Pacific Gas and
Electric Company®

Diablo Canyon Power Plant
P. O. Box 56
Avila Beach, CA 93424

November 3, 2008

PG&E Letter DCL-08-094

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

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to Request for Additional Information Regarding Supplemental Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors"

References:

1. PG&E Letter DCL-08-002, "Supplemental Response to Generic Letter 2004- 02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors,'" dated February 1, 2008.
2. PG&E Letter DCL-08-059, "Supplemental Response to Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors (Revision 1),'" dated July 10, 2008.
3. NRC letter to PG&E, "Diablo Canyon Units 1 and 2 – Request for Additional Information Regarding Supplemental Response to Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors,'" (TAC Nos. MD4682 and MD4683), dated August 1, 2008.

Dear Commissioners and Staff:

By letters dated February 1, 2008 (Reference 1) and July 10, 2008 (Reference 2), Pacific Gas and Electric Company (PG&E) provided its supplemental response to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents At Pressurized Water Reactors," for Diablo Canyon Power Plant (DCPP) Units 1 and 2. Reference 2 updated the February 1, 2008, submittal to identify actions completed prior to restart from the Unit 2 Fourteenth Refueling Outage; revised Sections 3m, Downstream Effects – Components and Systems, and 3n, Downstream Effects – Fuel and Vessel, to reflect recently completed evaluations; and discussed bottom nozzle testing conducted during May, 2008.

A116
NRR

A member of the STARS (Strategic Teaming and Resource Sharing) Alliance
Callaway • Comanche Peak • Diablo Canyon • Palo Verde • South Texas Project • Wolf Creek

By letter dated August 1, 2008 (Reference 3), the NRC requested additional information required to complete its review of PG&E's supplemental response to GL 2004-02. PG&E's response to that request is enclosed.

PG&E makes no regulatory commitments (as defined by NEI 99-04) in this letter.

If you have any questions, or require additional information, please contact Stan Ketelsen at (805) 545-4720.

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

Executed on November 3, 2008.

Sincerely,

James R. Becker
Site Vice President

tcg/4231
Enclosure
cc: Gary W. Butner, Acting Branch Chief,
California Department of Public Health
Elmo E. Collins, NRC Region IV
Michael S. Peck, NRC Senior Resident Inspector
Diablo Distribution
cc/enc: Alan B. Wang, Project Manager NRR

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

NRC Question 1:

Please verify that debris generation values were maximized, in light of the reduced zones of influence (ZOIs) for certain debris sources and the fact that the licensee's break selection methodology does not follow the incremental location guidance provided by the Nuclear Energy Institute (NEI) and the NRC staff. Please explain whether the originally applied break selection methodology was reconsidered once the ZOIs were reduced.

PG&E Response:

The methodology employed in producing the debris generation calculations utilized a comprehensive, systematic and iterative approach to ensuring a conservative and maximized result for debris generation. The process continually reassessed the worst case break locations with respect to reduced ZOIs and changing plant design inputs.

For break selection, the only exception taken to the NEI and NRC staff guidance was the use of the criterion specifying "every five feet" as described in Section 3.3.5.2 of the NRC Safety Evaluation Report. The break locations to analyze were determined analytically given knowledge of the following:

- Possible break locations
- Insulation target densities (number of targets in a given area)
- Insulation target's proximity to possible break locations
- Insulation volume of each target
- ZOI of different debris types and the overall ZOI size in relation to the compartmentalized configuration of Diablo Canyon Power Plant (DCPP) containment.

Several break locations were further analyzed by moving the break location from 6 inches to three feet up or down a pipe, recalculating the debris generated and comparing these results to the original location. Further conservatism was added by including any targets that were judged from the three dimensional model to be near the boundaries of the ZOI. Each revision of the debris generation calculations was typically the result of changes to design inputs or plant configuration. Each of these revisions required a review of the break selection analysis to ensure that the limiting breaks were properly identified and analyzed.

The following physical improvements were implemented and each necessitated a rigorous reexamination of break selection:

- Installation of reflective metal insulation (RMI) and stainless steel jacketed Temp-Mat on the replacement steam generators;
- Removal of cable tray fire stops inside the crane wall (inside the pipe break ZOIs);
- Installation of additional banding on calcium silicate (cal-sil) piping insulation inside the pipe break ZOIs;
- Installation of stainless steel jacketing on Temp-Mat piping insulation inside the pipe break ZOIs - except for the Temp-Mat on Unit 1 Pipe Support 11-2RR, an allowed exception per design since even if encapsulated it would remain within a ZOI;
- Installation of tray covers to protect the pressurizer heater cable insulation in cable trays below the pressurizer; and
- Installation of stainless steel jacketed Temp-Mat insulation on the pressurizer safety valves.

Several informal sensitivity analyses were performed in support of the formal debris generation calculations to provide additional confirmation of conservatism and final results. These included analyzing several additional break locations in the reactor coolant system (RCS) and inside the pressurizer cubicle.

Some of the additional analyses performed were:

- A cold leg break which was placed between temperature element (TE) TE-443B and Reactor Coolant Pump (RCP) 1-4. This break was placed such that it was within 3.7D of TE-443B (hence destroying the Temp-Mat at temperature element TE-443B), while maximizing any potential cal-sil loss from lines 24, 1038, 2002, and 2176.
- A hot leg break that was placed between TE-443A and Steam Generator 1-4. The break was placed such that it was within 3.7D of TE-443A (hence destroying the Temp-Mat at TE-443A), while maximizing any potential cal-sil loss from lines 215, 1038, 2002, and 2176.
- Several breaks were analyzed along the length of the crossover line (accurately placing the break along the elbows of the pipe) in order to verify the limiting break was selected. This analysis was performed to verify the maximum debris load associated with pressurizer heater cables installed at the base of the pressurizer.
- Several breaks within the pressurizer cubicle area were analyzed to verify selection of the limiting breaks. Breaks were selected with varying pipe diameters and locations within the cubicle area.

- For breaks within the pressurizer cubicle area, it was recognized that the ZOI sizes were small enough to justify treating insulation targets as three dimensional objects rather than point sources. The actual dimensional attributes of location, shape, and size of the various encapsulated Temp-Mat debris targets in the upper pressurizer cubicle area were considered. It was assumed that if any portion of the target was affected by the ZOI, then the entire insulation target was destroyed. These results were presented in the final debris generation calculations.

Through the course of the analysis preparation, the debris generation results were continually scrutinized and reexamined for the following factors:

- Changes to ZOIs.
- Modifications to DCPP plant configuration.

The break selection methodology was consistently reconsidered with changing inputs and no other breaks were found with the potential for greater debris generation.

NRC Question 2:

Please provide the basis for comparability/use of the jet impingement testing resulting ZOIs with a 3.5 inch jet when much larger jets could be experienced in a loss-of-coolant accident (LOCA).

PG&E Response:

The jet impingement testing program utilized an acceptable methodology to determine the resulting component ZOI using a 3.5 inch diameter test nozzle with 2000 psia and 530°F fluid. The resulting component ZOI represents the distance (length divided by pipe diameter or L/D) from a break where the stagnation pressure equates to the calculated damage pressure as experienced from the jet impingement test.

Jet impingement testing was performed to evaluate the potential debris generation resulting from jet impingement loads that might be applied to various potential debris sources. The tests performed are representative of at-power pressurized water reactor (PWR) cold leg break conditions; namely 2250 psia and 530°F.

To determine the effects of the jet originating from a postulated pipe break, the subcooled jet expansion model defined in American National Standards Institute/ American Nuclear Society (ANSI/ANS) Standard 58.2-1988, "American National Standard Design Basis for Protection of Light Water Nuclear Power plants Against the Effects of Postulated Pipe Rupture," 1988, was used. The application of the ANSI/ANS Standard 58.2-1988 subcooled jet model to evaluate the systems, structures and components in containment is consistent with its application as described in NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Revision 0, December 2004. As described in NEI 04-07, depending upon the material's proximity to the origin of a jet, damage may occur to the material due to pressure applied from the impaction of the jet on the material surface. This "damage pressure" was taken to be the stagnation pressure resulting from the expansion of a subcooled jet of fluid from the postulated break in the RCS. The ANSI/ANS Standard 58.2-1988 subcooled jet model was used to evaluate the pressure isobars for various distances from the nozzle for the test program.

A model was developed specifically for DCPP and uses, among others, the pipe diameter of the jet and local conditions to calculate the stagnation pressure isobars for the jet that impinges at the junction of the jet centerline and the test specimen located perpendicular to the jet centerline.

The test program used a facility capable of generating a subcooled jet that was representative of the range of temperatures and pressures associated with a large-break loss-of-coolant accident (LBLOCA). However, due to test facility limits on the available volume of the working fluid, the tests were only pressurized to 2000 psia and 530°F. Testing compensated for this slightly lower supply pressure by locating the test articles closer relative to the jet nozzle. Using the ANSI/ANS 58.2-1988 jet expansion model, the stagnation pressure at the point of jet impingement on the test article, calculated at 2000 psia, was the same as the stagnation pressure calculated with a supply pressure of 2250 psia. The difference lies with the proximity of the test article to the jet nozzle. The supply tank fluid was held at 2000 psia prior to and at the initiation of testing.

The test thermal hydraulic conditions (pressure and temperature) were selected so that conditions associated with a postulated LBLOCA blowdown were accurately simulated, and that the data from the test would be directly applicable to PWRs without any scaling or other type of compensation. This includes the 30-second blowdown time, which is bounding for the blowdown time duration for a postulated LBLOCA (double-ended guillotine break).

For the tests performed for DCPP, the test articles were placed at a distance from the 3.5-inch nozzle based on the calculated stagnation pressures that relate to a specific zone of influence (ZOI). The ZOI was based on the distance to the test article and the 3.5-inch nozzle (L/D). Although a break may result in a larger jet, the damage is a result of the stagnation pressure on a component. For a LOCA in an operating nuclear power plant like DCPP, the jet associated with the break will have the same stagnation pressure impinging on the system, structures and components as experienced by the test article. The equivalent ZOI in the operating plant will be based on the actual pipe diameter. In the case of a cold leg break at DCPP, the cold leg diameter is 27.5 inches. For a typical component located at 5D from the break, the jet would impact at approximately 11.4 feet as opposed to the 1.4 feet (16.3 inches) used in the test. In either case, the fluid conditions are such that the stagnation pressure, the maximum pressure experienced by the fluid at the point where the fluid is brought to rest (impingement), is the same. Hence the use of the jet impingement testing and resulting ZOIs calculated with a 3.5 inch jet are directly applicable to the much larger jets that could be experienced in a LOCA since it is not the size of the jet but the "damage pressure" based on the local conditions, that impinges on the system, structure or component that is of importance when determining debris generation within a ZOI.

In summary, the testing performed for DCPP to determine the potential for debris generation due to the effects of jet impingement on various potential debris sources was performed at conditions prototypical of an operating PWR and at distances from the break point scaled to postulated ZOIs. The results of this test program are directly applicable to operating nuclear power plants when determining the potential debris that may be generated during a postulated LOCA.

NRC Question 3:

Please provide the volumes of the inactive and sump pools to substantiate the 15% entrapment fraction of all debris in the inactive pools (i.e., is the volume of inactive pools greater or equal to 15% of total pool volume), and provide the justification for assuming all of the latent debris, instead of being distributed throughout containment, would be located in the sump pool during the pool fill phase, thereby maximizing the credit for latent debris to be captured in inactive pool volumes.

PG&E Response:

The open volume of the inactive pool, the incore instrumentation tunnel and the reactor cavity, is 10,493 ft^3. The volume of the active pool to a level of 2.6 feet (pool level at the start of recirculation) is 38,928 ft^3. The volume ratio of the inactive pool to the sump pool is 0.27, which is greater than 0.15, which meets the criteria of NEI 04-07, and therefore substantiates the use of 15 percent entrapment fraction of fine debris in the inactive pools.

With the exception of latent debris washed to the sump and inactive cavities during pool fill-up, it was conservatively assumed that all latent debris is in the lower containment, and would be uniformly distributed in the containment pool at the beginning of recirculation. This is a conservative assumption since no credit is taken for debris remaining on structures and equipment above the pool water level. However, this is not conservative with regards to maximizing the credit for latent debris that is captured in the inactive pool volumes.

To assess the suitability of the assumption that 15 percent of the latent debris is captured in the inactive pools the following evaluation is provided. Assuming 100 percent of the latent debris is transported to the strainer, the additional particulate and fibrous debris would increase 12.75 lbs and 2.25 lbm, respectively. As shown in the following table, when these slight increases are compared to the existing overall debris quantities the amount of the increase, maximum increase of 2.4 percent particulate and 5.3 percent fiber, may be considered insignificant. Also it should be noted that the latent debris survey had estimated a latent debris load of less than 60 pounds; however, DCPP conservatively utilized a value of 100 pounds in the analysis. This would translate into a margin of 34 pounds of particulate and 6 lbm fiber, which bounds the additional particulates and fiber added if 100 percent of the latent debris is assumed to be transported to the strainer. Additionally, the use of conservative scaling factors during the strainer testing program, along with conservatism in the calculation of the miscellaneous debris generated inside the crane wall would overshadow the assumption of the 15 percent entrapment fraction of latent debris in the inactive pools.

The increase of 2.25 lbm of fiber and 12.75 lbm of particulate is insignificant. It is therefore concluded that when compared to the overall quantities of the debris and when compared with the conservatisms of the analysis, the debris loads generated and transported to the strainer remain conservative even with the utilization of the 15 percent entrapment assumption for latent debris.

Head Loss Test	Fibrous Debris at Strainer (lbm)			Particulate Debris at Strainer (lbm)		
	If 0% Latent To Inactive Pool	If 15% Latent To Inactive Pool	% Change in debris at Strainer	If 0% Latent To Inactive Pool	If 15% Latent To Inactive Pool	% Change in Debris at Strainer
11-S-PSG	85.67	83.61	2.5	684.14	671.39	1.9
14-S-PSG	123.04	120.79	1.9	560.98	548.23	2.3
15-S-PSG	44.72	42.47	5.3	657.44	644.69	1.9

<u>NRC Question 4</u>:

Please provide the basis for crediting reflective metal insulation (RMI) debris with filtering out paint chips at the debris interceptors in light of the facts that (1) an insufficient amount of RMI for paint chip filtering may be destroyed for some break scenarios for which coating debris is generated, (2) the size distribution of actual destroyed RMI may be biased toward less transportable pieces than assumed by the NEI and NRC staff guidance for debris transport to the sump strainer, and (3) the flow velocity in the pool may not in actuality transport RMI to the interceptors for some of the breaks for which coating debris is generated (i.e., the transport metrics are biased towards maximizing RMI transport to the sump strainers).

PG&E Response:

DCPP intentionally chose to perform the debris interceptor test with a bed of RMI debris in front of the interceptor as it was determined that this configuration would provide the most conservative results as the RMI debris bed results in an increase in the velocity of the flowing fluid. It was additionally concluded that the presence or absence of the RMI debris bed, with regards to filtering out paint chip debris, would not have an impact on the overall capture effectiveness of the debris interceptors.

During the initial debris transport metric testing (e.g., tumbling test and over the curb velocity test), it became apparent that the debris, specifically the RMI, tended to react with each other readily within the test flume. During these debris transport metrics tests, only a few pieces of RMI debris were introduced along the bottom of the test flume and upstream of the debris curb. In these metric tests, the RMI debris would be stopped by the debris curb or other RMI debris that may have been held up due to imperfections of the test flume. The bottom of the test flume was painted and had similar surface contours as the containment floor.

To further explore this phenomenon with larger amounts of RMI debris, investigative flume test runs were performed to determine how RMI debris would react with prototypical amounts of RMI debris. RMI debris, sized predominately of 2-inch by 2-inch pieces and some 1/2-inch by 1/2-inch pieces, were introduced upstream of a 2-inch debris curb, along the bottom of the test flume through a 4 inch polyvinyl chloride (PVC) pipe. These investigative tests, along with the debris interceptor tests were performed at the expected maximum flow rates and minimum sump pool levels. Based on the size of the debris used and the velocity used, the testing demonstrated that the RMI debris would be transported to the debris interceptor. The RMI debris would collect on the 2-inch debris curb and a RMI debris bed would be formed as additional RMI debris was added. It became apparent that with the addition of more debris, that the RMI debris bed would reach a maximum height of approximately 5 inches. Any additional RMI added to the test flume would continue building the bed toward the point of the debris insertion, or any RMI debris that reached the top of the 5-inch debris bed would move along the top of the bed and tumble past the debris curb. However, the height of the debris bed did not increase. It was postulated that due to the amount of calculated debris generated (e.g., cables, 3M Foil tape, vapor barrier material, light bulbs, reflective tape and conduit tape, and lamicoids) along with the miscellaneous uncalculated debris that could be generated (e.g., conduit, instrument tubing, etc.) and distributed along the containment floor that an RMI debris bed could readily be formed. It was postulated that the RMI debris bed would have the impact of increasing the flow velocity due to the reduced flow area, an increase of approximately 17 percent in flow velocity. Therefore, DCPP made the decision to conservatively test the debris interceptors with the consideration of an RMI debris in front of the interceptor.

During the performance of debris interceptor tests, RMI debris was introduced upstream of the debris interceptor, along the bottom of the test flume through a 4 inch PVC pipe. As observed in the investigative tests, an RMI debris bed with a height of approximately 5 inches was formed upstream of the debris interceptor. After the formation of the RMI debris bed, unqualified coating debris was introduced to test the effectiveness of the debris interceptor.

It was observed during the debris interceptor testing that the RMI debris bed did tend to capture some of coating chip debris. However, it was also observed that of the suspended coating chips that did flow over the debris interceptor, these chips tended to flow at an approximate height of the debris interceptor, eighteen inches or greater. The coating chips below this level would swirl around and eventually settle out. It was therefore concluded that the presence or absence of the RMI debris bed, with regards to filtering out paint debris, would not have a significant impact on the amount of coating debris that travels past the debris interceptor.

NRC Question 5:

Please state whether the fire stops and unjacketed debris in containment outside the crane wall would be exposed to the runoff of spray drainage streams, and state whether this effect was accounted for in the erosion testing that was performed on these materials (as opposed to assuming that all spray flow was in the form of fine droplets).

PG&E Response:

Unjacketed debris outside the crane wall have the potential of being exposed to runoff of spray drainage streams, whereas fire stops are not exposed to runoff of spray drainage streams as the fire stops are protected by either a cable tray cover or by a cable tray above. The erosion tests for unjacketed insulation considered erosion due to the force of flowing fluid. The tested flow erosion values for unjacketed Temp-Mat and Cerablanket were determined to be insignificant.

Two separate test programs were implemented to determine the erosion from unjacketed insulation and fire stops outside the crane wall.

The erosion testing of unjacketed insulation involved both spray and flow erosion testing. Various samples were tested separately to determine the amount of erosion from a simulated containment spray environment and from a simulated flow environment. The tested spray conditions were selected such that the velocity of the water as it exits the tested spray nozzle will be greater than or equal to the spray terminal velocity of 15.75 ft/sec. The tested flow velocity was selected as 0.4 ft/sec. The tested spray duration was conservatively set for one hour spray, followed by a time delay, followed by another spray duration of one hour, where a one hour spray duration represents the design bases operation of containment spray. The tested flow erosion tests were conducted for a continuous duration of eight hours.

The test results show a spray erosion of 0.5 percent for unjacketed Temp-Mat and 2.4 percent for unjacketed Cerablanket. For the purpose of the debris generation analysis, conservative erosion values of 0.625 percent and 3.0 percent were selected for Temp-Mat and Cerablanket, respectively. The tested flow erosion values for Temp-Mat and Cerablanket were insignificant. The test report concluded that during the spray test the insulation fines would be dislodged or eroded from the insulation material by agitation due to the spray whereas during the flow erosion test this agitation did not occur to the same magnitude and thus the flow erosion values were lower. The debris generation analysis conservatively applies the spray erosion valves to unjacketed Temp-Mat and Cerablanket insulation.

The erosion testing for the fire stop material within cable trays outside the crane wall was performed with four different samples under a simulated containment spray environment. The tested cable tray samples were various configurations of covered, uncovered cable trays with both vented or solid bottom trays. Three tests were run with the cable trays in a horizontal configuration (see Figure 1) and one test was run with the cable tray vertically oriented. Similar to the unjacketed erosion tests, the velocity of the water as it exits the test nozzle was greater than or equal to the spray terminal velocity and the spray duration was one hour spray, followed by a time delay, followed by another hour of spray.

The test results show that for a horizontal covered cable tray, the amount of fibrous erosion is 4.9 percent, for a horizontal uncovered cable tray the amount of erosion is 12.7 percent, and for a vertical cable tray the amount of erosion is 36.2 percent. The debris generation analysis conservatively assumes cable tray erosion values of 5 percent, 13 percent, and 37 percent respectively.

The cable tray specimens were fabricated from 12-inch wide standard stock material. The trays were filled with an assortment of cables, numbered and sized to achieve a nominal fill of approximately 16 percent. This cable fill ratio maximizes the amount of fire stop material and bounds the majority of the cable trays. Fire stops were fabricated with foam and fibrous damming material (Kaowool board and Kaowool blanket). The fire stops were installed into the cable trays per existing plant details and drawings. The cover material for the covered cable tray specimens was either sheet metal or Kaowool board as per existing design details. As shown by Figures 2 and 3, the cable tray cover was conservatively sized to just cover the width of the fire stop leaving a portion of the damming material exposed to the tested spray water, whereas an actual cable tray cover would cover the entire length of the tray.

The actual field installation of the horizontal cable tray cover would be the length of the cable tray that passes under stairways, hatches, and gratings (see Figure 4). The actual installation of the horizontal cable tray cover would envelop the entire fire stop without exposing any of the damming material. The purpose of the cable tray cover is to protect the cables from any objects that could fall through the opening of the hatches and gratings above. Cable trays are often installed in stacks of two or more trays. In this case the lower cable trays are not installed with covers as the cable tray above would afford protection. Walkdowns were performed of the Unit 1 and Unit 2 containments to determine the type (vertical or horizontal and width) and the number of fire stops that would be susceptible to erosion due to the action of containment spray. The identified fire stops were in cable trays that were generally underneath grating and near stairways and hatches. The top cable tray in these areas would have a cover. If the identified fire stop did not have a cover it was because the fire stop was installed in a cable tray that was underneath another cable tray.

The erosion testing for the horizontal cable tray fire stops is conservative in that the covered fire stop specimen conservatively exposes the ends of the fire stop material to the erosion of the containment spray whereas the installed configuration has the fire stop completely covered. Also, the uncovered fire stop specimens were tested with direct spray; whereas the installed uncovered fire stops are afforded protection from the containment spray by the cable trays installed above. In both of these configurations, covered or uncovered cable trays, the fire stops would not be exposed to runoff or spray drainage streams as they are protected by the cable tray cover or the cable tray above.

The vertical cable trays were exposed to the spray directed upon one end of the specimen. The erosion for the vertical fire stop was 36.2 percent. This relatively high erosion rate was attributed to the Kaowool blanket exposed at the tray ends. In the unjacketed erosion tests, the spray action generated more erosion than that due to flow erosion. Therefore, the vertical fire stop spray test is conservative, despite the fact that the test did not account for runoff or spray drainage streams.

Based upon the above discussion, the affect of runoff of spray drainage streams has been considered and the existing erosion tests are considered conservative.

Figure 1 – Tray No. 3, Horizontal, Covered with Kaowool Board, During Testing

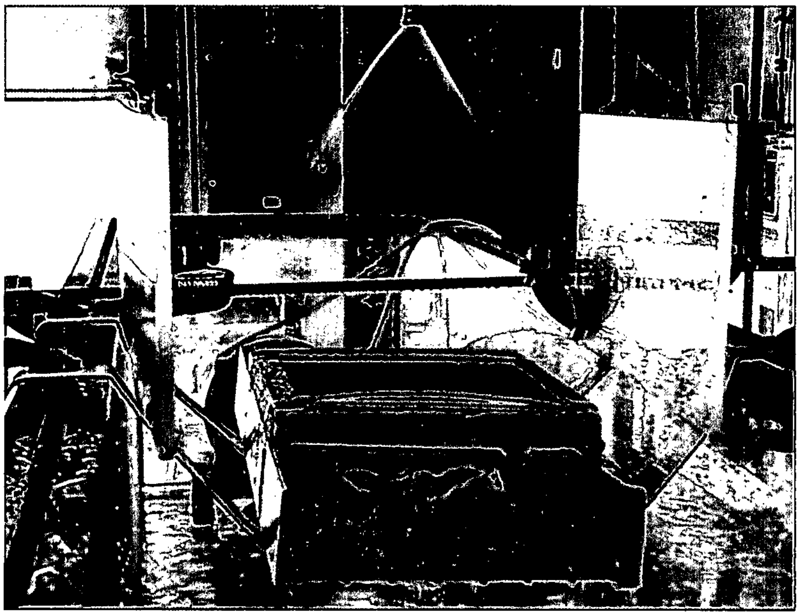


Figure 2 – Tray No. 3, Horizontal, Covered with Kaowool Board, Pre-Test

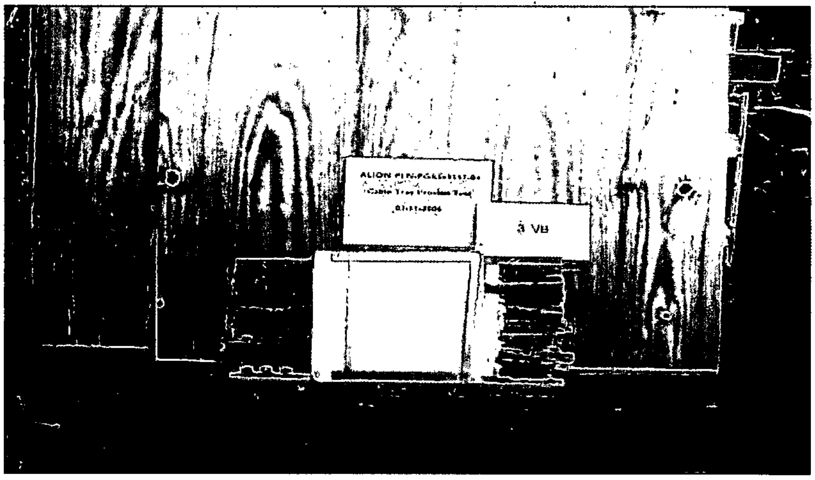


Figure 3 – Tray No. 2, Horizontal, Covered with Sheet Metal, Pre-Test

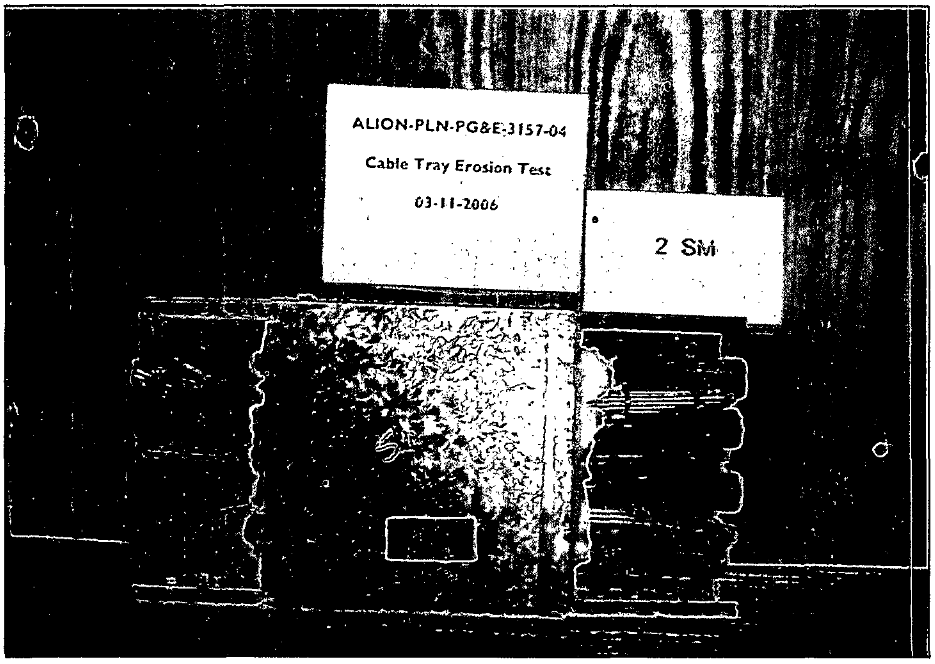
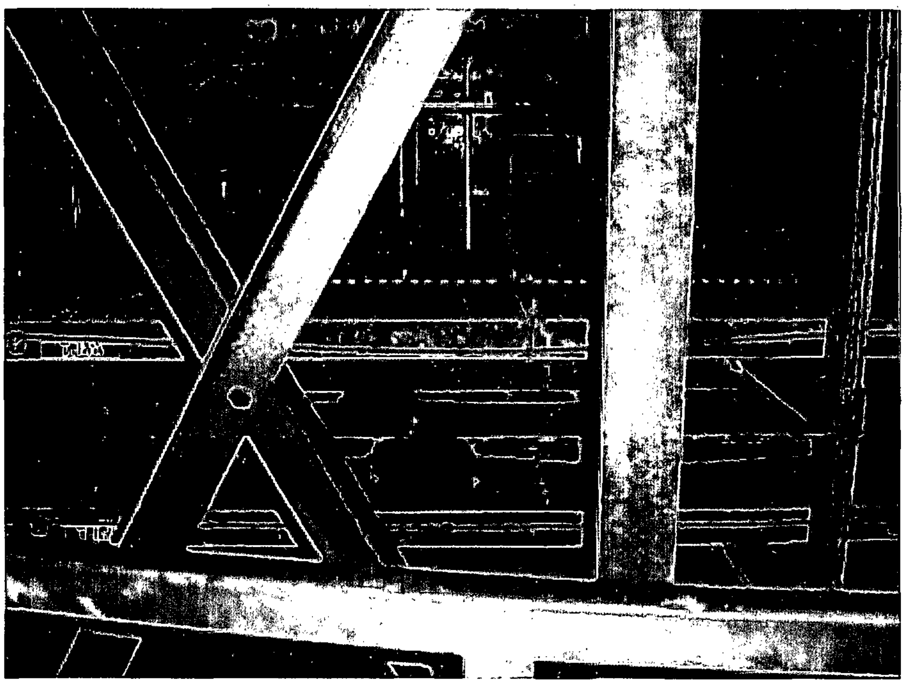


Figure 4 – Stacked Horizontal Cable Trays, Covered Tray on Top



NRC Question 6:

Please provide the amount of each size category of fiber added to each head loss test (e.g., fine, small, large, and intact). Provide a comparison between the amount of each fiber size category added to each test versus the amount of each fiber size category predicted to reach the strainer in the transport calculation. Verify that the fine fibers added to the test flume had not agglomerated during preparation and entered the test flume as suspended fiber.

PG&E Response:

Tables 6-1 through 6-4 list the amount and size category of fiber added for each design verification head loss test. The tables also list the scaling factor that determines the amount of each fiber size category added to each test versus the amount of each fiber size category predicted to reach the strainer in the transport calculation.

Lacking specific information, the debris generation analysis for DCPP conservatively assumes Temp-Mat, mineral wool and Kaowool targets within the respective ZOI will be destroyed as 100 percent fines. This conservative assumption is made to assure that the head loss test program is enveloping. From the jet impingement testing performed for DCPP, the fiberglass on the pressurizer heater cables and Flexicone 200 sleeving will be released as 100 percent fines. For fibrous debris susceptible to erosion due to containment spray, the fraction of fibrous material eroded, as determined from testing, is assumed to be released as 100 percent fines.

The surrogate fibrous debris used for the head loss test was processed per procedure. This procedure required that fibrous insulation be cut to approximate 12 inch squares and then shredded to conform to size classification Numbers 1 through 4 as identified in Table 3-2 in NUREG/CR-6806, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," or Table 3-1 of NEA/CSNI/R (95)11, "Knowledge Base for Emergency Core Cooling System Recirculation Reliability." Size classification Numbers 1 through 4 represent, very small pieces of fiberglass material, single strands of fiberglass, multiple interwoven strands, and clusters, respectively. The fibrous material was further prepared at the Continuum Dynamics Incorporated (CDI) test facility by introducing the fibrous material into buckets and mixed with water and separated into fines by the use of paint mixers. During the early prototype head loss testing of the previously installed perforated screens at the PG&E test facility in San Ramon, CA, fibrous debris was prepared in a similar manner. However, it was DCPP's experience that over mixing of the fibrous material would create small agglomerated pieces of fibrous material, similar in size to rice pellets. During the CDI debris preparation for the General Electric (GE) prototypical strainers, over mixing of the fibrous material was avoided by oversight of the process by the PG&E test director to assure a slurry of individual fibers was created.

Table 6.1
Loop 2 Crossover Leg Break at the Steam Generator Nozzle
Test 11-S-PSG Fiber Debris

Fiber Material (100% fines)	**Quantity Generated (lbm)**	**Transport %**	**Debris At Sump**	**Scaling Factor(a)**	**Required Test Debris**	**Tested Quantity (lbm)**
Rock Wool (mineral wool on pipe)	17.36	97	16.84	0.006814	0.1148	0.11
Nukon (Latent fiber)	13.75	85	11.69	0.006814	0.0797	
Nukon (Unjacketed Temp-Mat, outside ZOI)	1.78	100	1.78	0.006814	0.0121	
Nukon (Unjacketed Cerablanket outside ZOI)	0.21	100	0.21	0.006814	0.0014	
Nukon (Pressurizer heater cables)	29.80	97	28.91	0.006814	0.1970	
Nukon (Flexicone sleeve)	9.00	97	8.73	0.006814	0.0595	
			Total Nukon 51.32		Total Nukon 0.3497	Total Nukon 0.35
Kaowool (blanket)	0.12	97	0.12	0.006814	0.0008	
Kaowool (M board)	7.82	97	7.58	0.006814	0.0517	
Kaowool (uncovered fire stops)	2.28	100	2.28	0.006814	0.0155	
			Total Kaowool 9.98		Total Kaowool 0.0680	Total Kaowool 0.07
Fiberglass Tape	5.64	97	5.47	0.006814	0.0373	0.04
Total Fiber			83.61	0.006814	0.5698	0.57

(a) Equation for scaling factor:

$$Scaling\ Factor = \frac{Test\ Article\ Perforated\ Plate\ Area\ \left(20.85\ ft^2\right)}{Plant\ Strainer\ Perforated\ Plate\ Area\ \left(3200\ ft^2\right) - Sacrificial\ Screen\ Area\ \left(Break\ Specific\right)}$$

with a sacrificial screen area of 139.91 ft^2.

Table 6.2
Loop 4 Crossover Leg Break at the Reactor Coolant Pump Nozzle
Test 12-S-PSG Fiber Debris

Fiber Material (100% fines)	**Quantity Generated (lbm)**	**Transport %**	**Debris At Sump**	**Scaling Factor(a)**	**Required Test Debris**	**Tested Quantity (lbm)**
Rock Wool (minerial wool on pipe)	15.44	97	14.98	0.006952	0.1041	0.10
Nukon (Temp-Mat)	1.97	97	1.91	0.006952	0.0133	
Nukon (Latent fiber)	15.00	85	12.75	0.006952	0.0886	
Nukon (Unjacketed Temp-Mat, outside ZOI)	4.42	100	4.42	0.006952	0.0307	
Nukon (Unjacketed Cerablanket outside ZOI)	0.55	100	0.55	0.006952	0.0038	
Nukon (Pressurizer heater cables)	0	97	0	0.006952	0	
Nukon (Flexicone sleeve)	0	97	0	0.006952	0	
			Total Nukon 19.63		Total Nukon 0.1365	Total Nukon 0.14
Kaowool (blanket)	0.60	97	0.58	0.006952	0.0040	
Kaowool (M board)	10.88	97	10.55	0.006952	0.0733	
Kaowool (uncovered fire stops)	2.28	100	2.28	0.006952	0.0159	
			Total Kaowool 13.42		Total Kaowool 0.0932	Total Kaowool 0.09
Total Fiber			48.03	0.006952	0.3339	0.33

(a) Equation for scaling factor:

$$Scaling\ Factor = \frac{Test\ Article\ Perforated\ Plate\ Area\ \left(20.85\ ft^2\right)}{Plant\ Strainer\ Perforated\ Plate\ Area\ \left(3200\ ft^2\right) - Sacrificial\ Screen\ Area\ \left(Break\ Specific\right)}$$

with a sacrificial screen area of 201.05 ft^2.

Table 6.3
Pressurizer Loop Seal Line 727 Break
Test 14-S-PSG Fiber Debris

Fiber Material (100% fines)	Quantity Generated (lbm)	Transport %	Debris At Sump	Scaling Factor(a)	Required Test Debris	Tested Quantity (lbm)
Rock Wool (minerial wool on pipe)	4.91	97	4.76	0.006795	0.0323	0.03
Nukon (Temp-Mat)	102.75	97	99.67	0.006795	0.6773	
Nukon (Latent fiber)	15.00	85	12.75	0.006795	0.0866	
Nukon (Unjacketed Temp-Mat, outside ZOI)	1.33	100	1.33	0.006795	0.0090	
Nukon (Unjacketed Cerablanket outside ZOI)	0	100	0	0.006795	0	
Nukon (Pressurizer heater cables)	0	97	0	0.006795	0	
Nukon (Flexicone sleeve)	0	97	0	0.006795	0	
			Total Nukon 113.75		Total Nukon 0.7729	Total Nukon 0.77
Kaowool (blanket)	0	97	0	0.006795	0	
Kaowool (M board)	0	97	0	0.006795	0	
Kaowool (uncovered fire stops)	2.28	100	2.28	0.006795	0.0155	
			Total Kaowool 2.28		Total Kaowool 0.0155	Total Kaowool 0.02
Total Fiber			120.79	0.006795	0.8208	0.82

(a) Equation for scaling factor:

$$\text{Scaling Factor} = \frac{\text{Test Article Perforated Plate Area}\left(20.85\ ft^2\right)}{\text{Plant Strainer Perforated Plate Area}\left(3200\ ft^2\right) - \text{Sacrificial Screen Area}\left(\text{Break Specific}\right)}$$

with a sacrificial screen area of 131.58 ft^2.

Table 6.4
Loop 4 Crossover Leg Break at the Reactor Coolant Pump Nozzle
Test 15-S-PSG Fiber Debris

Fiber Material (100% fines)	Quantity Generated (lbm)	Transport %	Debris At Sump	Scaling Factor(a)	Required Test Debris	Tested Quantity (lbm)
Rock Wool (minerial wool on pipe)	15.44	97	14.98	0.006952	0.1041	0.10
Nukon (Latent fiber)	15.00	85	12.75	0.006952	0.0886	
Nukon (Unjacketed Temp-Mat, outside ZOI)	1.33	100	1.33	0.006952	0.0092	
Nukon (Unjacketed Cerablanket outside ZOI)	0	100	0	0.006952	0	
Nukon (Pressurizer heater cables)	0	97	0	0.006952	0	
Nukon (Flexicone sleeve)	0	97	0	0.006952	0	
			Total Nukon 14.08		Total Nukon 0.0978	Total Nukon 0.10
Kaowool (blanket)	0.60	97	0.58	0.006952	0.0040	
Kaowool (M board)	10.88	97	10.55	0.006952	0.0733	
Kaowool (uncovered fire stops)	2.28	100	2.28	0.006952	0.0159	
			Total Kaowool 13.41		Total Kaowool 0.0932	Total Kaowool 0.09
Total Fiber			42.47	0.006952	0.2953	0.29

(a) Equation for scaling factor:

$$Scaling\ Factor = \frac{Test\ Article\ Perforated\ Plate\ Area\ \left(20.85\ ft^2\right)}{Plant\ Strainer\ Perforated\ Plate\ Area\ \left(3200\ ft^2\right) - Sacrificial\ Screen\ Area\ \left(Break\ Specific\right)}$$

with a sacrificial screen area of 201.05 ft^2.

NRC Question 7:

Please provide an evaluation that shows that the stirring in the tank to prevent debris settling did not affect the formation of the strainer debris bed in a non-prototypical or non-conservative manner (prevention or wash away of debris beds, or disturbance of the debris bed by non-prototypical intrusion of paint chips or large pieces of fiber).

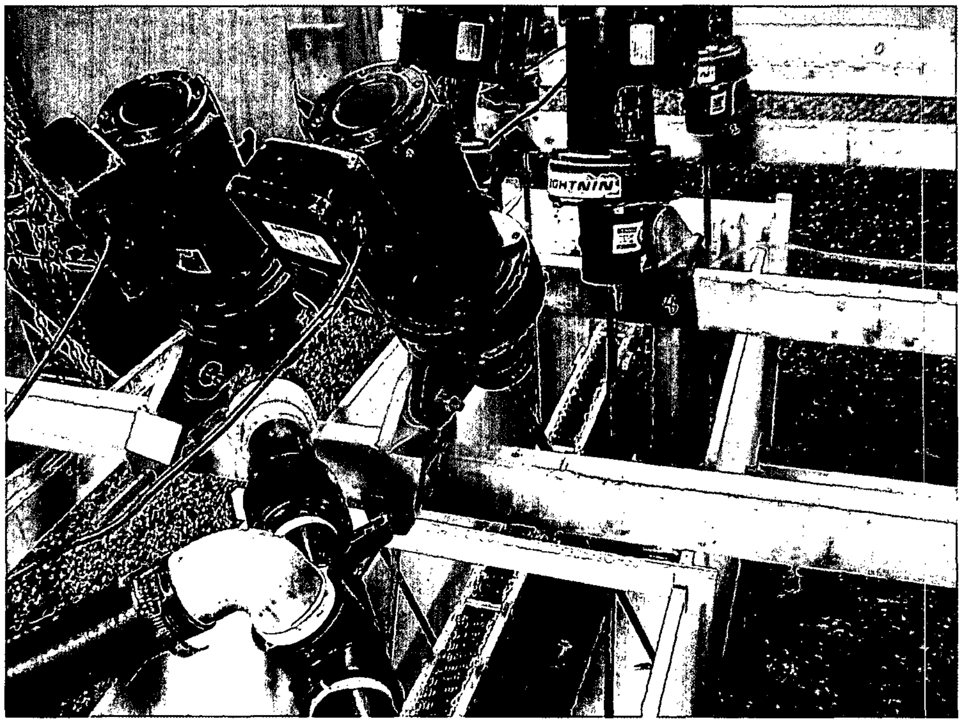
PG&E Response:

The placement and the number of the agitators used during the head loss test were designed to assure that all of the debris introduced was effectively suspended and was homogenous throughout the test flume; while preventing any wash away of the debris bed or disturbance of the debris bed by nonprototypical intrusion of paint chips. Post test photographs of Tests 14-S-PSG and 15-S-PSG (Figures 2 through 5) show uniform debris plateout on the strainer edges with no evidence of wash away of the debris beds.

A total of six motor driven agitators were used for each sector head loss test. The agitators were placed as follows (see Figure 1):

- 2 agitators vertically down, one on each side of the plenum
- 2 agitators crossed at approximately 60 degrees down on each side of the sector test article. The propellers on these 4 agitators were approximately 6 inches from the floor of the test tank.

Figure 1 – Test Tank Showing Agitators



The strainer is located approximately 1 inch above the floor of the test tank. The agitators ensure a uniform mixing, producing a homogeneous debris mix in the tank fluid. The agitators develop a relatively gentle circular eddy current with no preferential direction of the material. During the sector head loss testing it was observed that the paint chips would randomly circulate throughout the test tank; thus, the debris was not forced in any direction.

As part of the post head loss test evaluation, the two perforated plates of the sector test article were removed from each other to allow inspection of the debris bed. The debris beds formed for all the sector head loss tests were of a relatively symmetrical nature where the debris bed started to form from the center of the perforated screens where it was attached to the plenum, the point of lowest resistance. As the debris bed continued to build, the debris fanned its way from this point relatively symmetrically out to the front leading edge, and the top and bottom edges. The center flow path consistently had the lowest resistance, followed by the top flow path, and then the bottom flow path. The typical bed formation seen throughout the sector head loss testing is shown in Figures 2 through 5. The paint chip beds also exhibited a similar bed formation phenomenon. Throughout the test program, there was no evidence of wash away of the debris beds.

Figure 2 - Test 14-S-PSG (Left Side Disc; Plenum End is at Right Side of Photo)

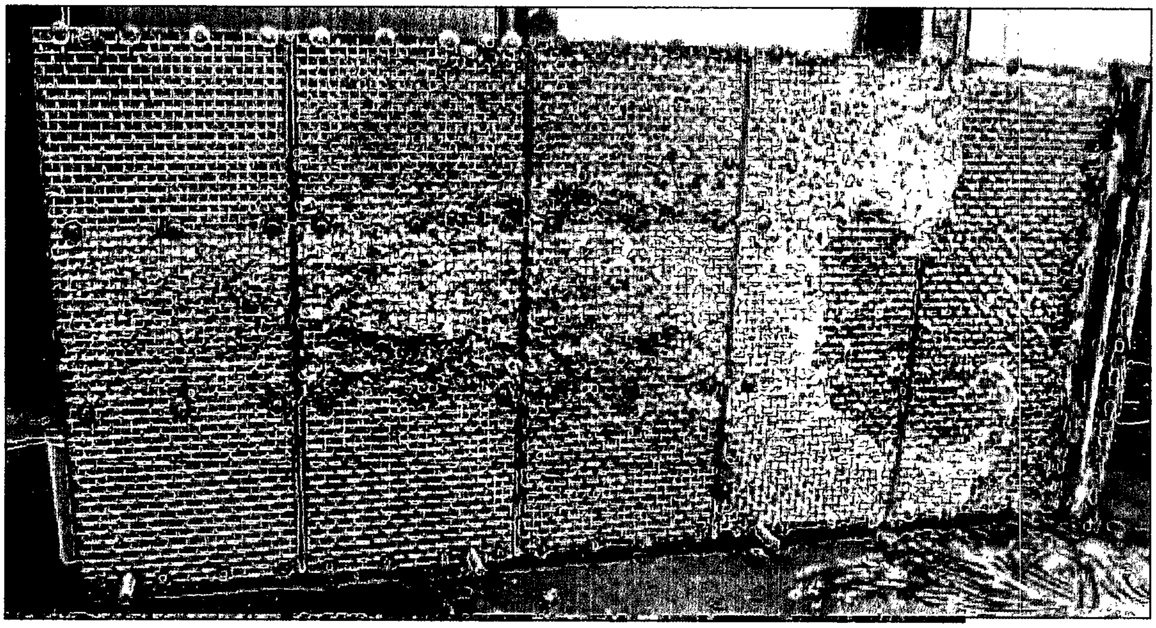


Figure 3 - Test 14-S-PSG (Right Side Disc; Plenum End is at the Left Side of Photo)

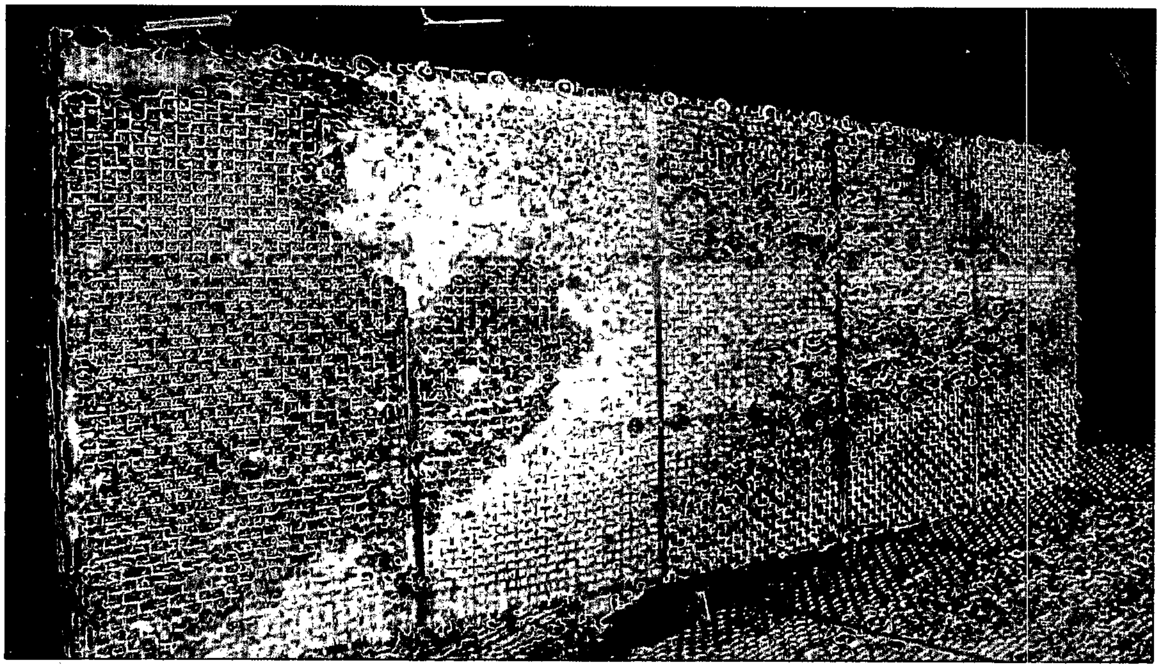


Figure 4 - Test 15-S-PSG (Left Side Disc; Plenum End is at Right Side of Photo)

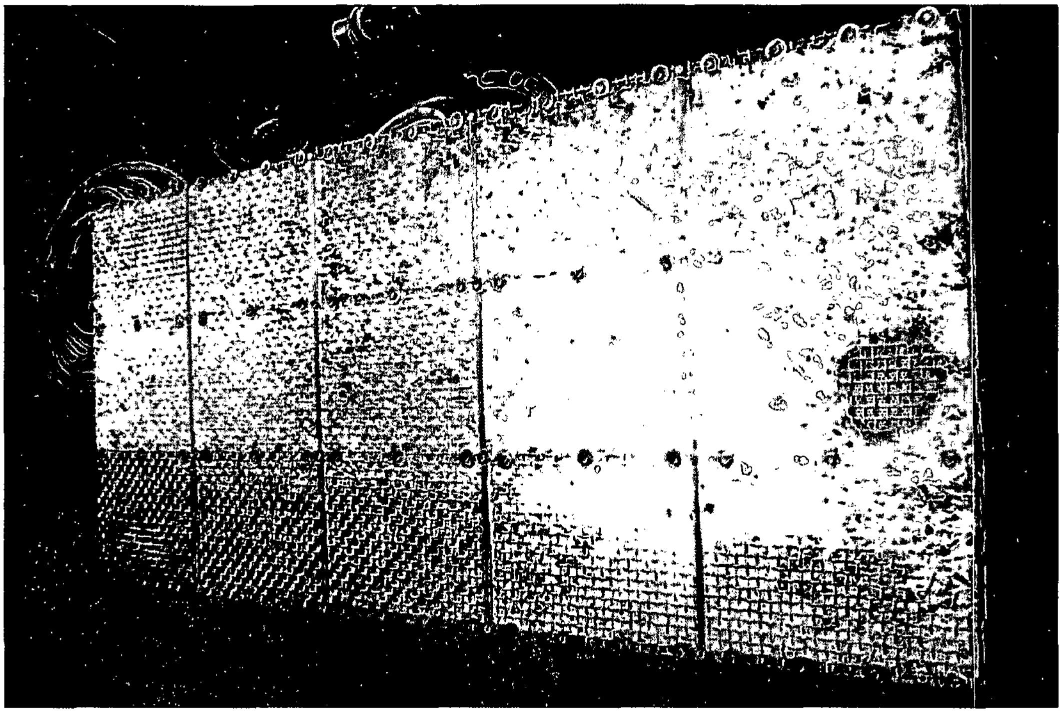
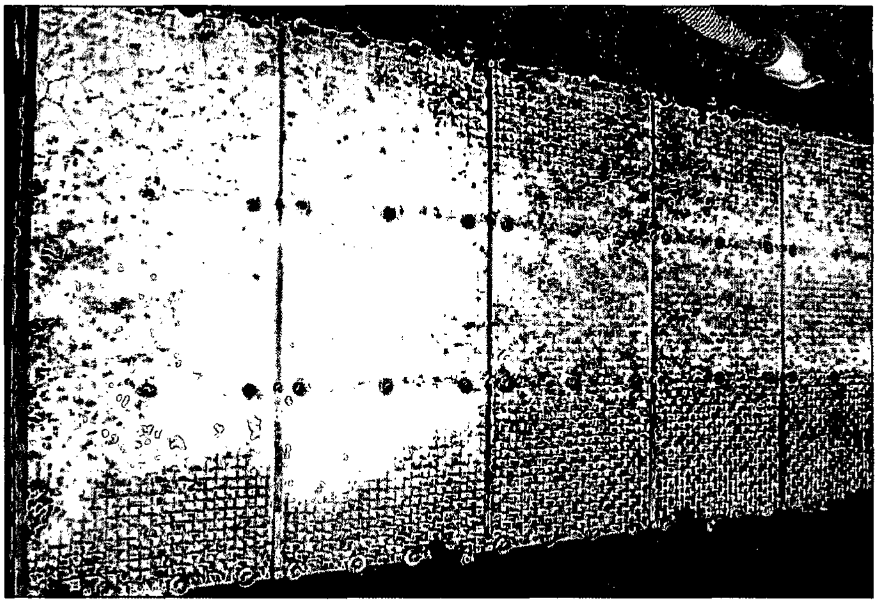


Figure 5 - Test 15-S-PSG (Right Side Disc; Plenum End is at Left Side of Photo)



NRC Question 8:

Please provide a basis for not performing a time-based extrapolation of the test data out to the emergency core cooling system (ECCS) mission time. [The staff understands that the integrated chemical head loss test was run for the number of fluid turnovers that would occur in the plant. However, there are potential time-based debris bed change mechanisms that could result in additional head loss (e.g., compaction). It has been observed in testing, after many test rig fluid volume turnovers, that after particulate debris has been filtered from the water the strainer head loss continues to increase with time.]

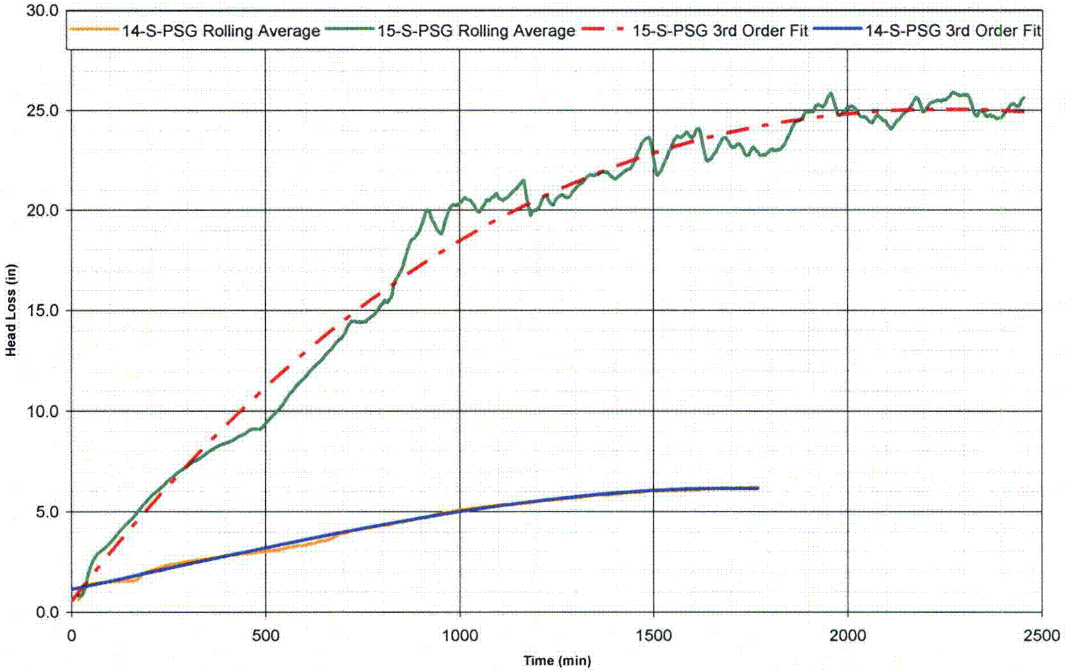
PG&E Response:

The goal of the DCPP head loss testing and debris mitigation program was to implement a sump design with a screen surface area sufficiently large and a calculated debris quantity sufficiently low at the strainer such that open screen area could be maintained. Open screen area, area without any accumulation of fibrous debris or any significant accumulation of paint chips, assures that the impact of chemical effects debris and particulate debris is isolated to the debris bed caused by the fibrous fines and areas of significant paint chip accumulation. Any unfiltered chemical effects debris or particulate debris would simply recirculate through the open screen area, not cause additional head loss, and not cause additional compaction of the debris bed. Open screen area and long-term stable head loss were validated by the head loss test results.

DCPP's head loss tests are continued for at least 24 hours after the last addition of chemicals. The amount of fiber debris has been limited based upon the extensive debris mitigation efforts. After this limited amount of fiber and/or paint chip debris has formed a debris bed (less than 100 percent coverage of the screens), a portion of the chemical and particulate debris will adhere to the fiber and/or paint chip bed and essentially block this portion of the screen area. Where there is open screen area the remaining chemical and particulate debris would pass through the screen without causing additional head loss. The resulting head loss observed is due to the flow across the limited open screen area. The turbidity of the test flume did not decrease after the debris bed was saturated with all of the chemical and particulate debris that it could absorb and the remaining chemical and particulate debris continued to be recirculated through the open screen area. At that time there is no further increase in head loss; in fact, a slight decrease in head loss was observed during some of the tests. Any extrapolation of data at the test termination point would be expected to essentially be a straight, flat line (see Figure 1).

For the front sector design basis testing, tank turnover time is approximately 6.2 minutes. Since these tests were continued for at least 24 hours after the last addition of chemicals, the test results are bounding for the number of turnovers in the plant for the ECCS mission time. In early testing DCPP discovered the adverse head loss effects of aged chemicals. Aged chemicals were proven to not be representative of chemicals in the plant. Thus the exhaustive testing performed under the DCPP test program have shown no additional time-based debris bed change mechanisms that produced additional head loss.

Figure 1 - Test 14-S-PSG, and 15-S-PSG Head Loss Testing Results



NRC Question 9:

The supplemental response states that the strainer is completely submerged for a large-break LOCA at the onset of recirculation. However, the supplemental response also states that the top of the strainers are at 93.6 ft and the water level is at 93.4 ft at the onset of recirculation. This implies that the strainer is not fully submerged at the onset of recirculation. Please provide clarification as to whether the strainer is submerged at the onset of recirculation. If it is not, provide an evaluation of the acceptability of the strainer performance under partially submerged conditions.

PG&E Response:

The strainer is submerged when the residual heat removal (RHR) pumps are started after switchover to the recirculation phase for the design basis LOCA. PG&E Letter DCL-08-059, dated July 10, 2008, revised the water level to 93.6 feet, the same level as the top of the sump strainers.

Amendment No. 199 to Facility Operating License DPR-80 and Amendment No. 200 to Facility Operating License DPR-82, for Units 1 and 2 respectively, revised Technical Specification (TS) 3.5.4, "Refueling Water Storage Tank (RWST)," Surveillance Requirement (SR) 3.5.4.2 to increase the minimum required borated water volume from, "≥400,000 gallons (81.5 percent indicated level)," to "≥455,300 gallons (93.6% level)" (PG&E Letter DCL-07-093, dated October 2, 2007), to ensure the strainer is submerged when the RHR pumps are started after switchover to the recirculation phase for the design basis LOCA. These amendments have been implemented for both units.

NRC Question 10:

The supplemental response states that for a small-break LOCA (SBLOCA) the strainer is not submerged completely. The response describes how the strainers were modified to reduce the potential for vortexing under partially submerged conditions and tested to verify the modifications were effective. However, it was not stated whether strainer testing was completed for partial submergence conditions with the expected debris loading on the strainer. Please provide an evaluation of strainer performance under partially submerged and debris laden conditions. Additionally, provide information that verifies that the clean strainer head loss calculation includes losses associated with the flow straighteners added to prevent vortex formation during SBLOCAs. [Regulatory Guide 1.82, Revision 3 discusses criteria that the strainer should meet under various conditions, including a criterion for allowable head loss for partially submerged strainers.]

PG&E Response:

The DCPP emergency sump strainer was evaluated for susceptibility to vortex induced air intrusion under partially submerged conditions. Two areas were identified susceptible to these conditions: the individual strainer sections (strainer discs), and the descending portion of the flow channel from the front strainer plenum.

The individual strainer discs were evaluated with debris as a part of the vendor strainer testing. This testing showed that the individual strainer discs are not susceptible to air ingestion when partially exposed under debris-laden conditions.

The descending portion of the flow channel from the front strainer plenum could be subject to vortexing under partially-submerged conditions. The flow from the upper plenum exits into a vertical flow section immediately after making a horizontal direction change. The design review of the upper plenum concluded that this arrangement would be susceptible to vortexing. Design modifications (addition of flow straighteners with cross-flow holes to interrupt vortex formation) were made to control vortexing in the descending flow channel.

PG&E performed testing to confirm the effectiveness of the vortex control modifications. The testing was performed on a full-scale mockup of the descending section of the strainer, and did not include the strainer discs. The testing replicated the partially-submerged conditions in the descending elbow between the front plenum and the sump suction piping. The testing did not include debris loading because the descending section is downstream of the strainer disks, and the disks are credited with removing the major constituents of the debris load. Conditions tested included a range of flow rates and water elevations that enveloped the SBLOCA flow conditions. The tests demonstrate acceptable performance under all conditions.

The limiting strainer head losses are associated with the LBLOCA cases. Strainer head loss calculations were provided by the vendor for all head losses internal to the strainers, including head losses associated with the flow straighteners. The total head loss in the net positive suction head (NPSH) analysis included the head losses across the strainers (as determined by the strainer testing for debris-laden strainers), head losses internal to the strainers (as determined by the vendor by a detailed analysis of the strainer structure including flow straighteners) and the entrance loss to the RHR system inlet piping. The results of these calculations are summarized in the response to Question 12.

NRC Question 11:

Please provide justification for the computed limiting ECCS flow rate being "worst case flow conditions." Please Include a description of the methodology used to determine the maximum flow rate (e.g., runout flow from the vendor pump curve, a calculation using a standard hydraulics code, etc.), as well as a description of the assumptions and the assumed system and component configuration that provides the conservative maximum flow rate (e.g., for single pump operation, can flow cross over to downstream piping in the non-operating train?).

PG&E Response:

The limiting ECCS flow rate was calculated using the network flow analysis code PEGISYS. The calculations determined a single RHR pump approaching run out conditions represents the most limiting ("worst case") design-basis conditions for pump NPSH requirements. The effects of the sump strainer head losses were evaluated for these conditions

To determine the maximum flow for the RHR pumps during recirculation, flow to systems supplied by the RHR pumps was maximized. Changes in system alignment, system resistance, and pump performance curves were included in this evaluation. System resistances were based on benchmarked system data. The pump performance curves included minimum and maximum pump performance curves.

To obtain the limiting flow conditions, various electrical and component failures were considered. The issues identified in NRC Information Notice 87-63, "Inadequate Net Positive Suction Head in Low Pressure Safety Systems," were also considered. Key assumptions used in the analysis include:

- The throttling valves in the RHR system were assumed to be in a failed open position of 70 degrees (lock nuts installed to limit opening) or Cv=700.
- The NPSH available (NPSHA) for run out conditions was adjusted for the minimum sump level.
- No credit was taken for sub-cooling of the sump water.
- For the RHR pumps, a conservative NPSH required (NPSHR) of 24 feet at a flow of 4900 gpm was assumed.
- Head loss for the strainers exclusive of the plenum and RHR entrance losses was assumed to be 33 inches at 7769 gpm.
- Plenum head loss for the strainers was assumed to be 8 inches at 7769 gpm.
- The entrance loss coefficient of the RHR suction from the strainer plenum was conservatively assumed to be 0.4.

The flow alignments analyzed are shown in Figures 1 and 2. These figures correspond to the single pump cold-leg and hot-leg recirculation cases reported in the response to Question 12.

Figure 1 - Cold Leg Recirculation Flow Path

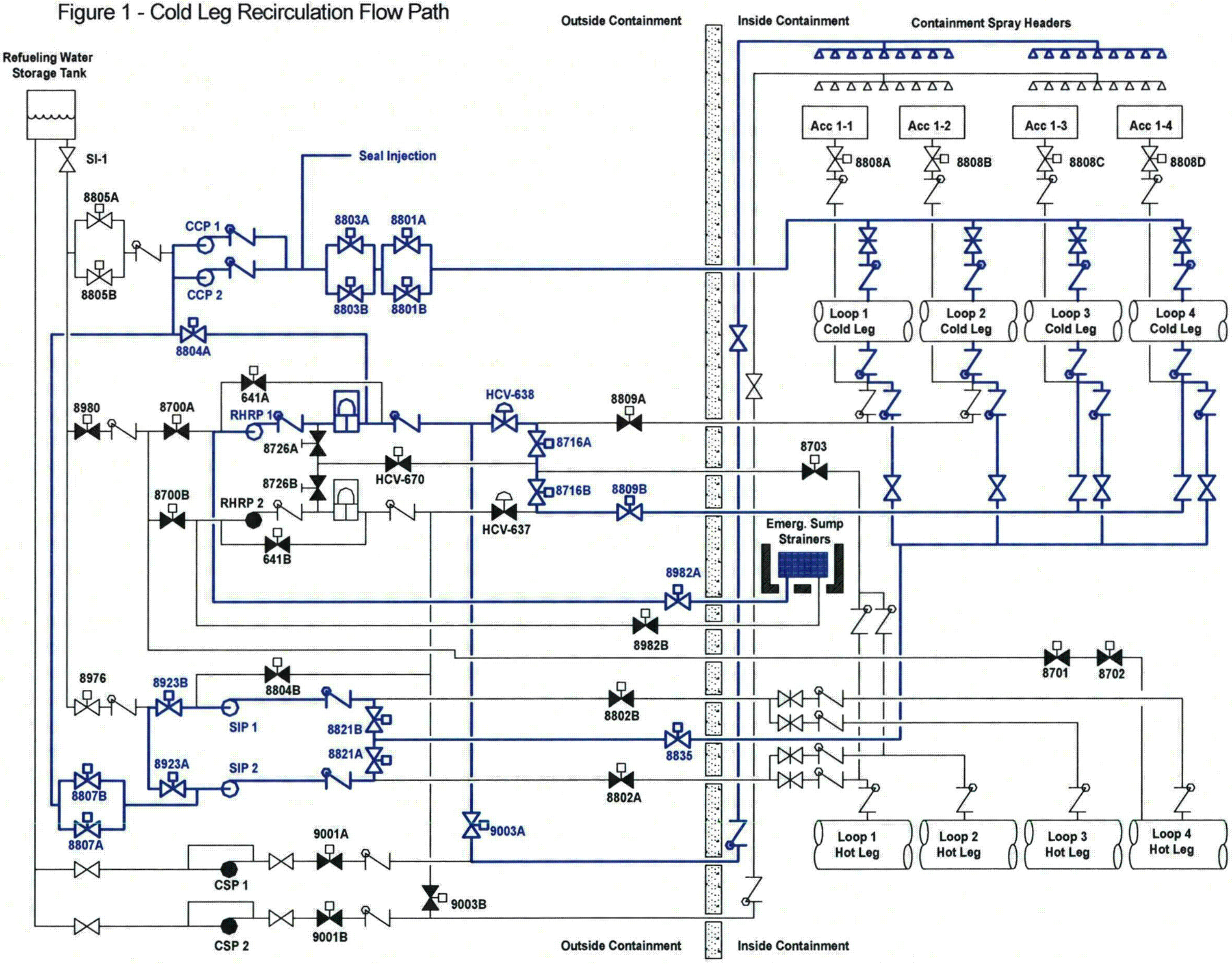
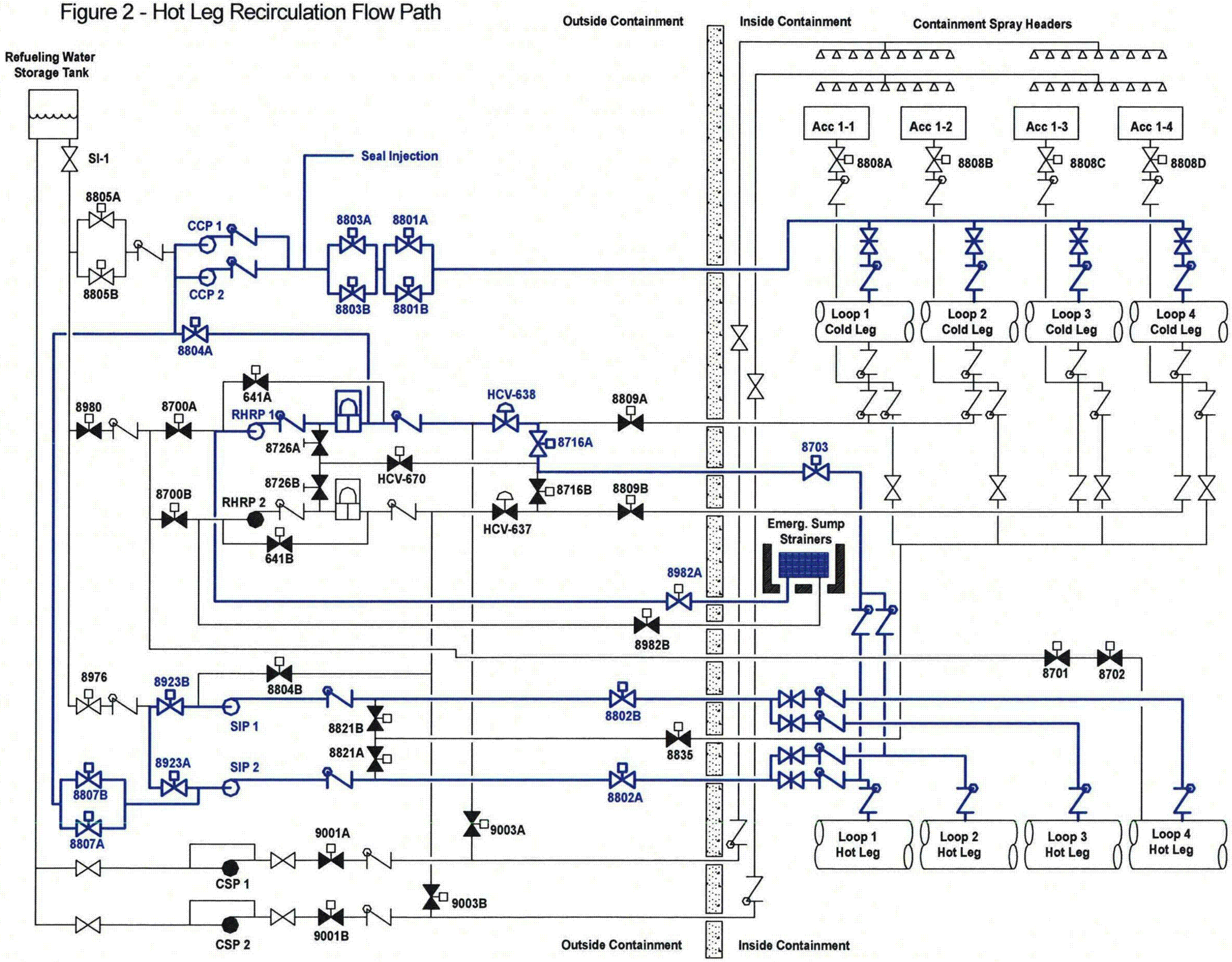


Figure 2 - Hot Leg Recirculation Flow Path



NRC Question 12:

Please provide a revised table of net positive suction head (NPSH) available and NPSH margin calculation results which does not include clean strainer head loss and head loss from accumulated debris.

PG&E Response:

The following table summarizes the limiting NPSH analysis results:

Pump	**Case**	**Flow (gpm)**	**Base NPSHA (ft)**	**Adjustments to NPSH Calculation for New Strainers**				**NPSHA (ft)**	**NPSHR (ft)**	**Margin (ft)**
				Level Change (ft)	**Debris-laden Screen (in)**	**Plenum (in)**	**RHR Inlet (ft)**			
RHRP1	Cold-leg Recirculation	4542	23.8	5	33	8	0.75	24.6	19	5.6
RHRP1	Hot-leg Recirculation	4891	27.6	2	33	8	0.87	25.3	24	1.3

The DCPP NPSH calculation determined the change in NPSH based on several changes that resulted from installation of the new sumps. These changes included changes in the minimum sump water level, head losses across the strainer and across the debris laden screens and an entrance loss to the RHR suction piping. The base calculations conservatively used a water level consistent with the operation of the previous sump strainers and did not take credit for minimum sump water levels. The NPSH calculations for the new sump strainer include credit for the minimum sump water level inside containment.

The limiting combined screen and plenum head loss stems from the maximum flow LBLOCA case. The acceptance criterion for debris–laden screen head loss testing was 33 inches. The testing was completed prior to the performance of the NPSH analysis. The corresponding plenum head loss was 8 inches.

The strainer head loss is based on the results of the testing performed for debris-laden strainer disks. The head loss used is conservatively based on the full flow rate through the strainers. A reduction in the flow rate to the level associated with the limiting NPSH conditions would reflect in a lowered strainer head loss due to the reduced flow rate through the strainer.

Additional strainer head loss testing performed subsequent to the NPSH reanalysis yielded a lower head loss based on an updated design-basis debris loading. The testing resulted in a head loss of 26.7 inches for the design-basis LBLOCA and represents potential margin for the NPSH analysis.

The plenum head loss is the head loss in the remainder of the strainer based on a detailed vendor hydraulic analysis of the strainers. The vendor analysis examined the flow through the strainer downstream of the strainer disks and evaluated flow losses through each section of the strainer up to the exit into the RHR pump suction line.

NRC Question 13:

Please verify that the 9.7 g/l AlOOH concentration for the Diablo Canyon settling test shown in the Figure 6 note is correct. The staff notes that the AlOOH precipitate settlement data provided in WCAP-16530-NP was obtained after diluting the various mixing tank concentrations to a 2.2 g/l concentration and that a higher concentration would favor more rapid settling.

PG&E Response:

Chemical precipitates were calculated using the methodology in WCAP-16530-NP, Revision 0, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191." DCPP has not utilized any of the additional inputs discussed in WCAP-16785-NP, "Evaluation of Additional Inputs to the WCAP-16530-NP Chemical Model." DCPP made one refinement to the WCAP-16530-NP methodology. The WCAP-16530-NP model was modified to include four inputs for plant aluminum inventory. Westinghouse has verified DCPP's proper implementation of the WCAP-16530-NP methodology including the aforementioned refinement. The chemical precipitate debris used in the test program was premixed in tanks and prepared in accordance with the recommendations in WCAP-16530-NP, with revised turbid volume acceptance criteria based on DCPP test observations.

During the early phases of the head loss testing program it was observed that higher head losses occurred when using aged chemicals, specifically aluminum oxyhydroxide (AlOOH). Subsequent analyses and tests were performed on the chemical precipitates. From the results of microscopic analysis, gravity head loss tests and the results of turbidity tests, it was concluded that the physical properties of AlOOH change with time. These changes become so pronounced that they eventually affect the test results.

An assumption in the WCAP-16530-NP methodology is that any chemical precipitates formed in the sump pool are transported to the sump screen and are either captured by the sump screen or settle out elsewhere in the recirculation path relatively shortly upon forming. Therefore, in accordance with the methodology of WCAP-16530-NP, un-aged (high turbid fraction) chemical precipitates should be used for head loss testing. Westinghouse has confirmed that un-aged chemical precipitates more closely model actual plant accident conditions. For all tests conducted after Test 7-S-RPT, the allowable turbid fraction for AlOOH and sodium aluminum silicate was revised to 90 percent minimum (from 40 percent). Also, the AlOOH concentration for the turbidity test was changed to 9.7 grams per liter.

PG&E used the 9.7 grams per liter AlOOH concentration for the Diablo Canyon settling test as that concentration favors a more rapid settling of precipitates during the turbidity test. Westinghouse agreed with DCPP's use of the revised criterion for the turbidity test. During testing, agitation of the debris in the test loop ensures there is no settling in the test tank. The chemicals remain homogeneously mixed. Turbidity remains constant in the test tank once head loss has stabilized. At the end of the test, settling of the chemicals is observed within a few minutes; indicating that the agitation is effective.