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February 27, 2008

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
San Onofre Nuclear Generating Station Units 2 and 3

Reference: NRC Generic Letter 2004-02 issued September 13, 2004; Subject: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors

Dear Sir or Madam:

By the referenced Generic Letter, the NRC requested that Southern California Edison (SCE) perform an evaluation of the Emergency Core Cooling System and Containment Spray System recirculation functions in light of information provided in the letter. Subsequent communications from NRC staff have established that a supplemental response to the Generic Letter is required to establish that corrective actions in response to the Generic Letter are adequate. This letter provides the required supplemental response for San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2 and 3).

Our response is organized as follows.

Attachment 1 is an item-by-item response to the revised content guide issued by NRC staff in a November 21, 2007 letter to Mr. Anthony Pietrangelo of the Nuclear Energy Institute (NEI).

Attachment 2 is an item-by-item response to the list of open items produced during the 2006 audit of corrective actions at SONGS 2 and 3 conducted by NRC staff and documented in an audit report dated May 16, 2007.

Attachment 3 is a matrix showing the SONGS 2 and 3 responses to the request for additional information issued by the NRC staff by letter dated February 9, 2006. The request has been superseded by subsequent communications from the NRC staff, so this attachment is supplied for information only.

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Attachment 4 is a matrix showing the SONGS 2 and 3 responses to the draft conditions and limitations to WCAP-16793-NP, Revision 0, "Evaluation Of Long-Term Cooling Considering Particulate, Fibrous And Chemical Debris In the Recirculating Fluid," proposed by NRC staff in a February 4, 2008 letter to Mr. Pietrangelo of NEI.

Attachment 5 is a listing of documents referenced in other attachments.

This submittal contains no new commitments.

If you have any questions or require any additional information, please contact Ms. Linda Conklin at (949) 368-9433.

Sincerely,

Attachments

cc: E. E. Collins, Regional Administrator, NRC Region IV
N. Kalyanam, NRC Project Manager, San Onofre Units 2 and 3
C. C. Osterholtz, NRC Senior Resident Inspector, San Onofre Units 2 and 3

ATTACHMENT 1

CONTENT GUIDE 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.

Southern California Edison (SCE) has completed the analyses and testing; and has completed the physical plant modifications for Units 2 & 3, 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 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. The testing and analyses demonstrating adequacy of the replacement sump screens are bounded by the postulated steam generator compartment break case, which includes a large quantity of mineral wool insulation debris from the steam generators. When the steam generators are replaced in 2009 and 2010, the mineral wool insulation will be replaced by RMI. The reduction in the anticipated quantity of mineral wool debris generated by the postulated line break will be approximately 84%, resulting in significant additional margin in the head loss analyses.
2. 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.
3. The analyses and testing have been 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.
4. 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 2 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.

5. The head loss associated with the RMI transported to the sump was treated as separate from the head loss associated with the other debris. This is considered conservative, because a mixed debris bed containing RMI would have a lower head loss.
6. 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.
7. The analyses and testing are based on a latent debris load of 200 lbs per generating unit, as compared to a walkdown-determined value of 155 lbs.
8. The analyses are based on a sacrificial area for labels and tags of 50 ft^2 per generating unit, as compared to a walkdown-determined sacrificial area of value of 45 ft^2. Consistent with Item 2 above, the total sacrificial area was conservatively applied to both of the two sump screens.
9. 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.
10. The Downstream Effects Evaluations are based on the quantity of qualified coatings within a 10L/D ZOI, rather than the 5L/D ZOI afforded by WCAP-16568-P, Rev. 0.
11. The prototypical non-chemical 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.
12. 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.
13. The NPSH margin evaluation conservatively does not credit containment overpressure post-LOCA.
14. The source of the Microtherm in the Reactor Nozzle Break Case is the band of Microtherm insulation on the reactor vessel. As a conservative assumption, the ability of the reactor vessel to act as a robust barrier and prevent destruction of a portion of the stainless steel encased Microtherm was ignored and total destruction was assumed.

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.

A general description of corrective actions was provided as a part of the September 1, 2005 Generic Letter 2004-02 response, as acknowledged and summarized in Section 1.3 of the NRC Audit Report dated May 16, 2007, TAC Nos. MC4714 and MC4715, ADAMS accession number ML071230749. At the time of the Audit in the Fall of 2006, SCE had completed the debris generation, debris transport, and debris head loss calculations; the downstream effects evaluations in accordance with WCAP-16406-P, Rev. 0; and non-chemical effects array head loss testing.

Subsequent to the Audit, the debris generation, debris transport, and debris head loss calculations; and the non-chemical effects head loss test report were revised in support of the Audit findings and Open Items. Upon issuance of WCAP-16406-P, Rev. 1 in September 2007, the affected downstream effects evaluations were revised. Finally, subsequent to the Audit, integrated chemical effects testing was completed, results applied to non-chemical effects testing in a revision to the head loss calculation, and a NPSH margin calculation generated. All calculations, evaluations, test plans and reports, revised or initially generated subsequent to the Audit are referenced in this submittal.

With respect to the physical plant modifications, the Unit 3 screen installation, bioshield gate modifications, and Microtherm-to-RMI insulation change-out were performed 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 only outstanding action in the SONGS Generic Letter 2004-02 program is the re-verification of the analyses prescribed by WCAP 16793-NP, Revision 0, once the corresponding Safety Evaluation is issued by the NRC. The analyses, based on the WCAP, yielded acceptable results, as described in Section 3.n below.

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.

> 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, 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, 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.

> Secondary line breaks are not considered in the evaluations. Per UFSAR 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, 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 was reviewed by the NRC as documented in Section 3.1 of the Audit Report, 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.

> SONGS used a Zone of Influence approach as documented in the NEI 04-07 SE. SONGS took exception to the SE for the ZOI used for stainless steel encapsulated mineral wool and considered the reactor vessel as a robust barrier for the stainless steel encapsulated Microtherm on the reactor vessel. The ZOI for qualified epoxy coating ZOIs are addressed in Section 3.h. The SONGS approach was reviewed by the NRC as documented in Section 3.2 of the Audit Report. The approach used by SONGS for the debris generation evaluation and the 4D ZOI exception taken for stainless steel encapsulated mineral wool was found to be acceptable by the NRC. The NRC, however, did not agree with the use of the reactor vessel as a robust barrier, resulting in Open Item 1. In response, additional analysis justifying use of a restricted pipe break was performed. However, a conservative approach was adopted in the analyses, assuming 100% destruction of the Microtherm on the Reactor Vessel. Please refer to the Audit Open Item List Section (Attachment 2) of this Submittal for further details.

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

> 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. 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).

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.

Debris quantities were reviewed by the NRC as documented in Section 3.2 of the Audit Report. 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) mineral wool quantities were revised for the Hot Leg Loop 1 and Hot Leg Loop 2 cases. The revised mineral wool quantities were the result of additional mineral wool debris associated with the Steam Generator sampling line. The Debris Generation Calculation was also revised for the Microtherm quantities generated; first to add additional justification for the shadowing assumption, and second, as a conservative measure, removing the shadowing assumption and assuming that 100% of the Microtherm on the vessel is destroyed. The revised quantities were then used in the revision to the Debris Head Loss Calculation (Reference 3).

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

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.

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 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 80% small pieces and 20% fines. Additional justification for this size distribution was included in the revision to the Alion Sciences and Technology Debris Generation Calculation (Reference 1, Section 4.5.9). Please see 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.

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. The NRC found the characteristics to be acceptable, with the exception of the mineral wool size distribution noted in Open Item 2.

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

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.

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. The NRC found the debris characterizations acceptable, with the exception of the mineral wool size distribution, which is addressed in Audit Open Item 2.

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.

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. The NRC concluded that the SONGS methodology was performed in a manner consistent with the SE 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.

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.

Please see the discussion in subsection d.i above.

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

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, Attachment 1, identified miscellaneous debris in the Unit 3 containment. Subsequent to the Audit, it has been 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 revised Alion Debris Head Loss Calculation (Reference 3). 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.

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 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, and found to be acceptable with the exception of the following: Open Item 4 addresses the assumed incipient tumbling velocity for mineral wool; Open Item 5 addresses mineral wool transport by floatation; Open Item 6 addresses the percentage of mineral wool erosion expected due to containment pool flow and containment spray drainage; and Open Item 7 to address the justification of graphically determined transport fractions from Figures 5.9.26 and 5.9.32 in the audited Debris Transport Calculation. Open Items 4 and 5 have been addressed by providing additional justification for the assumptions made, and Open Items 6 and 7 have been resolved by increasing the debris transport fractions in the Debris Transport Calculation (Reference 2). Please see Attachment 2 of this submittal for further details.

The Debris Transport Calculation (Reference 2) and Debris Head Loss Calculation (Reference 3) have been revised to incorporate the results of the resolution of these Open Items. Please see Attachment 2 of this submittal for further details.

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

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, 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.

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, 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.

No debris interceptors are credited.

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

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.

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, 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 described in the subsections above, the debris transport fractions for insulation debris were increased, as documented in the revised Debris Transport Calculation (Reference 2). Of primary interest, the transport of mineral wool insulation from the postulated steam generator compartment break increased from 72% to 79%, as documented in the Debris Head Loss Calculation (Reference 3), which was revised accordingly.

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).

The ECCS schematic diagrams are contained in the SONGS UFSAR, 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.

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, and found to be acceptable.

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

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, 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.

The strainer head loss was determined based on head loss results of prototypical strainer tank tests, and increased by bump-up factors determined through chemical effects testing.

The methodology, assumptions and results of the prototypical non-chemical debris head loss testing were reviewed by the NRC as documented in Section 3.6.1.3 of the Audit Report, 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. The temperature dependence and pH dependence of Microtherm were demonstrated in the Chemical Effects testing performed under the debris and chemical conditions expected in a post-LOCA environment, as documented in the Chemical Effects Head Loss Summary Report (Reference 24). Please see Attachment 2 of this submittal for further details.

The Alion Science and Technology Head Loss Calculation (Reference 3) has been revised to assess the impact on the head loss test results of higher mineral wool and Microtherm quantities, in order to address the resolution of Audit Open Items 1-7.

Chemical Effects Testing is addressed in Section 3.o of this submittal.

The overall strainer head loss, throughout the 30-day mission time, is less than the available ECCS NPSH margin. The time-dependent calculation shows that the most restrictive point in the event is near the onset of recirculation, when the head loss is predicted to be about 4.5 ft H_2O, as compared to the available NPSH margin of about 5.7 ft H_2O. This is documented in the Calculation of Containment Spray and HPSI Pump NPSH Margins (Reference 44).

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

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 is the Loop 1 Hot Leg Break Case The maximum volume of debris reaching the sump can be obtained by adding the individual debris volumes from Table 2.4.7 of the Alion Debris Head Loss Calculation (Reference 3). The total debris volume is approximately 155 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.

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 the "thin-bed" test, all of the particulate debris was added at the onset of the test, followed by incremental additions of fiber quantities equivalent to a 1/8" debris bed thickness. The test successfully demonstrated that the Top-Hat geometry precludes formation of a thin-bed, as intermediate fiber debris loadings did not produce higher head loss than the expected design debris loading. The approach used to add the debris, and the results of the testing were reviewed by the NRC as documented in Section 3.6.1.3 of the Audit Report, and found to be acceptable .

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

The strainer design maximum head loss is based on the head loss determined by the non-chemical prototypical testing documented in the revised Alion Sciences and Technology Debris Head Loss Report (Reference 11). For the fiber debris case, additional debris quantity above what was then the design quantity was tested, in order to allow for subsequent changes in the design quantity. This tested quantity envelopes the changes resulting from: 1) Addition of mineral wool from the steam generator sample lines, 2) Revision in the Debris Transport Fractions in resolution of Audit Open Items 6 and 7; and 3) Addition of sacrificial area in resolution of Audit Open Item 3. The chemical effects testing documented in the Chemical Effects Head Loss Summary Report (Reference 24), results in bump-up factors by which the non-chemical strainer head losses are then multiplied. The changes in the design debris quantity at the screens, inclusion of sacrificial area and clean screen assembly head loss, and the resulting total strainer head loss is documented in the revised Debris Head Loss Calculation (Reference 3). This bumped-up strainer head loss is the strainer design maximum head loss.

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

The determination of the strainer head loss and the vortex evaluation were performed by testing, and not by calculations. These tests were reviewed by the NRC as documented in Sections 3.6.1.3 and 3.6.1.4 of the Audit Report, and found to be acceptable. Vortex testing was performed with a simulated blockage of nearly 80%, well above the 50% original licensing basis. Reference 30 documents this evaluation.

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

The "clean strainer head loss" is 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). A significant conservative assumption in the calculation is taking the fluid properties at 60 F, rather than correcting for viscosity at higher temperatures. The resulting head loss through the manifold and the collector box was determined to be 0.23 feet of water.

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

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.

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. 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.

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.

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.

The head loss test data is corrected for post-LOCA sump temperature conditions using viscosity correction of the test data as described in the revised Alion Head Loss Test Report (Reference 11).

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 measured head losses (approximately 2 feet water column) are substantially 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.

Containment accident pressure is credited in evaluating whether flashing would occur across the strainer surface. The predicted head loss, including chemical effects is approximately 4.5 ft water column at a sump fluid temperature of 208 F. This is greater than the 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 1.4 psi above the sump fluid vapor pressure at 208 F. This is equivalent to a Post LOCA containment pressure of approximately 0.3 psig. The minimum Post LOCA containment pressure during the period that the 208 F sump fluid temperature is anticipated to occur is approximately 13 psig. 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.

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, and found to be acceptable.

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

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, and found to be acceptable.

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

The NPSH margin was developed using a standard Darcy approach for head losses in the piping and piping components. The NPSH margins were developed for a range of sump water temperatures encompassing the expected operating range of the sump post-LOCA. The NPSH calculation accounted for the void fraction of the water entering the pump suction, which reduced the calculated NPSH margins during low water temperature operation. These NPSH margins are compared to the associated strainer head loss to confirm that the NPSH margin exceeds the expected strainer head loss through the range of post-LOCA recirculation sump water temperatures. The NPSH margin calculation is Reference 44.

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

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, and found to be acceptable.

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

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, and found to be acceptable.

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

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.*

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, and found it to be acceptable.

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

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, 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.

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, 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.

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, and found to be acceptable.

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

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.

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, 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.

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, and found to be acceptable.

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

For containment pressure used in the NPSH analysis for containment sump temperatures greater than 208 °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 °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, and found to be acceptable.

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

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.

The NPSH margin analysis was reviewed by the NRC as documented in Section 3.6.2.2.3 of the Audit Report, and found to be acceptable. The smallest head loss margin determined is associated with the High Pressure Safety Injection pumps, and is 5.02 feet of water for 270 °F sump water temperature, as noted in Table 3.6.2.2.1-1 of the Audit Report (RECIRC Mode, Design Basis Case).

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.

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.

The Debris Generation Calculation reviewed as a part of the audit, as documented in Section 3.7 of the Audit Report, assumed conservatively 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 for the Mobil 84-V-2 sealer determined that its qualification documentation 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. To confirm that under these sealer failure rates the assumption that the entire containment was coated with DBA qualified Mobil 46-X-29 was bounding, an analysis was performed. The analysis compared the quantity of coating debris generated in the Debris Generation Calculation to that generated by 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). It was confirmed that the coating debris quantity generated using the assumption contained in the Debris Generation Calculation bounds the actual coating configuration of the Mobil 46-X-29 epoxy and Mobil 84-V-2 sealer.

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

The transport of coating debris was reviewed by the NRC as documented in Section 3.5 of the Audit Report, 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.

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, and found to be acceptable. Both qualified and unqualified coating debris were modeled with ground silica surrogate. The quantity of ground silica used for the testing was determined to provide the same equivalent volume as the coating debris evaluated to reach the sump strainers. The ground silica particulate is sized to mimic the 10 micron coating particle size assumed in the evaluations.

iv. Provide bases for the choice of surrogates.

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, 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.

The ZOI used for determining the quantity of coating debris generated was based on a 5D ZOI. This was reviewed by the NRC as documented in Section 3.7.1 of the Audit Report, 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. 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. All unqualified coating within the containment is conservatively assumed to be destroyed, resulting in 10 micron coating particles.

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

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

vii. Describe any ongoing containment coating condition assessment program.

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, 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.

GL 2004-02 Requested Information Item 2(f)

A description of the existing or planned programmatic controls that will ensure that potential sources of debris introduced into containment (e.g., insulations, signs, coatings, and foreign materials) will be assessed for potential adverse effects on the ECCS and CSS recirculation functions. Addressees may reference their responses to GL 98-04, "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.

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 has been bounded by 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.*

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.

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.

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.

As detailed in Section 4.1 of the NRC Audit Report, Microtherm insulation on piping within the ZOI of large piping breaks is being replaced with RMI. It is also noted in the Audit Report 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.

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

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.

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.

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.

The Screen Modification Package was reviewed by the NRC as documented in Section 4.2 of the Audit Report, 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.

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.

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 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.

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

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

Assumptions / design inputs are listed in Section 5.1.1 of the Audit Report. 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.

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

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).

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, 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.

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.

The SONGS evaluation of upstream effects was reviewed by the NRC as documented in Section 5.2 of the NRC Audit Report, 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.

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.

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.

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.

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.

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

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

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

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.

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. 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.

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.

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. 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.

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.

WCAP-16793-NP, Revision 0, provides generic arguments demonstrating that for the PWR fleet adequate flow is maintained to the core to provide acceptable post-LOCA core cooling under conditions of blockage of the core inlets, debris collection on the fuel spacer grids, and collection of fibrous debris on the fuel. Since adequate flow rates are maintained, the WCAP also concludes that the boric acid dilution evaluations are not affected.

The following demonstrates that the SONGS Containment Emergency Sump screen parameters and screen fiber bypass characteristics are consistent with the assumptions contained in the WCAP:

- The WCAP assumed screen assembly perforations are 0.10 inch or less. The SONGS screen perforations are 3/32" (0.094 inch) diameter (Reference 35), which is bounded by the sump screen perforation size assumed in the WCAP.
- The WCAP assumed the amount of fibers bypassing the screen would be on the order of 1 cubic foot per 1000 square feet of screen area. SONGS performed screen fiber bypass testing as reported in the Alion Fiber Bypass Test Report (Reference 12). The resulting fiber bypass quantity, assuming one sump suffers

a single failure (LPSI pump fails to stop on RAS) and the other sump operates per design, is 0.866 cubic feet, as documented in the revised Westinghouse Down Stream Effects Debris Ingestion Fuel Evaluation (Reference 7). With a total of 1952 square feet of screen per generating unit, this equates to 0.44 cubic foot per 1000 square foot of screen area.

- Reference 13 determined the size distribution of the fiber lengths bypassing the screen, and determined that approximately 95% of the fibers are less than 1000 microns in length. This is consistent with the assumption made in the WCAP, which assumes that the maximum bypassed fiber lengths are typically 2000 microns, with the majority of the bypassed fiber lengths in the range of 1000 microns or less.

The plant-specific analysis recommended in WCAP 16793 for addressing fuel chemical plate-out effects was performed. The analysis resulted in a maximum fuel surface temperature of 370 °F, which is less than the WCAP acceptance limit of 800 F; and total plate-out thickness on the fuel of 17.3 mils, which is less than the WCAP acceptance limit of 50 mils. This evaluation is documented in Reference 43, and will be revised, if required, upon receipt of the associated NRC SE. Draft Conditions and Limitations on the WCAP were transmitted by the NRC's letter of February 4, 2008, and are addressed in Attachment 4 of this submittal.

Previously, the Downstream Effects Fuel and Vessel Evaluations performed to WCAP 16406-P, Revision 0 were reviewed by the NRC as documented in Section 5.3.2 of the Audit Report, 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. Both these items are addressed in WCAP 16793-P, as discussed above. Please see Attachment 2 of this submittal for further details.

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.

The summary of evaluation results provided in this section of the Supplemental Response is based on "Draft Evaluation Guidance for the Review of GSI-191 Plant Specific Chemical Effects Evaluations", issued as Enclosure 3 in a letter from the NRC to NEI in dated September 27, 2007 (ADAMS Accession No. ML072600372). 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 Draft Evaluation Guidance, content for was gleaned from the "Staff Expectation" section.

SONGS' chemical effects testing was performed by Alion Sciences and Technology, utilizing integral generation of chemical products in-situ. The Alion chemical effects test specifications and reports are References 19 – 24.

SONGS acknowledges that the NRC, based on a site visit to the VUEZ laboratory and review of test procedures, developed and submitted a list of 29 questions to Alion Science and Technology. As indicated in Alion's letter of February 8, 2008 to the NRC, Alion has formed an Alion/VUEZ Users' Group for the purpose of addressing these questions. SONGS is an active participant in that group, and has agreed to allow plant-specific test data to be used in the group-resolution of these questions. Notwithstanding this group effort, several of the key questions raised by the NRC are addressed in the response which follows.

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

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

Based on the Alion Sciences and Technology Debris Generation, Debris Transport, and Head Loss Calculations (References 1-3) two Break Cases were identified as potentially limiting with respect to screen debris head loss. These break cases are: Case 1, RCS hot leg break inside steam generator compartment Loop 1, generating mineral wool insulation debris; and Case 3, nozzle break inside the reactor cavity, generating Microtherm insulation debris. While the mineral wool debris case generated a significantly higher head loss than the Microtherm debris case in the non-chemical effects testing, both cases were included in the chemical effects testing to ensure that the case producing the highest head loss with chemical effects was identified. As documented in the VUEZ Test Summary Report (Reference 23), the mineral wool case provided measurable head loss, whereas the Microtherm case did not.

ii. Plant Specific Materials and Buffers (3) – 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.

For the SONGS chemical effects testing, representative quantities of insulation debris, latent debris, coatings surrogate, containment metal and concrete coupons, boric acid, hydrochloric acid, nitric acid, lithium hydroxide, and TSP buffer were utilized. The resulting pH of the fluid during the chemical effects testing was therefore "self-determined", through the interaction of the above-described materials, and not purposely maintained at predetermined values.

A hybrid post-LOCA temperature profile was developed, using two of the cases from the SONGS Containment P/T Analysis for Design Basis LOCA Events (Reference 63). Case 7 provides the highest temperatures at the beginning of the accident scenario, which is considered most conducive to any leaching process that may contribute to chemical effects-related head loss; Case 9 provides the lowest temperatures at the end of the accident scenario, which ensures that a conservative estimate of chemical effects related head loss due to potential precipitation of materials at lower temperatures is obtained. The Case 7 profile is utilized for approximately the first 20 days of the test; the Case 9 profile is utilized for the balance of the 30 day test period.

At SONGS, the containment sprays are active for the duration of the accident scenario. As the chemical effects test set up does not include sprays, the coupons representing materials subjected to sprays in the plant post-LOCA environment were submerged for the entire duration of the test.

The materials expected to contribute to chemical effects are insulation debris, metals (aluminum, carbon steel, copper, and galvanized steel, based on encompassing the metals considered in WCAP-16530-NP), zinc coatings, concrete, boric acid, hydrochloric acid, nitric acid, lithium hydroxide; and TSP buffer. Scaled material and surrogate quantities, in liquid, bulk, or coupon form were included in the chemical effects test.

The above-described assumptions are documented in the following Alion Science and Technology documents: 30-Day Integrated Chemical Effects Test Specification (Reference 19), SONGS Design Input Requirements for the 30-Day Integrated Chemical Effects Testing (Reference 20), Scaling of Materials in the VUEZ Chemical Effects Head Loss Testing (Reference 21), and Surrogate Materials in the VUEZ Chemical Effects Head Loss Testing (Reference 22).

iii. Approach to Determine Chemical Source Term (4) – Identify the vendor who performed plant-specific chemical effects testing.

Alion Sciences and Technology performed the integrated 30-day chemical effects testing, through a sub-contract with VUEZ laboratories in Levice, Slovakia.

iv. Integral Generation of Chemical Products In-Situ (Alion) (18) – (a) Provide technical basis development to support selecting plant-specific test parameters that produce a conservative chemical effects test; and (b) Describe how inability to reach peak sump temperatures is offset by extended testing at highest loop temperatures.

(a) - The 30-day chemical effects test was designed to simulate, to the greatest extent possible in an auto-clave environment, the post-LOCA plant environment. As described above in Section 3.o.ii, a hybrid temperature profile was developed to ensure that both leachate and potential precipitate formation phases were adequately covered in the test. As described in part (b) of this section below, conservative compensating measures were taken with respect to dwell time at the highest test tank temperature. Finally, as described in Section 3.o.v. below, the containment water volume for materials scaling was conservatively selected.

(b) – The VUEZ test apparatus has a temperature limit of 190 ^{o}F, whereas the plant post-LOCA temperature profile ranges from 262 ^{o}F near the beginning of the event declining to 190 ^{o}F after about 17.6 hours, then dropping down to 122 ^{o}F by the end of the event. In order to compensate for elevated reaction rates that are assumed to occur at design sump temperatures exceeding the apparatus temperature limit, normalized reaction rates as a function of temperature were developed. By integrating these normalized reaction rates over time, the same integrated total reaction progress as would be realized in the plant post-LOCA was achieved by maintaining the 190 ^{o}F test temperature for the first 69 hours of the test, then reducing the temperature to meet the design temperature profile temperature of 166 ^{o}F.

The technical basis is documented in the Alion Science and Technology report entitled SONGS Design Input Requirements for the 30-Day Integrated Chemical Effects Testing (Reference 20).

v. Tank Scaling Bed Formation (19) – (a) Describe how the scaling factors for the test facilities are representative or conservative relative to plant-specific values, and (b) Describe how bed formation is representative of that expected for the size of materials and debris that is formed in the plant specific evaluation.

(a) – To replicate the corrosion potential of materials inside containment, the chemical effects test preserved the material surface area to pool volume ratio. The minimum expected containment pool volumes were utilized in scaling the containment materials. Given that the test autoclave volume is fixed, this provided larger coupon surface areas than if the maximum containment volume had been used in the scaling; this in turn maximized the potential quantity of chemical products formed.

Ideally, screen surface area would also be scaled by volume; however, scaling by volume would have resulted in a test flow rate of less than 1 liter per minute – which is below the control threshold for the test apparatus pump. Therefore, the screen size was increased, while maintaining the design approach velocity, to achieve the minimum 1 liter per minute flow rate. Insulation, coatings, and latent debris quantities were then scaled based on the ratio of the test screen area to the plant screen area. This then provides a conservative amount of insulation to interact chemically with the other materials inside containment. The above-described approach is documented in the Alion Science and Technology report Scaling of Materials in the VUEZ Chemical Effects Head Loss Testing (Reference 21).

(b) – The formation of the bed in the chemical effects test is considered to be conservative, with respect to the expected formation of the bed in a post-LOCA environment in the plant. The scaled quantity of debris is thoroughly mixed in hot water from the test tank, then introduced directly on to the screen to preclude bypass and settling on the bottom of the test tank. Every attempt was made to produce a uniform bed, in order to avoid open screen area, which would produce lower overall head loss and potentially mask the chemical effects impacts. The methodology is documented in the Alion 30-Day Integrated Chemical Effects Test Specification (Reference 19).

vi. Tank Transport (20) – Describe how transport of chemicals and debris in the test facility are representative or conservative with regard to the expected flow and transport in the plant-specific conditions.

As described above in Section 3.o.v., the debris expected to be transported to the screen post-LOCA was deposited directly on the screen in the chemical effects test. This precluded "near-field" settling effects, which are not credited in the analysis.

With respect to transport of chemicals, the circulating flow rate and hence the pool turn-over rate was higher than the design value, in order to maintain a minimum flow through the pump for control purposes, as described above in Section 3.o.v. This is considered to be conservative with respect to deposition of any chemical by-products on the debris bed.

vii. 30-day Integrated Head Loss Test (21) – (a) Provide the plant-specific test conditions and the basis for why these test conditions and test results provide for a conservative chemical effects evaluation; and (b) Provide a copy of the pressure drop curve(s) as a function of time for the testing of record.

(a) - Three test loops in the VUEZ facility were utilized for SONGS chemical effects testing:

- Loop 1 (VUEZ Case 4) represented what was then the "design" case for the Steam Generator Compartment Break, matching the design bases for the non-chemical effects testing previously performed.
- Loop 2 (VUEZ Case 5) represented a "bounding" case for the Steam Generator Compartment Break, where all of the mineral wool debris generated in the "base" case is conservatively assumed to transport to the sump. This case also included a conservative estimate of the additional material from the steam generator sample lines; again assuming that 100% of the debris would transport. This "bounding" case was selected to be tested in addition to the original "design" case, because at the time of the testing resolution of the Audit Open Items had not been completed.
- Loop 3 (VUEZ Case 6) represented a revised "design" case for the Reactor Vessel Nozzle Break, where 100% of the Microtherm on the reactor vessel is conservatively assumed to be generated as debris. The original "design" case, which was the basis for the non-chemical effects testing previously performed, differed in that 50% of the Microthern on the vessel was assumed to be generated as debris.

The plant-specific test conditions for the three loops, as well as the temperature profile utilized for all tests are shown in Tables A6, A7, A8, and A9, respectively, of the Alion Sciences and Technology 30-Day Integrated Chemical Effects Specification (Reference

19). Additional considerations with respect to the conservative nature of these tests are presented in the preceding sections.

(b) – Pressure drop curves as a function of time over the 30-day test duration for the three test loops described above are shown in Figures 4.4-2, 4.5-2, and 4.6-2 (respectively) of the Alion VUEZ Test Summary Report (Reference 23). Figure 1 at the end of this attachment presents the Loop 1 and Loop 2 debris bed pressure drop data superimposed as a function of time and temperature profile. Loop 3 produced no pressure drop, so it is not illustrated in this figure. The results of the Loop 3 test demonstrated that no unexpected reactions occurred with the Microtherm debris loads. This composite figure is taken from the Alion Sciences and Technology revised Debris Head Loss Calculation (Reference 3).

viii. Data Analysis "Bump-up" Factor (22) – Provide the details and technical basis that show why the bump-up factor from the particular debris bed in the test is appropriate for application to other debris beds.

Based on the VUEZ testing, a temperature-dependent bump-up factor was developed for application to the non-chemical effects head loss test results. A summary description of the development of the bump-up factor is described below; details are contained in the Alion revised Debris Head Loss Calculation (Reference 3) and the Alion Chemical Effects Head Loss Summary Report (Reference 24).

During the beginning of the test, as can be seen in Figure 1, high differential pressure (dP) was experienced in both Loops 1 & 2. At the first temperature reduction, from 190 °F to 166 °F, the high dP "spike" was significantly reduced. It was determined that gas formation occurred either within or just under the debris bed, based on the physical presence of gas. This occurred due to the addition of the concentrated buffer solution into the test tank. The amount of gas formation in Loop 1, where the higher dP spike was experienced, was significantly higher than Loop 2. This eventually lead to cavitation of the Loop 1 test pump and release of the gas void. As Loop 2 did not suffer a similar upset, the data for Loop 2 was used in the development of the Chemical Bump-Up (CBU) factor.

Head loss increases due to void formation under or within the debris bed are a recognized phenomenon, and can be an artifact of the vertical loop test set-up. Based on other testing conducted in the VUEZ laboratory, it has been confirmed that the early rise in dP can also be attributed to the formation of calcium phosphate.

Based on evaluation of SONGS data, and data from other tests performed in the VUEZ laboratory, an apportionment of the high dP witnessed at the beginning of the test between chemical effects and void formation was made. Based on this apportionment, a dP of 4.8 kPa was attributed to the formation of calcium phosphate; the balance of this initial dP "spike" was attributed to void formation, which would not occur in the array geometry. The increase in dP as the test progressed and the fluid temperature was decreased to 122 °F is attributed to sodium aluminum silicate chemical effects, bed compression, and viscosity effects.

The following table provides the Chemical Bump-Up (CBU) factor versus temperature. The head losses presented include chemical effects, bed compression, and viscosity effects. However, the head losses expected at 208 °F are conservatively set to those witnessed at 190 °F, even though head losses would be expected to decrease with increasing temperature. The CBU is first presented including viscosity effects, then corrected for viscosity relative to 190 °F for application to the non-chemical effects tests results (which already include viscosity effects).

Table 3.o-1; Chemical Bump-Up Factor vs. Temperature

Temperature °F	dP @ T=0 (kPa)	dP (kPa)	CBU w/ viscosity	CBU w/o viscosity
208	0.64	4.8	7.5	7.5

190	0.64	4.8	7.5	7.5
166	0.64	3.0	4.7	4.0
122	0.64	6.33	9.9	6.0

Applying the Chemical Bump-Up factor to the non-chemical effects test results as documented in the Alion Head Loss Test Report of a Prototypical Top-Hat Strainer Array (Reference 11), yields the dP's shown in the table below. These dP's also include the clean screen head loss (CSHL), and represent the total dP expected at the temperatures indicated. Also shown in the table below are the NPSH margins available for screen head loss taken from the SCE NPSH Margin Calculation (Reference 44), and the mission times corresponding to the temperatures, taken from the SONGS Design Input Requirements for the 30-Day Integrated Chemical Effects Testing (Reference 19).

Table 3.o-2; Screen dP and NPSH Margin vs. Mission Time and Temperature

Temperature °F	Mission Time (Days)	dP w/o CBU (ft H_2O)	dP w/ CBU & CSHL (ft H_2O)	NPSH Margin (ft H_2O)
208	0	0.570	4.51(1)	5.68
190	0.7		4.51(1)	15.80
166	2.9	0.787	3.38	24.28
135	21.3		6.33(2)	23.89
122	30	1.223	7.57	23.27

(1) Head loss at 208°F conservatively set to be equal to head loss at 190°F

(2) Interpolated, based on temperature

The data in the table above shows that the NPSH margin available is sufficient to meet the projected top-hat screen dP for the duration of the 30-day mission period. The screen dP and NPSH margin profile over the 30 day mission period is illustrated in Figure 2 at the end of this attachment.

The same bump-up factors were conservatively applied to the Microtherm case non-chemical effects head loss, even though the VUEZ chemical effects test showed no fiber-based dP, nor any chemical effects based interaction. The resulting dP's are lower than those provided above for the Steam Generator mineral wool debris case, and are therefore not the bounding case, and are not presented in this summary.

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.

The following UFSAR changes are in the process of being made as a result of the GL 2004-02 program:

- Section 6.2.1.1.2.4, "Potential Water Traps Inside Containment", has been 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", has been 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", has been 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", has been 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", has been 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...", will be 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" has been revised to reflect the replacement containment emergency sump screen configuration.

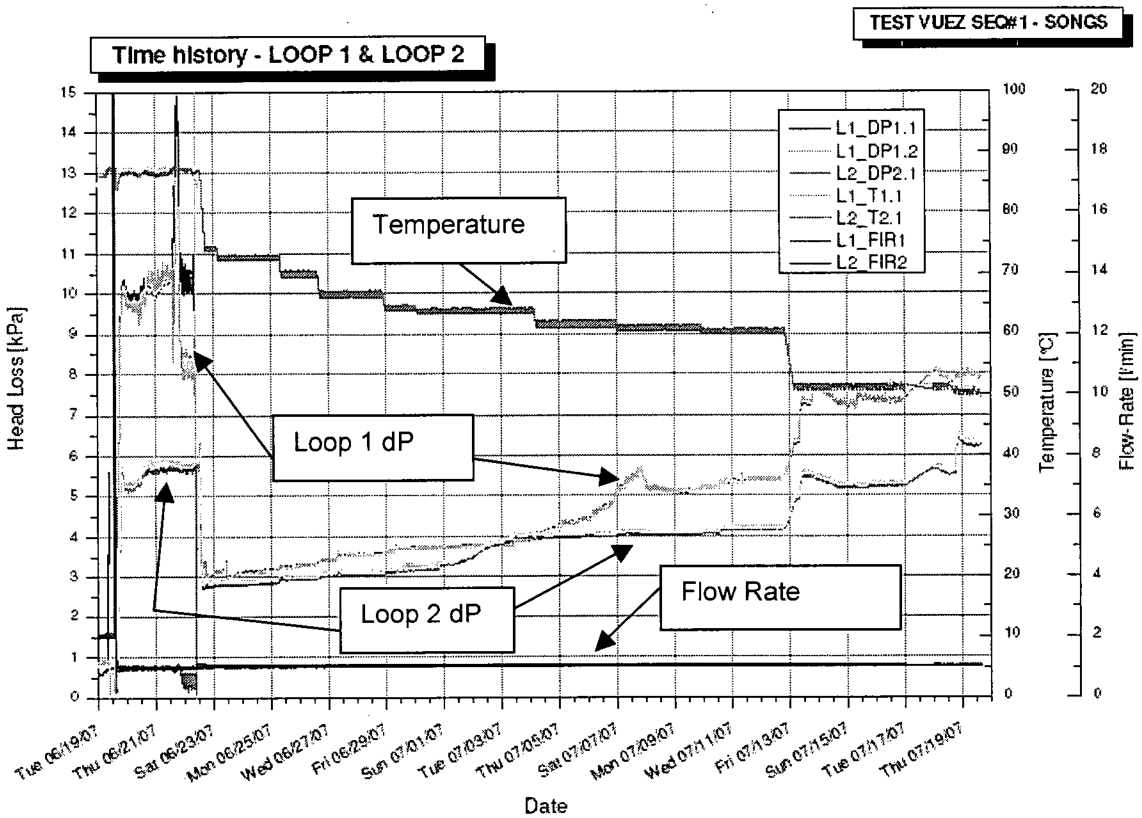

Figure 1 – VUEZ Loop 1 and Loop 2 Pressure Drop Profile

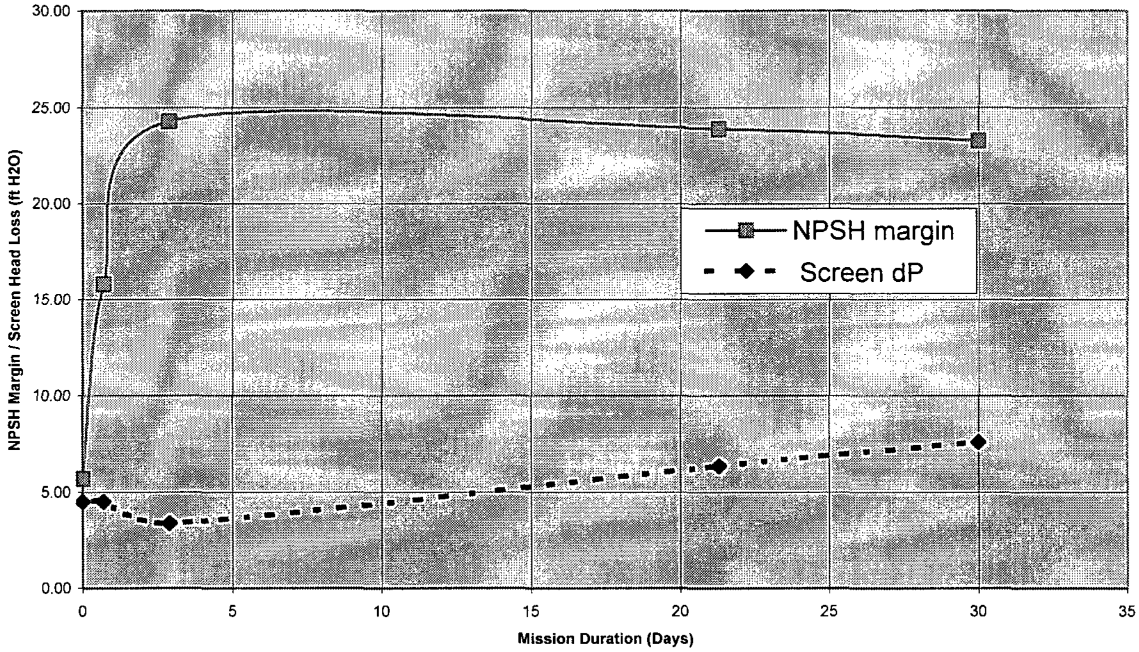

Figure 2 – Screen dP and NPSH Margin Profile
(Data source: Table 3.o-2)

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.

Further discussion of the applicable Zone of Influence for the restricted pipe break in the Reactor Cavity annular region relative to the destruction of Microtherm insulation has been included in Section 5.2.2.1.3 of the revised Alion Science and Technology Debris Generation Calculation (Reference 1). While the shadowing assumption yielding 50% debris generation is felt to be acceptable, a conservative approach has been taken in the calculation to assume 100% of the Microtherm on the reactor vessel is destroyed. This conservative approach was carried through in the revision to the Alion Debris Head Loss Calculation (Reference 3); and in the 30-day integrated Chemical Effects testing, as documented in Alion Test Specifications and Reports (References 19-24).

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.

Additional justification for the 20% fines / 80% small piece size distribution has been included in Section 4.5.9.1 of the revised Alion Science and Technology Debris Generation Calculation (Reference 1). In summary, the approach taken is deemed to be consistent with the Safety Evaluation (SE). The terms "fines" and "small pieces" in the Alion calculation are sub-sets of the term "small fines" as defined by the SE; 100% of the insulation debris generated is considered to be "small fines" as defined by the SE.

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.

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 Head Loss Calculation (Reference 3). 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.

> 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.

> Alion Sciences and Technology prepared a "Mineral Wool Buoyancy Evaluation" (Reference 4), which demonstrates that assuming mineral wool does not float, and is therefore subject to transport to the screens at the onset of the event, is conservative. This is due to the fact that NPSH margins are at the minimum point at the onset of the event, and mineral wool transported by flotation would be deposited later in the event, when NPSH margins are significantly higher.

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.

> Concentrated spray drainage is evaluated in Appendix 1 of the revised Alion Science and Technology Debris Transport Calculation (Reference 2). This evaluation resulted in increases to the fraction of insulation debris transported to the sump. This increase in the amount of debris transported to the sump was reflected in the revision to the Alion Debris Head Loss Calculation (Reference 3).
>
> Alion Science and Technology performed testing for SONGS of mineral wool erosion, as documented in the Mineral Wool Erosion Test Report (Reference 16). This testing demonstrated that a 10% value for mineral wool erosion is conservative. The testing showed that the term "erosion" is more aptly described as fiber "attrition"; the fibers do not erode over time, but rather release the loosely bound constituent fibers a short time after exposure to the flowing fluid – and further erosion after the initial release is minimal. 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.

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.

> 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 an increase in the amount of insulation debris transported to the sump, and was incorporated in the revision to the Alion Debris Head Loss Calculation (Reference 3).

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.

> 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.

> 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.
>
> The chemical effects testing performed by Alion, as documented in the Alion Science and Technology VUEZ Test Summary Report (Reference 23) and Chemical Effects Head Loss Summary Report (Reference 24), confirmed that the temperature and pH variations expected in a post-LOCA environment do not result in detrimental head loss for the SONGS Microtherm debris case.

Open Item 10

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

> 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 Guidance for Review of Final Licensee Responses to GL 2004-02 on September 27, 2007. Reference 2, Coatings Evaluation Guidance, 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.

> 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.

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.

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.

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.

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.

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.

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).

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.

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.

Please see Section 3.n of Attachment 1 for the correlation between SONGS and WCAP 16793 parameters, demonstrating that with respect to debris blockage of the fuel assembly support grids, SONGS is bounded by the WCAP analysis.

The plant specific analysis recommended in WCAP 16793 for addressing fuel chemical plate out effects was performed. The analysis resulted in fuel surface temperatures lower than the WCAP acceptance limit of 800 F, and total crud buildup on the fuel less than the WCAP acceptance limit of 50 microns. This evaluation is documented in Reference 43, and will be revised if required, upon receipt of the NRC Safety Evaluation.

Open Item 21

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

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 item is being handled generically with the Pressurized Water Reactor Owners Group, as acknowledged by the NRC during the SONGS Audit Exit teleconference on May 8, 2007.

Open Item 23

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

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

RAI RESPONSE MATRIX

Attachment 3 – RAI Compliance Matrix

No.	Question	Applicable References
	Plant Materials	
1	Identify the name and bounding quantity of each insulation material generated by a large-break loss-of-coolant accident (LBLOCA). Include the amount of these materials transported to the containment pool. State any assumptions used to provide this response.	Discussed in Attachment 1, Section 3.b.iv; material quantities generated are listed in Reference 1. Discussed in Attachment 1, Section 3.e.vi; material quantities transported are listed in Reference 2.
2	Identify the amounts (i.e., surface area) of the following materials that are: (a) submerged in the containment pool following a LOCA, - aluminum - zinc (from galvanized steel and from inorganic zinc coatings) - copper - carbon steel not coated - uncoated concrete (b) in the containment spray zone following a LOCA: - aluminum - zinc (from galvanized steel and from inorganic zinc coatings) - copper - carbon steel not coated - uncoated concrete Compare the amounts of these materials in the submerged and spray zones at your plant relative to the scaled amounts of these materials used in the Nuclear Regulatory Commission (NRC) nuclear industry jointly-sponsored Integrated Chemical Effects Tests (ICET) (e.g., 5x the amount of uncoated carbon steel assumed for the ICETs).	Discussed in Attachment 1, Section 3.o.ii; material quantities in the pool and in the spray zone are listed in Reference 79. A comparison of SONGS materials with ICET #2 materials was not prepared in a formal manner, as we are not utilizing the ICET data as design input. Instead, a stand-alone 30-day plant-specific chemical effects test has been performed as described in Attachment 1, Section 3.o.
3	Identify the amount (surface area) and material (e.g., aluminum) for any scaffolding stored in containment. Indicate the amount, if any, that would be submerged in the containment pool following a LOCA. Clarify if scaffolding material was included in the response to Question 2.	Discussed in Attachment 1, Section 3.o.ii; Reference 79 provides the quantity of scaffold material stored inside containment (galvanized steel).
4	Provide the type and amount of any metallic paints or non-stainless steel insulation jacketing (not included in the response to Question 2) that would be either submerged or subjected to containment spray.	There are no metallic paints not addressed in Question 2, and there is no non-stainless steel insulation jacketing.
	Containment Pool Chemistry	
5	Provide the expected containment pool pH during the emergency core cooling system (ECCS) recirculation mission time following a LOCA at the beginning of the fuel cycle and at the end of the fuel cycle. Identify any key assumptions.	Discussed in Attachment 1, 3.o.ii; the expected containment pool pH during the ECCS mission time is developed in Reference 80.
6	For the ICET environment that is the most similar to your plant conditions, compare the expected containment pool conditions to the ICET conditions	A comparison of SONGS expected pool conditions with the ICET #2 conditions has not been performed, as we are not utilizing the ICET

No.	Question	Applicable References
	for the following items: boron concentration, buffering agent concentration, and pH. Identify any other significant differences between the ICET environment and the expected plant-specific environment.	data as design input. Instead, a stand-alone 30-day plant-specific chemical effects test has been performed as described in Attachment 1, Section 3.o.
7	For a LBLOCA, provide the time until ECCS external recirculation initiation and the associated pool temperature and pool volume. Provide estimated pool temperature and pool volume 24 hours after a LBLOCA. Identify the assumptions used for these estimates.	Pool volume and temperature are discussed in Attachment 1, Section 3.g, "NPSH". References 61 and 63 provide the basis for containment flooding level, and post-LOCA temperature, respectively.
	Plant- Specific Chemical Effects	
8	Discuss your overall strategy to evaluate potential chemical effects including demonstrating that, with chemical effects considered, there is sufficient net positive suction head (NPSH) margin available during the ECCS mission time. Provide an estimated date with milestones for the completion of all chemical effects evaluations.	Discussed in Attachment 1, Section 3.o. Alion Chemical Effects test plans and reports are References 19 – 24, the results are developed and presented in References 3 and 44.
9	Identify, if applicable, any plans to remove certain materials from the containment building and/or to make a change from the existing chemicals that buffer containment pool pH following a LOCA.	Attachment 1, Section 3.i.v. discusses the removal of Microtherm Insulation on piping within LOCA ZOI; this work was performed via ECP per References 59 & 60.
10	If bench-top testing is being used to inform plant specific head loss testing, indicate how the bench-top test parameters (e.g., buffering agent concentrations, pH, materials, etc.) compare to your plant conditions. Describe your plans for addressing uncertainties related to head loss from chemical effects including, but not limited to, use of chemical surrogates, scaling of sample size and test durations. Discuss how it will be determined that allowances made for chemical effects are conservative.	Bench-top testing was performed by Alion Sciences and Technology; however, these tests were not used as input or design bases for the integrated Chemical Effects testing described in Section 3.o of Attachment 1. The test plans and reports (References 70-77) are therefore "reference" documents.
	Plant Environment Specific	
11	Provide a detailed description of any testing that has been or will be performed as part of a plant-specific chemical effects assessment. Identify the vendor, if applicable, that will be performing the testing. Identify the environment (e.g., borated water at pH 9, deionized water, tap water) and test temperature for any plant-specific head loss or transport tests. Discuss how any differences between these test environments and your plant containment pool conditions could affect the behavior of chemical surrogates. Discuss the criteria that will be used to demonstrate that chemical surrogates produced for testing (e.g., head loss, flume) behave in a similar manner physically and chemically as in the ICET environment and plant containment pool environment.	Discussed in Attachment 1, Section 3.o; Alion Chemical Effects test plans and reports are References 19 – 24.
12	For your plant-specific environment, provide the maximum projected head loss resulting from chemical effects (a) within the first day following a	Discussed in Attachment 1, Section 3.o.viii; head loss values are developed in Reference 3.

Attachment 3 – RAI Compliance Matrix

No.	Question	Applicable References
	LOCA, and (b) during the entire ECCS recirculation mission time. If the response to this question will be based on testing that is either planned or in progress, provide an estimated date for providing this information to the NRC.	
	ICET 1 and ICET 5 Plants	
13	(Not applicable)	N/a
	Trisodium Phosphate (TSP Plants)	
14	Given the results from the ICET #3 tests (Agencywide Document Access and Management System (ADAMS) Accession No. ML053040533 and NRC-sponsored head loss tests (Information Notice 2005-26 and Supplement 1), estimate the concentration of dissolved calcium that would exist in your containment pool from all containment sources (e.g., concrete and materials such as calcium silicate, Marinite, mineral wool, kaylo) following a LBLOCA and discuss any ramifications related to the evaluation of chemical effects and downstream effects.	An estimate of the concentration of dissolved calcium has not been performed, as we are not utilizing the ICET data as design input. Instead, a stand-alone 30-day plant-specific chemical effects test has been performed as described in Attachment 1, Section 3.o. The Alion VUEZ Test Summary Report (Reference 23) provides the calcium concentration in the recirculating test fluid as a function of time over the 30-day test period. (ICET #2 is the test most appropriate for SONGS).
15	(Not applicable)	N/a
16	(Not applicable)	N/a
	Additional Chemical Effects Questions	
17	(Not applicable)	N/a
18	(Not applicable)	N/a
19	(Not applicable)	N/a
20	(Not applicable)	N/a
21	(Not applicable)	N/a
22	(Not applicable)	N/a
23	(Not applicable)	N/a
24	(Not applicable)	N/a
	Coatings	
	Generic - All Plants	
25	Describe how your coatings assessment was used to identify degraded qualified/acceptable coatings and determine the amount of debris that will result from these coatings. This should include how the assessment technique(s) demonstrates that qualified/acceptable coatings remain in compliance with plant licensing requirements for design basis accident (DBA) performance. If current examination techniques cannot demonstrate the coatings' ability to meet plant licensing requirements for DBA performance, licensees should describe an augmented testing and inspection program that provides assurance that the qualified/acceptable coatings continue to meet DBA performance requirements. Alternately, assume all containment coatings fail and describe the potential for this debris to transport to the sump.	Coatings assessment is described in Attachment 1, Section 3.h.vii and in Attachment 2, Open Item 23. Reference 42 contains the SONGS evaluation of applicability of the EPRI/NUCC program for assessment of qualified coatings.
	Plant Specific	
26	(Not applicable)	N/a
27	(Not applicable)	N/a

Attachment 3 – RAI Compliance Matrix

No.	Question	Applicable References
28	(Not applicable)	N/a
29	Your GL response indicates that you may pursue a reduction in the radius of the zone of influence (ZOI) for coatings. Identify the radius of the coatings ZOI that will be used for your final analysis. In addition, provide the test methodology and data used to support your proposed ZOI. Provide justification regarding how the test conditions simulate or correlate to actual plant conditions and will ensure representative or conservative treatment in the amounts of coatings' debris generated in the interaction of coatings and a two phase jet. Identify all instances where the testing or specimens used deviate from plant conditions (i.e., irradiation of actual coatings vice samples, aging differences, etc.). Provide justification regarding how these deviations are accounted for with the test demonstrating the proposed ZOI.	The SONGS head loss testing and analyses work is based on a 5L/D ZOI for qualified coatings, as discussed in Section 3.h.v of Attachment 1 and Open Item 10 of Attachment 2. The basis for use of the 5L/D ZOI is WCAP-16568-P. It should be noted that for the downstream effects analyses, a 10L/D ZOI for qualified coatings is conservatively used.
30	The NRC staff's safety evaluation (SE) addresses two distinct scenarios for formation of a fiber bed on the sump screen surface. For a thin bed case, the SE states that all coatings debris should be treated as particulate and assumes 100% transport to the sump screen. For the case in which no thin bed is formed, the staff's SE states that the coatings debris should be sized based on plant-specific analyses for debris generated from within the ZOI and from outside the ZOI, or that a default chip size equivalent to the area of the sump screen openings should be used (Section 3.4.3.6). Describe how your coatings debris characteristics are modeled to account for your plant-specific fiber bed (i.e. thin bed or no thin bed). If your analysis considers both a thin bed and a non-thin bed case, discuss the coatings' debris characteristics assumed for each case. If your analysis deviates from the coatings' debris characteristics described in the staff-approved methodology, provide justification to support your assumptions.	Coatings size distribution is discussed in Section 3.h.vi of Attachment 1. Details are provided in the Alion Debris Generation Calculation (Reference 1).
31	Your submittal indicated that you had taken samples for latent debris in your containment, but did not provide any details regarding the number, type, and location of samples. Please provide these details.	Discussed in Attachment 1, Section 3.d.; the Survey is Reference 25.
32	Your submittal did not provide details regarding the characterization of latent debris found in your containment as outlined in the NRC SE. Please provide these details.	Discussed in Attachment 1, Section 3.d.; the Survey is Reference 25.
33	How will your containment cleanliness and foreign material exclusion (FME) programs assure that latent debris in containment will be controlled and monitored to be maintained below the amounts and characterization assumed in the ECCS strainer design? In particular, what is planned for areas/components that are normally inaccessible or	Discussed in Attachment 1, Section 3.i.; the Procedures that implement the programs are References 64 – 69.

No.	Question	Applicable References
	not normally cleaned (containment crane rails, cable trays, main steam/feedwater piping, tops of steam generators, etc.)?	
34	Will latent debris sampling become an ongoing program?	The latent debris sampling program per se is not an ongoing program. Control of containment cleanliness is discussed in Section 3.i of Attachment 1 and is governed by plant procedures (References 64 – 69).
35	You indicated that you would be evaluating downstream effects in accordance with WCAP 16406-P. The NRC is currently involved in discussions with the Westinghouse Owner's Group (WOG) to address questions/concerns regarding this WCAP on a generic basis, and some of these discussions may resolve issues related to your particular station. The following issues have the potential for generic resolution; however, if a generic resolution cannot be obtained, plant specific resolution will be required. As such, formal RAIs will not be issued on these topics at this time, but may be needed in the future. It is expected that your final evaluation response will specifically address those portions of the WCAP used, their applicability, and exceptions taken to the WCAP. For your information, topics under ongoing discussion include: a) Wear rates of pump-wetted materials and the effect of wear on component operation b) Settling of debris in low flow areas downstream of the strainer or credit for filtering leading to a change in fluid composition c) Volume of debris injected into the reactor vessel and core region d) Debris types and properties e) Contribution of in-vessel velocity profile to the formation of a debris bed or clog f) Fluid and metal component temperature impact g) Gravitational and temperature gradients h) Debris and boron precipitation effects i) ECCS injection paths j) Core bypass design features k) Radiation and chemical considerations l) Debris adhesion to solid surfaces m) Thermodynamic properties of coolant	Downstream Effects on components and systems are discussed in Section 3.m of Attachment 1. The SONGS Downstream Effects evaluations were revised as required to bring them into accord with WCAP-16406-P, Rev. 1. The revised downstream effects evaluations are References 6, 7, and 8. Downstream Effects on fuel and vessel are discussed in Section 3.n of Attachment 1. The plant-specific analysis recommended by WCAP-16793-NP, Rev. 0 for addressing chemical plate-out on the fuel was performed with acceptable results. The calculation evaluating the chemical plate-out on the fuel is Reference 43.
36	Your response to GL 2004-02 question (d) (viii) indicated that an active strainer design will not be used, but does not mention any consideration of any other active approaches (i.e., backflushing). Was an active approach considered as a potential strategy or backup for addressing any issues?	Active approaches, such as an active strainer design or back-flushing were not considered, as acceptable results were achieved with passive designs.
37	The NRC staff's SE discusses a "systematic approach" to the break selection process where an	The break selection process is described in Section 3.a.i of Attachment 1.

No.	Question	Applicable References
	initial break location is selected at a convenient location (such as the terminal end of the piping) and break locations would be evaluated at 5-foot intervals in order to evaluate all break locations. For each break location, all phases of the accident scenario are evaluated. It is not clear that you have applied such an approach. Please discuss the limiting break locations evaluated and how they were selected.	
38	Were secondary side breaks (e.g., main steam, feedwater) considered in the break selection analyses? Would these breaks rely on ECCS sump recirculation?	Consideration of secondary-side breaks is discussed in Section 3.a.ii of Attachment 1.
39	The staff SE refers to Regulatory Guide 1.82 which lists considerations for determining the limiting break location (staff position 1.3.2.3). Please discuss how these considerations were evaluated as part of the San Onofre break selection analyses.	The basis for selection of the limiting break is covered in Section 3.a.iii of Attachment 1.
40	You assumed a 4D ZOI for the mineral wool/stainless steel cassette insulation system at San Onofre and states that this is conservative because the 2D ZOI used for reflective metallic insulation (RMI) was doubled. Please discuss the technical basis for concluding that a 4D ZOI for this insulation system is adequate, including reference to applicable testing performed to determine the ZOI for the RMI and mineral wool insulations.	The 4L/D ZOI utilized for mineral wool is discussed in Section 3.b.i of Attachment 1.
41	You refer to hydraulic and material properties testing of a mineral wool sample from another utility's plant for mineral wool debris characteristics, and states that scanning electron microscopy (SEM) will be used to confirm that San Onofre's mineral wool is identical to that tested. Please discuss the debris characteristics assumed for mineral wool in your analyses and provide the results of the SEM analysis which justify the application of the hydraulic and material properties testing to San Onofre-specific materials.	Mineral wool debris characteristics are discussed in Section 3.c.ii of Attachment 1. Subsequent to the 9/1/05 Generic Letter submittal, SONGS performed SEM characterization of a mineral wool sample taken from the SONGS containment. The SEM results are presented in Reference 78.
42	Was the baseline guidance of 60% small fines and 40% large pieces followed for the characterization of mineral wool or other fibrous insulation debris that is present? If not, please provide a quantitative description of the characterization used for these fibrous materials.	The mineral wool debris size distribution is discussed in Section 3.c.i of Attachment 1, and Open Item 2 of Attachment 2. Justification for the size distribution is provided in the Alion Debris Generation Calculation (Reference 1).
43	The explanation that debris erosion should effectively cease after 24 hours is not clear to the NRC staff. The September 2005 response to GL 2004-02 indicates that test data (presumably from the staff's SE on the Nuclear Energy Institute guidance report) shows erosion as mainly due to loosely attached pieces of fiber breaking off of larger pieces, concluding that erosion should, therefore, taper off after approximately 24 hours. It is not clear to the NRC staff that this conclusion is actually	Mineral wool debris erosion is covered in Section 3.e.i of Attachment 1, and Open Item 6 of Attachment 2. Alion performed mineral wool erosion testing supporting the assumed 10% erosion, as documented in References 15 – 18.

No.	Question	Applicable References
	supported by the test data, since (1) Appendix III to the staff's SE indicates that the accumulation of eroded debris tended to hold at a somewhat sustainable rate, and (2) the test durations were only in the range of 3 - 5 hours. Please provide additional information and analysis to demonstrate that the overall treatment of mineral wool debris characterization and transport is conservative. Please consider the contribution of containment sprays to debris erosion, and note at what point or timeframe during the accident recovery sprays are likely to be terminated.	
44	What assumptions were made concerning the debris characterization for the various types of coatings that would be assumed to fail due to interaction with the containment environment (i.e., unqualified and degraded qualified coatings)? Were these coatings assumed to become particulate or chips? What size distributions were assumed?	Coatings size distribution is discussed in Section 3.h.vi of Attachment 1. Details are provided in the Alion Debris Generation Calculation (Reference 1).
45	Has debris settling upstream of the sump strainer (i.e., the near-field effect) been credited or will it be credited in testing used to support the sizing or analytical design basis of the proposed replacement strainers? In the case that settling was credited for either of these purposes, estimate the fraction of debris that settled and describe the analyses that were performed to correlate the scaled flow conditions and any surrogate debris in the test flume with the actual flow conditions and debris types in the plant's containment pool.	This is addressed in Section 3.f.xii of Attachment 1; near field settling was not credited in the prototypical strainer head loss testing.
46	Are there any vents or other penetrations through the strainer control surfaces which connect the volume internal to the strainer to the containment atmosphere above the containment minimum water level? In this case, dependent upon the containment pool height and strainer and sump geometries, the presence of the vent line or penetration could prevent a water seal over the entire strainer surface from ever forming; or else this seal could be lost once the head loss across the debris bed exceeds a certain criterion, such as the submergence depth of the vent line or penetration. According to Appendix A to Regulatory Guide 1.82, Revision 3, without a water seal across the entire strainer surface, the strainer should not be considered to be "fully submerged." Therefore, the NRC staff requests that, if applicable, the licensee explain what sump strainer failure criteria are being applied for the "vented sump" scenario described above.	This is addressed in Section 3.f.xi of Attachment 1; there are no vents nor piping exposed to the interior of the strainers that are open to the containment atmosphere, and the strainer is considered to be fully submerged.
47	What is the basis for concluding that the refueling cavity drain(s) would not become blocked with debris? What are the potential types and characteristics of debris that could reach these	Potential blockage of the refueling cavity drain is discussed in Section 3.l.iv. of Attachment 1. The detailed evaluation is provided in the Alion Debris Transport Calculation (Reference 2)

No.	Question	Applicable References
	drains? In particular, could large pieces of debris be blown into the upper containment by pipe breaks occurring in the lower containment, and subsequently drop into the cavity? In the case that large pieces of debris could reach the cavity, are trash racks or interceptors present to prevent drain blockage? In the case that partial/total blockage of the drains might occur, do water hold-up calculations used in the computation of NPSH margin account for the lost or held-up water resulting from debris blockage?	
48	What is the minimum strainer submergence during the postulated LOCA? At the time that the recirculation starts, most of the strainer surface is expected to be clean, and the strainer surface close to the pump suction line may experience higher fluid flow than the rest of the strainer. Has any analysis been done to evaluate the possibility of vortex formation close to the pump suction line and possible air ingestion into the ECCS pumps? In addition, has any analysis or test been performed to evaluate the possible accumulation of buoyant debris on top of the strainer, which may cause the formation of an air flow path directly through the strainer surface and reduce the effectiveness of the strainer?	Strainer submergence and potential vortexing are discussed in Sections 3.g and 3.f of Attachment 1. Vortex testing is further described in Open Item 11 of Attachment 2. Details of the vortex test are provided the Alion Head Loss Test Report of a Prototypical Top-Hat Strainer Array (Reference 11).
49	The September 2005 GL response indicated that your debris transport analysis included modeling of fiberglass debris erosion, with an assumption that erosion would taper off after 24 hours. Please explain the basis for this assumption.	This is a duplicate entry; please see item 43.

ATTACHMENT 4

Response To The Draft Conditions And Limitations To WCAP-16793-NP, Revision 0, "Evaluation Of Long-Term Cooling Considering Particulate, Fibrous And Chemical Debris In The Recirculating Fluid," Proposed By NRC Staff

Attachment 4 – WCAP-16793-NP Draft Conditions & Limitations

No.	Condition and Limitation	Response
1	WCAP-16793-NP states that licensees shall either demonstrate that previously performed bypass testing is applicable to their plant-specific conditions, or perform their own plant-specific testing. The staff agrees with this stated position.	Plant-specific bypass testing has been performed, as documented in the Alion Fiber Bypass Test Report (Reference 12).
2	There are very large margins between the amount of core blockage that could occur based on the fuel designs and the debris source term discussed in WCAP-16793-NP and the blockage that would be required to degrade the coolant flow to the point that the decay heat could not be adequately removed. Plant-specific evaluations referencing WCAP-16793-NP should verify the applicability of the WCAP-16793-NP blockage conclusions to licensees' plants and fuel designs.	Please see Attachment 1, Section 3.n.i, for verification that the SONGS sump screen parameters and screen fiber bypass characteristics are consistent with the assumptions contained in the WCAP.
3	Should a licensee choose to take credit for alternate flow paths such as core baffle plate holes, it shall demonstrate that the flow paths would be effective and that the flow holes will not be become blocked with debris during a loss-of-coolant accident (LOCA) and that the credited flowpath would be effective.	Alternate flow paths are not being credited.
4	Existing plant analyses showing adequate dilution of boric acid during the long-term cooling period have not considered core inlet blockage. Licensees shall show that possible core blockage from debris will not invalidate the existing post-LOCA boric acid dilution analysis for the plant.	The Westinghouse Downstream Effects Debris Ingestion Fuel Evaluation (Reference 7) documents that the potential fiber bed thickness is less than the 0.125" threshold; hence blockage is assumed not to occur.
5	The staff expects the Pressurized Water Reactor Owners Group (PWROG) to revise WCAP-16793-NP to address the staff's requests for additional information and the applicant's responses. A discussion of the potential for fuel rod swelling and burst to lead to core flow blockage shall be included in this revision.	It does not appear that licensee action is required for this item.
6	WCAP-16793 shall be revised to indicate that the licensing basis for Westinghouse two-loop PWRs is for the recirculation flow to be provided through the upper plenum injection (UPI) ports with the cold-leg flow secured.	It does not appear that licensee action is required for this item. Also, this is not applicable to San Onofre, as upper plenum injection is not utilized.
7	Individual UPI plants will need to analyze boric acid dilution / concentration in the presence of injected debris for a cold-leg break LOCA.	This is not applicable to San Onofre, as upper plenum injection is not utilized.
8	WCAP-16793 states that the assumed cladding oxide thickness for input to LOCADM will be the peak local oxidation allowed by 10 CFR 50.46, or 17 percent of the cladding wall thickness. The WCAP states that a lower oxidation thickness can be used on a plant-specific basis if that value is justified. The staff does not agree with the flexibility in this approach. Licensees shall assume 17 percent oxidation in the LOCADM analysis.	17% of the cladding wall thickness was assumed as the oxidation thickness in executing the LOCADM analysis.
9	The staff accepts a cladding temperature limit of 800°F as the long-term cooling acceptance basis for GSI-191 considerations. Should a licensee calculate a temperature that exceeds this value, cladding strength data must be provided for oxidized or pre-hydrided cladding material that exceeds this temperature.	As documented in the SONGS calculation executing the LOCADM analysis (Reference 43), the maximum cladding temperature is 370 °F, well below the 800 °F limit.

10	In the response to NRC staff requests for additional information, the PWR Owners Group indicated that if plant-specific refinements are made to the WCAP-16530-NP base model to reduce conservatisms, the LOCADM user shall demonstrate that the results still adequately bound chemical product generation. If a licensee uses plant-specific refinements to the WCAP-16530-NP base model that reduce the chemical source term considered in the downstream analysis, the licensee shall provide a technical justification that demonstrates that the refined chemical source term adequately bounds chemical product generation. This will provide the basis that the reactor vessel deposition calculations are also bounding.	SONGS did not make any plant-specific refinements to the WCAP-16530-NP base model. With respect to the LOCADM spreadsheet, the aluminum quantity was not refined by alloy type.
11	WCAP-16793-NP states that the most insulating material that could deposit from post-LOCA coolant impurities would be sodium aluminum silicate. WCAP-16793 recommends that a thermal conductivity of 0.11 BTU/hr-ft-°F be used for the sodium aluminum silicate scale and for bounding calculations when there is uncertainty in the type of scale that may form. If plant-specific calculations use a less conservative thermal conductivity value for scale (i.e., greater than 0.11 BTU/hr-ft-°F), the licensee shall provide a technical justification for the plant-specific thermal conductivity. This justification shall demonstrate why it is not possible to form sodium aluminum silicate or other scales with conductivities below the selected value.	A thermal conductivity of 0.2 W/m-°K, which is equivalent to 0.11 BTU/hr-ft-°F, was used in the execution of the LOCADM analysis.
12	WCAP-16793-NP indicates that initial oxide thickness and initial crud thickness could either be plant-specific estimates based on fuel examinations that are performed or default values in the LOCADM model. Consistent with Conditions and Limitations item number 8, the default value for oxide used for input to LOCADM will be the peak local oxidation allowed by 10 CFR 50.46, or 17 percent of the cladding wall thickness. The default value for crud thickness used for input to LOCADM is 127 microns, the thickest crud that has been measured at a modern PWR. Licensees using plant-specific values instead of the WCAP-16793-NP default values for oxide thickness and crud thickness shall justify the plant-specific values.	17% of the cladding wall thickness was assumed as the oxide thickness in executing the LOCADM analysis. A default value for crud thickness of 140 microns was assumed in the execution of the LOCADM analysis.

13	As described in the Conditions and Limitations for WCAP-16530-NP (ADAMS ML073520891), the aluminum release rate equation used in WCAP-16530-NP provides a reasonable fit to the total aluminum release for the 30-day ICET tests but underpredicts the aluminum concentrations during the initial active corrosion portion of the test. To provide more appropriate levels of aluminum for the LOCADM analysis in the initial days following a LOCA, licensees shall apply a factor of two to the aluminum release as determined by the WCAP-16530-NP spreadsheet, although the total aluminum considered does not need to exceed the total predicted by the WCAP-16530-NP spreadsheet for 30 days. Alternately, licensees may choose to use a different method for determining the aluminum release, but in all cases licensees shall not use a method that under-predicts the aluminum concentrations measured during the initial 15 days of ICET 1.	Licensees input the aluminum quantities, and the LOCADM spreadsheet calculates the aluminum release rate and resulting by-products. In order to bound the exposure to this item, the LOCADM spreadsheet was run with double the aluminum quantity. This sensitivity run yielded an increase in LOCA scale thickness (from 131 microns to 158 microns), and a corresponding increase in total plate-out thickness (from 17.3 mils to 18.4 mils). This increased thickness remains well below the acceptable threshold thickness of 50 mils. The maximum cladding temperature remained unchanged at 370 °F, well below the 800 °F limit. This sensitivity analysis is documented in Reference 81. The calculation (Reference 43) will be revised, as required, upon receipt of the Safety Evaluation and associated revised LOCADM model.

ATTACHMENT 5

LIST OF REFERENCED DOCUMENTS

Attachment 5 - References

1. Debris Generation Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-02 / SO23-205-7-C2, Revision 2
2. Debris Transport Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-03 / SO23-205-7-C7, Revision 3
3. Debris Head Loss Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-04 / SO23-205-7-C8, Revision 3
4. Mineral Wool Buoyancy; Alion Science and Technology; ALION-REP-SONGS-4194-06 / SO23-205-7-C142, Revision 0
5. RMI and Fiber Debris Transport; Alion Science and Technology; ALION-REP-SONGS-3987-03 / SO23-205-7-C81, Revision 0
6. Down Stream Effects Debris Ingestion Evaluation; Westinghouse; CN-CSA-05-16 / SO23-205-7-C9, Revision 2
7. Down Stream Effects Debris Ingestion Fuel Evaluation; Westinghouse; CN-CSA-05-35 / SO23-205-7-C10, Revision 1
8. Down Stream Effects Plugging and Wear Evaluation for Heat Exchangers, Orifices, Spray Nozzles, Instrument Tubing, and Pumps; Westinghouse; CN-SEE-05-62 / SO23-205-7-C5, Revision 2
9. Down Stream Effects Vessel Blockage Evaluation; Westinghouse; CN-CSA-05-3 / SO23-205-7-C4, Revision 0
10. Down Stream Effects Plugging and Wear Evaluation of ECCS and CS Valves; Westinghouse; CN-SEE-05-66 / SO23-205-7-C6, Revision 0
11. Head Loss Testing (Report) of a Prototypical Top-Hat Strainer Array; Alion Science and Technology; ALION-REP-ENER-3154-02 / SO23-205-7-C69, Revision 1
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
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15. Test Plan for the Erosion Testing of LD & HD Fiberglass Insulation; Alion Science and Technology; ALION-PLN-LAB-2352-77 / SO23-205-7-M77, Revision 0
16. Mineral Wool Erosion Test Report; Alion Science and Technology; ALION-REP-SONGS-3987-04 / SO23-205-7-M80, Revision 0
17. Test Report: Erosion Testing of Low Density Fiberglass Insulation; Alion Science and Technology; ALION-REP-LAB-2352-77 / SO23-205-7-M78, Revision 0
18. Test Report: Erosion Testing of Mineral Wool Insulation; Alion Science and Technology; ALION-REP-LAB-2352-99 / SO23-205-7-M79, Revision 0
19. 30-Day Integrated Chemical Effects Test Specification; Alion Science and Technology; ALION-TS-ALION-1002-01 / SO23-205-7-M127, Revision 1
20. SONGS Design Input Requirements for the 30-Day Integrated Chemical Effects Testing; Alion Science and Technology; ALION-CAL-SONGS-4194-03 / SO23-205-7-C126, Revision 1

21. Scaling of Materials in the VUEZ Chemical Effects Head Loss Testing; Alion Science and Technology; ALION-REP-ALION-1002-01 / SO23-205-7-C136, Revision 0
22. Surrogate Materials for the VUEZ Chemical Effects Head Loss Testing; Alion Science and Technology; ALION-REP-ALION-1002-02 / SO23-205-7-C-137, Revision 0
23. VUEZ Test Summary Report; Alion Science and Technology; VUEZ-TR-ALION 01 / TR-OTS-1599 / SO23-205-7-M141, Revision 1
24. Chemical Effects Head Loss Summary Report; Alion Science and Technology; ALION-RPT-SONGS-4194-05 / SO23-205-7-C144, Revision 0
25. Quantification of Containment Latent Debris; Southern California Edison; RPA 02-0080, Revision 1
26. Action Request Assignment Report documenting Unit 3 walkdown of tape, stickers, and other miscellaneous debris; Southern California Edison; 060901108-02
27. Action Request Assignment Report requiring Unit 2 walkdown of tape, stickers, and other miscellaneous debris; Southern California Edison; 060901108-03
28. Action Request Assignment Report developing bounding sacrificial area for miscellaneous debris to be used in the Alion Head Loss Calculation; Southern California Edison; 070600413-04
29. Action Request Assignment Report documenting the telecon between SCE, Alion, and the NRC regarding Microtherm temperature dependency; Southern California Edison; 070600413-07
30. Action Request Assignment Report demonstrating that the new screen design complies with the existing licensing basis with respect to vortex formation; Southern California Edison; 060901108-89
31. Action Request Assignment Report documenting the acceptability of leaving the ECCS and CS pump cyclone separators in place; Southern California Edison; 060901108-06
32. Cyclone Separator Seal Piping Drawing; Ingersoll-Rand; C-8X20WDF321X10B; SO23-933-61, Revision 11, Page 92
33. Cyclone Separator Seal Piping Drawing; Ingersoll-Rand; D-4X9CA321X1A; SO23-933-68, Revision 6, Sheet 153
34. CES Strainer – Unit 3 Train A Isometric View & General Notes Drawing; ENERCON Services, Inc.; SOCALS001-C-201A / SO23-205-7-D28, Revision 5
35. CES Strainer – Unit 3 65" Top Hat Assembly Drawing; ENERCON Services, Inc.; SOCALS001-C-102 / SO23-205-7-D16, Revision 2
36. CES Strainer – Unit 3 Filter Element Drawing; ENERCON Services, Inc.; SOCALS001-C-103 / SO23-205-7-D17, Revision 1
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39. Action Request Assignment Report documenting the evaluation of the potential impact of large debris on the top-hat; Southern California Edison; 060901108-88
40. Top-hat Qualification Calculation; ENERCON Services, Inc.; SCSN001-CALC-001 / SO23-205-7-C37, Revision 2

41. Pen & Ink Change (PIC) adding level transmitter EQ, compliance with vortexing licensing basis, and potential impact of floating debris on top-hats; Southern California Edison; PIC A48856 to ECP 040301974-11

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43. Calculation Evaluating Long Term Cooling in Accordance with WCAP-16793-P, Revision 0; Southern California Edison; M-0012-004, Revision 0

44. Calculation of Containment Spray and HPSI pump NPSH Margins; Southern California Edison; M-0012-01D, Revision 2, CCN-5

45. Test Procedure - Design Basis Accident Simulation of Coated Steel and Concrete Samples; Wyle Laboratories, Inc.; 1814-AA516-M0013, Revision 0

46. Test Report – Design Basis Accident Simulation of Coated Steel and Concrete Samples; Wyle Laboratories, Inc; 1814-AA516-M0017, Revision 0

47. Action Request Assignment Report confirming that the coating debris quantity assumed in the Alion Debris Generation Calculation bounds the actual coating configuration of the Mobil 46-X-29 epoxy and Mobil 84-V-2 sealer; Southern California Edison; 070600413-6

48. Hydraulic Analysis of Unit 2 Containment Recirculation Sump Strainers; ENERCON Services, Inc.; SCSN001-CALC-008 / SO23-205-7-C115, Revision 0,

49. Hydraulic Analysis of Unit 3 Containment Recirculation Sump Strainers; ENERCON Services, Inc.; SCSN001-CALC-004 / SO23-205-7-C124, Revision 0,

50. Top Hat Assembly Qualification (Units 2 & 3); ENERCON Services, Inc.; SCSN001-CALC-001 / SO23-205-7-C122, Rev. 1

51. Analysis of Containment Emergency Sump Strainer Flow Plenums A, B, C and D Structure (Unit 2); ENERCON Services, Inc.; SCSN001-CALC-006 / SO23-205-7-C108, Rev. 2

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53. Analysis of Containment Emergency Sump Strainer Collector Box Structure (Unit 2); ENERCON Services, Inc.; SCSN001-CALC-007 / SO23-205-7-C109, Rev. 2

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55. Analysis of Containment Emergency Sump Level Instrument Support, Vent Strainer and Temporary Strainer (Unit 2); ENERCON Services, Inc.; SCSN001-CALC-009 / SO23-205-7-C110, Rev. 1

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59. Engineering Change Package (ECP) for the removal of Microtherm insulation, and replacement with reflective metallic insulation (RMI) in Unit 2; Southern California Edison; AR 040301974-74

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67. Configuration Control Procedure; Southern California Edison; SO123-O-A4

68. Plant Maintenance Procedure for Coating Service Level I Application; Southern California Edison; SO23-I-1.11.1

69. Coating Assessment Procedure; Southern California Edison; SO23-V-8.17

70. SONGS 24-hr Non-Safety Chemical (Bench-top) Test Plan; Alion Sciences and Technology; ALION-PLN-SONGS-4261-01 / SO23-205-7-M82, Rev. 1

71. SONGS 24-hr Non-Safety Chemical (Bench-top) Test Report; Alion Sciences and Technology; ALION-REP-SONGS-4261-01 / SO23-205-7-M123, Rev. 1

72. Aluminum & Nukon Dissolution and Corrosion in TSP (Bench-top) Test Plan; Alion Sciences and Technology; ALION-PLN-LAB-2352-200 / SO23-205-7-M130, Rev. 0

73. Aluminum & Nukon Dissolution and Corrosion in TSP (Bench-top) Test Report; Alion Sciences and Technology; ALION-RPT-LAB-2352-103 / SO23-205-7-M133, Rev. 0

74. Aluminum, Zinc, Nukon and Mineral Wool Corrosion and Dissolution in TSP (Bench-top) Test Plan; Alion Sciences and Technology; ALION-PLN-LAB-2352-204 / SO23-205-7-M131, Rev. 0

75. Aluminum, Zinc, Nukon and Mineral Wool Corrosion and Dissolution in TSP (Bench-top) Test Report; Alion Sciences and Technology; ALION-REP-LAB-2352-104 / SO23-205-7-M134, Rev. 0

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78. Mineral Wool Material Characterization Report (SEM); Alion Sciences and Technology; ALION-REP-WEST-2933-001-001 / SO23-205-7-M12, Rev. 0.

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81. Action Request Assignment Report documenting sensitivity evaluation for WCAP-16793-NP Draft Condition and Limitation #13 regarding aluminum release rates; Southern California Edison; 070600413-15