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A. Edward Scherer
Director
Nuclear Regulatory Affairs

February 23, 2009

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

Subject: **Docket Nos. 50-361 and 50-362**
Response to Request for Additional Information
NRC Generic Letter 2004-02
San Onofre Nuclear Generating Station, Units 2 and 3

Reference: Letter dated November 26, 2008 from N. Kalyanam (NRC) to Ross T. Ridenoure (SCE), Subject: San Onofre Nuclear Generating Station, Unit 2 and 3 – Request for Additional Information Related to Test Protocol Used in the Testing at VUEZ (TAC Nos. MC4714 and MC4715)

Dear Sir or Madam:

The referenced letter requested additional information regarding our submittal of February 27, 2008 on the subject of Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors."

Specifically, the referenced letter provided a list of nine items for which NRC staff requires additional information for San Onofre Nuclear Generating Station Units 2 and Unit 3. The Southern California Edison response is contained in enclosure 1.

The responses to items 2 and 4 consider benefits of the upcoming replacement of steam generators for both Units 2 and 3. Once the steam generators are replaced, the mineral wool quantity generated by the postulated break is reduced by approximately 80%. Enclosure 2 contains a commitment regarding replacement steam generator installation.

A116
NRR

P.O. Box 128
San Clemente, CA 92674

If you have any questions concerning this subject please call Ms. Linda T. Conklin at (949) 368-9443.

Sincerely,

Enclosure 1: Generic Letter 2004-02 Supplemental Response, Request for Additional Information
Enclosure 2: Commitments

cc: E. E. Collins, Regional Administrator, NRC Region IV
N. Kalyanam, NRC Project Manager, SONGS Units 2 and 3
G. G. Warnick, Senior Resident Inspector, SONGS Units 2 and 3

Enclosure 1
Generic Letter 2004-02 Supplemental Response
Request For Additional Information
Southern California Edison (SCE)
San Onofre Nuclear Generating Station Units 2 and 3

NRC Item 1

Please provide your plant-specific approach to resolution of in-vessel downstream effects, which the NRC staff considers to not be fully addressed at SONGS, Units 2 and 3. The submittal refers to draft Westinghouse Topical Report (TR) WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." At this time, the NRC staff has not issued a final safety evaluation (SE) for WCAP-16793-NP. Because of this, the licensee may demonstrate that in-vessel downstream effects issues are resolved for SONGS, Units 2 and 3, by either (1) demonstrating, without reference to WCAP-16793-NP, that in-vessel downstream effect issues have been addressed or (2) showing that plant conditions are bounded by the final WCAP-16793-NP and addressing any conditions and limitations specified in the NRC final SE for the topical report. The specific issues raised in this question (RAI 1) should be addressed regardless of which approach the licensee chooses to take in response to RAI 1. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the NRC staff expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue 191 "Assessment of Debris Accumulation on PWR Sump Performance."

SCE Response: SCE previously demonstrated that plant conditions were bounded by WCAP-16793-NP, Rev. 0 (Reference 3), as described in our Supplemental Response of February 27, 2008 (Reference 4). SCE anticipates being able to demonstrate that plant conditions remain bounded by the revised WCAP-16793-NP, once the NRC Safety Evaluation (SE) is issued. Any conditions and limitations specified in the SE will also be addressed.

NRC Item 2

The licensee stated that additional justification for the 20 percent fines/80 percent small-piece size distribution has been included in Section 4.5.9.1 of the revised Alion Science and Technology Debris Generation Calculation. The NRC staff considers that the approach taken is inconsistent with the SE. The terms "fines" and "small pieces" in the Alion calculation are sub-sets of the term "small fines" as defined by the SE; all of the insulation debris generated is considered to be "small fines" as defined by the SE. Testing conducted for NUREG/CR-6369, "Drywell debris Transport Study" (ADAMS Accession nos. ML003726871, ML00328226, and ML03728322), with a zone of influence (ZOI) of 8D indicated a 20 percent fine fiber debris generation fraction. A 4D ZOI would be expected to generate a significantly higher proportion of fine fiber. The amount of fine fiber is significant from a head loss testing perspective. Please provide detailed

information which justifies the assumed size distribution of 20 percent fines and 80 percent small pieces for the 4D mineral wool ZOI.

SCE Response: Details on the resolution of Open Item 2 from the NRC Audit Report (Reference 2) were provided in the revised Alion Sciences and Technology Debris Generation Report (Reference 5); the pertinent sections are excerpted below. In summary, the 20% fines, 80% small pieces size distribution for the SONGS mineral wool within the 4D Zone of Influence (ZOI) was judged to be appropriate even when considering issues such as the closer proximity of the insulation to the break location, two-phase jet effects, and the fragility of mineral wool.

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

> (Cited assumptions and references are presented at the end of the excerpt; abbreviations appearing in the excerpt have been spelled out for clarity the first time used, in italics).
>
> "4.5.9 Mineral Wool will be assumed to have the same size distribution as NUKON® (Assumption 3.7), as they are both fibrous-based insulations. For a baseline analysis of NUKON®, the GR *(Guidance Report)* recommends a size distribution with two categories—60% small fines, and 40% large pieces [Ref. 8.2]. The SER *(Safety Evaluation (Report); used interchangeably with SE)* (Appendix VI, Section 3.2) suggests a more refined approach for determining the debris size distribution based on applicable air jet impact tests (AJIT). Using Appendices II and VI from the SER [Ref. 8.3] a debris size distribution for NUKON® was developed in Alion Technical Document ALION-REP-ALION-2806-01 [Ref. 8.4], "Insulation Debris Size Distribution for use in GSI-191 Resolution". It was determined that within the overall ZOI the size distribution would vary based on the distance of the insulation from the break (i.e. insulation debris generated near the break location would consist of more small pieces than insulation debris generated near the edge of the ZOI). Therefore, based on the data, three separate sub-zones were defined for NUKON® and the corresponding size distribution within each sub-zone was determined. These size distributions and subzone ZOIs are shown in Table 4.5.2.

Table 4.5.2 – LDFG Debris Size Distribution Within Each Sub-Zone

Size	18.6 psi ZOI (7.0 L/D)	10.0 – 18.6 psi ZOI (11.9 – 7.0 L/D)	6.0 – 10.0 psi ZOI (17.0 – 11.9 L/D)
Fines (Individual Fibers)	20%	13%	8%
Small Pieces (< 6" on a Side)	80%	54%	7%
Large Pieces (> 6" on a side)	0%	16%	41%
Intact (covered) Blankets	0%	17%	44%

The size distribution will apply to both scenarios even though the distribution presented above applies to a ZOI of 17L/D. In the case of ZOI of 4L/D, the size distribution will be 20% fines and 80% small pieces."

"4.5.9.1 In Section 3.3.2.1 of the SONGS audit report, the NRC agreed with the general approach to Alion's methodology for determining a fiberglass debris size distribution, but raised concerns regarding 1) the application of the proprietary Alion size distribution methodology for insulation within a 7D ZOI to the SONGS mineral wool insulation within a 4D ZOI, 2) whether the potential for more destruction due to a two-phase jet (compared to an air jet) had been properly accounted for, and 3) whether mineral wool has a higher fragility than Nukon, which could cause increased fines generation."

"4.5.9.1.1 4D ZOI versus 7D ZOI

The 7D ZOI sub-zone in the Alion size distribution methodology [Ref. 8.4] is based on the data shown in Figure II-2 of the SER [Ref. 8.2], and reproduced below. Note that the term "small fines" shown in the figure as defined in the SER is made up of both "fines" and "small pieces" of fiberglass debris. Note that Alion's calculations do not use the "small fines" designation, but instead use the "fines" and "small pieces" designation.

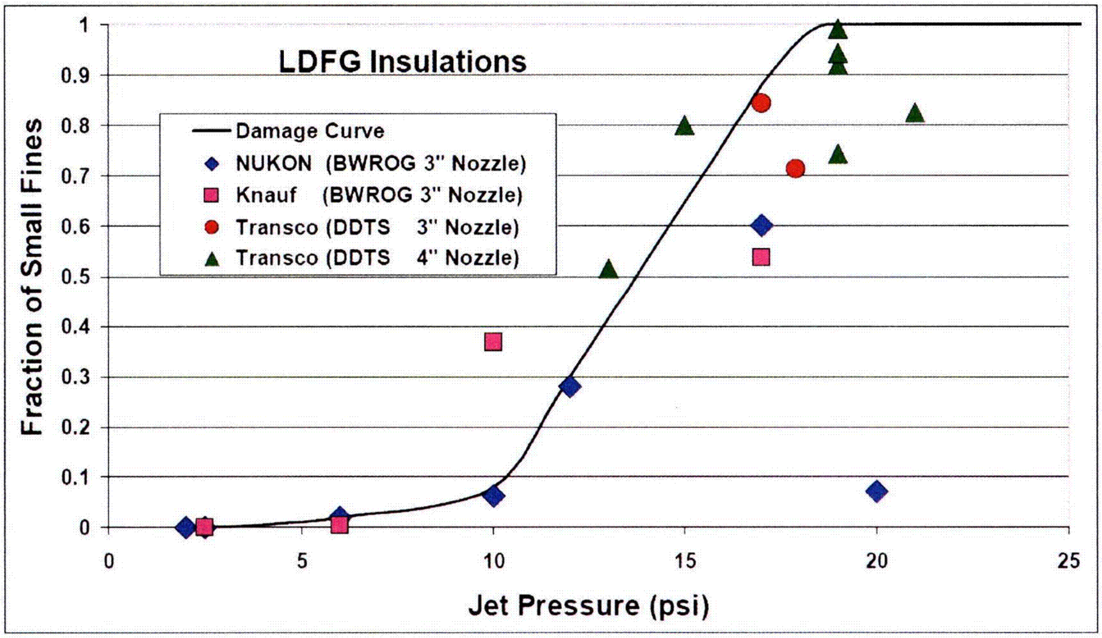


Figure II-2. LDFG Damage Curve for Small Fine Debris

The curve that is fit through the data shows that 100% of the insulation debris generated is destroyed as "small fines" for destruction pressures greater than or equal to approximately 18.6 psi, which is equivalent to a 7.0D sphere [Ref. 8.4]. Note, however, that the limited air jet data points at pressures higher than 18.6 psi indicate that a significantly lower fraction of "small fines" could be generated at locations very close to the break. Or in other words, the "small fines" destruction curve may peak with maximum destruction at around 18.6 psi, and at higher pressures drop off to lower fractions of generated "small fines".

In the Alion size distribution methodology, however, no credit is taken for reduced "small fines" destruction fractions at higher pressures. Instead, it was very conservatively assumed that 100% of the insulation inside 7D would be generated as "small fines" whether the insulation is located at 7D, 4D, or 1D.

In the Drywell Debris Transport Study (DDTS) destruction testing [Ref. 8.27], as described by the SER Appendix VI, 15% to 25% of the small LDFG *(Low Density Fiberglass)* insulation debris was too fine to collect by hand [Ref. 8.2]. This debris was either blown through the fine-mesh screen at the end of the test chamber and lost from the facility or was deposited onto surfaces inside the chamber in such a manner that it could be collected only by hosing down the walls and structures. Following the approach taken by the SER, an average of 20% of the "small fines" debris was assumed to be fines (individual fibers), and the remaining 80% of the "small fines" debris was assumed to be small pieces. In both the SER and in Alion's size distribution report, this 20/80 split for fines and small pieces was applied for debris generated at any distance from the break location.

Therefore, the size distribution used for the SONGS mineral wool is consistent with the guidance in the SER since 100% of the insulation within the 4D ZOI was conservatively assumed to fail as "small fines", and was further broken down to 20% fines and 80% small pieces.

Based on publicly available data, only one two-phase jet test has been conducted for a fiberglass sample. In this test (performed as a part of the OPG *(Ontario Power Generation)* testing) approximately 50% of the fiberglass insulation remained on the target and the remainder of the insulation was blown off as "small fines" [Ref. 8.28]. The target distance for this test was 10 L/D (jet length over nozzle diameter), which corresponded to a pressure of approximately 42 psi at the target [Ref. 8.28]. Note that 42 psi is equivalent to a spherical ZOI of approximately 3.8D. This is approximately the same ZOI size used for the SONGS insulation, but the size distribution from the OPG testing would result in lower quantities of mineral wool being transported to the sump even if the transport fraction for "small fines" is conservatively increased to 100%. Therefore, this further demonstrates the conservatism of the size distribution determined using the Alion size distribution methodology."

"4.5.9.1.2 <u>Increased destruction potential from a two-phase jet</u>

When compared to the AJIT test data, there has been concern that a two-phase jet could generate a somewhat higher fraction of "small fines". In Appendix VI of the SER, the guidance for addressing this concern is to increase the fraction of "small fines" that is generated by 10% and reduce the fraction of large debris generated by an equal amount. However, since the fraction of "small fines" at SONGS was already very conservatively assumed to be 100% within a 4D ZOI, the fraction of large debris cannot be reduced any more. Therefore, the conservatism in Alion's size distribution methodology accounts for the potentially greater destructive force of a two phase jet. Also, as discussed above, an analysis of the fiberglass destruction data available for a two-phase jet test showed that the Alion size distribution methodology conservatively bounds the results of the two phase test."

"4.5.9.1.3 <u>Potential increased fragility of mineral wool insulation</u>

According to knowledge base documentation, mineral wool insulation debris could potentially become more fragile and break down when subjected to operating conditions over a period of time [Ref. 8.15]. This increased fragility is likely due to the breakdown of the binder material in the mineral wool, and could result in the formation of fines during normal operation. In the case of SONGS, however, a mineral wool cassette that was taken from the plant was opened up and it was observed that the mineral wool insulation was still intact. SEM *(Scanning Electron Microscopy)* photos of the mineral wool sample also showed that the original binder material was still present [Ref. 8.29]. Therefore, increased destruction of the mineral wool due to aging effects is not considered to be a significant issue for SONGS."

"4.5.9.1.4 Additional considerations

Figure II-8 in Appendix II of the SER shows a comparison of low density fiberglass insulation to two high density fibrous insulation types. This figure is reproduced below.

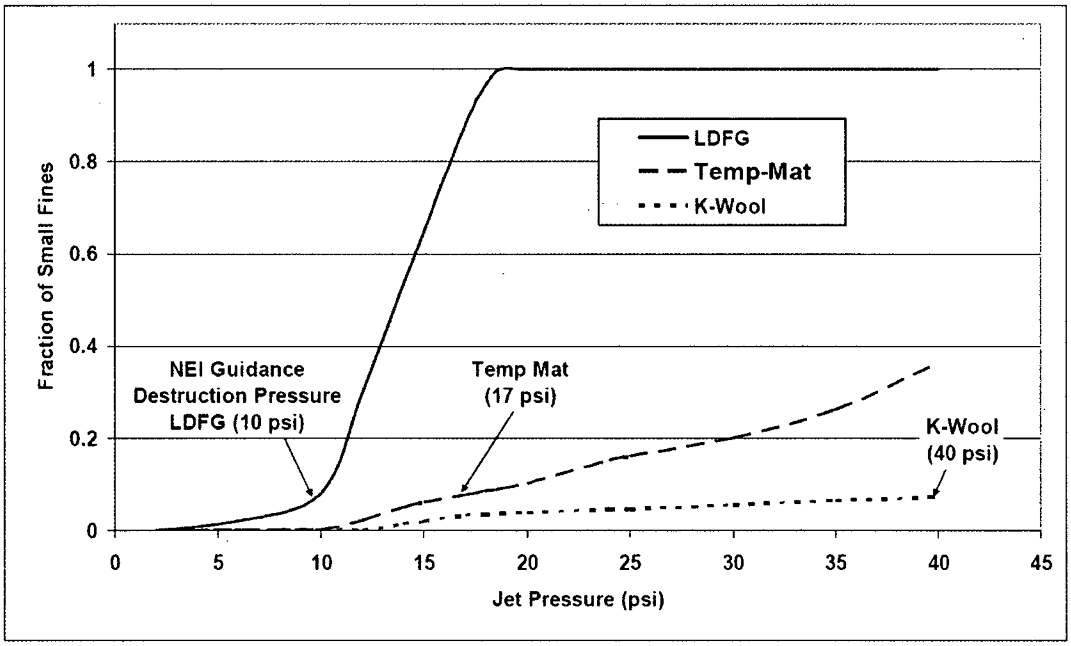


Figure II-8. Comparison of Fibrous Insulation Damage Curves

This figure shows that for the high density fibrous debris types tested, the size distribution consists of a significantly smaller fraction of "small fines" debris than the low density fiberglass. Since mineral wool insulation is also a high density fibrous material, it is likely that using the low density fiberglass size distribution for the SONGS mineral wool is very conservative.

Based on the above assessment, the 20% fines, 80% small pieces size distribution for the SONGS mineral wool within the 4D ZOI is judged to be appropriate even when considering issues such as the closer proximity (4D versus 7D) of the insulation to the break location, two-phase jet effects, and the fragility of mineral wool."

Assumptions and References for the excerpt presented above from the Alion Debris Generation Calculation (Reference 5):

"Assumption 3.7: Mineral wool is a fibrous type of insulation and it is assumed that the size distribution for mineral wool is similar to NUKON. Per the OECD *(Organization for Economic Cooperation and Development)* International Report mineral wool is classified as a fibrous type of insulation [Ref. 8.15]. The mineral wool insulation that was fabricated for SONGS was likely manufactured in accordance with ASTM specification C553 CL3, which addresses mineral fibers, intended for thermal insulation for commercial applications. The SONGS mineral wool blanket (ASTM C553 CL3, Attachment H) is also fully encapsulated within 24 gauge 304 stainless steel jacketing [Ref. 8.13]. Hence, the SONGS mineral wool is part of a robust engineered insulation system, and is certainly stronger than a typical low density fiberglass such as NUKON. As such, applying a NUKON size distribution is conservative. Mineral wool has been analyzed via SEM and has been found to be of similar diameter as fiberglass type fibers. As stated in ASTM C553 mineral wool blanket insulation shall be composed of rock, slag or glass processed from molten state into fibrous form. This material is bonded with an organic or inorganic binder, or both, just as fiberglass insulation. Therefore, it is considered appropriate that the size distribution for fibrous debris can be applied to mineral wool."

"Reference 8.2: NEI PWR Sump Performance Task Force, "PWR Sump Performance Evaluation Methodology, December 2004"

"Reference 8.3: NRC SER, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Nuclear Energy Institute Guidance Report 'Pressurized Water Reactor Sump Performance Methodology', December 2004"

"Reference 8.4: ALION-REP-ALION-2806-01, "Insulation Debris Size Distribution for use in GSI-191 Resolution, Revision 3, April 13, 2006"

"Reference 8.13: Transco Insulation Drawings [detailed list of drawings is provided in Reference 5)"

"Reference 8.15: OECD/CSNI *(Committee on the Safety of Nuclear Installations)* International Task Group, Knowledge Base for Emergency Core Cooling System Recirculation Reliability, NEA *(Nuclear Energy Agency)* /CSNI/R (95)11"

"Reference 8.27: NUREG/CR-6369, "Drywell Debris Transport Study", February 1998"

"Reference 8.28: NUREG/CR-6762, "Technical Assessment: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance (Report LA-UR-01-4083, Revision 1 by LANL *(Los Alamos National Laboratory))*", Volumes 1-4, August 2002"

"Reference 8.29: ALION-REP-WEST-2933-001-001, "Mineral Wool Material Characterization Report (SEM)", Revision 0"

NRC Item 3
There is the NRC audit report dated May 16, 2007 (ADAMS Accession No. ML071230749). Attachment 2 to the licensee's letter dated February 27, 2008, is a item-by-item response to the list of open items produced during the 2006 audit of corrective actions at SONGS, Units 2 and 3. The audit open item number 5 stated that the licensee had not justified neglecting the transport of mineral wool by flotation. The response to this item is that the licensee had a vendor prepare a buoyancy evaluation for mineral wool. The evaluation showed that the mineral wool would arrive later in the event when adequate NPSH [net positive suction head] margin existed to allow for any head loss that might be caused by the floating insulation. The response for this open item has no technical basis for the head loss that could result. Please provide a technical basis for the delayed transport and for the strainer head loss that would occur when the mineral wool transported by flotation does reach the strainer.

SCE Response: During the telephone conversation on November 17, 2008, the NRC staff provided additional clarification of Open Item #5 from the NRC Audit Report (Reference 2); the issue relates to large pieces of mineral wool that could transport to the sump by flotation, then subsequently sink and block off the top of the sump pit containing the strainers, thereby significantly reducing the effective filtering area. The following replaces our previous response to this open item.

The NRC staff concurred in the Audit Report (Reference 2, Section 3.2) that the appropriate Zone of Influence (ZOI) for the SONGS stainless steel encased mineral wool is 4D. The Debris Generation Calculation (Reference 5) calculates the mineral wool debris generated within a 4D ZOI of the assumed pipe break. Case #1, an RCS line break at one of the Steam Generators, creates the highest mineral wool debris load at the strainers; 81.6 cubic feet is generated, and based on the current revision of the Debris Transport Calculation (Reference 6), 79% (64.5 cubic feet) is transported in the sump fluid to the screens. For the purpose of this evaluation, it will be postulated that the 17.1 cubic feet of mineral wool assumed to not transport in the Debris Generation Calculation is instead assumed to transport by flotation. Note that the above-cited quantity of mineral wool transported to the sump is based on the existing steam generators. Once the steam generators are replaced, the mineral wool quantity generated by the postulated break is reduced by approximately 80%.

The size distribution assumed in the Debris Generation Calculation is 100% small pieces and fines; 0% large pieces. However, for the purposes of this evaluation, it will be postulated that the mineral wool that transports by flotation is instead large pieces, as large pieces would be necessary in order to bridge the sump open area and block off the top of the sump pit. (Note that the revision to the Debris Generation and Debris Transport calculations to be made in response to RAI items 2 and 4 will increase the transport fraction of small pieces and fines. However, for the purposes of the evaluation provided herein, utilization of the lower small pieces & fines debris transport fraction is considered to be conservative, as the balance is assumed to be large pieces that transport by floatation).

The insulation drawing for the panels for the steam generators (Reference 8) shows the panels to be 3" thick. It will therefore be postulated that the mineral wool transported by flotation consists of insulation pieces 3" thick. The 17.1 cubic feet of insulation, at 3" thickness, would occupy a surface area of 68.4 square feet.

The Containment Emergency Sump civil drawing (Reference 9) shows that the interior dimensions of each sump pit between the curbs and wall are 9' 2" by 12', for a surface area of 110 square feet. The 68.4 square feet of surface area postulated for the floating mineral wool represents approximately 62% of the total surface area available, leaving sufficient open area to allow the flow of water to the sump screens.

Finally, it should be noted that if any of the large pieces subsequently sink into the sump pit, this can be assumed to occur later in the event, when NPSH margins are significantly higher. As detailed in the Alion Mineral Wool buoyancy evaluation (Reference 17), within 24 hours of the initiation of the event, the NPSH margin increases almost five-fold from the minimum available at event initiation, while NUREG/CR-6808 indicates that most mineral wool does not readily absorb water and can remain afloat for several days.

NRC Item 4
Audit open item number 6 stated that no justification had been provided for the assumption that containment spray drainage enters the pool as a dispersed flow rather than in concentrated streams. The open item noted that this could affect transport and the assumption of 10 percent erosion of small and large pieces of fibrous debris. The response to this item may have been partially acceptable in that the transport evaluation was revised to include a larger fraction of debris transported to the sump and a revision to the transport calculation. However, certain technical information, such as the magnitude of the change and the basis for the magnitude were not provided. In addition, the response noted that testing had been done to justify the assumption of 10 percent erosion of fibrous debris. Please provide the information that justifies the 10 percent erosion assumption. Also, please provide the information regarding the change in transport fractions due to the change in spray flow, including the basis for the change in transport.

SCE Response: With respect to spray drainage, the Revision 3 of the Alion Debris Transport Calculation (Reference 6) treats the spray flow as either dispersed spray flow, or concentrated stream flow, depending on whether the flow is direct spray flow or is spray flow collected on intermediate floors and subsequently cascaded into the pool. Revision 2 of this calculation (Reference 7) treated all of the spray flow as dispersed spray flow. Also, Revision 3 of the calculation models the introduction of the spray flow at the surface of the pool, whereas Revision 2 modeled the introduction of the spray flow at the bottom of the pool. Finally, Revision 3 sub-divides the flow paths considered in Revision 2 for a more detailed evaluation. For the bounding mineral wool debris scenario (Case 1), the debris transport fraction for mineral wool increased from 72% in Revision 2 of the calculation, to 79% in Revision 3.

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

SCE believes that the testing performed, as summarized below, justifies the use of the 10% erosion of small pieces of mineral wool. However, in order to add additional conservatism, the analysis will be revised to utilize the 90% erosion value specified in the Safety Evaluation. The resulting increase in debris transport fraction, along with the revised size distribution at the screens, will form the basis for the debris load definition for the "Test-for-Success" program.

A synopsis of the erosion test program is presented below.

Fiberglass Testing (Reference 10)

Alion performed generic fiberglass erosion tests to determine the erosion fraction that would be expected from fibrous material on a generic basis. The tests are similar to the NUREG/CR-6773 tests documented in Appendix III, Section III.3.3.3 of Reference 1 for fibrous material erosion, except these generic tests are performed over a much longer duration than the 5 hour duration used in the NUREG Tests.

The erosion tests were conducted both in Alion's Vertical Test Loop (VTL) and Flume as described in Figures 1 and 2. The VTL consists of a closed loop with flow circulated through the loop approaching the sample location from above. The fibers eroded off the samples are captured in the filter located downstream of valve TL-V07. The fiberglass small pieces are supported on a perforated plate at the sample location as flow passes through the samples.

The Flume test apparatus is described in Figure 2. Flow enters the flume from the right side of the tank, flows through a vertical flow straightener to collimate the flow and through the samples. The fiberglass samples are supported on a vertically mounted perforated plate and encompassed by an insulation cage to prevent the samples from escaping the sample location and not being exposed to the flow. The insulation cage is constructed of large mesh wire, to prevent interfering with the flow passing through the samples. Flow passing through the sample location is filtered to capture fibers eroded from the fiberglass samples.

The fiberglass samples of interest used for these tests consist of several 1 inch diameter balls of fiberglass (small pieces). The samples were prepared by shredding suitable size samples from the bulk material then boiling the fiberglass balls to simulate aging and the containment environment prior to the testing. The balls are then placed on the perforated plate to perform the test.

The flow rate passing through the sample during the test is based on the incipient tumbling velocity of the material being tested. The incipient tumbling velocity is the maximum relative velocity at which the small pieces are expected not to transport. This velocity is selected since it yields the highest relative velocity difference between the material and the passing flow. If the flow velocity difference exceeds the incipient tumbling velocity, the fiber mass is expected to move with the flow maintaining this relative velocity difference or a lower relative velocity. For fiberglass, an incipient tumbling velocity of 0.12 feet/sec is used for small pieces in the testing. For SONGS mineral wool small pieces, an incipient tumbling velocity of 0.16 feet/sec is used. The justification for using a 0.16 feet/sec incipient tumbling velocity for mineral wool small pieces was provided in the response to Audit Open Item 4 in the Supplemental Response (Reference 4).

Tap water at ambient temperature is used in the testing. This lower test water temperature relative to LOCA sump water temperatures is considered conservative for erosion testing. The lower test water temperature yields a higher fluid viscosity. The lack in the test fluid of the dominant chemicals in the post LOCA fluid environment, boric acid and tri-sodium phosphate (TSP), is not expected to impact the results of the erosion testing. The mineral wool used in the testing was pre-baked, which removed any binder or oil from the mineral wool prior to the test, which may have been attacked by these chemicals. In addition as concluded in the Alion Report, the loss of fibers from mineral wool is the result of the loss of loose fibers in the mineral wool not the erosion of fibers off the mineral wool. Based on this information, chemicals such as boric acid or TSP in the post LOCA fluid environment would not enhance the removal of loose fibers from the mineral wool.

The results of the small piece fiberglass testing are plotted in Figure 3. The erosion fractions are plotted against the durations that the samples were exposed to the erosion flow. Durations run from 2 hours to approximately 30 days. Data from both the Vertical Test Loop (diamond symbols) and the Flume (square symbols) are plotted on the graph. The distribution of the test results indicate that an erosion rate mechanism does not occur over the duration of the tests. If this mechanism were present, there should be an upward trend of erosion fraction with increasing duration, which is not indicated. The distribution of the test results reflects a mechanism by which loss of fibers result from loose fibers initially present on each sample being forced off the sample during the test. Once these loose fibers are removed, no further fiber loss occurs. Based on this mechanism, averaging the erosion fractions for all the samples would reflect the expected erosion fraction. This averaging results in an average erosion fraction of 5.93%.

Mineral Wool Testing (References 11 and 12)

The fibrous insulation material used at SONGS is mineral wool. The mineral wool has a fibrous structure similar to fiberglass, but with a more dense weave. The intent of the mineral wool testing was to determine, with more limited testing than that performed for fiberglass, if the resulting mineral wool erosion fraction would be within the scatter of the fiberglass test results and thus have the same erosion characteristics as fiberglass.

The mineral wool testing was performed with the VTL since the fiberglass testing showed similar average erosion fraction results for the VTL and Flume testing (See Figure 3). Sample sizes used for the small piece mineral wool testing were also 1 inch diameter pieces. Multiple mineral wool small pieces were also used as the sample for each test. The test was performed with tap water at ambient temperature as was done for the fiberglass tests.

All mineral wool samples were baked to remove the binder and simulate the aging of the material in the containment. Some of the samples were boiled in addition to baking. Alion considered boiling redundant to the baking performed, but testing was performed with boiled and non-boiled samples.

The mineral wool tests were performed at incipient tumbling velocity of 0.12 feet/sec and 0.16 feet/sec. For the purposes of determining the SONGS erosion fraction for mineral wool, only tests performed at 0.16 feet/sec flow velocity are used. Testing was performed on boiled mineral wool samples at an incipient tumbling velocity of 0.12 feet/sec and for non-boiled samples at an incipient tumbling velocity of 0.16 feet/sec.

Figure 4 provides the results for the mineral wool testing. The erosion fraction is plotted against the duration the samples were exposed to the flow. The tests were performed at durations of 2 hours and 16 hours. The boiled data (diamond symbol) is not applicable since this testing was performed at an incipient tumbling velocity of 0.12 feet/sec. The non-boiled data (square symbol) is the relevant data with the test conducted at an incipient velocity of 0.16 feet/sec. Comparing the mineral wool and fiberglass data contained in Figures 3 and 4, the mineral wool data points are within the scatter of the fiberglass data, confirming the similarity in erosion characteristics between the materials. Using an averaging approach, as used for fiberglass, on the mineral wool data at 16 hours yields a SONGS mineral erosion fraction of 9.4%; the fraction would be significantly lower if all mineral wool data were used.

Figure 1 - Vertical Test Loop Apparatus

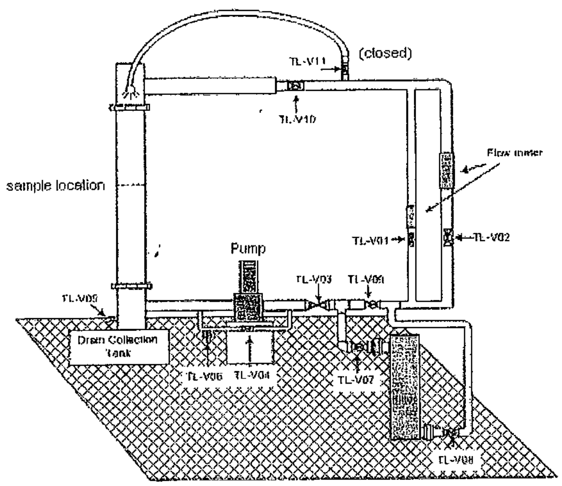


Figure 2 - Flume Test Apparatus

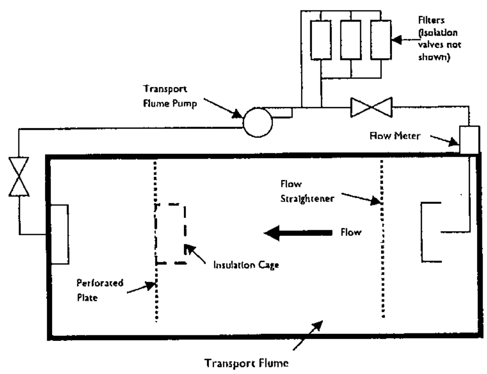


Figure 3 Fiberglass Small Pieces Test Results

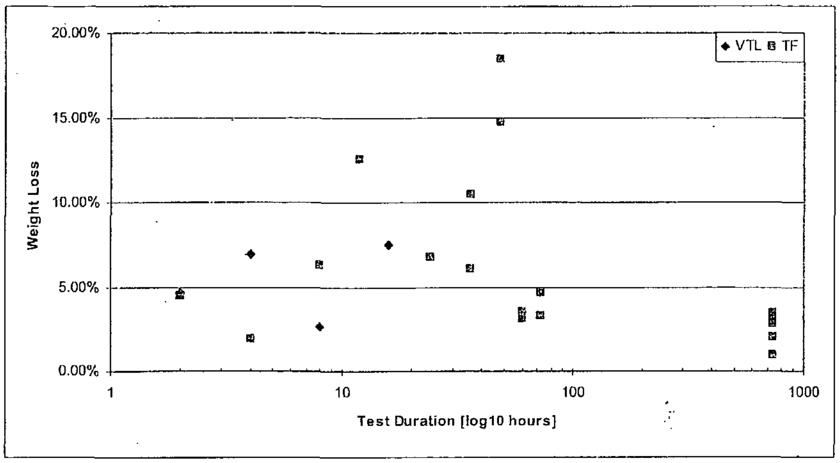
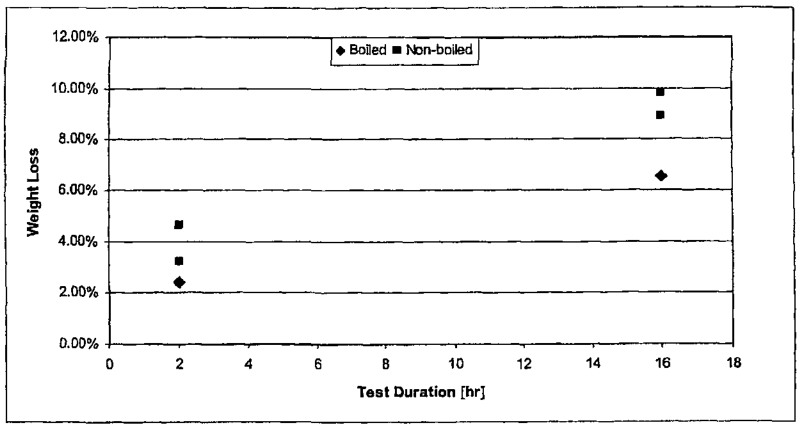


Figure 4 Mineral Wool Small Pieces Test Results



NRC Item 5
It is not apparent that the strainers were tested with the quantity and type of fine fibrous debris expected to arrive at the strainers, appropriately introduced under prototypical flow conditions to ensure that a thin bed would not occur in the plant. Please provide documentation that demonstrates that the fibrous debris sizes used for testing matched the debris transport calculation.

SCE Response: SCE will be performing another series of tests to determine successful combinations of non-chemical and chemical debris, from which (if necessary) plant modifications can be engineered and executed. The program is described in SCE's letter of October 30, 2008 (Reference 14). SCE is participating with several other utilities in ongoing NRC review of testing protocol developed by Alion Science and Technology, which specifically addresses the points raised in this RAI. SCE will utilize the final agreed-upon protocol in development of the plant-specific test plan.

NRC Item 6
Please provide justification for the application of the bump-up factor developed with a different debris bed composition than that used in the small-scale chemical tests.

SCE Response: The "Test for Success" program described above in Item 5 does not utilize a bump-up factor. Rather, prototypical tests will be performed for non-chemical debris loads, and for non-chemical plus chemical debris loads.

NRC Item 7
Please evaluate how the increase in the amount of Microtherm by a factor of two confirms that the head loss determined by testing is prototypical or conservative.

SCE response: In the debris generation calculation for the Microtherm debris case, SCE initially made an assumption that destruction of the Microtherm insulation on the reactor vessel would be limited to 50% of the total volume of material, due to shadowing by the vessel. This assumption was challenged by NRC staff during the audit of our Generic Letter 2004-02 response (Open Item 1 of the NRC audit report, Reference 2). For the VUEZ test, SCE utilized 100% of the Microtherm quantity.

Based on the results obtained in SCE's previous testing utilizing WCAP-16530-NP precipitates, prior to executing the "Test-for Success" program described in item 5 above, SCE plans to perform a calculation to justify a reduced ZOI.

The hot and cold leg piping is restrained following the postulated line break; axially by the configuration of the piping, and radially by the piping penetration through the primary shield wall surrounding the reactor. Utilizing the methodology outlined in Method 3, "Break Specific Analysis Using Break-Dependent Zones of Influence" in the Utility

Resolution Guidance document (Reference 16, Section 3.2.1.2.3.3), a reduced spherical ZOI that credits the benefits of pipe motion restraint will be computed. This spherical ZOI volume will be reshaped to account for the confined space between the shield wall and the reactor vessel, such that the ZOI volume is maintained.

NRC Item 8

During small-scale testing, voiding occurred that reportedly resulted in high head losses. The submittal dated February 27, 2008, also described that head loss attributable to chemical effects likely occurred at the same time. The licensee determined that most of the head loss that occurred during this period was due to voiding and some smaller fraction was due to chemical effects. This was reportedly based on evaluation of the SONGS, Units 2 and 3, data and other small scale testing. The technical basis for the determination of apportioning the head loss to these two phenomena is not clear. Please justify the method used to determine how much head loss was attributable to voiding and how much was attributable to chemical effects during the small-scale chemical effects testing.

SCE response: As described in Item 5 above, SCE will be performing another series of tests to determine successful combinations of non-chemical and chemical debris, from which (if necessary) plant modifications can be engineered and executed. The "Test for Success" program will be performed on a prototypical top-hat strainer array.

NRC Item 9

Please provide a justification for the selection of 4.8 kPa as a chemical effects portion of the high-pressure drop observed during the initial part of the test.

SCE response: As described in Item 5 above, SCE will be performing another series of tests to determine successful combinations of non-chemical and chemical debris, from which (if necessary) plant modifications can be engineered and executed. The "Test for Success" program will be performed on a prototypical top-hat strainer array.

References

1. NEI 04-07, Pressurized Water Reactor Sump Performance Evaluation Methodology, Volumes 1 and 2, Revision 0, dated December 2004, SO23-205-7-M138, Revision 0
2. NRC Audit Report of Corrective Actions to Address Generic Letter 2004-02; May 16, 2007 (ADAMS Accession No. ML071230749 and ML 070950240)
3. Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid; WCAP-16793-NP, Rev, 0; May 2007
4. SONGS Supplemental Response for NRC Generic Letter 2004-02, Docket Nos. 50-361 and 50-362, NRC Generic Letter 2004-02, San Onofre Nuclear Generating Station, Units 2 and 3, dated February 27, 2008.
5. Debris Generation Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-02 / SO23-205-7-C2, Rev. 2
6. Debris Transport Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-03 / SO23-205-7-C7, Rev. 3
7. Debris Transport Calculation; Alion Science and Technology; ALION-CAL-SONGS-2933-03 / SO23-205-7-C7, Rev. 2
8. Steam Generator Insulation Drawing; Transco; DR-4237-G9 / SO23-411-16-33-1
9. Containment Emergency Sump Civil Drawing; Southern California Edison; 23149, Rev. 8
10. Test Report: Erosion Testing of Low Density Fiberglass Insulation, Alion Science and Technology; ALION-REP-LAB-2352-77 / SO23-205-7-M78, Rev. 0
11. SONGS Mineral Wool Erosion Test Report; Alion Science and Technology; ALION-REP-SONGS-3987-04 / SO23-205-7-M80, Rev. 0
12. Test Report: Erosion Testing of Mineral Wool Insulation; Alion Science and Technology; ALION-REP-LAB-2352-99 / SO23-205-7-M79, Rev. 0
13. Letter dated September 17, 2008 from N. Kalyanam (NRC) to Ross T. Ridenoure (SCE), Subject: San Onofre Nuclear Generating Station, Unit 2 and 3 – Request for Additional Information Related to Test Protocol Used in the Testing at VUEZ (TAC Nos. MC4714 and MC4715)
14. Letter dated October 30, 2008 from Michael P. Short (SCE) to the NRC, Subject: "Extension Request Related to Generic Letter 2004-02", Responds to Reference 13, and provides SONGS commitment to perform "Test for Success" chemical effects test program
15. Head Loss Testing (Report) of a Prototypical Top-Hat Strainer Array; Alion Science and Technology; ALION-REP-ENER-3154-02 / SO23-205-7-C69, Rev. 1
16. Utility Resolution Guidance for ECCS Suction Strainer Blockage; NEDO-32686, Rev. 0; November 1996
17. SONGS Mineral Wool Buoyancy Evaluation; Alion Science and Technology; ALION-REP-SONGS-4194-06 / SO23-205-7-C142, Rev. 0

Enclosure 2

Commitments

1. The replacement steam generators are to be installed during the Unit 2 Fuel Cycle 16 refueling outage, currently scheduled to begin in September 2009 and the Unit 3 Fuel Cycle 16 refueling outage, currently scheduled to begin in October 2010.