP-16568-P, Rev. 0.
6. The debris transport calculation assumes the higher recirculation flow (9000 gpm) associated with the failure of a LPSI pump to trip on one train, coupled with design recirculation flow (3500 gpm) on the other train. In combination with Item 1 above, the debris calculated to be transported to the single sump screen is based on a transport flow rate of greater than 3-1/2 times the design single-train flow rate.
7. No credit was taken for hold up of debris in the reactor cavity. Settling in the reactor cavity may be significant for the Microtherm debris case, as the Microtherm is located on the reactor vessel within the cavity.
8. Large and small pieces of insulation debris are assumed to be uniformly distributed along the flowpath between the debris generation source and the sump strainers. In actuality, it is expected that multi-directional flows would occur during the blowdown and pool fill-up phases which would disperse the debris throughout containment – including areas with reduced transport flows.
9. All debris from upper containment is assumed to be washed down into the containment pool; no credit is taken for capture of debris on gratings or floors in upper containment.
10. 100% of the small fines fibrous and particulate debris in active volumes of the containment pool is conservatively assumed to be transported to the sumps.
11. The vortex testing in essence simulated blockage of nearly 80% of the top-hat screen surface, a significant increase above the 50% blockage criteria in the original licensing basis. Additionally, vortex testing was conducted down to 4 inches of submergence, well below the nominal 1 foot minimum submergence postulated post-LOCA.
12. The prototypical head-loss tests were conducted utilizing 42" top-hats in lieu of the 65" top-hats installed in the plant, due to test-tank geometry limitations. This is considered to provide conservative test results, because the shorter top-hats tend to promote more uniform debris loading, and correspondingly less open area.
13. Credit is only taken for the interstitial volume between the strainer top-hats, ignoring the potential for debris to fill the space between the flow plenums and sump side walls, or to fill the open area between the plenums adjacent to the ECCS suction piping.
14. All unqualified coatings, labels, and tags are assumed to be transported to the sump at the onset of recirculation. This is conservative in that these materials will most likely require a period of time for them to fail (if they were to fail), and NPSH margins are significantly higher as the post-LOCA period progresses.

15. The mineral wool debris eroded from small pieces in the pool is assumed to be generated at the onset of the event, rather than over the 30-day mission period.
16. All of the non-chemical debris postulated to transport to the sump is assumed to be transported to the sump at the onset of recirculation.
17. The NPSH margin evaluation conservatively does not credit containment overpressure post-LOCA.
18. In the evaluation of deaeration across the debris bed and postulated impact on the pump NPSH required, all of the fluid is conservatively assumed to flow though the bed at the minimum screen submergence level, thereby maximizing the amount of air evolving from the liquid. Additionally, it is conservatively assumed that none of the air is absorbed back into solution as the water transits to the pumps, which are located at a substantially lower elevation.
19. The Downstream Effects Evaluations, except for the WCAP 16793 fuel evaluation, are based on the quantity of qualified coatings within a 10 L/D ZOI, rather than the 4 L/D ZOI afforded by WCAP-16568-P, Rev. 0.
20. For the Downstream Effects Evaluations, 100% of the particulate is assumed to bypass the screens; no credit is taken for filtering of the particulate by the fibrous debris bed.
21. For the chemical effects evaluations, the maximum water level is used in order to maximize the amount of chemical precipitates generated, whereas for the NPSH calculations, the minimum water level is used.
22. The chemical debris is assumed to be transported to the sump immediately upon generation.

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 <u>Requested Information</u> 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.)

GL 2004-02 Requested Information Item 2(b)

A general description of and implementation schedule for all corrective actions, including any plant modifications, that you identified while responding to this generic letter. Efforts to implement the identified actions should be initiated no later than the first refueling outage starting after April 1, 2006. All actions should be completed by December 31, 2007. Provide justification for not implementing the identified actions during the first refueling outage starting after April 1, 2006. If all corrective actions will not be completed by December 31, 2007, describe how the regulatory requirements discussed in the Applicable Regulatory Requirements section will be met until the corrective actions are completed.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C), to summarize the work performed following submittal of the Supplemental Response.

A general description of corrective actions was provided as a part of the September 1, 2005 Generic Letter 2004-02 response (Reference A), as acknowledged and summarized in Section 1.3 of the NRC Audit Report (Reference B) dated May 16, 2007.

At the time of the February 2008 Supplemental Response (Reference C), SCE had completed the debris generation and debris transport calculations, the downstream effects evaluations in accordance with WCAP-16406-P, Rev. 1; array non-chemical head loss testing in Alion Science and Technology's Warrenville laboratory; and integrated 30-day chemical effects testing at the VUEZ laboratory.

In a letter dated September 17, 2008 (Reference D), the NRC issued a request for additional information (RAI) related to the test protocol used in the VUEZ chemical effects testing. The RAI letter suggested that in lieu of addressing the 18 specific questions on the in-situ VUEZ test protocol, an alternate testing approach could be considered. In a response letter dated October 30, 2008 (Reference E), SCE committed to performing a retest, utilizing WCAP-16530 chemical precipitates.

In a letter dated November 26, 2008 (Reference F), the NRC issued a request for additional information (RAI) related to the February 27, 2008 Supplemental Response (Reference C). Many of these RAI were follow-up questions to Audit Report (Reference B) Open Item responses provided by SCE in the Supplemental Response. SCE provided responses to the RAI in a letter dated February 23, 2009 (Reference G); in addition, SCE indicated that credit would be taken for the pending steam generator replacement projects, in order to reduce the quantity of mineral wool debris. The RAI responses are also incorporated into the appropriate sections in this updated Supplemental Response.

The retest was conducted during the first two weeks of June 2009; the test plans, procedures, and results are described herein.

With respect to the physical plant modifications, the Unit 3 screen installation, bioshield gate modifications, and Microtherm-to-RMI insulation change-out were performed in Unit 3 during the U3C14 refueling outage at the end of 2006. Essentially identical modifications were performed in Unit 2 during the U2C15 refueling outage, which commenced on November 26, 2007 and concluded on January 19, 2008.

The recently completed analysis and testing work take credit for the reduced quantity of mineral wool insulation on the replacement steam generators. The Unit 2 steam generators will be replaced during the Unit 2 Cycle 16 refueling outage that commenced in September 2009, and the Unit 3 steam generators will be replaced during the Unit 3 Cycle 16 refueling outage that is currently scheduled to commence in October 2010.

Also outstanding is performance of the evaluations prescribed by WCAP 16793-NP, Revision 1 to ensure long-term core cooling, once the corresponding Safety Evaluation is issued by the NRC.

In SCE's RAI response letter of October 30, 2008 (Reference E), SCE included a detailed description of mitigative actions already taken to minimize the risk of degraded Emergency Core Cooling System and Containment Spray System functions pending completion of the work. These measures include procedural guidance and training; containment cleanliness and control of debris sources; containment coatings, and permanent modifications, including the installation of the top-hat screens, replacement of Microtherm insulation with RMI on select piping, and modification of the bioshield gates to preclude debris and water hold-up.

3. Specific Information Regarding Methodology for Demonstrating Compliance:

a. 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.

i. Describe and provide the basis for the break selection criteria used in the evaluation.

> *This section remains unchanged, except for adding reference numbers, from that provided in the February 2008 Supplemental Response (Reference C).*
>
> The break selection criteria are based on identifying the break size and location that presents the greatest challenge to the post-LOCA emergency sump performance. The evaluation performed complies with the NRC Safety Evaluation (SE) of NEI 04-07 (Reference 3), except for considering breaks every 5 feet along the subject piping. Instead, breaks were considered at key points relative to insulation damage potential. The approach taken and exception noted were reviewed by the NRC as documented in Section 3.1 of the Audit Report (Reference B), and found to be acceptable.

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

> *This section remains unchanged, except for adding reference numbers, from that provided in the February 2008 Supplemental Response (Reference C).*
>
> Secondary line breaks are not considered in the evaluations. Per UFSAR (Reference 4) Table 7.3-1, only a large break or small break LOCA results in recirculation operation of the Containment Emergency Sump. This determination was reviewed by the NRC as documented in Section 3.1 of the Audit Report (Reference B), and found to be acceptable.

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

> *This section remains unchanged, except for adding reference numbers, from that provided in the February 2008 Supplemental Response (Reference C).*
>
> This was reviewed by the NRC as documented in Section 3.1 of the Audit Report (Reference B), and found to be acceptable.

b. 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.

i. 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.

> *This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect the revised calculation approach for determining the Zone of Influence of a postulated high-energy line break in the reactor cavity on Microtherm insulation located on the reactor vessel.*
>
> SONGS used a Zone of Influence approach as described in the NEI 04-07 SE (Reference 3). SONGS took exception to the ZOI prescribed in the SE for mineral wool, citing the similarity between the encapsulation systems for mineral wool and RMI at SONGS. The SONGS approach for the debris generation evaluation, and the 4D ZOI exception taken for stainless steel encapsulated mineral wool were reviewed by the NRC

as documented in Section 3.2 of the Audit Report (Reference B), and found to be acceptable by the NRC.

SONGS also took exception to the SE by considering the reactor vessel as a robust barrier for the stainless steel encapsulated Microtherm on the reactor vessel. As documented in Section 3.2 of the Audit Report (Reference B), the NRC did not agree with this exception, resulting in Open Item 1, for development of a detailed analysis for a restricted pipe break in the reactor vessel annular region.

In response, as detailed in the February 2008 Supplemental Response (Reference C), SCE indicated that the VUEZ testing had been performed using 100% of the Microtherm quantity, with no adverse affects. Subsequently, based on the RAI related to the VUEZ test protocol (Reference D) and Item 7 of the RAI related to the February 2008 Supplemental Response (Reference F), a detailed analysis was performed in support of subsequent testing performed in 2009.

The detailed analysis was performed using the restrained piping jet model methodology developed in ANSI/ANS-58.2 (Reference 20), resulting in a conservative design basis of approximately 8% of the Microtherm on the Reactor Vessel being generated as debris. Please refer to the Audit Open Item List Section (Attachment 2, Open Item 1) of this Submittal for further details.

The ZOI for qualified epoxy coating ZOIs are addressed in Section 3.h.

ii. Provide destruction ZOIs and the basis for the ZOIs for each applicable debris constituent.

This section remains unchanged, except for adding reference numbers, from that provided in the February 2008 Supplemental Response (Reference C).

The ZOIs (excluding coatings) used in the evaluations and the basis for each of the ZOIs were reviewed by the NRC as documented in Section 3.2 of the Audit Report (Reference B). The NRC found these to be acceptable, with the exception of the use of the reactor vessel as a robust barrier as noted in the subsection above.

iii. 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).

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Destruction testing was only performed to determine the ZOI for qualified coatings. Please see Section 3.h for information on coating destruction testing.

iv. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect changes made to credit the replacement steam generator projects in the reduction of mineral wool debris, and to incorporate the analysis for a restricted pipe break in the reactor vessel annular region performed to reduce the quantity of Microtherm debris as described in Section 3.b.i above.

Debris quantities were reviewed by the NRC as documented in Section 3.2 of the Audit Report (Reference B). This Section reviewed the debris types generated by each of the 4 breaks considered. In work subsequent to the NRC Audit, the Debris Generation Calculation (Reference 1) insulation quantities for the Hot Leg Loop 1 and Hot Leg Loop 2 cases were revised to reflect that the replacement steam generators will be insulated with reflective metallic insulation, in lieu of the mineral wool insulation present on the existing steam generators. For these same break cases, the mineral wool debris associated with the Steam Generator sampling lines was added.

With the significant reduction in the quantity of mineral wool debris generated by a break in the steam generator compartment within the bioshield, lines outside the bioshield were evaluated to assess whether or not a different break location would produce a governing mineral wool debris quantity. Five potential break locations where mineral wool debris would be generated were identified, as documented in the Debris Generation Calculation (Reference 1). A break in the Low Pressure Safety Injection (LPSI) Line 45, in the vicinity of Main Steam Line 002 was found to produce the governing quantity of mineral wool. The net result of the evaluations described above is a reduction in the mineral wool debris quantity from that reviewed during the Audit of approximately 80%.

As described above in Section 3.b.i, the Microtherm debris quantity was recalculated considering a limited-separation line break. The results of this calculation (Reference 22) are that approximately 8% of the total Microtherm on the reactor vessel in the vicinity of the hot and cold leg lines is generated as debris. The Microtherm debris head loss test of record was conducted with Microtherm debris loading of approximately 17% of the total quantity; in addition, a sensitivity test was performed using 100% of the total quantity. Additional detail is provided in Section 3.o of this submittal.

Two debris cases were evaluated through head loss testing: 1) A line break that generates mineral wool, coatings, and latent debris; and 2) A line break that generates Microtherm, coatings, and latent debris.

A summary of the plant debris loads, taken from the SCE debris margin calculation (Reference 72), is provided in the table below.

Table 3.b-1 – Summary of Plant Debris Loads, as Generated

Debris Type	Mineral Wool Debris Case	Microtherm Debris Case
Mineral Wool (ft^3)	16.65	-
Microtherm (ft^3)	-	1.78
Qualified Epoxy (On Concrete) (ft^3)	4.73	4.82
Qualified Epoxy (On Steel) (ft^3)	1.60	1.20
Unqualified Coating (ft^3)	0.90	0.90
Latent Fiber (ft^3)	9.69	9.69
Latent Dirt and Dust (ft^3)	0.78	0.78

v. Provide total surface area of all signs, placards, tags, tape, and similar miscellaneous materials in containment.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Please see Section 3.d, Latent Debris.

c. 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.

i. Provide the assumed size distribution for each type of debris.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect a revision to the mineral wool debris size distribution.

The debris characteristics used in the transport analysis and strainer head loss evaluations were either based on NEI 04-07 SE, or determined from data obtained from published reports. The debris characteristics used in the evaluations were reviewed by the NRC as documented in Audit Report (Reference B) Section 3.3. The review found that the debris characteristics used in the evaluations were acceptable, with the exception of the size distribution utilized for mineral wool. As a result of this review, Open Item 2 was generated to address the size distribution of mineral wool taken as 20% fines and 80% small pieces. Additional justification for this size distribution was included in a revision to the Alion Sciences and Technology Debris Generation Calculation (Reference 1, Section 4.5.9), and briefly described in the February 2008 Supplemental Response (Reference C).

In the NRC's RAI letter of November 26, 2008 (Reference F), Item 2 requested additional justification for the 20% fines / 80% small pieces mineral wool debris size distribution. The additional information provided in Alion's calculation was excerpted in SCE's RAI response letter of February 23, 2009 (Reference G). While the arguments put forth in the calculation excerpt were felt to justify the use of the 20% / 80% size distribution, in order to bound the potential exposure relative to this issue, the amount of fines was doubled - resulting in a revised mineral wool debris size distribution of 40% fines / 60% small pieces.

Please see Open Item 2 in Attachment 2 of this submittal for further details.

ii. 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.

This section remains unchanged, except for adding and clarifying references, from that provided in the February 2008 Supplemental Response (Reference C).

The RMI, mineral wool, Microtherm, latent fiber, and latent particulate characteristics used in the evaluations were reviewed by the NRC, as documented in Section 3.3 of the Audit Report (Reference B). The NRC found the characteristics to be acceptable, with the exception of the mineral wool size distribution, which is addressed in Section 3.c.i above.

iii. Provide assumed specific surface areas for fibrous and particulate debris.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Specific surface areas of fibrous and particulate debris were not utilized in the SONGS analyses. Head loss was determined through testing, not through NUREG 6224-based evaluations.

iv. Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.

This section remains unchanged, except for adding and clarifying references, from that provided in the February 2008 Supplemental Response (Reference C).

The technical bases for the debris characterization assumptions (except for coatings) used in the evaluations were reviewed by the NRC as documented in Section 3.3 of the Audit Report (Reference B). The NRC found the debris characterizations acceptable, with the exception of the mineral wool size distribution, which is addressed in Section 3.c.i above.

d. 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.

i. Provide the methodology used to estimate quantity and composition of latent debris.

This section remains unchanged, except for adding reference numbers, from that provided in the February 2008 Supplemental Response (Reference C).

The methodology used to estimate the quantity of latent debris within the containment was based on walk downs and selected sampling of various areas in the containment. Based on the sampling data, the quantity of Latent Debris was estimated.

The methodology used for estimating the quantity and composition of latent debris in the SONGS containment was reviewed by the NRC as documented in Section 3.4 of the Audit Report (Reference B). The NRC concluded that the SONGS methodology was performed in a manner consistent with the NEI 04-07 SE (Reference 3) approved methodology. Audit Open Item 3 was generated as a result of the review, resulting in the update of documentation for the Latent Debris evaluation of Unit 2. Please see Attachment 2 of this submittal for further details.

ii. Provide the basis for assumptions used in the evaluation.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Please see the discussion in the subsection above.

iii. 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.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Please see the discussion in subsection d.i above.

iv. Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.

This section remains unchanged, except for adding and clarifying references, from that provided in the February 2008 Supplemental Response (Reference C).

At the time of the NRC Audit, miscellaneous debris had not been included in the analyses. Audit Open Item 3 resulted from the audit review, noting that procedure SO23-XV-23.1.1 (Reference 64), Attachment 1, identified miscellaneous debris in the Unit 3 containment. Subsequent to the Audit, it was determined through walkdown that Unit 3 bounds Unit 2 relative to miscellaneous debris, and 50 ft^2 of sacrificial area has been included in the Alion Debris Generation Calculation (Reference 1). Please see Attachment 2 of this submittal for further details.

e. 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.

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

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to revise the response in the following areas: 1) Mineral wool transport by flotation, 2) Containment spray drainage, and 3) Mineral wool erosion.

The evaluation uses a Transport Tree approach, with evaluations used to determine the transport fractions associated with the branches of the Transport Tree. Refinements to the NEI 04-07 SE (Reference 3) included 4 debris sizes, Computational Fluid Dynamics (CFD) analysis of containment pool transport, erosion of small and large pieces, washdown of debris after filling of inactive pool volumes, and direct transport to the sump in selected cases. The transport methodology was reviewed by the NRC as documented in Section 3.5 of the Audit Report (Reference B), and found to be acceptable with the following exceptions:

Open Item 4 addresses the assumed incipient tumbling velocity for mineral wool, and was addressed by providing additional justification for the assumptions made, in the February 2008 Supplemental Response (Reference C).

Open Item 5 addresses mineral wool transport by floatation. A response was provided in the February 2008 Supplemental Response; however; a request for additional information was received in the NRC's letter of November 26, 2008 (Reference F), Item 3, which clarified the issue. An analysis was performed, as documented in SCE's letter of February 23, 2009 (Reference G), demonstrating that insufficient mineral wool debris is generated to cause screen blockage from the top by floating debris. This analysis has been revised for this submittal to reflect the reduced mineral wool quantity associated with the replacement steam generators. This is coupled with an assumption that 40% of the mineral wool debris is generated as large pieces, consistent with the NEI 04-07 SE (Reference 3) size distribution for other fibrous insulation types. The analysis shows that there is insufficient large-piece mineral wool debris to bridge the sump opening. Please see Open Item 5 in Attachment 2 for further details.

Open Item 6 relates to the potential effects of concentrated spray drainage, including its effect on the local velocity and turbulence fields in the sump pool. In response, the February 2008 Supplemental Response (Reference C) described revisions made to the Alion Science and Technology Debris Transport Calculation (Reference 2) that resulted in increases to the debris transport fraction. In the NRC's RAI letter of November 26, 2008 (Reference F), additional clarification was requested in Item 4, which was provided in SCE's response letter of February 23, 2009 (Reference G).

Open Item 6 also relates to the long-term erosion of pieces of mineral wool debris that do not transport to the sump screen. In the February 2008 Supplemental Response, testing performed by Alion Sciences and Technology justifying the assumed 10% erosion fraction was briefly described. In the NRC's RAI letter of November 26, 2008 (Reference F), additional information on the Alion testing was requested in Item 4; SCE's response letter of February 23, 2009 (Reference G) provided a summary of the testing. Notwithstanding that SCE believes that the Alion testing justifies the use of the 10% erosion fraction, SCE indicated in the response letter that the NEI 04-07 SE (Reference 3) default erosion fraction of 90% would be used. The Debris Transport Calculation (Reference 2) was revised accordingly

Open Item 7 requested justification of graphically determined transport fractions from Figures 5.9.26 and 5.9.32 in the audited Debris Transport Calculation. Open Item 7 was resolved by increasing the debris transport fractions in the Debris Transport Calculation (Reference 2).

Please see Attachment 2 of this submittal for further details on these items.

ii. Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.

This section remains unchanged, except for adding references, from that provided in the February 2008 Supplemental Response (Reference C).

The technical bases for the assumption and methods used in the Debris Transport analysis were reviewed by the NRC as documented in Section 3.5 of the Audit Report (Reference B), and found to be acceptable with the exception of the Open Items listed above.

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

This section remains unchanged, except for adding references, from that provided in the February 2008 Supplemental Response (Reference C).

The Debris Transport Analysis utilized the Flow 3-D, Version 8.2 computational fluid dynamics code. The methodology, modeling assumptions and results were reviewed by the NRC as documented in Section 3.5 of the Audit Report (Reference B), and found to be acceptable with the exception of the Open Items listed above.

iv. Provide a summary of, and supporting basis for, any credit taken for debris interceptors.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

No debris interceptors are credited.

v. State whether fine debris was assumed to settle and provide basis for any settling credited.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

No credit was taken for Stokes Law settling or turbulent kinetic energy settling.

vi. Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the strainers.

This section was revised from that provided in the February 2008 Supplemental Response (Reference C), to reflect an increase in the debris transport fraction due to resolution of Open Items and follow-up RAI.

The debris transport fractions and total quantities of debris by type transported to the strainers were reviewed by the NRC as documented in Section 3.5 of the Audit Report (Reference B), and found to be acceptable, with the exception of Open Items 4, 5, 6 and 7. As a result of resolution of the Audit Open Items and follow-up RAI described in the subsections above, the debris transport fractions for insulation debris were increased, as documented in the Debris Transport Calculation (Reference 2). Additionally, as a result of Open Item 2 and follow-up RAI, revising the mineral wool debris size distribution by doubling the fines also increased the mineral wool debris transport fraction. Of primary interest, the net impact on the transport of mineral wool insulation from the postulated steam generator compartment break increased from 72% at the time of the Audit, to 98%.

f. 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.

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

This section remains unchanged, except for adding references, from that provided in the February 2008 Supplemental Response (Reference C).

The ECCS schematic diagrams are contained in the SONGS UFSAR (Reference 4), Section 6.3 – Figures 6.3-2 and 6.3-3. The Containment Spray System schematic is contained in UFSAR Section 6.2 – Figure 6.2-46.

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

This section remains unchanged, except for adding references, from that provided in the February 2008 Supplemental Response (Reference C).

The bounding minimum submergence level of the strainer was determined to occur under conditions of a small break LOCA. This small break LOCA containment pool level affords a strainer submergence of approximately 1 foot. The basis for this submergence level was reviewed by the NRC as documented in Section 3.6.1.2.3 of the Audit Report (Reference B), and found to be acceptable.

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

This section remains unchanged, except for adding references, from that provided in the February 2008 Supplemental Response (Reference C).

The vortex evaluation was conducted through tank testing of prototypical top-hat screens, rather than by analytical means. The methodology, assumptions and results of the vortex testing were reviewed by the NRC as documented in Section 3.6.1.4.1 of the Audit Report (Reference B), and found acceptable.

iv. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C), in order to reflect the "Test-for-Success" head loss testing performed in June 2009.

The strainer head loss was determined based on head loss results of prototypical strainer tank tests, using non-chemical fibrous and particulate debris, as well as chemical debris precipitates determined in accordance with WCAP-16530-NP.

The methodology, assumptions and results of the prototypical non-chemical debris head loss testing performed in 2006 were reviewed by the NRC as documented in Section 3.6.1.3 of the Audit Report (Reference B), and found to be acceptable with the exception of two Open Items. Open Item 8 addressed the potential increase in head loss resulting from RMI occupying the interstitial volume of the strainer prior to the mineral wool reaching the strainer, which was not considered in the testing; and Open Item 9 addressed the documentation of resolution of the potential temperature dependence of Microtherm material properties. These items were discussed during the SONGS Audit Exit teleconference on May 8, 2007, and the NRC indicated acceptance of the conclusions reached. Please see Attachment 2 of this submittal for details.

Debris head loss testing was re-performed in June 2009, utilizing the Head Loss Chemical Effects Testing Protocol (Reference 70) prepared by Alion Sciences and Technology. This protocol was developed in accordance with the NRC Staff Review Guidance Regarding Strainer Head Loss and Vortexing (Reference 86), and Guidance Regarding Plant-Specific Chemical Effect Evaluations (Reference 87). A second protocol for applying chemical effects refinements to the hydraulic test results (Reference 71) was also developed by Alion Sciences and Technology.

SONGS-specific Test Plans and Test Procedures (References 75-77) were prepared in accordance with the above-described protocols.

Two tests were performed, as described in the paragraphs below:

The first test was designed to simulate the debris from a high energy line break that would generate mineral wool insulation debris. A hybrid test case was developed that utilized the break generating the bounding mineral wool insulation debris (Break #7, LPSI Line 45 in the vicinity of Main Steam Line 002), with the break generating the bounding qualified coatings debris (Break #5a, Hot Leg break at Steam Generator #1), as determined by the Alion Debris Generation Calculation (Reference 1). The non-chemical debris also includes unqualified coatings, latent fiber and latent dirt/dust. The non-chemical particulate debris was added first, followed by batching of the fibrous debris. Following introduction of all of the non-chemical debris, calcium-based chemical effects precipitates were added, followed by batching of aluminum-based precipitates designed to mimic the temperature-dependent production profile predicted by WCAP-16530.

The second test was designed to simulate the debris from a high energy line break that would generate the bounding quantity of Microtherm insulation debris. A line break at the Reactor Vessel nozzle (Break #3) as defined in the Alion Debris Generation Calculation (Reference 1), generates Microtherm debris and qualified coatings. As documented in the Microtherm Debris Generation Calculation (Reference 22), the debris generated by a break in the Hot Leg governs. The non-chemical debris also includes unqualified coatings, latent fiber and latent dirt/dust. The non-chemical and chemical debris sequencing for the second test was as described above for the first test.

Of the two tests described above, the mineral wool test produced the higher head loss, and governs with respect to NPSH margin. The test demonstrated that the overall strainer head loss, throughout the 30-day mission period, is less than the corresponding available ECCS NPSH margin. Details of the head loss test results and comparison with the NPSH margin available for the debris-laden sump screen are provided in Section 3.o, "Chemical Effects Testing", of this submittal.

v. Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) in order to reflect the reduced mineral wool debris loads associated with the replacement steam generators.

The available interstitial volume afforded by the strainer assembly is calculated in the ENERCON Services, Inc. Hydraulic Analyses (References 48 & 49). The analyses conservatively calculate the available interstitial volume between the strainer top hats, ignoring the potential for debris filling the space between the plenums and sump side walls, or filling the open area between plenums and adjacent to the ECCS suction piping. The calculated interstitial volume per sump is 233 cubic feet.

The Break Case that results in the largest total volume of debris reaching the sump screens following replacement of the Steam Generators is Break No. 5, Hot Leg Break in SG Loop 1. The quantities generated are presented in Tables 6.13, 6.14, and 6.15 of the Debris Generation Calculation (Reference 1); the transport fractions for each debris type for Break 5 are presented in Table 6.1 of the Debris Transport Calculation (Reference 2). The total debris volume postulated to be transported to the sump is developed in a Notification Assignment (Reference 90). The total debris volume is approximately 103 cubic feet, which is substantially below the available strainer interstitial volume of 233 cubic feet. This evaluation conservatively assumes that all debris is directed to a single sump and, as noted above, that no debris falls into the open areas surrounding the plenums.

vi. Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) in order to describe results of the June 2009 head loss testing.

The impact on head loss due to the potential formation of a "thin bed' was tested during the prototypical 3 x 3 top hat strainer array tank tests. In both tests, all of the particulate debris was added at the onset of the test, followed by incremental additions of fiber. As documented in the Alion Array Test Design Input Calculation (Reference 74), for the mineral wool insulation debris test, the total equivalent fiber thickness was approximately 3/8 inch; the total equivalent fiber thickness for the Microtherm insulation debris test was approximately 1/6 inch. The test successfully demonstrated that the Top-Hat geometry precludes formation of a uniform thin-bed at less than the design thickness; following the third of four fibrous debris additions, clean screen was still observed on the majority of the top-hats. This observation is documented in the Alion Prototypical Strainer Array Test Report (Reference 78). Head losses during the fiber batch additions increased generally linearly, providing further indication that a "thin-bed" effect was not occurring.

vii. Provide the basis for the strainer design maximum head loss.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) in order to reference the June 2009 head loss testing.

The strainer design maximum head loss is based on prototypical testing of non-chemical and chemical debris, and is documented in the Alion Prototypical Strainer Array Test Report (Reference 78). The Test Report data was corrected for temperature and flow, and extrapolated to the appropriate mission time in the Alion Head Loss Calculation (Reference 79), to yield a time and temperature dependent head loss curve. The head loss curve is presented in Section 3.o, "Chemical Effects" of this submittal.

viii. Describe significant margins and conservatisms used in the head loss and vortexing calculations.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) in order to describe results of the June 2009 head loss testing.

The determination of the strainer head loss and the vortex evaluation were performed by testing, and not by calculations. The vortex test was reviewed by the NRC as documented in Section 3.6.1.4 of the Audit Report (Reference B), and found to be acceptable. Vortex testing was performed with a simulated blockage of nearly 80%, well above the 50% original licensing basis, as documented in an SCE Action Request Assignment (Reference 30).

ix. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C), in order to clarify the application of the clean strainer head loss.

The "clean strainer head loss" is developed using the standard Darcy Formula. The individual top hat strainer head loss is not considered part of the "clean strainer head loss", since it is included in the prototypical strainer head loss testing results. The head loss resulting from flow through the manifold leading from the individual strainers to the collector box and the head loss through the collector box to the ECCS suction piping is evaluated in the ENERCON Hydraulic Analyses of the Unit 3 Containment Recirculation Sump Strainer Calculation (Reference 49). (The Unit 2 calculation is identical to the Unit 3 calculation). The resulting head loss through the manifold and the collector box was determined to be 0.23 feet of water at a water temperature of 60 °F. This calculated head loss is added to the head loss across the top-hat (including the debris bed) as determined by testing, as documented in Reference 79.

x. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

As indicated above, a testing approach was used to determine the strainer head loss, as opposed to an analytical approach.

xi. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C), to include verification that structural limits are not exceeded.

The sump and strainers are considered to be fully submerged under all accident scenarios requiring post-LOCA recirculation. This was reviewed by the NRC as documented in Section 3.6.1.2.3 of the Audit Report (Reference B). There are no vents, nor piping exposed to the interior of the strainers that are open to the containment atmosphere. In addition to the loss of NPSH margin due to debris loading on the strainers, the impact of the failure of the LPSI pump to terminate on recirculation initiation was applied. The strainers are designed to accommodate the increased pressure differential loading without structural impact to the affected train, and without any impacts to the unaffected strainer train. Verification that the structural limits are not exceeded with the higher flow rate associated with the errant LPSI pump is documented in Reference 62.

xii. 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.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Near-field settling was not credited in the prototypical strainer head loss testing.

xiii. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C); changes were made in the description of the Alion temperature correction methodology, and in citing the measured head loss.

The head loss test data is corrected for post-LOCA sump temperature conditions using a viscosity / density correction of the test data, as described in the Alion Head Loss Calculation (Reference 79).

The basis for concluding that boreholes or other differential pressure induced effects do not affect the debris bed morphology is based on the limitations placed on the application of the NUREG/CR-6224 correlation approach contained in Appendix V of the NRC SE to the NEI 04-07 Guidance. Page V-30 of Appendix V notes that application of the NUREG/CR-6224 correlation is limited to a 20 feet water column differential pressure across the debris bed since debris bed disruption (bore holes) is expected to occur at higher differential pressures. Since the maximum predicted head loss across the debris bed of 10.0 ft H_20 is below this 20 foot water column limitation, no bed disruption that would change the morphology of the bed is expected to occur.

xiv. 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.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to revise the summary of the results of the flashing evaluation, based on the June 2009 head loss test results.

Containment accident pressure is credited in evaluating whether flashing would occur across the strainer debris bed. The predicted strainer head loss, including chemical effects, is approximately 2.8 ft water column at a sump fluid temperature of 208.8 F. This is greater than the approximately 1 foot of water minimum submergence of the top-hats. At lower sump fluid temperatures, the fluid vapor pressure is lower and containment accident pressure is not credited. As documented in Reference 62, the required Post LOCA containment pressure to prevent flashing across the strainer debris bed is approximately 0.8 psi above the sump fluid vapor pressure at 208.8 F. The minimum

Post LOCA containment pressure during the period that the 208.8 F sump fluid temperature is anticipated to occur is approximately 11.3 psi above the sump fluid vapor pressure at 208.8 F. Consequently, flashing across the strainer debris bed is not expected to occur.

The anticipated post LOCA containment pressure as a function of time is determined from the Containment Pressure and Temperature Analysis (Reference 63). The calculation determined the post LOCA sump water and containment pressures anticipated to occur following a large-break LOCA within the containment. The calculation evaluates the impact of the steam and fluid discharge from the break and the impact of the safety injection and containment spray system on the resulting containment pressure and sump water temperatures.

g. 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.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The post-LOCA flow rates, sump temperature and the minimum containment water level were reviewed by the NRC as documented in Section 3.6.2 of the Audit Report (Reference B), and found to be acceptable.

ii. Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The assumptions used in the NPSH margin calculation for the above parameters and the source/bases for these assumptions were reviewed by the NRC as documented in Section 3.6.2 of the Audit Report (Reference B), and found to be acceptable.

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

This section has been revised from that provided in the February Supplemental Response (Reference C), to revise the discussion regarding deaeration in accordance with additional RAI received (Reference I).

The NPSH required values were obtained from the certified pump curves for the ECCS pumps, as documented in the NPSH margin calculation (Reference 44). The NPSH required values were then increased to account for deaeration across the strainer, as described below.

The NPSH margin calculation, as reviewed by the NRC and documented in Section 3.6.2.2.1 of the Audit Report (Reference B), considered two physical models. The first model was based on a comparison of the required NPSH with the difference between the pressure at the pump inlet and the water vapor pressure; the second considered screen head losses which would result in the void fraction of the water reaching the 2% acceptance criteria given in Regulatory Guide 1.82. In this calculation, the acceptance criteria given in Regulatory Guide 1.82 for the pump inlet, was instead very conservatively applied at the eye of the pump impeller. In the discussion below, the void fraction is more appropriately applied at the pump inlet.

Based on RAI received from the NRC on August 25, 2009 (Reference I), the potential for deaeration within the ECCS system during recirculation was re-evaluated through a revision to the NPSH calculation (Reference 44), for comparison with the following acceptance criteria: Appendix V of the NEI 04-07 SE (Reference 3) establishes an acceptable void fraction immediately downstream of the screen of less than or equal to 3%; and as noted above, Regulatory Guide 1.82 (Reference 89) establishes an acceptable void fraction at the pump inlet of less than or equal to 2%.

The calculation assumes that the liquid is saturated with air at the surface of the containment pool, using Henry's Constant for solubility. The amount of air that evolves from solution due to pressure drop across the sump screen was calculated using the results of the head loss test for the range of temperatures of the post-LOCA period. The void fraction ranges from 0.11% at 208.8 °F to 0.63% at 122 °F, immediately downstream of the sump screens. These void fractions are considerably less than the NEI 04-07 acceptance criteria of 3%.

The calculation of the above-cited void fraction conservatively credited only the minimum submergence of approximately 1 foot at the top of the top-hats. At lower depths along the top-hat, the deaeration across the debris bed would be reduced – and in fact cease, where the submergence depth is greater than the head loss. The water with the higher void fraction from the top of the top-hat would be diluted by the water containing a lower or zero void fraction from the lower portion of the top hat as the water travels down through the annular space, resulting in a significantly lower void fraction in the plenum beneath the top-hats.

Other key assumptions in the calculation are as follows: The containment pressure assumed throughout the 30-day mission period is 13.8 psia; this is the minimum containment pressure pre-LOCA. At the post-LOCA high temperature design point of 208.8 °F, the sump fluid is at saturation temperature, and there is no credit available for vapor pressure. As the water cools off, vapor pressure differential increases and is credited. Finally, no credit is taken for post-LOCA humidity.

With the elevation change of approximately 25 feet between the plenum below the top-hat screens and the pump inlet, it is expected that some of the air that evolves from solution across the screens would be reabsorbed before the liquid reaches the pump inlet. However, as a conservative approach, it was assumed that the air would not be reabsorbed. Credit has been taken for compression of the void volume (and therefore reduction of the volume-based void fraction) due to the change in elevation, based on application of the ideal gas law. Conversely, the frictional pressure drop has been debited. The void fraction at the pump inlet ranges from 0.07% at 208.8 °F to .036% at 122 °F. These void fractions are considerably less than the Regulatory Guide 1.82 acceptance criteria of 2%.

While the void fractions at the pump inlet are less than the acceptance criteria of 2%, Appendix A of Regulatory Guide 1.82 prescribes that the required NPSH be corrected, based on the void fraction. The increase in NPSH required results in an equal reduction in the NPSH margin available for screen head loss. The reduction ranges from 0.8 ft H_2O at 208.8 °F to 4.2 ft H_2O at 122 °F. The uncorrected and corrected NPSH margin curves are presented in Appendix 3 of this Submittal.

iv. Describe how friction and other flow losses are accounted for.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

Friction head losses through the piping and associated piping components are calculated using the Darcy equation and developed Fanning Friction Factors. The NPSH margin evaluation utilizing this approach was reviewed by the NRC as documented in Section 3.6.2 of the Audit Report (Reference B), and found to be acceptable.

v. Describe the system response scenarios for LBLOCA and SBLOCAs.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The system response scenarios for both the large break and small break LOCAs were reviewed by the NRC as documented in Sections 3.6.1.2 and 3.6.2.2.2 of the Audit Report (Reference B), and found to be acceptable.

vi. Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

During the automatic injection mode of post-LOCA operation, two HPSI pumps, two LPSI pumps and two containment spray pumps are operating. Upon Recirculation Actuation Signal actuation, both LPSI pumps are automatically tripped.

vii. Describe the single failure assumptions relevant to pump operation and sump performance.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

Two single-failure scenarios were considered: the failure of a complete train to operate; and the failure of a single LPSI pump failing to terminate on RAS initiation. Based on the SONGS dual ECCS and CSS train design, in either single-failure scenario, the unaffected train is used as the basis for the NPSH margin calculation. The debris loading considered for SONGS assumes all debris is transported to the unaffected sump, and the containment pool transport flows are assumed to include the errant LPSI flow in addition to both trains of HPSI and CSS pumps operating. This approach was reviewed by the NRC as documented in Section 3.6.2.2.3.2 of the Audit Report (Reference B), and found it to be acceptable.

viii. Describe how the containment sump water level is determined.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The minimum containment pool water level was determined evaluating the small break LOCA and large break LOCA cases. The lower of the two levels was determined to be the small break LOCA case, and this case was used for the NPSH evaluations. The evaluations accounted for minimum transfer from the RWST tanks, and hold up volumes within the containment. It accounted for operational differences between the large and small break LOCA cases such as the assumption that the SITs do not discharge on a small break LOCA. The evaluation was reviewed by the NRC as documented in Section 3.6.2.2.3.1 of the Audit Report (Reference B), and found to be acceptable.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

As noted above, the minimum post-LOCA containment pool water level evaluation was reviewed by the NRC as documented in Section 3.6.2.2.3.1 of the Audit Report (Reference B), and found to be acceptable.

x. 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The empty containment spray piping volume was calculated and subtracted from the available water volume on the containment floor. To account for water in the containment atmosphere, the volume of air in the containment was assumed saturated and that mass of water was subtracted from the volume of water in the containment pool. The approximate surface areas in the containment were estimated and assumed to be coated with condensation. The volume of condensed water was calculated and subtracted from the volume of water in the containment pool. These items were reviewed by the NRC as documented in Section 3.6.2.2.3.1 of the Audit Report (Reference B), and found to be acceptable.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

To determine the post-LOCA minimum containment pool level, the bulk of the volume credited for displacing water was the concrete walls and supports within the containment. In addition to these items, the Reactor Coolant Drain Tank which is located at the 17'-6" elevation and miscellaneous steel structures, piping and equipment amounting to approximately 4% of the floodable volume was also credited (Reference 61).

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The water sources credited to establish the minimum post-LOCA containment pool level were reviewed by the NRC as documented in Section 3.6.1.2.3 of the Audit Report (Reference B), and found to be acceptable. The water source credited for the limiting case (small break LOCA) and its volume is the Refueling Water Storage Tank at 300,000 gallons. This minimum RWST injection volume is the limiting safety injection requirement protected by the SONGS Technical Specifications.

xiii. 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

Containment accident pressure above the saturation pressure is not credited in the NPSH analysis. The NPSH analysis was reviewed by the NRC as documented in Section 3.6.2.2.3 of the Audit Report (Reference B), and found to be acceptable.

xiv. Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

For containment pressure used in the NPSH analysis for containment sump temperatures greater than 208.8 °F, the sump water vapor pressure was assumed equal to the containment pressure, thereby effectively ignoring the containment accident pressure. For containment pressures at sump water temperatures less than or equal to 208.8 °F, the containment pressure assumed was the minimum containment pressure prior to the LOCA. The sump water temperatures and containment pressures used in the NPSH analysis were reviewed by the NRC as documented in Section 3.6.2.2.3.1 of the Audit Report (Reference B), and found to be acceptable.

xv. Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

See the description of the containment accident pressure assumed in the NPSH analysis in Subsection xiv above.

xvi. Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.

This section has been revised from that provided in the February Supplemental Response (Reference C), to reflect a revision to the NPSH calculation.

The NPSH margin analysis that was reviewed by the NRC is documented in Section 3.6.2.2.3 of the Audit Report (Reference B), and found to be acceptable. The smallest head loss margin determined was for the High Pressure Safety Injection pumps, and was 5.68 feet of water at a sump water temperature of 208 °F, as noted in Table 3.6.2.2.1-2 of the Audit Report (Reference B) (HPSI P-018, 208 °F).

Subsequently, the NPSH margin was revised to address temperature round-off; the smallest head loss margin for HPSI P-018 is 5.13 feet of water for 208.8 °F sump water temperature, as documented in the revision to the NPSH Calculation (Reference 44).

h. 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.

i. 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.

This section has been revised from that provided in the February Supplemental Response (Reference C), to move the discussion on Mobil 84-V-2 sealer to subsection 3.h.v.

The qualified coating systems in the SONGS Unit 2 and 3 Containment are Mobil 46-X-29 epoxy at a dry film thickness of 30 mils and Mobil 84-V-2 epoxy sealer at a dry film thickness of 2 mils for concrete surfaces, and Keeler and Long 6548/7107 epoxy at a dry film thickness of 20 mils for steel surfaces. The Mobil 46-X-29 epoxy is used for the containment floor surfaces and on the concrete walls up to a height 1 foot off the floor surface. The remaining interior and exterior bioshield and primary shield concrete walls are coated with Mobil 84-V-2 epoxy sealer. Miscellaneous unqualified coating (enamel, alkyd and epoxy) exist in the containment on selected equipment. All unqualified coating located in containment is assumed to be destroyed.

ii. Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The transport of coating debris was reviewed by the NRC as documented in Section 3.5 of the Audit Report (Reference B), and found to be acceptable. Table 3.5-5 notes the transport fractions used for qualified coating within the ZOI and unqualified coating within the Containment. Transport fractions of 99% for the qualified epoxy coatings and 100% for the unqualified coatings were used.

iii. 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.

This section has been revised from that provided in the February Supplemental Response (Reference C), to reflect the coating surrogate used in testing and to add reference numbers.

Suction strainer head loss testing relative to the coating debris was reviewed by the NRC as documented in Section 3.6.1.3.1.2 of the Audit Report (Reference B), and found to be acceptable. Both qualified and unqualified coating debris were modeled with ground silicon carbide surrogate. The quantity of ground silicon carbide used for the testing was determined to provide the same equivalent volume as the coating debris evaluated to reach the sump strainers. The ground silicon carbide particulate is sized to mimic the 10 micron coating particle size assumed in the evaluations.

iv. Provide bases for the choice of surrogates.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The coating surrogate selection was based on providing a surrogate with the size characteristics as assumed in the evaluations for qualified and unqualified coating debris (coating particles of approximately 10 micron diameter). To account for density differences between this coating surrogate and the actual coatings, the surrogate quantity was increased to provide an equivalent volume of surrogate as compared to the coating debris. This coating surrogate and volume equivalence approach was reviewed by the NRC as documented in Section 3.6.1.3.1.2 of the Audit Report (Reference B), and found to be acceptable.

v. 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.

This section has been revised from that provided in the February Supplemental Response (Reference C), to reflect the coatings debris quantification for the retest program.

The ZOI used for determining the quantity of coating debris generated for qualified coatings was based on a 5D ZOI. This was reviewed by the NRC as documented in Section 3.7.1 of the Audit Report (Reference B), and resulted in Open Item 10, which required resolution of the generic issue of coatings ZOI. Westinghouse Report WCAP-16568-P, Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA Qualified/Acceptable Coatings, which justified use of a 5D ZOI, was subsequently accepted by the NRC. Please see Open Item 10 in Attachment 2 of this submittal for further details.

The evaluation of coating debris both inside and outside the ZOI is evaluated consistent with the recommendations of the NEI 04-07 SE (Reference 3). All DBA qualified coating in the ZOI is assumed destroyed, resulting in 10 micron coating particles. DBA Qualified coating outside the ZOI is assumed to remain intact. Unqualified coating within the containment is conservatively assumed to be destroyed, resulting in 10 micron coating particles.

The Debris Generation Calculation reviewed as a part of the audit, as documented in Section 3.7 of the Audit Report (Reference B), assumed that all concrete wall surface areas in the containment are coated with design basis accident (DBA) qualified Mobil 46-X-29 epoxy, as opposed to Mobil 84-V-2 sealer, due to the thicker dry film thickness of the epoxy. It was assumed that the Mobil 46-X-29 epoxy would fail in the ZOI, but not fail outside the ZOI.

A subsequent review of the DBA qualification documentation for the SONGS' coatings systems determined that the documentation for the Mobil 84-V-2 sealer was inadequate, and the Mobil 84-V-2 sealer was retested. The retesting procedure and results report are contained in References 45 and 46, respectively. It was determined that the sealer under

DBA conditions, failed at a rate of 65% under direct spray conditions, and 15% under immersion conditions. The amount of coatings debris generated was reevaluated based on the test results, using the actual coating configuration of Mobil 46-X-29 epoxy and Mobil 84-V-2 sealer, and is documented in an Action Request Assignment (Reference 47). These revised quantities were then utilized in the "Test-for-Success" program.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

All coating debris is assumed to be destroyed as 10 micron particles, consistent with the NEI 04-07 SE (Reference 3). This was reviewed by the NRC as documented in Section 3.7.2 of the Audit Report (Reference B), and found to be acceptable.

vii. Describe any ongoing containment coating condition assessment program.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The containment coating condition assessment program carried out by the industry on DBA qualified coatings was reviewed by the NRC as documented in Section 3.7.2 of the Audit Report (Reference B), and resulted in Open Item 23, which is a generic issue on the Industry's qualified coatings assessment program. A test program consisting of adhesion testing performed in conjunction with visual inspection was conducted to confirm the ASTM coating inspection methods. Please see Open Item 23 in Attachment 2 of this submittal for further details.

i. 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

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

<u>GL 2004-02 Requested Information Item 2(f)</u>

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, "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.

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

i. 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 debris remain valid.

This section has been revised from that provided in the February Supplemental Response (Reference C), to reflect the reduced fiber debris loads associated with the replacement steam generators.

Please see Section 3.d. for the discussion on the latent debris evaluation process. The Containment Cleanliness / Loose Debris Inspection Procedure (Reference 64), described in the subsection below, is designed to ensure that latent debris quantities are bounded by the analysis values.

Following the steam generator replacements in 2009 and 2010, SONGS will be an RMI / low fiber plant. This configuration forms the basis for the thin-bed head loss testing that was performed, as described in Subsection 3.f.vi.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The Containment Cleanliness / Loose Debris Inspection Procedure (Reference 64) provides guidelines and methods for implementing containment cleanliness / loose debris requirements which relate to the safe operation of the emergency sumps during accidents / emergencies, and refueling outages. This procedure requires that a "clean as you go" approach be employed during execution of work, that periodic inspection walk-downs be conducted throughout outage periods, and that inspections be performed prior to mode changes during plant restart.

iii. 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The Engineering Change Package (ECP) procedure (Reference 65), controls the introduction of materials into containment, so that the materials are properly evaluated for potential impacts to post-LOCA debris generation and chemical effects interaction. Specifically, the ECP Design Criteria Requirements Checklist addresses the following:

- Addition or removal of coatings, with verification that any coatings added are Design Basis Accident (DBA) qualified
- Addition of materials subject to failure by LOCA jet impact by being located within the ZOI of high energy piping considered in the analysis
- Addition of materials exposed to the containment pool or spray flow that are affected by post-LOCA temperature or radiation; and /or chemically reactive with boric acid, TSP or lithium hydroxide
- Addition of aluminum components or materials exposed to the containment pool or spray flow

iv. A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

Temporary Modification Control is governed by a procedure (Reference 66), which describes the acceptable processes for documenting the Plant structure, systems, and components (SSC) when they are in an other-than-designed condition. Except in an emergency declared by the Shift Manager, modified SSC are controlled by either: Temporary or permanent ECP; a non-conformance report; or an approved procedure (normally used to control the plant configuration during maintenance calibrations and during the refueling evolution).

The Configuration Control Procedure (Reference 67) provides guidance regarding acceptable tagging, labeling and signage for use inside containment. Signs and tags have been replaced with signs and tags constructed of materials qualified for the post-LOCA environment.

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.

v. Recent or planned insulation change-outs in the containment which will reduce the debris burden at the sump strainers.

This section has been revised from that provided in the February Supplemental Response (Reference C), to credit the reduction in mineral wool debris associated with the replacement steam generators.

As detailed in Section 4.1 of the NRC Audit Report (Reference B), Microtherm insulation on piping within the ZOI of large piping breaks is being replaced with RMI. It is also noted in the Audit Report (Reference B) that the Mineral Wool insulation on the steam generators will be replaced with RMI when the steam generators are replaced, but that this change-out is not credited in the GL 2004-02 program. Subsequent to the Audit, and as a part of the "Test-for-Success" program undertaken in 2007, the insulation change-out associated with the steam generator replacement has been credited. The revised analyses referenced herein, as well as the head loss testing performed in June 2009, are based on reduced mineral wool debris quantities.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The existing insulation has not been modified to reduce the generation of debris, which in turn would reduce the debris burden at the sump screens.

vii. Modifications to equipment or systems conducted to reduce the debris burden at the sump strainers.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

There were no modifications made to equipment or systems to reduce the debris burden at the sump screens.

viii. Actions taken to modify or improve the containment coatings program.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

There have been no actions taken to modify the containment coatings program, as a part of the GSI-191 program. The Plant Maintenance Procedure for Coating Service Level I Application (Reference 68) specifies that only DBA qualified and approved coatings are used. The Coating Assessment Procedure (Reference 69) performs a condition assessment of DBA qualified coatings, and documents the quantity of unqualified coatings in containment. Assessments are performed each outage to update the Unqualified Coatings Log.

j. Screen Modification Package

The objective of the screen modification package section is to provide a basic description of the sump screen modification.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The Screen Modification Package was reviewed by the NRC as documented in Section 4.2 of the Audit Report (Reference B), and was found to be acceptable with the exception of three Open Items as described in the subsections below.

i. Provide a description of the major features of the sump screen design modification.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The existing grating, backed by screen, which is mounted on the curb surrounding each sump is removed and replaced with vertical steel bars, 10" on center. A screen assembly, consisting of top-hats mounted vertically to flow plenums and a central collector box, filter the recirculating fluid. The assembly fits within the confines of the sump pit, and mates up to the existing suction elbow (upon removal of the existing vortex breaker cage). The modification increases the screen surface area from approximately 75 square feet per sump to approximately 976 square feet. Audit Open Items 11 and 12 tasked SCE with documenting evaluations of the ability of the screens to continue to function relative to the existing design and licensing basis; Item 11 concerns vortexing at 50% screen blockage, and Item 12 concerns potential damage from large debris passing through the vertical trash bars. Please see Attachment 2 of this submittal for further details.

ii. 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

In addition to the modifications described above, three additional modifications were made: 1) The steel mesh on the bottom of the bioshield gates was removed to preclude collection of debris and resultant blockage of flow paths to the sump; 2) The sump cover plate was modified for access into the sump pit; and 3) The level instrument was relocated in order to maximize the number of top-hats and thus screen area in each sump.

Audit Report (Reference B) Open Item 13 tasked the licensee with documenting in the modification package the functionality of the level transmitter in the revised location. Please see Attachment 2 of this submittal for further details.

k. 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.

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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The Sump Structural Analysis was reviewed by the NRC as documented in Section 5.1 of the Audit Report (Reference B), and found to be acceptable.

i. Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

Assumptions / design inputs are listed in Section 5.1.1 of the Audit Report (Reference B). Loads considered were dead weight, seismic (including hydrodynamic mass of the water); and differential pressure loading. Specific load combinations for each of the component qualifications are specified in the ENERCON Services, Inc. calculations reviewed during the Audit.

The design codes utilized in the structural qualification were the AISC Manual of Steel Construction 9th Edition; Regulatory Guide 1.92; and ASME Section III, Appendix 1, 1989 Edition. This is documented in Section 5.1.1 of the Audit Report (Reference B).

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The Sump Screen Assembly is composed of three major components; individual top-hats, flow plenums, and a box collector. Additionally, a support was provided as a part of the relocation of the containment emergency sump water level instrument. (The instrument was relocated to accommodate installation of an additional top-hat in each sump, in order to maximize screen area). The table below provides the component type, calculation reference and the structural design margin (calculated/allowable) for the sump screen assembly:

Table 3.k-1; Sump Screen Assembly Component Design Margins

Component	ENERCON Calculation	Design Margin
Screen Top Hats	Reference 50 (Units 2 & 3)	Member stress = 74% Studs = 35% IR Weld = 32%
Screen Flow Plenums	Reference 51 (Unit 2) Reference 52 (Unit 3) (1)	Member stress = 72% Anchors Bolts = 82% IR (1)
Screen Box Collector	Reference 53 (Unit 2) Reference 54 (Unit 3) (1)	Member stress = 78% (1) Anchor Bolts = 98% load Weld = 99% IR
Sump Level Instrument Support	Reference 55 (Unit 2) Reference 56 (Unit 3)	Member stress = 5% Anchor Bolts= 19% Studs = 45% load Weld = 36%

(1) The Unit 3 "as-built" configuration is governing.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

High energy pipe break analysis in the vicinity of the sumps was reviewed by the NRC as documented in Section 5.1.5 of the NRC Audit Report (Reference B), and found to be acceptable. In summary, there is only one postulated breakpoint in the vicinity of the sump, and this breakpoint does not have a potential impact on the sump from either a pipe-whip or a jet-impingement perspective.

There are no postulated missiles in the vicinity of the Containment Emergency Sumps. The Top-hat Qualification Calculation (Reference 50), Appendix 4, includes an evaluation of jet impingement of water discharged from the 8" Low Temperature Over Pressure (LTOP) line. The impact is found to be bounded by the 10 psid differential pressure load applied during the postulated LOCA.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

Backflushing of the screens is not credited in the SONGS GSI-191 analyses.

I. 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.

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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The SONGS evaluation of upstream effects was reviewed by the NRC as documented in Section 5.2 of the NRC Audit Report (Reference B), and found to be acceptable.

i. 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

Flow paths were evaluated in Section 5.2 of the Alion Sciences and Technology Debris Transport Calculation (Reference 2). Potential choke points were identified at the entrances to the steam generator compartments, and the refueling canal drain line.

ii. Summarize measures taken to mitigate potential choke points.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The bioshield gates at the entrances to the steam generator compartments were modified to remove the grating at the bottom of the gates, in order to preclude trapping of debris and resultant hold-up of recirculating water.

iii. Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

SONGS has no debris interceptors; the potential debris interceptors at the bioshield gates have been removed, as described above. The existing curbs are very low, relative to the minimum containment water level, hence water hold-up is not postulated. Debris ramping is addressed in Section 5.8.8 of the Alion Sciences and Technology Debris Transport Calculation (Reference 2).

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

The reactor cavity has no drains, per se. Large HVAC ducts allow free-flow of water out of the cavity. The refueling cavity drain is evaluated in Section 5.2 of the Alion Sciences and Technology Debris Transport Calculation (Reference 2), and found to not impede the flow of water based on the size of the drain and protective grating, relative to the size of the debris generated and expected to be blown upward through the floor grating.

m. Downstream effects - Components and Systems

The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the containment sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams.

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.

<u>GL 2004-02 Requested Information Item 2(d)(v)</u>

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.

<u>GL 2004-02 Requested Information Item 2(d)(vi)</u>

Verification that the close-tolerance subcomponents 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.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

The SONGS evaluation of Components and Systems downstream effects was reviewed by the NRC as documented in Section 5.3.1 of the Audit Report (Reference B). The SONGS downstream effects evaluations that were reviewed by the NRC during the 2006 GSI-191 Audit, were performed by Westinghouse Electric Co. in accordance with WCAP-16406-P, Rev. 0. Open Items 14 – 17 resulted from the Audit; please see the subsections that follow, and Attachment 2 of this submittal for further details.

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

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

Following issuance of Rev. 1 of WCAP-16406-P, the affected downstream effects evaluations were revised by Westinghouse to reflect the WCAP revision, as well as input from the Alion Fiber Bypass Testing Report (Reference 12) and changes in the Alion Debris Generation Calculation (Reference 1).

The affected Component and System Calculations are: 1) Debris Ingestion Evaluation (Reference 6); and 2) Plugging and Wear evaluations for Heat Exchangers, Orifices, Spray Nozzles, Instrument Tubing and Pumps (Reference 8). The Debris Ingestion Fuel Evaluation (Reference 7) was also revised; see Section 3n. Audit Open Items 15 and 16 were addressed in the revision to the pump evaluation (Reference 8) by the application of the evaluation process prescribed in Rev. 1 of the WCAP.

The Westinghouse Vessel Blockage Evaluation (Reference 9), and Plugging and Wear Evaluation of ECCS and CS Valves (Reference 10) were unaffected by the WCAP revisions, and conservative relative to the bypass test results and changes in the Debris Generation Calculation, and therefore not revised.

ii. Provide a summary and conclusions of downstream evaluations.

This section remains unchanged from that provided in the February Supplemental Response (Reference C), with the exception of adding reference numbers.

In summary, the Westinghouse calculations, revised as necessary to reflect the WCAP revisions, show no adverse plugging or wear impacts due to post-LOCA downstream effects.

Additionally, SCE has completed the evaluation of the operation of the High Pressure Safety Injection (HPSI) and Containment Spray (CS) pumps' seal system cyclone separators, cited as Open Item 14 in the Audit Report (Reference B). The evaluation shows that the cyclone separators will perform as designed and can be left in place. Please refer to Attachment 2 of this submittal for further details.

Finally, SCE has performed an evaluation for the potential impact of safety pump seal leakage into the Auxiliary Building, in response to Audit Open Item 17. As described in Attachment 2 of this submittal, the habitability and equipment qualification limits are not challenged by the postulated inleakage.

iii. Provide a summary of design or operational changes made as a result of downstream evaluations.

This section remains unchanged from that provided in the February Supplemental Response (Reference C).

No design or operational changes were required to be made as a result of the downstream effects evaluations.

n. Downstream Effects - Fuel and Vessel

The objective of the downstream effects, fuel and vessel section is to evaluate the effects that debris carried downstream of the containment sump screen and into the reactor vessel has on core cooling.

i. 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 WCAP methods were not used or exceptions were taken, and summarize the evaluation of those areas.

This section has been revised from that provided in the February Supplemental Response (Reference C), to show the evaluation relative to WCAP-16793-NP as open, pending receipt of the WCAP Safety Evaluation.

The Downstream Effects Fuel and Vessel Evaluations initially performed to WCAP 16406-P, Revision 0 were reviewed by the NRC as documented in Section 5.3.2 of the Audit Report (Reference B), and were found to be acceptable with the exception of Open

Items 18, 19 and 20. In summary, Open Items 18 and 19 addressed the higher bypass fiber loads expected due to the higher flows from a single failure of a LPSI pump to stop on initiation of recirculation mode operation on one of the operating sumps. The revision to the Alion Fiber Bypass Test Report (Reference 12) evaluated the larger fiber bypass quantity due to this higher flow rate. This data was applied in the revised Westinghouse Down-Stream Effects Debris Ingestion Fuel Evaluation (Reference 7), and the fiber bed thickness was found to remain below the acceptable 0.125" threshold.

Audit Open Item 20 addressed fuel support grid blockage due to debris bypassing the screen, and chemical plate-out on the fuel. SCE previously demonstrated that plant conditions were bounded by WCAP-16793-NP, Revision 0, as described in our Supplemental Response of February 27, 2008 (Reference C). Upon issuance of the Safety Evaluation for WCAP-16793-NP, Revision 1, SCE will perform the prescribed evaluations and submit the results to the NRC Staff. This issue is also captured as Item 1 in the RAI related to the February 2008 Supplemental Response (Reference F).

o. Chemical Effects

The objective of the chemical effects section is to evaluate the effect that chemical precipitates have on head loss and core cooling.

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.

This entire "Chemical Effects" section has been revised from that provided in the February 2008 Supplemental Response (Reference C). The previous response was based on integrated chemical effects testing performed in the VUEZ laboratory; this response is based on separate effects head loss testing performed in Alion's Warrenville laboratory, using WCAP-based chemical precipitates.

The summary of evaluation results provided in this section of the Supplemental Response is based on NRC Staff Review Guidance for Plant Specific Chemical Effect Evaluations (Reference 87). Figure 1, "Chemical Effects Evaluation Process Flow Diagram" was utilized in selecting the appropriate technical issues to be addressed in this summary. Where "GL Supplemental Content" was not specified in the Evaluation Guidance, content for the response was gleaned from the "Staff Expectation" section.

Separate effects head-loss testing was performed by Alion Sciences and Technology, utilizing WCAP-16530 based chemical precipitates. The Alion test protocols, non-chemical and chemical debris definition calculations, test plan and procedures, test report, and head loss calculation are References 70 – 71, and 73 – 79.

As described in Section 3.f.iv, two sump screen head loss tests were conducted. The first test assessed the head loss associated with a line break generating mineral wool insulation debris; the second assessed the head loss associated with a line break generating Microtherm insulation debris. Across the full range of temperatures assessed, the mineral wool debris case produced higher head losses than those produced by the Microtherm debris case. As illustrated at the end of this section, the head loss across sump screens throughout the post-LOCA mission period remains well below the available NPSH margin. The head loss also remains below the structural screen design limit.

Numbers in parenthesis in the titles of the sub-sections that follow correspond to the Chemical Effects Evaluation Process Flow Diagram evaluation steps, for the approach taken.

i. (2) Debris Bed Formation – Discuss why the debris from the break location selected for plant-specific head loss testing with chemical precipitates yields the maximum head loss.

The Alion Sciences and Technology Debris Generation Calculation (Reference 1) identified three break cases as potentially limiting with respect to screen debris head loss. Break #5a, a RCS hot leg break inside steam generator compartment Loop 1, generates the highest quantity of qualified coatings debris in conjunction with mineral wool debris. Break #7, a LPSI line break in the vicinity of Main Steam Line 002 generates the highest quantity of mineral wool debris, and a lower quantity of qualified coatings debris than Break #5a. Break #3, a RCS line break inside the reactor cavity, generates Microtherm insulation debris. A hybrid debris load was developed for Test #1 that combined the high mineral wool debris load generated by Break #7, with the high qualified coatings load generated by Break #5, to preclude having to run two different mineral wool debris tests. Test #2 tested the debris loading for Break #3, which is the only postulated break that generates Microtherm debris.

Test #1, the hybrid mineral wool debris test, produced higher head losses than Test #2, the Microtherm debris test, at each of the temperature-dependent chemical debris loads.

ii. (3) Plant Specific Materials and Buffers – Provide the 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 precipitate loading was determined utilizing the WCAP-16530 chemical model. The chemical model predicts the type and quantity of precipitate that forms, based on plant-specific materials and post-LOCA conditions. Plant-specific parameters were developed as described below, and as documented in the Alion Chemical Product Generation Report (Reference 73).

A post-LOCA containment pool and containment spray pH calculation (Reference 82) was performed to determine the range of pH over the mission period, as well as the time-dependent profile in transitioning from the time of the postulated LOCA to the recirculation mission time. Sensitivity analyses were performed to select the range and profile, such that the production of chemical precipitates as predicted by the WCAP-16530 model was conservative.

The temperature profile was selected from the cases presented in the SONGS Containment P/T Analysis for Design Basis LOCA Events (Reference 63). Case 7 was selected as it provides the highest temperature profile early in the post-LOCA period, which results in the greatest quantity of corrosion products and hence precipitate formation, as predicted by the WCAP-16530 model.

The materials expected to contribute to chemical effects, as captured in the WCAP-16530 model, are insulation debris (mineral wool and Microtherm), latent fiber (Nukon as a surrogate), metals (aluminum), concrete, and TSP buffer. The quantities of insulation material and latent fiber in the post-LOCA pool are identified in the Debris Generation Calculation (Reference 1); the quantities and locations of metals and other materials, as well as fluid chemical constituents, are identified in the Calculation of Data Input for WOG Chemical Testing (Reference 81).

As described in the Calculation of Data Input for WOG Chemical Testing (Reference 81), minimum and maximum post-LOCA coolant volumes have been calculated. In order to ensure a bounding chemical product generation analysis, the maximum volume has been assumed in determining the submergence of materials. Materials not submerged are subjected to sprays for the entire mission period.

The WCAP-16530 model presents the option of allowing the elemental mass already released into the sump solution to impact the dissolution rate from each material containing that element by crediting mixing in the sump; it was conservatively assumed that the sump was not mixed for the duration of the mission period. Two WCAP-16530 runs were produced; one for the mineral Wool debris case, and the other for the Microtherm debris case. The above-described inputs and results are documented in the Alion Chemical Product Generation Report (Reference 73)

iii. (4) Approach to Determine Chemical Source Term (Decision Point) – (a) Identify whether a single (separate) chemical effects test or an integrated chemical effects test was performed, and (b) Identify the vendor who performed plant-specific chemical effects testing.

Separate chemical effects head loss testing was performed by Alion Sciences and Technology, utilizing WCAP-16530 precipitates, in their Warrenville, Illinois laboratories.

iv. (5) Separate Effects (Decision Point) – Identify whether a single variable test (WCAP-16530) or single-effects bench testing was utilized for assessing plant-specific chemical effects.

Chemical precipitate quantities as predicted by the WCAP-16530 model, rather than by single-effects bench testing, were utilized

v. (7) WCAP Base Model – (a) 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. (b) List the type (e.g., AlOOH) and amount of predicted plant-specific precipitates.

(a) In order to take advantage of the time-dependency of aluminum precipitate production in assessing head loss relative to NPSH margin available, the spreadsheet was modified, consistent with the guidance provided in the WCAP-16530 Safety Evaluation (Reference 92), as amplified during the chemical effects refinement telecom of April 2, 2009 (Reference H). The release rates for aluminum were doubled, until such point as the base model 30-day aluminum precipitate quantities were achieved; this production-equivalency point was reached at approximately 9.25 days into the 30 day mission period. There were no other modifications or refinements made in the WCAP-16530 evaluation.

(b) The total amount of precipitate predicted by the WCAP-16530 model for the two debris cases, as documented in the Alion Chemical Product Generation Report (Reference 73), is as follows. (These are total plant precipitate loads; precipitate loads tested were scaled from these quantities):

Mineral Wool Debris Case:

- $NaAlSi_3O_8$: 36.63 kg
- AlOOH: 43.95 kg
- $Ca_3(PO_4)_2$: 24.19 kg

Microtherm Debris Case:

- $NaAlSi_3O_8$: 18.21 kg
- AlOOH: 40.87 kg
- $Ca_3(PO_4)_2$: 1.09 kg

vi. (10) Precipitate Generation (Decision Point) – Identify the method used for precipitate generation – injection of chemicals into the flowing stream in a test flume, or creation of a surrogate precipitate in a separate mixing tank.

The head loss testing utilized surrogate WCAP-16530 chemical precipitates, generated in a separate tank prior to introduction into the test tank.

vii. (12) Pre-Mix in Tanks (WCAP) – Identify any exceptions taken to the procedure recommended for surrogate precipitate formation in WCAP-16530.

As specified in the Prototype Top-Hat Strainer Array Test Plan (Reference 75), the chemical precipitates were prepared as prescribed by WCAP 16530. Confirmation is provided in Attachment G, Chemical Preparation Logs, of the Alion Head Loss Test Report (Reference 78). In summary, no exceptions were taken to the recommended procedure for surrogate precipitate generation.

viii. (13) Technical Approach to Debris Transport (Decision Point) – Identify the debris transport approach taken – crediting debris settlement, or using agitation or other means to keep debris suspended such that it reaches the strainer surface.

The debris transport approach taken was to provide agitation in the test tank to keep the debris in suspension. As documented in the Alion Head Loss Test Report (Reference 78), a sparger system was installed on the return line and resided against the back wall of the test tank to aid in the suspension of the debris within the water. In addition, two mechanical mixers were installed in the tank, at opposite corners. The agitation devices were.located in the tank, to prevent disruption of the formed debris bed. Debris was added in a controlled manner at the side of the test tank adjacent to the sparger, in order to ensure suspension. Finally, during the initial stages of each test, where visibility allowed identification of settled fiber, manual paddle stirring was utilized to re-suspend the fibrous debris.

ix. (15 & 15a) Head Loss Testing Without Near Field Settlement – (a) 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, and (b) 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).

(a) Post-test observations after the tank had been drained down, as documented in the Alion Head Loss Test Report (Reference 78), indicated that nearly all of the fiber and particulate debris reached the strainers. It is also noted in the report that a small quantity of particulate debris was removed with the water prior to some of the chemical debris additions, in order to manage the tank water level. (The water removal took place following head loss stabilization from the previous debris addition, which required a large number of pool turnovers passing through the strainer debris bed, thereby filtering out the majority of the particulate)

It is reasoned that the small amount of fiber and particulate witnessed on the tank floor at the completion of the test can be dispositioned as acceptable for the following reasons: 1) The fiber and particulate on the tank floor may be an artifact of the drain-down process, which causes the debris bed to slough off of the top-hats; and 2) As described in subsection viii above, prototypical agitation was employed in the test tank to keep debris in suspension in the vicinity of the top-hats, whereas in the plant, the quiescent pool, low strainer approach velocity, 4" curb surrounding the sump pit, and lack of mechanical agitation in the sump would allow some of the debris to settle prior to reaching the top-hat screens.

(b) As documented in Attachment G of the Alion Head Loss Test Report (Reference 78), chemical precipitates were generated in 63 batches for aluminum oxyhydroxide, 68 batches for sodium aluminum silicate, and 42 batches for calcium phosphate. Initial settling testing was performed to ensure compliance with the WCAP-16530 SE (Reference 92) criteria of 1-hour settled volume of 6 ml or greater for the aluminum-based precipitates, and 1-hour settled volume of 5 ml or greater for the calcium-based precipitates. One of the aluminum oxyhydroxide batches did not meet the settled volume criteria, and was discarded.

In order to effectively manufacture, store, and transport the surrogate precipitate between the Alion facilities, in many cases the batches were combined in barrels. Settling tests were then performed on the combined batches, to establish a base-line settled volume. If necessary, additional settling tests were performed such that the surrogate precipitate was tested within 24 hours of use in the test tank.

Alion Test Procedures (References 76 & 77) document verification that the 1-hour settling criteria were met, prior to adding the surrogate precipitate to the test tank.

x. (16) Test Termination Criteria – Provide the test termination criteria.

Stabilization criteria were established in the Alion Strainer Array Test Plan and Test Procedures (References 75-77) for intermediate debris additions, as well as for termination of the test following the last debris addition, as follows:

Both the Mineral Wool and the Microtherm tests were conducted as "thin-bed" tests, wherein the particulate debris was added to the test tank first. Following the addition of the particulate debris, a minimum of 5 pool turnovers was to be achieved prior to addition of the first fiber debris batch.

Following each fiber debris batch, the criteria were: 1) Achieving a minimum of 10 pool turnovers, and 2) Achieving a stable head loss over a one hour period, where the head loss is considered to be stable if the differential pressure changes by: a) Less than or equal to 0.02 ft H_2O per hour if the measured head loss is less than or equal to 2 ft H_2O, or b) Less than or equal to 1% per hour if the measured head loss is greater than 2 ft H_2O. In the event of a bed reformation, the head loss was to be allowed to stabilize in accordance with the aforementioned criteria.

Following the fiber debris batches, the chemical precipitate was batched in. The stabilization criteria between batches, and the test termination criteria following the final precipitate batch were as described above for the fiber debris additions.

Achievement of the above-described criteria during the head loss tests is documented in the Alion Head Loss Test Report (Reference 78).

xi. (17) Data Analysis – (a) Provide a copy of the pressure drop curves as a function of time for the testing of record, and (b) Explain any extrapolation methods used for data analysis.

a) The pressure drop curves as a function of time are presented in Appendix 1 for the Mineral Wool Debris test; and in Appendix 2 for the Microtherm Debris test. The test data is also presented below in tabular form, showing the head loss associated with the sequenced debris additions.

Testing was performed in accordance with the Alion Test for Success Head Loss Testing Protocol (Reference 70), the Alion Test Plan (Reference 75), and Alion SONGS-specific Test Procedures (References 76 & 77). The source for the curves and data is the Alion Array Head Loss Test Report (Reference 78). The fiber additions are annotated with the approximate equivalent bed thickness (ebt). Three of the aluminum precipitate additions are identified by the temperature associated with precipitate loading; this was engineered to allow time / temperature comparison of head loss data with the NPSH margin available for head loss. The other two intermediate aluminum precipitate additions for the Mineral Wool debris case (WCAP 6 & 7) were designed to capture the chemical effects associated with a further reduction in the Mineral Wool quantity in the plant, in the event that the head loss at the full mineral wool debris load did not satisfy the available margin. Based on the successful test results, this correlation was not required to be used. (The WCAP batch numbering is not sequential, as some intermediate cases that were developed were not ultimately tested). The data provided in the tables below is uncorrected for flow and temperature, and is not extrapolated for the appropriate mission period.

Table 3.o-1; Mineral Wool Debris Test Head Loss Results

Debris Addition	Head Loss (ft H_2O)
Particulate (Coatings, dirt)	0.04
Fiber 1 (Latent + MinWool; ~ 0.125" ebt)	0.12
Fiber 2 (MinWool; ~0.125" ebt)	0.24
Fiber 3 (MinWool; ~0.075" ebt)	0.27
Fiber 4 (MinWool; ~0.075" ebt)	0.33
WCAP 1 (CaPh 50%)	1.50
WCAP 2 (CaPh 100%)	1.77
WCAP 3 (Al 210 °F)	2.73
WCAP 4 (Al 202 °F)	3.89
WCAP 5 (Al 189 °F)	4.45
WCAP 6 (Al for zero MinWool)	7.91
WCAP 7 (Al for ~ 50% MinWool)	8.68
WCAP 9 (Al total; 122 °F)	9.31

Table 3.o-2; Microtherm Debris Test Head Loss Results

Debris Addition	Head Loss (ft H_2O)
Particulate (Microtherm, coatings, dirt)	0.16
Fiber 1 (Latent; ~ 0.125" ebt)	0.25
Fiber 2 (Latent; ~0.037" ebt)	0.29
WCAP 1 (CaPh 50%)	0.30
WCAP 2 (CaPh 100%)	0.30
WCAP 3 (Al 210 °F)	1.22
WCAP 4 (Al 202 °F)	2.18
WCAP 5 (Al 189 °F)	3.62
WCAP 7 (Al total; 122 °F)	3.84

Following completion of the Microtherm Debris Test detailed in Table 3.o-2 above and depicted by the curves in Appendix 3, supplemental testing was performed to assess the potential impact of increased Microtherm quantities. Supplemental additions of Microtherm and chemical precipitates were made, in 7 batches, up to 100% of the Microtherm quantity in the vicinity of the high energy piping nozzles on the Reactor Vessel nozzles. The resultant head loss, uncorrected for flow and temperature, and not extrapolated for the mission period was 15.56 ft H_2O. This supplemental test was performed as specified in the Alion Test Plan and Test Procedure (References 75 and 77); however, as the Microtherm debris was added with the chemical precipitates, this supplemental test was not conducted in accordance with the Alion Test for Success Head Loss Testing Protocol (Reference 70).

b) The test data was extrapolated for the appropriate mission period, and corrected for temperature and flow, as described below.

As detailed in the Alion Head Loss Calculation (Reference 79), the raw test data for each appropriate chemical debris addition, starting from the point at which the debris addition was completed and ending when the head loss was declared to be stable, was curve fit using a weighted (10%) smoothing algorithm. This process minimizes the impact of outliers, and provides a continuous representation of the data for further analysis. The smoothed head loss data was then curve fit to a natural logarithmic expression. Finally, the natural logarithmic curve was conservatively adjusted up vertically, such that the entire data set was below the curve. For each data set, extrapolation was made if the test stabilization time period was less than the respective mission time period; this led to extrapolation of several of the intermediate debris addition head loss values, as shown in

Tables 3.o-3 and 3.o-4 below. In extrapolating, credit was not taken for the stabilization period; instead, head loss was conservatively extrapolated from the point at which the debris addition was completed. Finally, it should be noted that the extrapolations are based on time durations; this is conservative, as extrapolations would be more accurately made based on pool turnovers, and the test tank turns over more rapidly than the plant containment pool.

As detailed in the Alion Head Loss Calculation (Reference 79), the temperature and flow corrections were based on determination of the laminar and turbulent flow ratios through the test array. Flow sweeps were performed following stabilization of the final debris addition for each of the two tests. The down-sweep data was used for corrections, as the flow up-sweeps increase the potential for the bed to reform due to the changing velocity, thereby compromising the data. For the Mineral Wool test, the flow was found to be 100% turbulent; for the Microtherm test it was found to be ~ 60% laminar and ~ 40% turbulent. For head loss corrections for flow rate, the appropriate laminar and turbulent corrections were used. For laminar flow corrections, the flow rate ratio taken to the first power was used; for turbulent flow corrections, the flow rate ratio taken to the second power was used. For head loss corrections for temperature (in all cases these were corrected to a higher temperature), the appropriate laminar and turbulent corrections were used; the laminar correction is based on the ratio of viscosities, whereas the turbulent correction is based on the ratio of densities.

The tables below show the head loss values extrapolated for mission time, and then corrected for flow and temperature.

Table 3.o-3; Mineral Wool Debris Test Extrapolated and Corrected Head Loss Results

Debris Addition	Measured Head Loss (ft H_2O)	Extrapolated Head Loss (ft H_2O)	Corrected Head Loss (ft H_2O)
WCAP 3 (Al 210 °F)	2.73	2.73 (1)	2.59
WCAP 4 (Al 202 °F)	3.89	4.29	4.14
WCAP 5 (Al 189 °F)	4.45	4.72	4.69
WCAP 9 (Al 122 °F)	9.31	9.99	9.96

(1) The stabilization time period exceeded the prescribed extrapolation time period; hence the stabilized head loss value is used.

Table 3.o-4; Microtherm Debris Test Extrapolated and Corrected Head Loss Results

Debris Addition	Measured Head Loss (ft H_2O)	Extrapolated Head Loss (ft H_2O)	Corrected Head Loss (ft H_2O
WCAP 3 (Al 210 °F)	1.22	1.22 (1)	0.78
WCAP 4 (Al 202 °F)	2.18	2.18 (1)	1.38
WCAP 5 (Al 189 °F)	3.62	3.62 (1)	2.39
WCAP 7 (Al 122 °F)	3.84	4.06	3.38

(1) The stabilization time period exceeded the prescribed extrapolation time period; hence the stabilized head loss value was used.

For the supplemental Microtherm test, the head loss extrapolated to the 30-day mission time period is 16.52 ft H_2O, and the head loss corrected for flow and temperature is 16.30 ft H_2O.

c) Comparison of the screen head loss with available NPSH margin for screen head loss was developed as described below, and is presented graphically in Appendix 3. The NPSH margin available exceeds the predicted screen assembly head loss throughout the 30-day mission period.

By Inspection of Tables 3.o-3 and 3.o-4, the Mineral Wool case test results yielded higher predicted screen head loss throughout the 30-day mission period, as compared to the Microtherm case test results. Therefore, the Mineral Wool case was evaluated relative to meeting the available NPSH margin. The extrapolated and corrected values from Table 3.o-3 represent the head loss across the debris bed and the top hat, and are presented in Table 3.o-5 below as "Corrected Head Loss". The plenum head loss of 0.23 ft H2O from the ENERCON Hydraulic Analyses (References 48 & 49) was added, in order to represent the full screen assembly. Next, the NPSH margin without consideration for deaeration is provided, followed by the NPSH margin corrected for the deaeration associated with the assembly head loss. The NPSH values, both uncorrected and corrected for deaeration, are taken from the NPSH margin calculation (Reference 44).

Table 3.o-5; Mineral Wool Case Predicted Head Loss and NPSH Margin

Temperature (°F)	Corrected Head Loss (ft H_2O)	Plenum Head Loss (ft H_2O)	Ass'y Head Loss (ft H_2O	NPSH Margin w/o Deaeration (ft H_2O)	NPSH Margin Corrected for Deaeration (ft H_2O)
210	2.59				
208.8	2.82 (1)	0.23	3.05	5.13	4.33
202	4.14	0.23	4.37	9.43	8.10
189	4.69	0.23	4.92	16.26	14.72
166	6.50 (1)	0.23	6.73	24.91	22.62
135	8.94 (1)	0.23	9.17	31.61	28.09
122	9.96	0.23	10.19	33.26	29.09

(1) Interpolated values

As shown in Table 3.o-5, the NPSH margin available for the screen assembly, corrected for deaeration, exceeds the predicted head loss for the duration of the 30-day mission period. The data is presented graphically in Appendix 3.

p. 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 and 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.

This section remains essentially unchanged from that provided in the February 2008 Supplemental Response (Reference C).

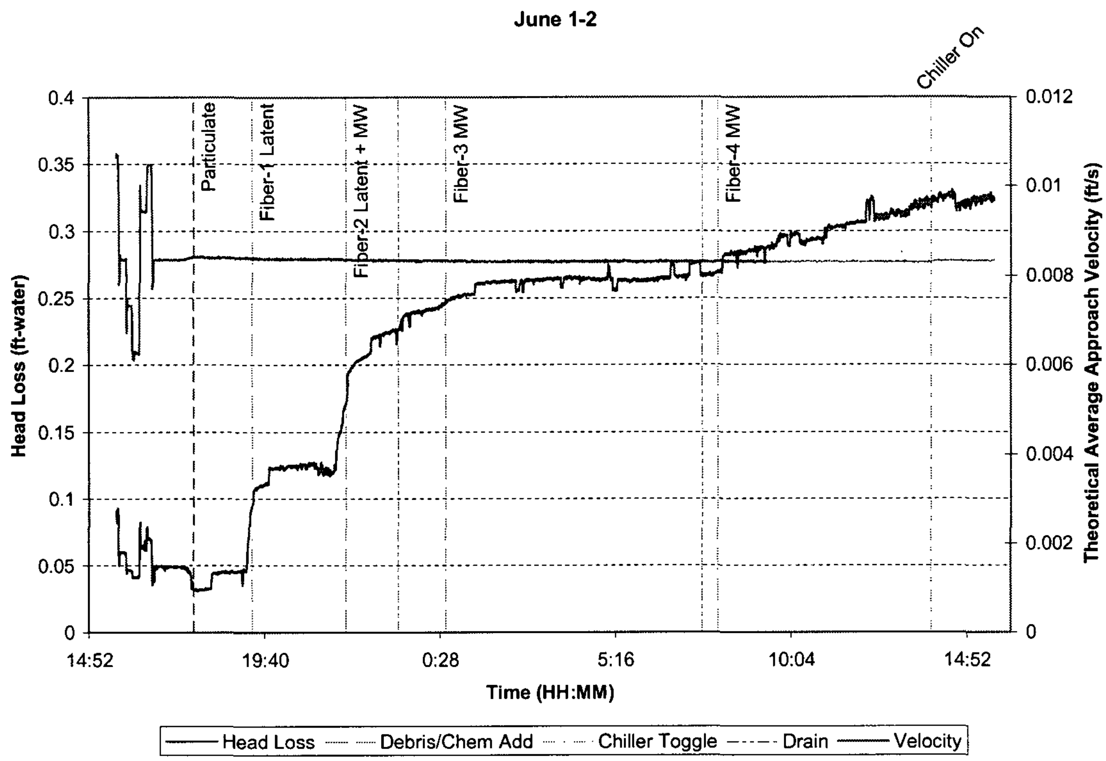
The following UFSAR changes were made as a result of the GL 2004-02 program:

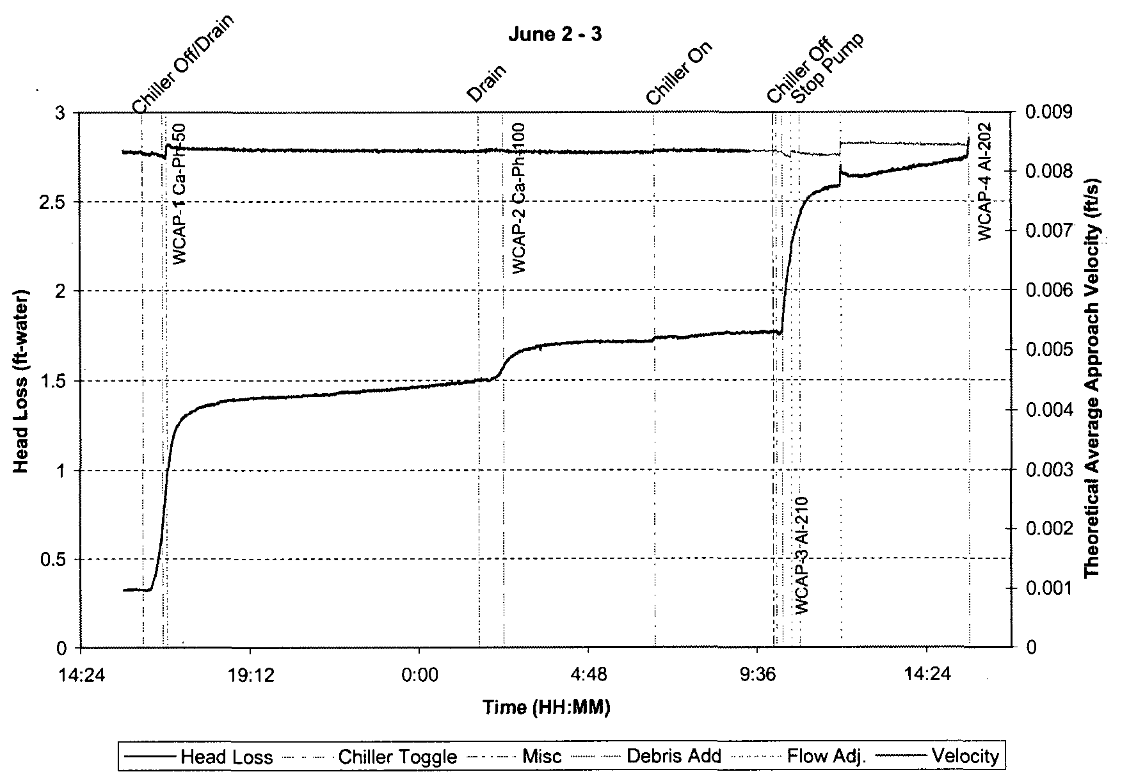
- Section 6.2.1.1.2.4, "Potential Water Traps Inside Containment", was revised to include the head loss through a debris-laden containment emergency sump strainer assembly in the NPSH available values.

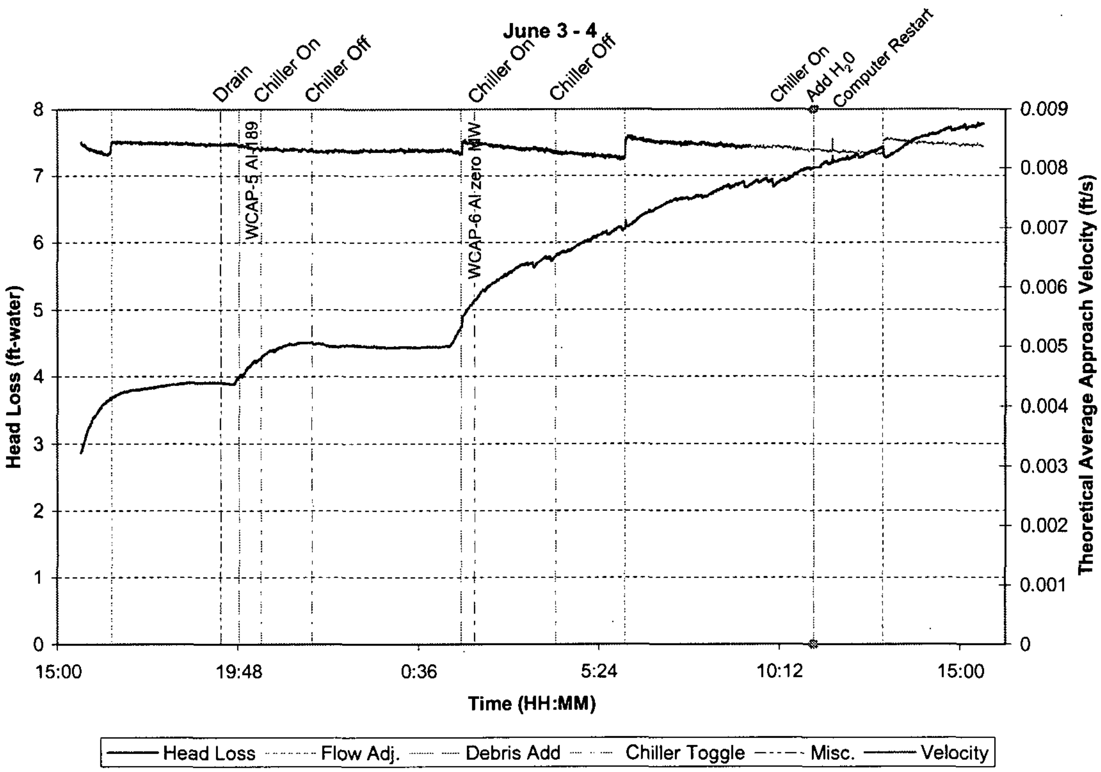
- Table 6.2.13, “Passive Heat Sinks”, was revised to reflect the increase in material associated with the replacement containment emergency sump trash rack, top-hat, plenum, and collector box configuration.
- Section 6.2.2.1.2.5.1, “Containment Emergency Sumps”, was revised to describe the replacement containment emergency sump trash rack, top-hat, plenum, and collector box configuration.
- Section 6.2.1.8.2.5, “Insulation”, was revised to reduce the inventory value of Microtherm-insulated piping, to reflect the removal of this insulation to reduce the debris source term.
- Section 6.3.4.1, “ECCS Performance Tests”, was revised to include a description of the vortex testing performed for the replacement Containment Emergency Sump screen top-hats.
- Appendix 3A.1.1, “Regulatory Guide 1.1...”, was revised to indicate that the containment emergency sump and ECCS recirculation design meets the performance and evaluation requirements of GL 2004-02, as described in the UFSAR sections listed above, and in this Supplemental Response.
- Table 3A-2, “Analysis of Containment Emergency Sump Design With Respect to Regulatory Guide 1.82” was revised to reflect the replacement containment emergency sump screen configuration.

APPENDIX 1

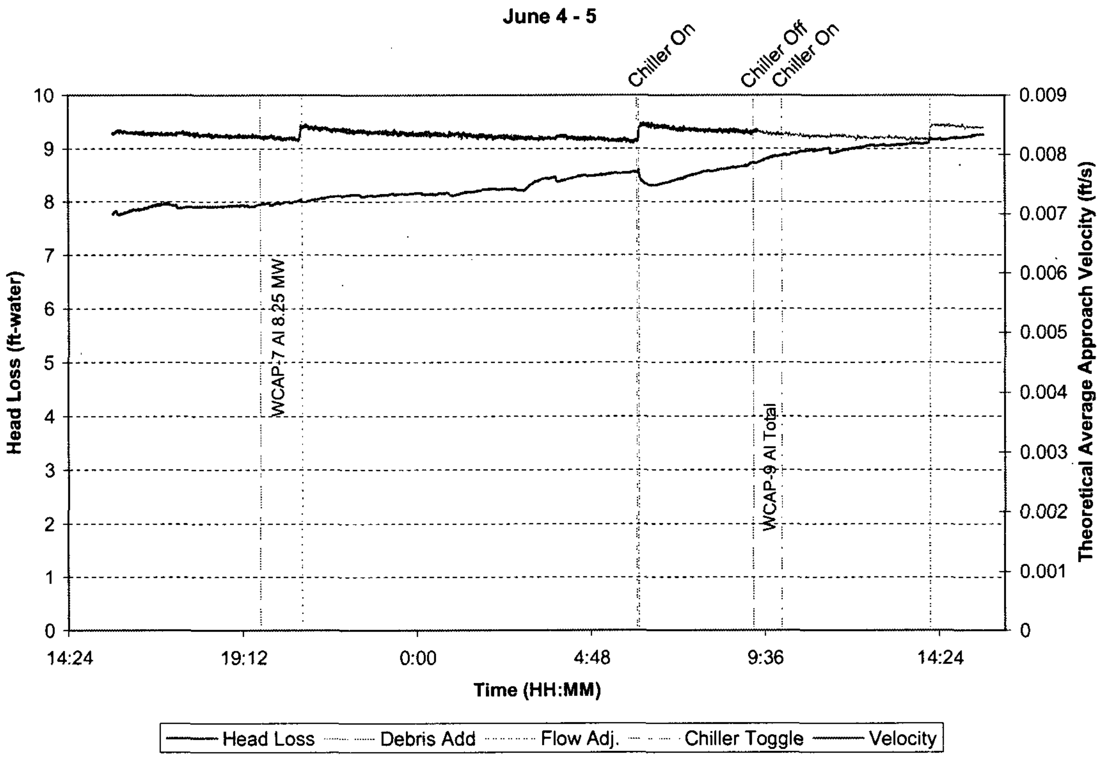
Strainer head loss and approach velocity plotted as a function of time for the Mineral Wool debris case test are presented in five sequential graphs. Debris additions and other significant events during the test are annotated. The source for these graphs is the Alion Strainer Array Test Report (Reference 78).


June 1-2
Chiller On
Particulate
Fiber-1 Latent
Fiber-2 Latent + MW
Fiber-3 MW
Fiber-4 MW
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
Time (HH:MM)
14:52
19:40
0:28
5:16
10:04
14:52
Head Loss
Debris/Chem Add
Chiller Toggle
Drain
Velocity

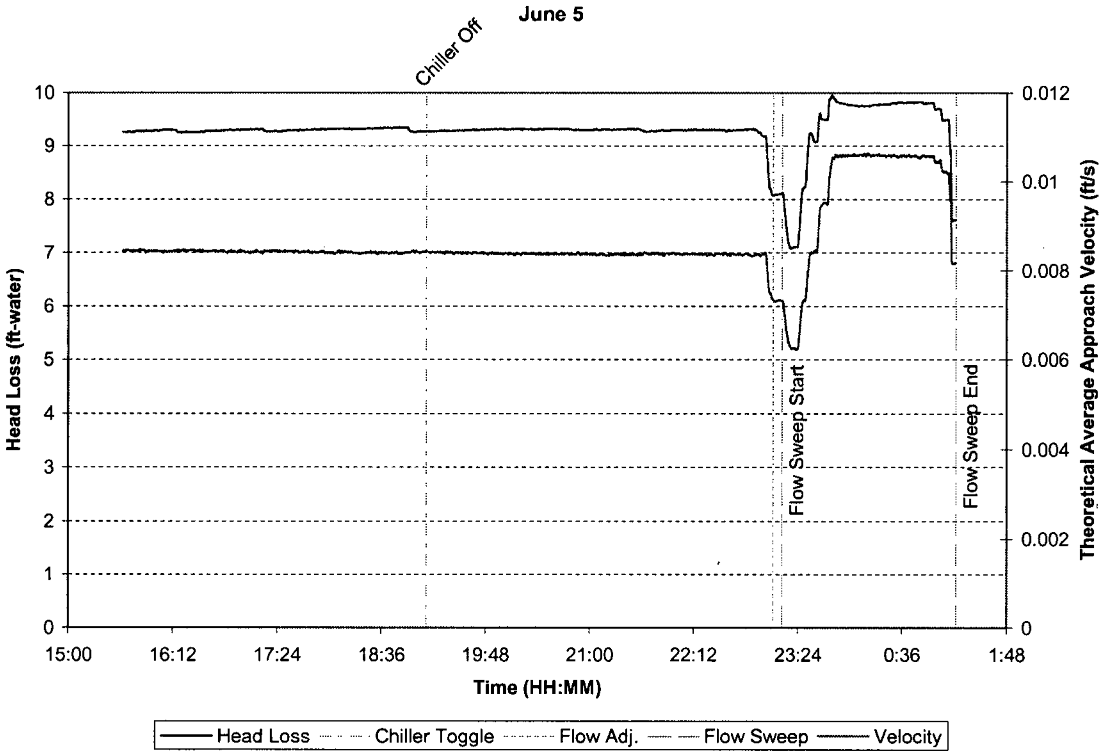

June 2 - 3
Chiller Off/Drain
Drain
Chiller On
Chiller Off
Stop Pump
WCAP-1 Ca-Ph-50
WCAP-2 Ca-Ph-100
WCAP-3-Al-210
WCAP-4 Al-202
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
Time (HH:MM)
14:24
19:12
0:00
4:48
9:36
14:24
Head Loss
Chiller Toggle
Misc
Debris Add
Flow Adj.
Velocity



June 3 - 4
Drain
Chiller On
Chiller Off
Chiller On
Chiller Off
Chiller On
Add H20
Computer Restart
WCAP-5 Al 189
WCAP-6 Al zero MW
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
Time (HH:MM)
15:00
19:48
0:36
5:24
10:12
15:00
Head Loss
Flow Adj.
Debris Add
Chiller Toggle
Misc.
Velocity

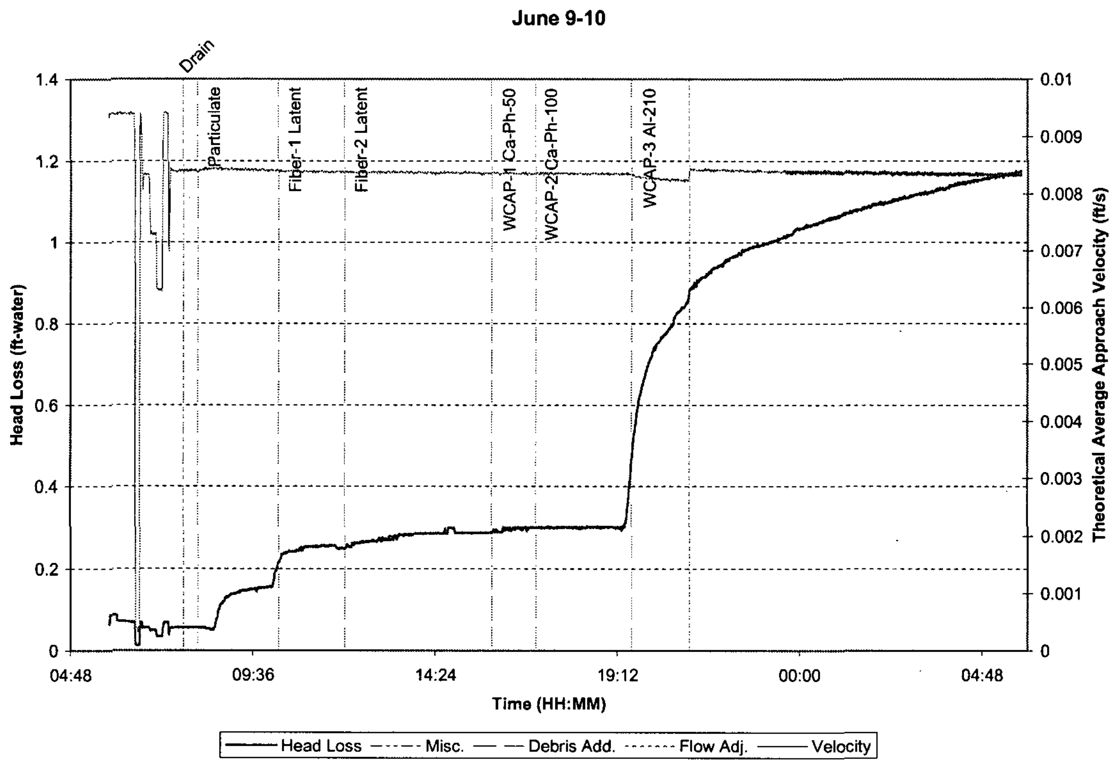


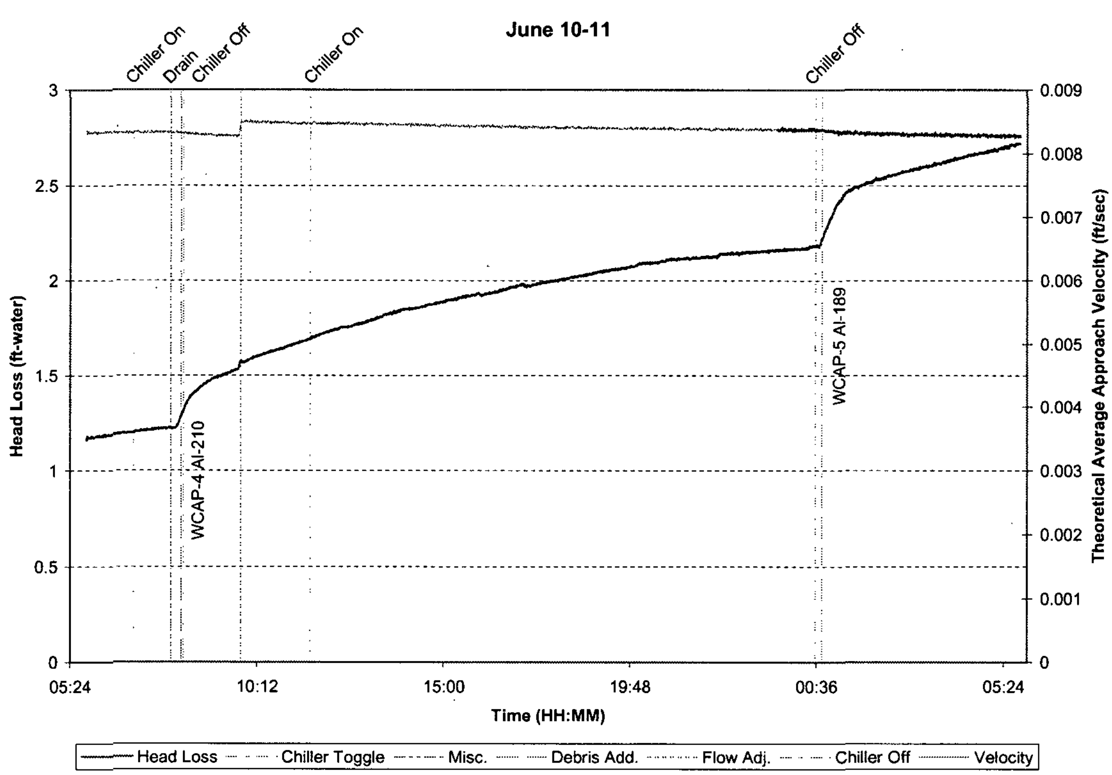
June 4 - 5
Chiller On
Chiller Off
Chiller On
WCAP-7 Al 8.25 MW
WCAP-9 Al Total
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
Time (HH:MM)
14:24
19:12
0:00
4:48
9:36
14:24
Head Loss
Debris Add
Flow Adj.
Chiller Toggle
Velocity


June 5
Chiller Off
Flow Sweep Start
Flow Sweep End
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
Time (HH:MM)
10
9
8
7
6
5
4
3
2
1
0
0.012
0.01
0.008
0.006
0.004
0.002
0
15:00
16:12
17:24
18:36
19:48
21:00
22:12
23:24
0:36
1:48
Head Loss
Chiller Toggle
Flow Adj.
Flow Sweep
Velocity

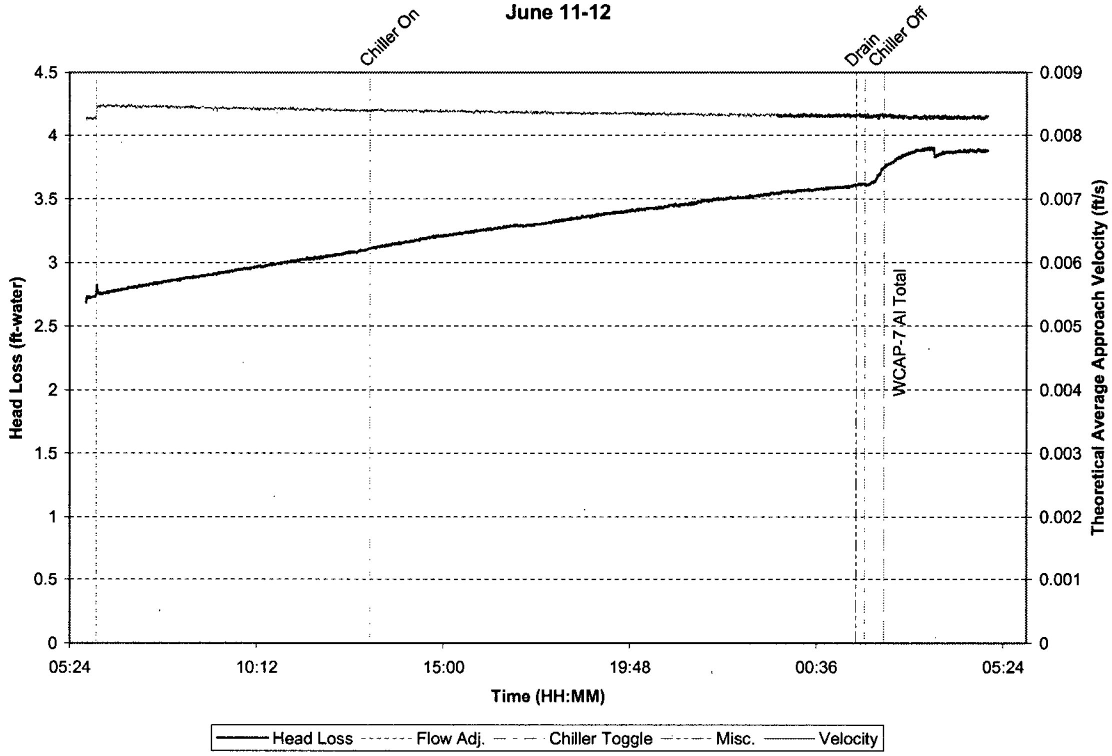
APPENDIX 2

Strainer head loss and approach velocity plotted as a function of time for the Microtherm debris case test are presented in four sequential graphs. Debris additions and other significant events during the test are annotated. The source for these graphs is the Alion Strainer Array Test Report (Reference 78).

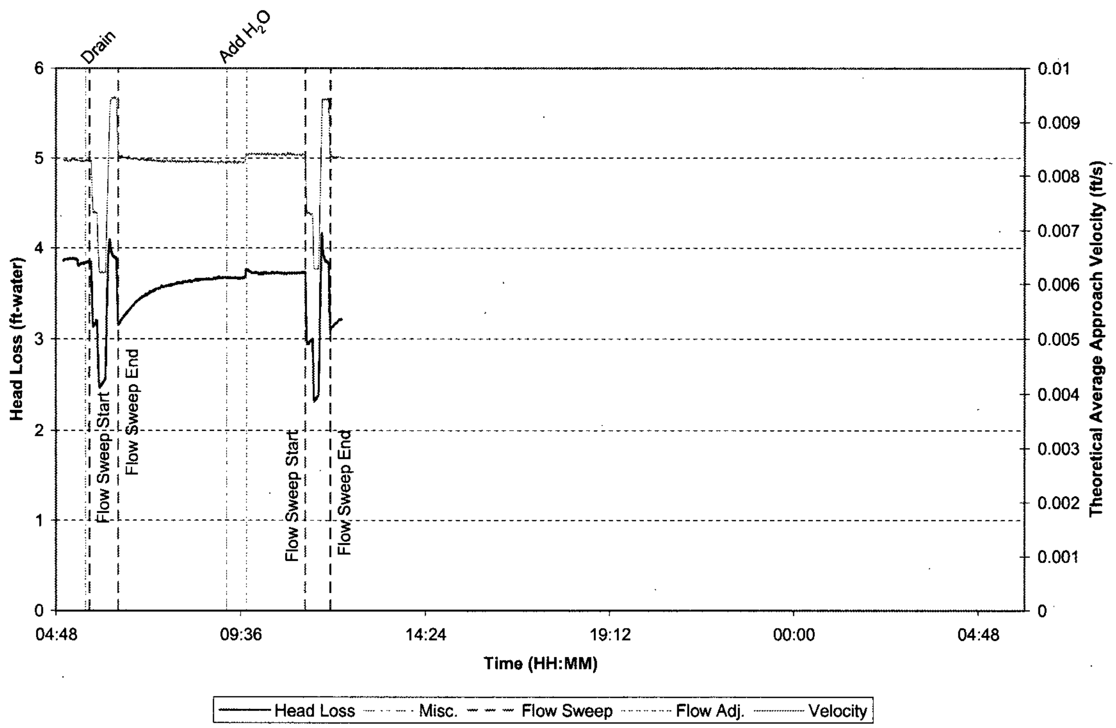

June 9-10
Drain
Particulate
Fiber-1 Latent
Fiber-2 Latent
WCAP-1 Ca-Ph-50
WCAP-2 Ca-Ph-100
WCAP-3 Al-210
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/s)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
04:48
09:36
14:24
19:12
00:00
04:48
Time (HH:MM)
Head Loss
Misc.
Debris Add.
Flow Adj.
Velocity


June 10-11
Chiller On
Drain
Chiller Off
Chiller On
Chiller Off
WCAP-4 Al-210
WCAP-5 Al-189
Head Loss (ft-water)
Theoretical Average Approach Velocity (ft/sec)
3
2.5
2
1.5
1
0.5
0
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
05:24
10:12
15:00
19:48
00:36
05:24
Time (HH:MM)
Head Loss
Chiller Toggle
Misc.
Debris Add.
Flow Adj.
Chiller Off
Velocity

June 11-12

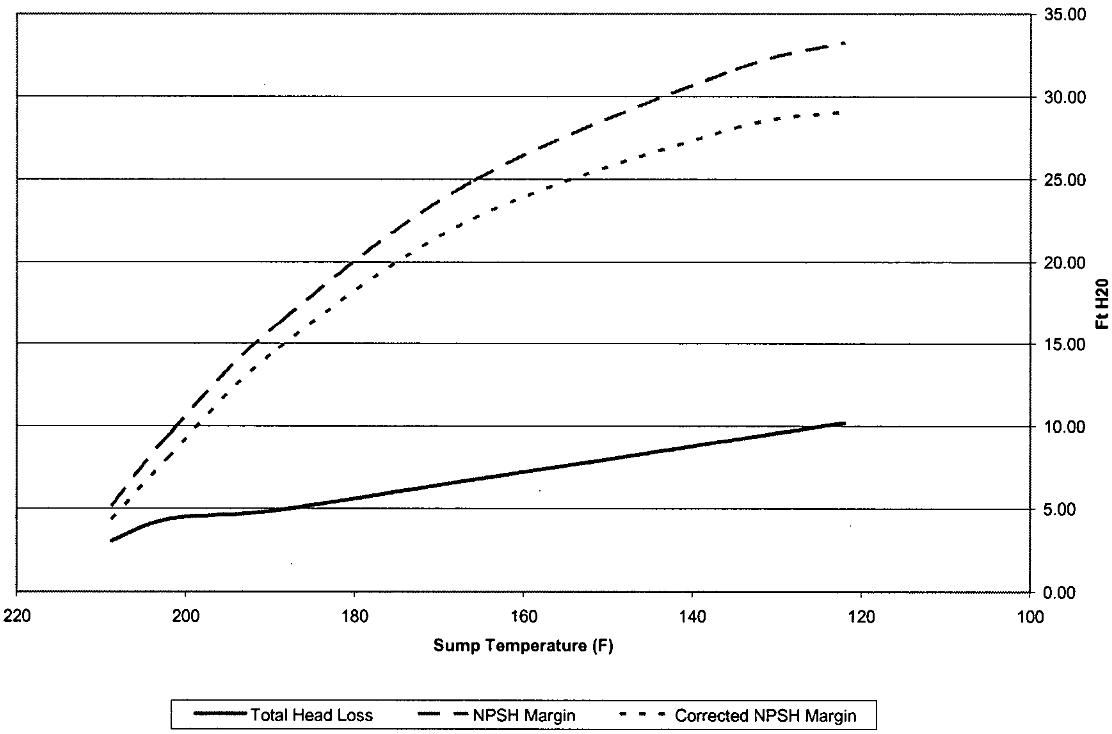


June 12-13



APPENDIX 3

The predicted total strainer assembly head loss (including the plenum head loss), NPSH margin uncorrected for deaeration, and NPSH margin corrected for deaeration are plotted as a function of temperature for the bounding Mineral Wool debris case. The development of the data is described in Section 3.o.



35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ft H20
220
200
180
160
140
120
100
Sump Temperature (F)
Total Head Loss
NPSH Margin
Corrected NPSH Margin

ATTACHMENT 2

AUDIT OPEN ITEMS RESPONSE

Attachment 2 - SONGS Audit Open Items List

Open Item 1

The licensee did not develop detailed analysis for a Microtherm ZOI for a restricted pipe break in the reactor vessel annular region.

> *This response has been rewritten from that provided in the February 2008 Supplemental Response (Reference C), to outline the detailed analysis performed for Microtherm debris generation.*
>
> Outline of SONGS Alternate Restrained Break ZOI Calculation Methodology

1) Background on the Microtherm insulation configuration, and need to perform an alternate analysis from the spherical ZOI approach prescribed in NEI 04-07 (Reference 3) is provided below.
   a) Microtherm insulation is located on the reactor vessel below the hot leg and cold leg piping, in a 3-foot high band, opposite the radiation shield "plug". The Microtherm is 1-1/2 inches thick, and there is an air gap of approximately 1 inch between the Microtherm and the plug. The Microtherm was used in this location due to its thermal resistance properties, and the need to minimize the air gap between the vessel and the plug. The reactor vessel shell insulation layout drawing (Reference 23) depicts the arrangement between the vessel, insulation, and plug. The construction sequencing and resultant physical restraints make it virtually impossible to remove the Microtherm insulation.
   b) For SONGS, the ZOI radius for the encapsulated Microtherm insulation, assuming a double-ended guillotine break with full separation, is 4D as documented in Section 3.2 of the Audit Report (Reference B). Application of this spherical ZOI would result in destruction of the entire band of insulation. Previous WCAP-based chemical effects head loss testing performed by SCE identified the need to reduce the quantity of Microtherm debris generated in order to achieve a successful test result. Therefore, SCE performed the calculations described herein to reduce the ZOI by considering limited separation of the postulated guillotine breaks in the hot leg and cold leg piping in the reactor cavity.
   c) LOCA pipe restraints were engineered and installed at the time of original construction, in order to limit travel of the piping, and reduce the blowdown loads. While SCE now credits leak-before-break at SONGS, the restraints for the hot leg and cold leg piping interfacing with the reactor vessel remain in place.
2) ANSI/ANS-58.2 (Reference 20), provides a methodology for evaluation of a jet discharging from a guillotine break with limited separation. This standard allows determination of the geometry of a jet discharging from a pipe break, as well as determination of the jet impingement pressure. Three different break configurations are covered by this standard: Circumferential break with unrestrained ends, circumferential break with restrained ends (limited separation), and longitudinal break. Figure 7-2 of the standard depicts the jet shapes for each of these three breaks.
   a) As shown in Figure 7-2, the general shape of the jet emanating from a guillotine break with limited separation ("B") is that of a disk, perpendicular to the pipe centerline, with increasing width as the jet expands radially from the pipe break.
   b) The limited separation break methodology is limited to breaks with axial separation (parallel to the piping centerline) less than or equal to half of the pipe diameter and radial offset (perpendicular to the piping centerline) less than or equal to the wall thickness of the subject pipe. As described in Section 3 below, both the hot leg and the cold leg breaks meet the criteria.
   c) Appendix C of the standard provides a simplified model for defining the geometry of the jet. Primary inputs are the vessel (piping) pressure, piping diameter, axial separation, mass flow rate at the break plane, and amount of sub-cooling. The width of the jet can be calculated at any distance from the surface of the pipe.

d) Given the disk geometry established through application of Appendix C, Appendix D of the standard provides a simplified model for calculating the pressure force of the jet at any point along the "centerline" (center-disk), as well as at any point from the centerline out to the edge of the disk. (The pressure decays from centerline outward). This pressure can then be compared to 40 psi – the encapsulated Microtherm destruction pressure corresponding to a 4D ZOI radius in the Safety Evaluation for NEI 04-07 (Reference 3).

3) SCE Calculation M-0012-045 (Reference 21) was performed to assess the axial separation and radial offset for the hot leg and cold leg piping in the reactor cavity, crediting the existing LOCA pipe restraints. The calculated separations and offsets meet the criteria outlined in Section 2b above for utilization in the ANSI/ANS jet calculation described in Section 4 below. The LOCA pipe restraints are described below.

   a) The hot leg piping is restrained axially by the sliding base on the steam generator. This restraint will be maintained with the replacement steam generators.

   b) The hot leg piping is restrained radially by stiffness of the piping and close tolerances against side-to-side motion of the steam generator sliding stop.

   c) The cold leg piping is restrained axially by travel stop on the reactor coolant pump. The axial movement of the piping is then resolved into axial separation and radial offset components at the weld face based on piping and travel stop geometry.

   d) The cold leg piping is restrained radially by a travel stop at the piping elbow adjacent to the reactor vessel. The radial movement of the piping is then resolved into axial separation and radial offset components at the weld face based on piping and travel stop geometry.

4) SCE Calculation M-0012-048 (Reference 22) was performed to calculate the geometry of the disk-shaped jet, and pressure of the jet at the interface with the Microtherm insulation. The calculation yields a value for the Microtherm debris generated that represents approximately 8% of the total quantity of Microtherm on the reactor vessel below the hot leg and cold leg nozzles. The calculation includes the following significant conservatisms:

   a) The axial separation used in the Microtherm debris quantity calculation (Reference 22) was increased by approximately 2-1/2 times from that determined in the axial separation and radial offset calculation (Reference 21). This results in a larger jet, with higher pressure at a given distance from the pipe.

   b) The centerline of the disk-shaped jet was assumed to be coincident with the plane of the Microtherm insulation, whereas in the installed configuration, the centerline of the jet is approximately 2 feet away from the face of the Microtherm panels. This results in a higher pressure on the Microtherm panels at a given vertical distance from the pipe.

   c) In determining the quantity of Microtherm debris generated, it is conservatively assumed that the entire Microtherm panel is destroyed, even if only a portion of the panel is exposed to the 40 psid destruction pressure.

5) As a cross-check, SCE also applied the methodology described in Utility Resolution Guidance (URG) for ECCS Strainer Blockage, NEDO-32686-A (Reference 19), for computing the equivalent spherical ZOI for restrained breaks. The spherical ZOI's computed for both the hot leg and cold leg were such that no Microtherm debris was generated from the postulated breaks. This evaluation is documented in calculations performed by Alion Sciences and Technology (References 1 & 24).

Open Item 2

The licensee did not justify the assumed size distribution of 20% fines and 80% small pieces for the 4D mineral wool ZOI.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect a revision to the mineral wool debris size distribution.

Additional justification for the 20% fines / 80% small pieces size distribution was included in Section 4.5.9.1 of the revised Alion Science and Technology Debris Generation Calculation (Reference 1), and was excerpted in SCE's letter of February 23, 2009 (Reference G), submitted in response to the NRC's RAI letter of November 26, 2008.

In summary, use of the 20% fines / 80% small pieces size distribution established by Alion for a 7D Zone of Influence (ZOI) was judged to be appropriate for the SONGS mineral wool within the 4D ZOI - even when considering issues such as the closer proximity of the insulation to the break location, two-phase jet effects, and the fragility of mineral wool. The approach taken was also deemed to be consistent with the NEI 04-07 SE (Reference 3), as the terms "fines" and "small pieces" in the Alion debris generation calculation are sub-sets of the term "small fines" as defined by the SE. For SONGS, 100% of the insulation debris generated is considered to be "small fines" as defined by the SE.

SCE believes that the arguments put forth in the debris generation calculation and excerpted in the RAI response letter justify the use of the 20% fines / 80% small pieces size distribution; however, the scarcity of data at lower ZOI's is recognized. Therefore, in order to bound the potential exposure relative to this issue, the analysis was revised to double the amount of fines, resulting in a 40% fines / 60% small pieces size distribution. The resulting increase in debris transport fraction, along with the revised size distribution at the screens, formed the basis for the debris load definition for the "Test-for-Success" program.

Open Item 3

Miscellaneous debris that was left in the Unit 3 containment, as identified in Attachment 1 of SO23-XV-23.1.1, needs to be further evaluated by the licensee. Also, the value assumed for the SONGS Unit 2 latent debris source term needs to be confirmed by the licensee.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C, with the exception of clarification of references.

With respect to miscellaneous debris (tape, labels, and tags) that cannot be removed, SCE performed an inventory in Unit 3 during the U3C14 outage in the fall of 2006, as documented in Action Request (AR) 060901108-02 (Reference 26). SCE subsequently performed an inventory in Unit 2 during the U2C15 outage in the fall of 2007, as documented in AR 060901108-3 (Reference 27). These walkdowns concluded that the Unit 3 inventory is bounding with respect to miscellaneous debris.

Based on the Unit 3 survey cited above, with 10% margin added (to account for potential future discovery of other miscellaneous debris, 50 ft^2 of sacrificial area (~ 5% of strainer surface area) in each train was included in the revised Alion Science and Technology Debris Generation Calculation (Reference 1). The development of the sacrificial area is documented in AR 070600413-04 (Reference 28).

Based on inspections performed in both units during the Cycle 13 outages, the SONGS Unit 3 latent debris source term was determined to be bounding for both Units 2 and 3, and was therefore used in the GSI-191 analyses and testing. The Quantification of Containment Latent Debris Survey (Reference 25) has been updated to address both units.

Open Item 4

The licensee did not adequately justify the assumption of 0.16 ft/s as the incipient tumbling velocity metric for small pieces of mineral wool.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Additional justification for the utilization of 0.16 ft/s as the incipient tumbling velocity for small pieces of mineral wool has been included in Section 3.1.a, "General Assumptions" of the revised Alion Science and Technology Debris Transport Calculation (Reference 2). Comparisons of material properties and transport test data for mineral wool and low-density fiberglass (Nukon & Thermal-Wrap) are made, concluding that the assumed 0.16 ft/s incipient tumbling velocity is appropriate.

Open Item 5

The licensee should establish the adequacy of mineral wool transport by floatation in the presence of the SONGS sump strainer cover plates.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C), to respond to the issue as clarified in the NRC's RAI letter of November 26, 2008 (Reference F). Note that the response has also been revised from that provided in the RAI response letter (Reference G), as described below.

RAI Item 3 in the NRC's letter of November 26, 2008 (Reference F), and a follow-up telephone conversation on November 17, 2008, clarified Open Item #5 from the NRC Audit Report (Reference B). The issue concerns large pieces of mineral wool that could transport to the sump by flotation, then subsequently sink and block off the top of the sump pit containing the strainers, thereby significantly reducing the effective filtering area. A response was provided in SCE's letter of February 23, 2009 (Reference G); that response has been revised for the response provided herein, to account for the reduced mineral wool quantity associated with the replacement steam generators.

The NRC staff concurred in the Audit Report (Reference B), Section 3.2, that the appropriate Zone of Influence (ZOI) for the SONGS stainless steel encased mineral wool is 4D. The Debris Generation Calculation (Reference 1) calculates the mineral wool debris generated within a 4D ZOI of the assumed pipe break. Break #7 a LPSI line break outside the bioshield creates the highest mineral wool debris load at the strainers; 16.65 cubic feet.

As discussed in Open Item 2 above, the size distribution adopted in the Debris Generation Calculation is 40% fines, 60% small pieces, and 0% large pieces. However, for the purposes of this evaluation, it is postulated that the mineral wool is instead destroyed as 60% fines and small pieces, and 40% large pieces, consistent with the size distribution for other fibrous insulation materials listed in Table 3-3 of the NEI 04-07 Safety Evaluation (Reference 3).

Additionally, it is postulated that all of the mineral wool debris destroyed as large pieces transports by floatation to the sump. This is considered to be conservative, as a portion of the large-piece debris would be blown upward and held up on platforms and grating; furthermore, not all of the large-piece insulation in the pool would be expected to float.

The piping isometric drawing for the main feedwater piping (Reference 83) shows the mineral wool insulation to be 3-1/2" thick. It will therefore be postulated that the mineral wool transported by flotation consists of insulation pieces 3-1/2" thick. Applying the 40% large-piece size distribution to the total mineral wool debris quantity generated of 16.65 cubic feet yields a large-piece mineral wool debris quantity of 6.66 cubic feet. With the assumed thickness of 3-1/2", the large-piece insulation would occupy a surface area of 22.8 square feet.

The Containment Emergency Sump civil drawing (Reference 84) shows that the interior dimensions of each sump pit between the curbs and wall are 9' 2" by 12', for a surface area of

110 square feet. The 22.8 square feet of surface area postulated for the floating mineral wool represents approximately 21% of the total surface area available, leaving sufficient open area to allow the flow of water to the sump screens.

Finally, it should be noted that if any of the large pieces subsequently sink into the sump pit, this can be assumed to occur later in the event, when NPSH margins are significantly higher. As detailed in the Alion Mineral Wool buoyancy evaluation (Reference 43), within 24 hours of the initiation of the event, the NPSH margin increases almost three-fold from the minimum available at event initiation, while NUREG/CR-6808 (Reference 85) indicates that most mineral wool does not readily absorb water and can remain afloat for several days.

Open Item 6

The licensee also had not resolved the potential effects of concentrated spray drainage, including its effect on the local velocity and turbulence fields in the sump pool, nor justified the assumption that only 10% of the small and large pieces of mineral wool in the containment pool would be subject to erosion.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to provide additional information on concentrated spray drainage, and to increase the mineral wool erosion fraction from 10% to 90%.

With respect to spray drainage, the current revision of the Alion Debris Transport Calculation (Reference 2) treats the spray flow as either dispersed spray flow, or concentrated stream flow, depending on whether the flow is direct spray flow or is spray flow collected on intermediate floors and subsequently cascaded into the pool. Revision 2 of this calculation, which was the revision audited, treated all of the spray flow as dispersed spray flow. Also, the current revision of the calculation models the introduction of the spray flow at the surface of the pool, whereas the revision audited modeled the introduction of the spray flow at the bottom of the pool. Finally, the current revision sub-divides the flow paths considered in the audited revision for a more detailed evaluation. For mineral wool debris, based on the above-described changes only, the debris transport fraction for mineral wool increased from 72% to 79%. (As described in Section 3.e.vi of this submittal, the above-described changes along with the change in mineral wool debris size distribution described in Section 3.c.i of this submittal and the increase in mineral wool erosion fraction described in the paragraphs below, increased the debris transport fraction for mineral wool to 98%.)

With respect to mineral wool erosion, the SONGS-specific erosion fraction was determined based on a combination of fiberglass and mineral wool erosion testing conducted by Alion at their Warrenville facilities. The erosion fraction is defined as the mass of material eroded off pieces of mineral wool by flow across the pieces, divided by the initial mass of the pieces. The tests involved the flow of water over submerged small pieces (1" diameter pieces) of both mineral wool and fiberglass. The fibers coming off the small pieces were filtered and weighed to determine the erosion fraction as a function of the time exposed to the flow. Based on the results of this testing, the fraction of mineral wool expected to erode off the small pieces and result in fines over a 30 day post LOCA period was determined as approximately 10%, which validated the erosion value used in the audited Alion Debris Transport Calculation.

SCE believes that the testing performed, as documented in the SONGS Mineral Wool Erosion Test Report (Reference 16), justifies the use of the 10% erosion of small pieces of mineral wool. Further information is contained in the test plan and reports of other generic insulation erosion testing performed by Alion (References 15, 17, and 18), which are referenced in the SONGS Test Report. However, in order to bound the potential exposure relative to this issue, the analysis was revised to utilize the 90% erosion value specified in the NEI 04-07 SE (Reference 3). The resulting increase in debris transport fraction, along with the revised size distribution at the screens, formed the basis for the debris load definition for the "Test-for-Success" program.

Open Item 7

The licensee did not provide adequate justification for the graphically determined debris transport fractions obtained from Figures 5.9.26 and 5.9.32 in the debris transport analysis report.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C), except to clarify referenced calculations.

The revision to the Alion Science and Technology Debris Transport Calculation (Reference 2) incorporates revised debris transport fractions in accordance with the Audit findings. This change resulted in a small increase in the amount of insulation debris transported to the sump, and is included in the overall mineral wool debris transport fraction of 98% cited in the discussion under Open Item 6 above.

Open Item 8

The licensee had not addressed the potential head loss change from RMI debris entering the interstitial volume of the sump pit, and did not provide sufficient evidence to support the assumption that excluding RMI from head loss testing would result in conservative head loss measurement.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

The Alion Science and Technology report entitled RMI Fiber and Debris Transport (Reference 5) concludes that based on a comparison of incipient tumbling velocities, the RMI is not expected to arrive at the sump pit prior to the mineral wool. This report was discussed during the SONGS Audit Exit teleconference on May 8, 2007, and the NRC indicated acceptance of the conclusions reached.

Open Item 9

The licensee had not resolved Microtherm temperature-dependent material behavior for the pH value or values expected in the post-LOCA sump pool.

This section has been revised from that provided in the February 2008 Supplemental Response (Reference C) to remove reference to the VUEZ chemical effects testing.

The teleconference held between Alion, SCE, and NRC personnel on October 3, 2006 following the on-site audit, contained in Appendix III of the NRC Audit Report, has been documented in AR 070600413-07 (Reference 29). During the SONGS Audit Exit teleconference on May 8, 2007, the NRC indicated that they had reviewed the information and found the conclusions on the temperature-related behavior of Microtherm relative to head loss to be acceptable.

Open Item 10

The licensee was unable to provide documentation justifying use of a 5L/D ZOI for coatings.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C), with the exception of clarifying references and adding reference numbers.

The basis for SONGS' use of a 5L/D ZOI for qualified epoxy coatings is WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA-Qualified / Acceptable Coatings". The NRC indicated during the SONGS Audit Exit Teleconference of May 8, 2007 that review of this WCAP by a third-party Contractor was pending.

Subsequently, the NRC issued Draft Coatings Evaluation Guidance (Reference 88), which indicates that Licensees may use WCAP-16568-P as the basis for using a ZOI of 4L/D or greater for qualified epoxy coatings.

Open Item 11

The licensee has not demonstrated that the new design complies with the existing licensing basis to the extent that if functions satisfactorily at 50% screen blockage.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Action Request 060901108-89 (Reference 30) documents an evaluation of vortex test results reported in the revised Alion Science and Technology Head Loss Testing Report (Reference 11). The AR concludes that the test results demonstrated that no adverse vortexing occurred with a simulated equivalent blockage of nearly 80%, thereby meeting the existing licensing basis.

Engineering Change Notice (ECN) A48856 (Reference 41) adds this statement of compliance with the existing licensing basis to the Unit 3 Engineering Change Package (ECP) 040301974-11 (Reference 58). The Unit 2 ECP 040301974-12 (Reference 57) was subsequently issued with a similar statement of compliance in the ECP.

Open Item 12

The licensee had not documented an evaluation of the ability of the new screens to continue to function and withstand damage from relatively large debris that bypasses the new trash racks.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Action Request 060901108-88 (Reference 39) documents the evaluation performed relative to damage from large debris. The evaluation references the ENERCON Services, Inc. structural top-hat qualification calculation (the Unit 3 calculation is Reference 40; the updated calculation for inclusion of Unit 2 is Reference 50), and concludes that at the very low sump approach velocities, a piece of debris impacting the screen would have to weigh approximately 8000 pounds to exceed the allowable impact load to the top of the top-hat. Based on the Alion Science and Technology Debris Generation and Transport Calculations (References 1&2), there are no large insulation pieces expected to be generated, nor then transported, to the screens. An 8000 pound piece of debris transporting to the sump pit and floating between the vertical bars of the sump enclosure is not considered credible. The potential impact to the screen assembly top-hats by any large floating debris pieces that might be generated, transported, and pass through the new trash racks is considered to be acceptable.

NRC staff concurred with the approach and conclusions described above during the Audit Exit Teleconference on May 8, 2007.

ECN A48856 (Reference 41) adds the conclusion that the top-hats will not be damaged by large debris to the Unit 3 ECP (Reference 58). The Unit 2 ECP (Reference 57) was subsequently issued with a similar direct conclusion.

Open Item 13

The licensee had not documented in its engineering change package a direct conclusion regarding transmitter functionality in its new location.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

ECN A48856 (Reference 41) to the Unit 3 ECP (Reference 58) provides a direct conclusion that a review of the environmental qualification package for the level transmitter has been performed, and that the instrument is qualified at the new location. The ECP includes addition of a debris cage surrounding the level transmitter to insure that large debris pieces will not impede travel of the float. The Unit 2 ECP (Reference 57) was subsequently issued with a similar direct conclusion.

Open Item 14

Licensee reviews of installation and operation of HPSI pump cyclone separators had not been completed at the time of the audit.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Fiber bypass testing was conducted as documented in the Alion Science and Technology Fiber Bypass Test Report (Reference 12). Subsequent to this test, the bypass product was evaluated by selective electron microscopy, as documented in the Alion SEM / Fiber Sizing Report (Reference 13), and found to be shard-like, rather than fibrous. Action Request 060901108-06 (Reference 31), which makes reference to various vendor drawings (References 32 thru 36), evaluates the shard lengths relative to clearances in the cyclone separators and concludes that the installed cyclone separators will continue to perform as designed, and can be left in place.

Open Item 15

The licensee had not evaluated pump hydraulic degradation due to internal wear.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

The Westinghouse Downstream Effects Debris Ingestion Evaluation (Reference 6) and Mechanical Equipment Plugging and Wear Evaluation (Reference 8) have been revised in accordance with WCAP-16406-P Revision 1, and the associated Safety Evaluation. The revised evaluations show the pump degradation due to internal wear to be within acceptable limits. It should be noted that the revised evaluations conservatively assumed a Zone of Influence (ZOI) for qualified coatings of 10L/D, rather than the 5L/D ZOI allowed by WCAP-16568-P as discussed above in Open Item 10.

Open Item 16

The licensee had not evaluated the range of pressures and flows used by SONGS to evaluate pump wear rates in order to properly predict degradation or assess operability.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

The Westinghouse Downstream Effects Debris Ingestion Evaluation (Reference 6) and Mechanical Equipment Plugging and Wear Evaluation (Reference 8) have been revised in accordance with WCAP-16406-P Revision 1, and the associated Safety Evaluation. The revised evaluations show the pump degradation due to internal wear to be within acceptable limits. It should be noted that the revised evaluations conservatively assumed a Zone of Influence (ZOI) for qualified coatings of 10L/D, rather than the 5L/D ZOI allowed by WCAP-16568-P as discussed above in Open Item 10.

Open Item 17

The licensee did not quantify HPSI Pump debris-induced seal leakage into the Auxiliary Building, and did not perform an evaluation of the resultant affects on equipment qualification and room habitability.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

A calculation change notice was prepared to assess potential impact to the qualification of the Equipment Rooms in the Auxiliary Building due to High Pressure Safety Injection or Containment Spray pump seal leakage in the event of single-failure of a primary seal (Reference 38). The results show that the room heat load is only marginally impacted, such that the room temperatures remain within evaluated limits.

Open Item 18

The licensee did not perform an analysis of bypass flow debris quantities for a 9000 gpm operating condition (one low pressure ECCS pump for an operating train inadvertently not tripped).

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

The Alion Science and Technology Fiber Bypass Test Report (Reference 12) was revised to add an appendix estimating the quantity and size distribution of fibrous material passing through the SONGS strainer at the increased flow rate associated with the "errant" LPSI pump single-failure scenario in one train. The total bypass amount resulting from one train in normal operation, and one train in the above-described single-failure scenario was utilized as input to a revision of the Westinghouse Downstream Effects Debris Ingestion Fuel Evaluation (Reference 7), as described in the response to Open Item 19 below.

Open Item 19

Due to lack of a licensee analysis of bypass flow debris quantities associated with a one train 9000 gpm operating condition, the licensee was unable to reach a conclusion as to whether the top of the core might be blocked by debris following a LOCA at SONGS.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

As described in the response to Open Item 18 above, the Alion Science and Technology Fiber Bypass Test Report (Reference 12) was revised to add an appendix estimating the quantity and size distribution of fibrous material passing through the SONGS strainer at the increased flow rate associated with the "errant" LPSI pump single-failure scenario in one train. The total bypass amount resulting from one train in normal operation, and one train in the above-described single-failure scenario was then utilized as input to a revision of the Westinghouse Downstream Effects Debris Ingestion Fuel Evaluation (Reference 7). The revised evaluation was performed in accordance with WCAP-16406-P Revision 1, and the associated NRC Safety Evaluation, and shows that the potential fibrous buildup on the top or bottom of the core remains less than the acceptable thickness of 0.125 inches. It should also be noted that the Alion SEM/Fiber Sizing Report (Reference 13) shows that the bypass product is shard-like in nature, and that formation of a fiber bed would most likely not occur.

Open Item 20

The licensee did not form a conclusion on the various potential effects of debris blockage of the fuel assembly support grids and chemical concentration through boiling in the SONGS reactor.

This section has been revised from that provided in the February Supplemental Response (Reference C), to show the evaluation relative to WCAP-16793-NP as open, pending receipt of the WCAP Safety Evaluation.

SCE previously demonstrated that plant conditions were bounded by WCAP-16793-NP, Revision 0, as described in our Supplemental Response of February 27, 2008 (Reference C). Upon issuance of the Safety Evaluation for WCAP-16793-NP, Revision 1, SCE will perform the prescribed evaluations and submit the results to the NRC Staff. This issue is also captured as Item 1 in the RAI related to the February 2008 Supplemental Response (Reference F).

Open Item 21

The licensee had not resolved the chemical effects issue at SONGS at the time of the audit.

This section remains unchanged from that provided in the February 2008 Supplemental Response (Reference C).

Please see Section 3.o "Chemical Effects" of Attachment 1 of this submittal.

Open Item 22

The licensee had not justified that leaching from coatings or changes in the form of coatings will not produce greater head loss than was observed in head loss testing.

This section was revised from that provided in the February 2008 Supplemental Response (Reference C) to reflect resolution of this generic issue.

Alion Sciences and Technology submitted a test report for unqualified alkyd coatings bench top testing (Reference 91) to the NRC, which concludes: "Overall, the alkyd coatings were shown to not play a significantly [sic] role in the creation of chemical precipitates and were not seen to generate any new chemical effects with the potential of impacting debris head loss. Thus their treatment as inert fine-scale particulate from a head loss impact perspective is seen to be reasonable and conservative."

It is SCE's understanding that this report satisfactorily addressed this issue.

Open Item 23

The licensee had not conducted a full evaluation of the applicability of the EPRI/NUCC coatings test data at SONGS.

This section is unchanged from that provided in the February 2008 Supplemental Response (Reference C).

As a part of the EPRI/NUCC program, adhesion testing was performed in conjunction with visual inspection of qualified coatings at several plants. The results, as documented in a report entitled: "Plant Support Engineering; Adhesion Testing of Nuclear Service Level I Coatings" (EPRI PSE Report No. 1014883; issued August 2007), provide confirmatory support for ASTM coating inspection methods. The steel and concrete qualified coating systems at SONGS were among those tested and documented in the above-referenced report. The evaluation is documented in Action Request 070600413-08 (Reference 42).

ATTACHMENT 3

REQUEST FOR ADDITIONAL INFORMATION (RAI) RESPONSE MATRIX

Attachment 3 – RAI Compliance Matrix

This section has been revised to refer to Request for Additional Information received since the submittal of the February 2008 Supplemental Response

A. Request for additional Information (RAI) related to Test Protocol used in the testing at VUEZ; transmitted in a letter from the NRC dated September 17, 2008 (Reference D).

In SCE's response to this RAI in a letter dated October 30, 2008, (Reference E), SCE committed to performing a retest, in lieu of addressing the specific information requests. Therefore, a compliance matrix has not been prepared.

B. Request for additional information (RAI) related to the February 27, 2008 Supplemental Response (corrected title); received in a letter from the NRC dated November 26, 2008 (Reference F).

SCE responded to this RAI in a letter dated February 23, 2009 (Reference G). The RAI are addressed in this Supplemental response as outlined in the matrix below.

	Question	Applicable Supplemental Response Section
1	Please provide your plant-specific approach to resolution of in-vessel downstream effects, which the NRC staff considers to not be fully addressed at SONGS, Units 2 and 3. The submittal refers to draft Westinghouse Topical Report (TR) WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." At this time, the NRC staff has not issued a final safety evaluation (SE) for WCAP-16793-NP. Because of this, the licensee may demonstrate that in-vessel downstream effects issues are resolved for SONGS, Units 2 and 3, by either (1) demonstrating, without reference to WCAP-16793-NP, that in-vessel downstream effect issues have been addressed or (2) showing that plant conditions are bounded by the final WCAP-16793-NP and addressing any conditions and limitations specified in the NRC final SE for the topical report. The specific issues raised in this question (RAI 1) should be addressed regardless of which approach the licensee chooses to take in response to RAI 1. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the NRC staff expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue 191 "Assessment of Debris Accumulation on PWR Sump Performance."	Discussed in Attachment 1, Section 3.n.i, and in Attachment 2, Open Item 20. Upon issuance of the Safety Evaluation for WCAP-16793-NP, Revision 1, SCE will perform the prescribed evaluations and submit the results to the NRC Staff.
2	The licensee stated that additional justification for the 20 percent fines/80 percent small-piece size distribution has been included in Section 4.5.9.1 of the revised Alion Science and Technology Debris Generation Calculation. The NRC staff considers that the approach taken is inconsistent with the SE. The terms "fines" and "small pieces" in the Alion calculation are sub-sets of the term "small fines" as defined by the SE; all of the insulation debris generated is considered to be "small fines" as defined by the SE. Testing conducted for NUREG/CR-6369, "Drywell debris Transport Study"	Discussed in Attachment 1, Section 3.c.i, and in Attachment 2, Open Item 2. SCE has adopted a revised size distribution of 40% fines and 60% small pieces.

	Question	Applicable Supplemental Response Section
	(ADAMS Accession nos. ML003726871, ML00328226, and ML03728322), with a zone of influence (ZOI) of 8D indicated a 20 percent fine fiber debris generation fraction. A 4D ZOI would be expected to generate a significantly higher proportion of fine fiber. The amount of fine fiber is significant from a head loss testing perspective. Please provide detailed information which justifies the assumed size distribution of 20 percent fines and 80 percent small pieces for the 4D mineral wool ZOI.	
3	There is the NRC audit report dated May 16, 2007 (ADAMS Accession No. ML071230749). Attachment 2 to the licensee's letter dated February 27, 2008, is a item-by-item response to the list of open items produced during the 2006 audit of corrective actions at SONGS, Units 2 and 3. The audit open item number 5 stated that the licensee had not justified neglecting the transport of mineral wool by flotation. The response to this item is that the licensee had a vendor prepare a buoyancy evaluation for mineral wool. The evaluation showed that the mineral wool would arrive later in the event when adequate NPSH [net positive suction head] margin existed to allow for any head loss that might be caused by the floating insulation. The response for this open item has no technical basis for the head loss that could result. Please provide a technical basis for the delayed transport and for the strainer head loss that would occur when the mineral wool transported by flotation does reach the strainer.	Discussed in Attachment 1, Section 3.e.i, and in Attachment 2, Open Item 5. Analysis assumes 40% of mineral wool is destroyed as large pieces and that these large pieces transport to the sump by floatation. Resulting sump surface area coverage is approximately 21%, leaving adequate area for flow to top-hats.
4	Audit open item number 6 stated that no justification had been provided for the assumption that containment spray drainage enters the pool as a dispersed flow rather than in concentrated streams. The open item noted that this could affect transport and the assumption of 10 percent erosion of small and large pieces of fibrous debris. The response to this item may have been partially acceptable in that the transport evaluation was revised to include a larger fraction of debris transported to the sump and a revision to the transport calculation. However, certain technical information, such as the magnitude of the change and the basis for the magnitude were not provided. In addition, the response noted that testing had been done to justify the assumption of 10 percent erosion of fibrous debris. Please provide the information that justifies the 10 percent erosion assumption. Also, please provide the information regarding the change in transport fractions due to the change in spray flow, including the basis for the	Discussed in Attachment 1, Section 3.e.i, and in Attachment 2, Open Item 6. Revisions to the Debris Transport Calculation (Reference 2) resulted in an increase in the transport fraction related to this issue from 72% to 79%. Discussed in Attachment 1, Section 3.e.i, and in Attachment 2, Open Item 6. SCE has adopted the 90% erosion fraction stipulated in the NEI 04-07 SE (Reference 3).

	Question	Applicable Supplemental Response Section
	change in transport.	
5	It is not apparent that the strainers were tested with the quantity and type of fine fibrous debris expected to arrive at the strainers, appropriately introduced under prototypical flow conditions to ensure that a thin bed would not occur in the plant. Please provide documentation that demonstrates that the fibrous debris sizes used for testing matched the debris transport calculation.	Discussed in Attachment 1, Sections 3.f.iv and 3.f.vi. A retest was performed utilizing Test Protocol (Reference 70) developed in accordance with NRC Staff Review Guidance Regardiing Strainer Head Loss and Vortexing (Reference 86).
6	Please provide justification for the application of the bump-up factor developed with a different debris bed composition than that used in the small-scale chemical tests.	Not Applicable A retest was performed, as described in Attachment 1, Sections 3.f and 3.o that does not utilize application of a bump-up factor.
7	Please evaluate how the increase in the amount of Microtherm by a factor of two confirms that the head loss determined by testing is prototypical or conservative.	Discussed in Attachment 1, Sections 3.b.i, 3.b.iv, and 3.o.xi; and in Attachment 2, Open Item 1. The Microtherm debris generated was recalculated using the ANSI/ANS-58.2 jet model. Head loss testing was conducted at over twice the design value; additionally, a sensitivity test was performed with loading equivalent to 100% of the Microtherm debris.
8	During small-scale testing, voiding occurred that reportedly resulted in high head losses. The submittal dated February 27, 2008, also described that head loss attributable to chemical effects likely occurred at the same time. The licensee determined that most of the head loss that occurred during this period was due to voiding and some smaller fraction was due to chemical effects. This was reportedly based on evaluation of the SONGS, Units 2 and 3, data and other small scale testing. The technical basis for the determination of apportioning the head loss to these two phenomena is not clear. Please justify the method used to determine how much head loss was attributable to voiding and how much was attributable to chemical effects during the small-scale chemical effects testing.	Not Applicable A retest was performed using prototypical top-hats, as described in Attachment 1, Sections 3.f and 3.o which did not result in the voiding experienced during the flat-plate testing.
9	Please provide a justification for the selection of 4.8 kPa as a chemical effects portion of the high-pressure drop observed during the initial part of the test.	Not Applicable A retest was performed, as described in Attachment 1, Sections 3.f and 3.o which provided direct head loss results, and did not require apportionment between two different phenomena.

Attachment 3 – RAI Compliance Matrix

C. Request for additional information (RAI) related to deaeration across the debris bed and potential effects on the ECCS pumps due to gas ingestion; received in an e-mail from the NRC dated August 25, 2009 (Reference I).

SCE responded to this RAI in an e-mail dated September 4, 2009 (Reference J). This RAI is addressed in this Supplemental response as outlined in the matrix below.

	Question	Applicable Supplemental Response Section
1	Please provide an evaluation of gas evolution downstream of the strainer that could reach the pump suction. Please provide the percentage of evolved gas estimated at the pump inlet. Evaluate the effects of any potential gas ingestion to the pumps taking suction from the sump as described in RG 1.82, Appendix A. The staff is concerned that any gasses that are stripped from the fluid as it passes through the strainer could collect within the strainer and eventually transport to the pump suction as larger air pockets. In addition, the staff has not received information that would characterize the reabsorption of air or gas as the static head on the fluid increases as it flows to the pumps suction. If reabsorption of air is credited, please provide an evaluation of the variables that could affect the reabsorption.	Discussed in Attachment 1, Sections 3.g.iii and 3.o.xi. A deaeration evaluation was performed which resulted in a reduction in the NPSH available. The NPSH margin available for the screen assembly, corrected for deaeration, exceeds the predicted head loss for the duration of the 30-day mission period.

ATTACHMENT 4

LIST OF REFERENCED DOCUMENTS

Attachment 4 - References

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C. Letter; Ross T. Ridenoure, SCE to NRC; Generic Letter 2004-02 Supplemental Response; February 27, 2008

D. Letter; N. Kalyanam, NRC to Ross T. Ridenoure, SCE; Request for Additional Information Related to Test Protocol Used in the Testing at VUEZ; September 17, 2008

E. Letter; Michael P. Short, SCE to NRC; Response to Request for Additional Information Related to Test Protocol Used in the Testing at VUEZ; October 30, 2008

F. Letter; N. Kalyanam, NRC to Ross T. Ridenoure, SCE; Request for Additional Information Related to the February 27, 2008 Supplemental Response (corrected title); November 26, 2008

G. Letter; A. Edward Scherer, SCE to NRC; Response to Request for Additional Information Related to the February 27, 2008 Supplemental Response (corrected title); February 23, 2009

H. NRC Memorandum; Phone Call Summary with Licensees and Alion Sciences and Technology on April 2, 2009 to Address NRC Staff Position on Chemical Effects Refinements; April 7, 2009; ADAMS accession number ML090970582

I. E-mail; Randy Hall, NRC to Linda Conklin, SCE; Additional Staff Question of Potential Deaeration Phenomenon for GL 2004-02; August 25, 2009

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7. Down Stream Effects Debris Ingestion Fuel Evaluation; Westinghouse; CN-CSA-05-35 / SO23-205-7-C10, Revision 1
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12. Fiber Bypass Testing (Report) of a Prototypical Top-Hat Strainer Array; Alion Science and Technology; ALION-REP-ENER-3154-03 / SO23-205-7-C70, Revision 1
13. SEM / Fiber Sizing Report (of Bypass Product): Alion Science and Technology; ALION-REP-ENER-3154-04 / SO23-205-7-C73, Revision 0
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