ATTACHMENT (1)

SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02

OVERALL COMPLIANCE

***NRC Issue* 1:**

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

Response to Issue 1:

At Calvert Cliffs, an emergency recirculation sump is provided for each unit. Each Emergency Core Cooling System (ECCS) sump serves both trains of the ECCS and the Containment Spray (CS) system. In response to the Nuclear Regulatory Commission (NRC) Generic Letter (GL) 2004-02, Calvert Cliffs Nuclear Power Plant has significantly modified the containment ECCS sump strainer with a passive strainer system designed, manufactured and tested by Control Components, Incorporated (CCI) of Winterthur, Switzerland. This system has a strainer surface area of approximately 6,000 ft^2. The sump strainer system is designed to ensure the allowable pump head loss is not exceeded following a loss-of-coolant event (LOCA), thereby not impacting the operability of the ECCS and CS system.

The containment sump strainer system was installed on Unit 2 in the spring 2007 refueling outage and on Unit 1 during the spring 2008 refueling outage. The system has three strainer module rows utilizing 33 strainer modules connected to a central water duct that discharges directly into the sump, which houses the two ECCS pump suction lines. Each strainer module has a series of strainer cartridges constructed of perforated stainless steel plate. Following a LOCA event, all liquid used for recirculation must pass through these strainer cartridge perforations or similar sized strainer system gaps prior to entering the sump. The strainer in the Containment is sized for the expected full design basis debris load.

Quality-assured strainer head loss testing performed in November 2007 using fiber, coating, and chemical precipitant debris loads generated from a double-ended guillotine break of the Reactor Coolant System (RCS) hot leg demonstrated a strainer head loss that exceeded the allowable head loss limit as noted in Reference 1. Quality-assured testing in April and May 2008 demonstrated lower head loss than the November 2007 tests. Calculations that incorporate the strainer head loss results from the latest tests have not determined net positive suction head (NPSH) margin is adequate for the CS pumps.

The Calvert Cliffs licensing basis will be updated in accordance with the requirements of 10 CFR 50.71 to reflect the results of the analyses and the modifications performed to demonstrate compliance with the regulatory requirements. A license amendment has been requested to change the containment buffer material from trisodium phosphate to sodium tetraborate (Reference 23). The requested buffer material change will reduce the chemical effects on the strainers by eliminating the calcium phosphate precipitate, thereby reducing the assumed head loss across the strainer and debris bed. Additional licensing actions may be needed to improve NPSH margin.

GENERAL DESCRIPTION OF AND SCHEDULE FOR CORRECTIVE ACTIONS

***NRC Issue 2*:**

Provide a general description of actions taken or planned, and dates for each. For actions planned beyond December 31, 2007, reference approved extension requests or explain how regulatory requirements will be met as per "Requested Information" Item 2(b). That is provide a general description *of and implementation schedule for all corrective actions, including any plant modifications, that you identified while responding to this generic letter. Efforts to implement the identified actions should be initiated no later than the first refueling outage starting after April 1, 2006. All actions should be completed by December 31, 2007. Provide justification for not implementing the identified actions during the first refueling outage starting after April 1, 2006. If all corrective actions will not be completed by December 31, 2007, describe how the regulatory requirements discussed in the Applicable Regulatory Requirements section will be met until the corrective actions are completed.*

Response to Issue 2:

As of September 30, 2008, Calvert Cliffs Units 1 and 2 have completed the following GL 2004-02 actions, analyses and modifications.

- Latent debris walkdowns
- Debris generation analysis
- Containment debris transport analysis
- Hydraulic model of the ECCS
- Bypass testing
- Detailed structural analysis of the new strainers
- Installed 6000 ft^2 surface area replacement strainer system in Units 1 and 2
- Head loss analysis
- Calcium-silicate pipe insulation removal or banding within the zone of influence
- High pressure safety injection (HPSI) cyclone separator blockage testing
- Aluminum abatement (Unit 1 complete, Unit 2 to be performed in Spring 2009 refueling outage)
- Vortex testing and/or analysis
- HPSI cyclone separator replacement
- In-vessel downstream effects analysis

Calvert Cliffs Units 1 and 2 have requested (Reference 24) and received approval for (Reference 25) an extension to complete the following activities:

- Head loss testing for the strainer (including chemical effects with the replacement buffer)
- In-vessel downstream effects calculations (in accordance with WCAP-16793-NP)
- Aluminum abatement for Unit 2
- Insulation debris calculation (including RMI transport)
- Owner acceptance of the following completed calculations:
  - Downstream effects on static components
  - Downstream effects on pumps
  - Strainer vendor head loss testing report
  - Strainer vendor head and vortexing calculation
  - NPSH margin calculation
- Containment sump buffer replacement for Unit 2 in the Spring 2009 refueling outage
- Containment sump buffer replacement for Unit 1 by June 1, 2009

The following tests were presented in the February 2008 supplemental response. Subsequent analyses have shown that these tests are no longer necessary. Calvert Cliffs no longer intends to perform them.

- ECCS throttle valve wear and blockage testing (accepted by analysis)
- CS and HPSI pump mechanical seal testing (accepted by analysis)
- Debris interceptor testing (not credited in any analysis)

SPECIFIC INFORMATION REGARDING METHODOLOGY FOR DEMONSTRATING COMPLIANCE

***NRC Issue 3a*:**

Break Selection

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

1. *Describe and provide the basis for the break selection criteria used in the evaluation.*
2. *State whether secondary line breaks were considered in the evaluation (e.g., main steam and feedwater lines) and briefly explain why or why not.*
3. *Discuss the basis for reaching the conclusion that the break size(s) and locations chosen present the greatest challenge to post-accident sump performance.*

*Response to Issue 3a*1:

A number of breaks were considered to ensure that the breaks that bound variations in debris generation by the size, quantity, and type of debris are identified. The selection of line break locations to be evaluated depends on both maximizing debris generation, and maximizing debris types which might create the worst-case debris mixture for strainer head loss. Based on various postulated break locations, the following break locations were evaluated to maximize the postulated debris created.

The reactor cavity wall and bio-shield walls of the containment interiors divide the RCS piping into two completely separate compartments which are closed at the top and sides, and partially closed at the bottom. The compartment size is such that a break in the hot leg (42" ID) can adversely affect all the non-encapsulated insulation inside the compartment in which it is located. Therefore, the maximum insulation debris generation is a hot leg break (which is larger than a cold leg break) located at the base of the steam generator (largest source of insulation) as this will maximize the amount of insulation removed from the steam generator.

A break in 11/21 Steam Generator compartment would generate more insulation debris because the pressurizer surge line and the pressurizer spray lines are located in these compartments. A break in 12/22 Steam Generator compartment was also reviewed since there is more mineral wool insulation (from the regenerative heat exchanger) in this compartment. This evaluation showed that no mineral wool insulation debris would be generated by the limiting hot leg break location in the 11/21 compartment and some mineral wool insulation debris would be generated in the 12/22 compartment. Therefore, a hot leg break in 12/22 Steam Generator compartment was found to be bounding.

Breaks in other parts of the RCS hot leg would generate less steam generator insulation debris. Breaks in the RCS cold leg and surge lines will generate the same types of insulation debris in smaller quantities plus a small amount of mineral wool and Marinite board. A maximum of 10 ft^2 of half inch thick Marinite board is assumed to produce a total of 0.104 ft^3 of fines (assuming 25% is reduced to fines). See the Response to Issue 3b3. A break in the reactor cavity (inside the primary shield wall) will only generate reflective metal insulation debris, and thus will have much less impact on strainer head loss.

Response to Issue 3a2:

For feedwater line breaks and main steam line breaks, recirculation from the ECCS sump is not credited for the accident response for Calvert Cliffs. Therefore, analysis of breaks in the main steam and feedwater lines were not performed in response to GL 2004-02.

Response to Issue 3a3:

Based on the above discussion, the break selection included the location with the greatest effect on insulation, has the most direct path to the ECCS sump, and generated the largest amount of coating debris. Since this results in the greatest impact on head loss and wear of downstream components the hot leg break in the 12/22 Steam Generator compartment is considered to be the biggest challenge to post-accident sump performance. However, walkdowns were conducted during the spring 2008 refueling outage using reduced zones of influence for coatings. The results of these walkdowns and subsequent debris generation and transport calculations may indicate that a cold leg break could generate more coatings debris. The calculations are not complete for all break locations in both Units. However, there is reasonable assurance that the hot leg break is bounding.

NRC Issue 3b:

Debris Generation/Zone of Influence (zone of influence) (excluding coatings)

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

1. *Describe the methodology used to determine the zone of influences for generating debris. Identify which debris analyses used approved methodology default values. For debris with zone of influences not defined in the guidance report (GR)/safety evaluation (SE), or if using other than default values, discuss method(s) used to determine zone of influence and the basis for each.*
2. *Provide destruction zone of influences and the basis for the zone of influences for each applicable debris constituent.*
3. *Identify if destruction testing was conducted to determine zone of influences. If such testing has not been previously submitted to the NRC for review or information, describe the test procedure and results with reference to the test report(s).*
4. *Provide the quantity of each debris type generated for each break location evaluated. If more than four break locations were evaluated, provide data only for the four most limiting locations.*
5. *Provide total surface area of all signs, placards, tags, tape, and similar miscellaneous materials in containment.*

Response to Issues 3b1 and 3b2:

The current debris generation analysis uses approved methodology default values for Transco reflective metal insulation, Transco mineral wool, unjacketed Temp-Mat, and jacketed generic fiberglass.

Destructive testing was used to determine the zone of influences of the remaining debris sources listed below.

Material	Zone of Influence Radius Break Diameter	Reference
Transco reflective metal insulation	2	Reference 4, page 30
Transco mineral wool	2	Note 1
Nukon jacketed w/standard bands	7	Reference 5, page 1-6 (Note 2)
Transco Thermal Wrap	7	Note 3
Calcium-silicate insulation	3	Reference 6, page 1-4 (Note 4)
Generic fiberglass insulation	17	Note 5
Temp-Mat insulation	11.7	Reference 4, Table 3-2 (Note 6)
Inorganic zinc coatings without topcoat	5	Reference 7, page 1-2
Epoxy coatings	4	Reference 7, page 1-3
Marinite board	8	Reference 8, page 4-3

Note 1: The mineral wool at Calvert Cliffs was procured from Transco using the same specification as the Transco reflective metal insulation. Both insulations are encapsulated in an identical manner. Therefore a zone of influence equal to Transco reflective metal insulation is employed. Use of a relatively small zone of influence in this application is corroborated by the work done in Reference 5 for encapsulated Min-K insulation where a small zone of influence was also observed.

Note 2: Reference 5 actually justifies a zone of influence of 5 L/D; however, for conservatism the document recommends a zone of influence of 7 L/D.

Note 3: Transco Thermal Wrap is a low-density fiberglass insulation nearly identical to Nukon, and is jacketed in a nearly identical manner. Therefore, the same zone of influence is applied.

Note 4: Use of the specified zone of influence assumes that jacketing is banded at 3" centers. All calcium-silicate insulation with the potential of being in a zone of influence has been banded at 3" centers.

Note 5: CCNPPs generic fiberglass insulation, while a low-density fiberglass, does not have the cloth jacketing of Nukon or thermal wrap, and its jacketing is of a thinner gauge and is held on by rivets, not bands. At present, the conservative zone of influence for unjacketed Nukon from page 30 of Reference 4 is applied.

Note 6: Temp-Mat is a heavier insulation than Nukon, and per Table 3-2 of Reference 4 it has a zone of influence of 11.7 when a stainless steel wire retainer is used.

<u>*Response to Issue 3b3*</u>:

The current debris generation analysis uses approved methodology default values for Transco reflective metal insulation, Transco mineral wool, unjacketed Temp-Mat, and jacketed generic fiberglass.

Destructive testing was used to determine the zones of influence of the remaining debris sources listed in the response above. Documentation of this testing is provided in References 5 through 8. A summary description of the test procedure and results is provided below.

The following description applies to all the WCAP testing:

Testing was conducted at Wyle Labs. The jet model described in American National Standards Institute/American Nuclear Society Standard 58.2-1988 was used to evaluate the placement of test articles in front of the jet nozzle. A two-phase jet originating from a sub-cooled, high pressure, high temperature reservoir was directed at the test articles. A rupture disk was used to simulate a pipe break. This is a similar approach as that taken by the NRC for testing reported in Appendix VI.3.2.2 of Reference 4, and by others as reported in Section 3.2.2 of Reference 9.

WCAP-16710-P: The test article consisted of jacketed Nukon fiber wrapped around an 8" schedule 80 pipe. At a zone of influence of 5 diameters (D) no damage to the Nukon pillow was observed beyond that attributed to the impact and abrasion of the test fixture.

WCAP-16720-P: The test article consisted of jacketed calcium-silicate insulation banded at 3" centers mounted on a 2" schedule 160 pipe. At a zone of influence of 3D, the stainless steel jacketing was bent and torn between the clamps, and the calcium-silicate insulation appeared intact along the length of the specimen.

WCAP-16568-P: The test articles of interest to Calvert Cliffs included non-topcoated inorganic zinc primer on a steel substrate and inorganic zinc primer with two coats of epoxy topcoat on a steel substrate. For epoxy-based coatings regardless of the substate to which they were applied no detectible coating loss was determined at the tested length/diameters (L/D) of 2.06 and 1.37. The non-topcoated inorganic zinc primer showed some loss of coating thickness at an L/D = 3.23, and less at an L/D = 3.68. Extrapolation determined that no coating loss would occur at an L/D of 4.28.

SL-009195: Testing was conducted at Wyle Labs using their hot water blowdown test facility. The test article consisted of ½" Marinite board attached to 16-gauge galvanized steel cable tray sections. At zones of influence less than 8.0 D, erosion was observed at the point of jet impingement. The maximum specimen weight-loss was found to be 0.87%.

Response to Issue 3b4:

The following table presents the debris generated for postulated breaks located in the listed compartments.

Table 3b4-1
Summary of LOCA Generated Debris

Debris Name	Debris Type	11 Compartment Volume (ft^3)	12 Compartment Volume (ft^3)	21 Compartment Volume (ft^3) (Note 1)	22 Compartment Volume (ft^3) (Note 1)	Bounding Volume (ft^3)
Mineral wool insulation	Fiber	0.00	8.66	0.00	8.66	8.66
Generic fiberglass	Fiber	38.15	46.25	38.15	46.25	46.25
Temp-Mat insulation	Fiber	15.0	21.05	15.0	21.05	21.05
Transco Thermal Wrap insulation	Fiber	458.75	458.75	458.75	458.75	458.75
Nukon insulation	Fiber	374.47	321.30	374.47	321.30	374.47
Transco reflective metal insulation (Note 4)	Metal	2240 ft^2	2240 ft^2	2240 ft^2	2240 ft^2	2240 ft^2
Qualified coatings	Particulate	0.99	N/A (Note 2)	0.99	N/A (Note 2)	0.99
Unqualified coatings, Alkyds	Particulate	1.30	1.30	1.30	1.30	1.30
Latent debris	Particulate	1.5	1.5	1.5	1.5	1.5
Qualified Inorganic Zinc Primer	Particulate	0.66	N/A (Note 2)	0.66	N/A (Note 2)	0.66
Unqualified coatings, Inorganic Zinc Primer	Particulate	3.83	N/A (Note 2)	3.83	N/A (Note 2)	3.83
Marinite Board	Total	0.021	0.104	0.021	0.104	0.104
Marinite Board	Fiber (Note 3)	0.002	0.008	0.002	0.008	0.008
Marinite Board	Particulate (Note 3)	0.019	0.096	0.019	0096	0.096

Note 1: Unit 2 insulation quantities are assumed equal to those of Unit 1.

Note 2: Coatings debris for Compartment 12 breaks were not explicitly presented in the design calculation due to the greater number of pipe supports in Compartment 11 which gives rise to greater debris generation.

Note 3: Marinite board is about 8% fiber and 92% particulate according to the manufacturer's data sheets. The board is assumed to erode in similar proportions during the LOCA event.

Note 4: The accepted practice is to provide debris quantities for Reflective Metal Insulation in square feet of metal foil. The foil of the Calvert Cliffs insulation is 0.002 inches thick.

Response to Issue 3b5:

The strainer design allows for 270 ft^2 of sacrificial surface area. This is to account for the stick-on type labels applied to items such as cable trays. Valve tag labels are made of materials that will sink intact. Procedures require that all placards be chained so they won't transport to the sump strainer.

***NRC Issue 3c*:**

Debris Characteristics

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

1. *Provide the assumed size distribution for each type of debris.*
2. *Provide bulk densities (i.e., including voids between the fibers/particles) and material densities (i.e., the density of the microscopic fibers/particles themselves) for fibrous and particulate debris.*
3. *Provide assumed specific surface areas for fibrous and particulate debris.*
4. *Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.*

Response to Issue 3c1:

The debris sources at Calvert Cliffs include insulation, coating, and latent debris.

Table 3c1–1
Debris Sources

Material	Percentage Small Fines	Percentage Large Pieces
Nukon insulation	60	40
Transco Thermal Wrap insulation	60	40
Temp-Mat insulation	60	40
Generic fiberglass	100	0
Mineral wool	100	0
Fire barrier in zone of influence	100 (Note 1)	0
Coatings in zone of influence	100 (<10 μm)	0
Qualified coatings outside zone of influence	0	0
Unqualified coatings outside zone of influence	See Response to Issue 3c4	See Response to Issue 3c4
Fire barrier (covered) outside zone of influence	0	0
Fire barrier (uncovered) outside zone of influence	0	0
Latent debris	100 (<100 μm)	0

Note 1: Calvert Cliffs uses Marinite board as a fire barrier material for cable trays. It has been assumed that all contributions from Marinite board in the zone of influence becomes small fines. As part of the effort to reduce strainer head loss, Calvert Cliffs used data from Reference 8 to determine the percentage of small fines of Marinite board in the zone of influence. See response to Issue 3a1.

Response to Issue 3c2:

The bulk densities of material and destroyed debris are provided in the debris generation calculation and listed in the table below. These values are obtained from the NRC approved methodology or vendor specific information in the case of coatings.

Table 3c2-1
Debris Densities

Insulation Type	**Density of Individual Fiber (lbm/ft^3)**	**Density of a Blanket of Product (lbm/ft^3)**
Nukon	159	2.4
Transco Thermal Wrap	159	2.4
Generic fiberglass	159	2.4
Temp-Mat	162	11.8
Mineral wool	90	8

Coating Material	**Material Density (lbm/ft^3)**	**Characteristic Size (ft)**
Inorganic zinc	457	$3.2x10^{-5}$
Alkyd coating	98	$3.2x10^{-5}$

Topcoats

Vendor	**Trade Name**	**Dry Film Density (lb/gal)**	**Dry Film Density (lb/ft^3)**
Carboline	Carboguard 890	14.52	109
Ameron	Amercoat 66	14.04	105
Ameron	Amercoat 90	14.80	111
Valspar	89 Series	14.04	105

Primers

Vendor	**Trade Name**	**Density (lb/gal)**	**Density (lb/ft^3)**
Carboline	Carboguard 890	14.52	109
Carboline	Starglaze 2011 S	19.28	144
Ameron	Dimetcote 6	40.1	300
Ameron	Nu-Klad 110AA	20.1	150
Valspar	13-F-12	40.1	300

From Section 3.5.2.3 of Reference 10 the following properties are to be used for latent debris: (Note that latent debris was assumed to be all particulate. No fibers were observed in latent debris sampling and any fibers assumed would add an insignificant fiber load to the debris noted in Response to Issue 3b4 above.)

Particulate density = 100 lbm/ft^3
Particulate diameter = 10 μm ($3.28x10^{-5}$ ft)

Response to Issue 3c3:

Since the head loss across the ECCS strainers is determined via testing, these values are not used in the design basis for Calvert Cliffs. Therefore, these values are not provided as part of this response.

Response to Issue 3c4:

The Calvert Cliffs debris generation, transport, and head loss analyses have used the debris characterization assumptions provided in Reference 10, Volumes 1 and 2. Specifically, the size of particulates is consistent with 10 microns for coatings particulate. Coatings that were installed as qualified, but have been subsequently classified as unqualified based on inspections are assumed to have failure distributions consistent with that reported in Reference 11. In general, Reference 11 concludes that epoxy topcoated systems fail as chips when exposed to design basis accident environments, while non-topcoated inorganic zinc primers fail in pigment size (i.e., 10 microns). For downstream effect evaluations, the size distribution of unqualified coatings was assumed to be that given in the Linear Mass Fraction column of Table I-1 of Reference 12.

***NRC Issue 3d*:**

Latent Debris

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

1. *Provide the methodology used to estimate quantity and composition of latent debris.*
2. *Provide the basis for assumptions used in the evaluation.*
3. *Provide results of the latent debris evaluation, including amount of latent debris types and physical data for latent debris as requested for other debris under c. above.*
4. *Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.*

Response to Issue 3d1:

Latent debris walkdowns were performed at Calvert Cliffs Units 1 and 2 in accordance with Reference 10, Section 3.5. Approximately 32 samples were taken of 10 different surface types. When multiple samples were taken of the same surface type the results were averaged. The debris weighed over the sampled area was then ratioed to the total surface area inside Containment for that type of debris. The total surface area was determined using plant drawings. This latent debris walkdown was repeated in the Unit 1 Containment during the spring 2008 refueling outage. Approximately 60 samples were taken. These data were used to update the latent debris quantities.

Response to Issue 3d2:

Debris was assumed to be normally distributed for a given sample type. This assumption was supported by the walkdown observation that latent debris was uniform for a given surface type. Averaging the latent debris for surface types having multiple samples is consistent with the sampling approach taken to estimate the amount of latent debris inside Containment.

Response to Issue 3d3:

Latent debris includes dirt, dust, lint, fibers, etc., that are present inside the Calvert Cliffs Containments and could be transported to the ECCS sump screen during the post-LOCA recirculation phase of ECCS operation. This debris could be a contributor to head loss across the ECCS sump screen. In accordance with recommendations in Reference 13, latent debris samples were collected to estimate the actual mass of latent debris inside of Containment. A latent debris load of 150 lbs was computed. The latent debris was described as dust with no fiber in any sample.

Response to Issue 3d4:

Latent debris in the form of dust/fiber is accounted for in test and analysis by including it in the debris mix. Therefore, no specific sacrificial area needs to be allocated to it. Foreign material such as paper inadvertently left inside Containment is accounted for by crediting the foreign material exclusion programmatic methods described in the Response to Issue 3i3 below. Therefore, Calvert Cliffs does not provide an amount of sacrificial strainer surface area allotted to miscellaneous latent debris other than that allocated for stick-on labels (see Response to Issue 3b5 above).

***NRC Issue 3e*:**

Debris Transport

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

1. *Describe the methodology used to analyze debris transport during the blowdown, washdown, pool-fill-up, and recirculation phases of an accident.*
2. *Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.*
3. *Identify any computational fluid dynamics codes used to compute debris transport fractions during recirculation and summarize the methodology, modeling assumptions, and results.*
4. *Provide a summary of, and supporting basis for, any credit taken for debris interceptors.*
5. *State whether fine debris was assumed to settle and provide basis for any settling credited.*
6. *Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the strainers.*

Response to Issue 3e1:

Calvert Cliffs uses the transport fractions for fiber and particulate provided in Table 3-3 of Reference 4. For previously qualified coatings outside the zone of influence, credit is taken for the non-transportability of the coating chips at velocities less than 0.2 ft/sec as allowed by Reference 14. Calvert Cliffs used the same velocity to determine the non-transport ability of reflective metal insulation foil fragments.

Response to Issue 3e2:

There were no deviations from approved guidance (References 4 and 14) regarding debris transport.

Response to Issue 3e3:

No computational fluid dynamics codes were used by Calvert Cliffs.

Response to Issue 3e4:

Calvert Cliffs installed debris interceptors in Unit 1 during the spring 2008 refueling outage to shield a portion of the strainer surface area from debris. At present, no credit is taken in evaluations for these debris interceptors. No similar debris interceptor is planned to be installed in Unit 2. The installed debris interceptors on Unit 1 are being considered for removal.

Response to Issue 3e5:

Calvert Cliffs did not credit the settling of small debris fines in the transport calculations.

<u>*Response to Issue 3e6*</u>:

Table 3e6-1
Bounding Debris Quantity at ECCS Sump Screen for Calvert Cliffs

Debris Name	Quantity Generated (ft^3)	Transport Fraction	Quantity at Sump (ft^3)
Fibrous debris			
- Nukon	374.47	0.60	224.68
- Transco	458.75	0.60	275.25
- Temp-Mat	21.05	0.60	12.63
- Generic	46.25	1.00	46.25
- Mineral wool	8.66	1.00	8.66
		TOTAL	567.47
Transco reflective metal insulation debris (RMI foil 0.002" thick)	2240 ft^2	0 (Note 1)	0
Qualified coatings	1.65	1.00	1.65
Unqualified coatings	5.13	1.00	5.13
Latent debris	1.5	1.00	1.5
Marinite board particulate	0.096	1.00	0.096

Note 1: Calvert Cliffs has determined that the flow speed in the recirculation pool in lower Containment is inadequate to suspend and transport RMI foil to the strainer. See the Response to Issue 3e1 above.

***<u>NRC Issue 3f</u>*:**

Head Loss and Vortexing

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

1. *Provide a schematic diagram of the emergency core cooling system (ECCS) and containment spray systems (CSS).*
2. *Provide the minimum submergence of the strainer under small-break loss-of-coolant accident (SBLOCA) and large-break loss-of-coolant accident (LBLOCA) conditions.*
3. *Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.*
4. *Provide a summary of the methodology, assumptions, and results of prototypical head loss testing for the strainer, including chemical effects. Provide bases for key assumptions.*
5. *Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.*
6. *Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.*
7. *Provide the basis for the strainer design maximum head loss.*
8. *Describe significant margins and conservatisms used in the head loss and vortexing calculations.*
9. *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.*

10. *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.*
11. *State whether the sump is partially submerged or vented (i.e., lacks a complete water seal over its entire surface) for any accident scenarios and describe what failure criteria in addition to loss of net positive suction head (NPSH) margin were applied to address potential inability to pass the required flow through the strainer.*
12. *State whether near-field settling was credited for the head-loss testing and, if so, provide a description of the scaling analysis used to justify near-field credit.*
13. *State whether temperature/viscosity was used to scale the results of the head loss tests to actual plant conditions. If scaling was used, provide the basis for concluding that boreholes or other differential-pressure induced effects did not affect the morphology of the test debris bed.*
14. *State whether containment accident pressure was credited in evaluating whether flashing would occur across the strainer surface, and if so, summarize the methodology used to determine the available containment pressure.*

Response to Issue 3f1:

Diagrams of the Calvert Cliffs ECCS and CS system for Units 1 and 2 are provided in Attachment (2) to the submittal.

Response to Issue 3f2:

Calculations for minimum containment flood level have demonstrated that, for a small break LOCA (SBLOCA) and a large break LOCA (LBLOCA), the ECCS strainers will be completely submerged at the time of ECCS switchover to the containment ECCS sump. The minimum calculated submergence level (level over the top of the strainer cassette), is as follows:

- SBLOCA – 1" (Note: this is applicable to break sizes smaller than 0.08 ft^2)
- LBLOCA – 6"

Response to Issue 3f3:

Calvert Cliffs has completed vortex testing and analysis. CCI performed generic vortex testing for their strainer design in March 2005. The test results from those tests are used in the analysis which shows that vortexing is not possible at the design flows for the Calvert Cliffs strainers. Specifically, the Froude number for the Calvert Cliffs strainers is about 0.0025 (Fr = flow speed squared divided by the product of gravitational constant times the submergence depth) and the submergence of the strainer is about 25 mm minimum. Under such conditions, air ingestion via vortex development is not possible.

Vortex development may arise due to flow disturbances, possibly caused during pump start and stop cycles. The flow disturbances can produce boreholes in the debris bed which provide channels for high speed flow. Such high speed flow can induce vortexing. CCI testing for this phenomenon does produce local vortex formation. Based on CCI test results including tests specific for Calvert Cliffs, the critical Froude number for borehole induced vortexing is 62 and the plant Froude number is 55. (Here the Froude number is defined as follows: Fr = 2 x measured head loss ÷ submergence depth.) The plant Froude number is lower than the critical Froude number for the submergence depth. Therefore, the strainer will not ingest air via vortices caused by boreholes.

Response to Issue 3f4:

Calvert Cliffs used the ECCS sump strainer supplier, CCI, to perform plant specific strainer head loss testing.

Two different test loop configurations were utilized for the Calvert Cliffs head loss testing, as follows:

1. Large Scale Loop Facility in Winterthur, Switzerland;
2. Multi Functional Test Loop (MFTL) at CCIs facility in Winterthur, Switzerland.

In each test one or more full-size strainer cartridges are placed in a test tank, and are subsequently loaded with the amount of debris computed to transport to this portion of the overall strainer. The volumetric flow rate is scaled so that the average velocity through the strainer cartridges corresponds to the expected average flow speed through the strainer installed in the plant during a LOCA.

Debris was introduced into the tank at the entrance to the strainer pockets, and approximately 5' away. Fiber debris is shredded, and diluted in water to minimize agglomeration of fines. Chemical precipitants are generated in separate tanks according to the methods described in Reference 22.

Large Scale Loop Facility:

The Large Scale testing loop contained a two-sided strainer array with three CCI strainer cartridges, per side, with 60 pockets placed in a pool that is filled with water (see Figure 3f4-1).

This testing provided further information into the expected head loss behavior of various types of debris.

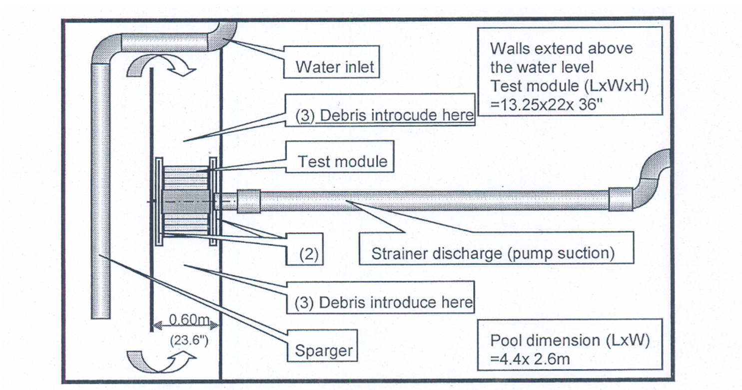


Figure 3f4-1
Outline of Large Scale Loop Facility

Multi Function Test Loop (MFTL):

The CCI MFTL is a closed recirculation loop as shown in Figure 3f4-2. The water recirculation in the loop occurs by means of a centrifugal pump with a flow rate capacity up to 125 m^3/h and a flow meter capacity of 80 m^3/h. The flow rate is adjustable by controlling the speed of the pump motor via a frequency based variable speed controller. Additionally the flow rate can be pre-adjusted by means of a valve in the downstream line. The water flow rate is measured using a KROHNE magnetic inductive flow meter. The temperature of the water is measured using a Ni-CrNi Thermocouple Type K.

The test program did not intend to take credit for near field debris settling. The debris was introduced directly at the inlet surface of the strainer. The chemicals were introduced in the loop close to the sparger where flow returns to the flume. The volume of water in the test loop is approximately 1700 liters.

Some debris settlement occurred in the MFTL testing. Debris was added to the test flume immediately upstream of the strainer pockets. Approximately half of the debris was transported into the strainer pockets by the flume flow but some settled to the floor of the flume. Agitation was used to suspend the settled debris. The agitation methods were successful at resuspending some debris but were not successful at moving all the settled debris into the pockets. The debris that did not enter the strainer pockets settled at the base of the strainer, within about 30 centimeters.

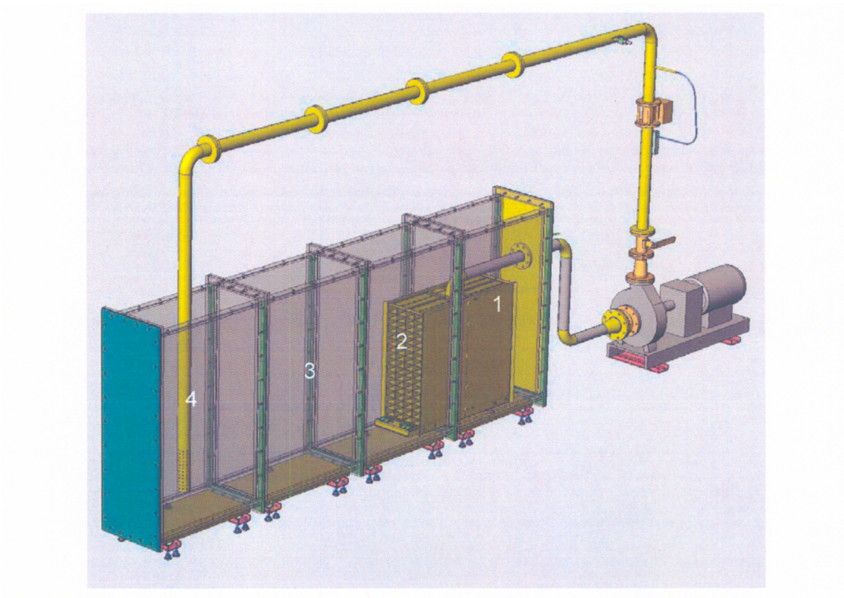


Figure 3f4-2
Outline of MFTL for Calvert Cliffs testing (4 modules shown)

The fibers used in the test were from materials identical to plant insulation, each with an as-fabricated density consistent with Reference 4, Section 3.5.2.3. The fibers were decomposed by first cutting the insulation material into 50 cm^2 pieces, then soaking the pieces in a water bucket. A water jet was used to separate the fiber in the bucket after soaking. The fibers used in the testing were produced by a number of suppliers.

Test Results

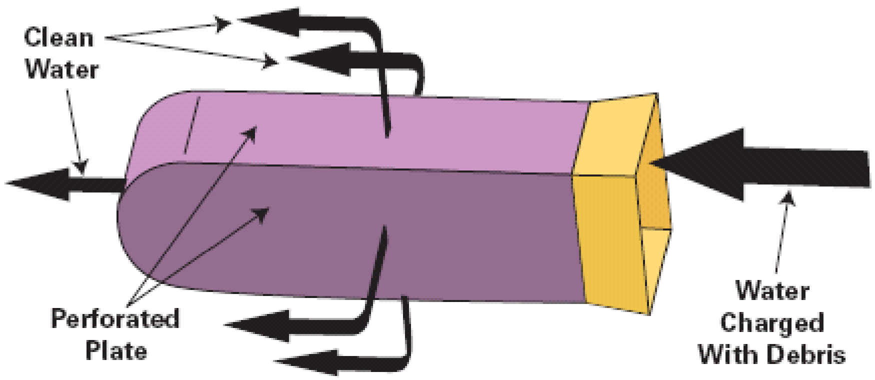
The latest-quality assured testing, conducted in April and May 2008, showed with a maximum head loss of 59.1 millibar (0.857 psid).

Response to Issue 3f5:

The pockets in CCIs strainer cassettes are designed to fill with debris with additional debris depositing on the outside of the strainer. The spacing of the strainer module rows between each other and with plant structures allows sufficient space for the debris to accumulate without interfering with the debris from another strainer row.

Response to Issue 3f6:

The strainer installed at Calvert Cliffs is CCI's pocket cassette type strainer. Figure 3f6-1 shows a representative pocket cassette strainer. During the April/May 2008 testing at CCIs MFTL, attempts were made to generate a thin bed using Calvert Cliffs specific debris. The geometry of the pocket filtration surface is such that it was not possible to have a uniform fiber bed on the filtration surface. This test utilized CCI's experience in determining the most conservative debris addition sequence. This consisted of adding particulate and fiber in alternating small batches. All of the particulate was added with 40% of the fiber load. The measured head loss in this condition was a maximum of 0.6 millibar (0.009 psid) and was replicated in two tests.



CCI's horizontal cassette pocket with five flow paths

Figure 3f6-1
Pocket Cassette Strainer

The thin bed test methodology was as follows:

- Add 50% of the particulate and 10% of the fibrous debris (expected bed thickness 0.1 inch). Measure head loss.
- Add 50% of the particulate and 10% of the fibrous debris (expected total bed thickness 0.2 inches). Measure head loss.

Response to Issue 3f7:

The acceptable maximum strainer head loss is based on ensuring adequate NPSH available to the pumps taking suction from the containment sump. The strainer head loss includes both the tested head loss across the strainer filtration surface, and the analytically computed head loss in the strainer duct channels.

The strainer postulated maximum head loss due to the maximum quantity of debris that was calculated to reach the screens, including chemical effects was determined by testing in the spring of 2008 and found to be 59.1 millibar (0.857 psid). Refer to the response to Issue 3f4. The overall strainer head loss including the analytically computed head loss in the strainer duct channels is 68 millibar (0.99 psid).

Response to Issue 3f8:

The key conservatism for the hydraulic analyses is the assumption that all small fines transport to the sump strainer. Testing at CCI's MFTL has shown quantities of settled small fines even in an agitated test pool. Substantially all settled debris was found at the base of the test strainer. The low flow velocities in the Calvert Cliffs Containment account for the observed settling. We understand that other CCI customers did not observe this degree of settling because their flow rates were determined to be higher. The fact that the strainer flow rate is so small that fines tend to settle, even at the inlet to the strainer, indicates a conservative overall design.

Response to Issue 3f9:

The clean strainer head loss across the filtration surface as measured in CCIs Large Scale Loop Facility was approximately zero. This head loss was confirmed in the demonstration testing performed in the MFTL.

The head loss in the axial flow channel between cartridges and in the radial duct is computed using formulas in Reference 15. Based on the computed Reynolds Number (1.64×10^6), flow formulas applicable to turbulent flow are used.

Influx flow from the side (i.e., through the cartridges) into the axial flow channel is considered. The friction drag coefficient is developed from the well-known Moody friction curves. A value of $\lambda = 0.025$ is used which is conservative for high Reynolds numbers. A relative roughness of 0.001 is used for the smooth stainless steel.

Head loss due to flow obstructions (i.e., seven stabilizer plates) and enlargements in the flow stream are considered using equations from Reference 15. The computed analytical head loss for the strainer interior for the design flow rate is approximately 4.2".

Response to Issue 3f10:

A debris head loss analysis was performed by CCI during the sizing of the strainer using the equations from Reference 16.

The governing head loss analysis consists of the analytically determined head loss of the strainer internals (see Response to Issue 3f9), and test results of the head loss across the debris bed on the filtration surface (See Response to Issue 3f4).

Response to Issue 3f11:

The ECCS sump screens are fully submerged under all accident scenarios that include ECCS recirculation. There is no vent above the water level.

Response to Issue 3f12:

The quality assured head loss testing with chemical effects conducted in November 2007 did not involve debris settling because a flow baffle plate was used to drive all debris to the strainer. Calvert Cliffs was concerned that this artificial means of driving the debris to the strainer was affecting the nature of the debris bed compaction, and thus providing a non-realistic head loss result. Additional testing conducted in January 2008 did not utilize this baffle plate, and a significant percentage of debris (both fiber and particulate) were observed to fall almost straight down from the introduction point, and not transport to the strainer. Quality assured testing in April and May 2008 also observed the immediate settling of debris. The spring 2008 tests, which are relied on for design basis calculations, used a debris introduction point immediately adjacent to the strainer and in-flume agitation to compensate for the settling phenomenon. Other CCI customers utilized the exact same test loop without a baffle plate and did not have this degree of debris settling. The strainer vendor attributes the observed settling to the low approach velocities associated with our Containment layout. While we believe this demonstrates the overall conservativeness of our design, we also understand that the NRC has concerns about debris settling effects. Therefore, we will ensure future testing does not have some attribute that leads to debris settling that might not occur under actual accident conditions. Also, note that Calvert Cliffs does not use a computational fluid dynamics analysis to compute the amount of debris that transports to the strainer, but instead assumes the transport fractions provided in Reference (10).

Response to Issue 3f13:

The test tank fluid temperature for head loss testing was approximately 15-20°C. No scaling via dynamic viscosity is used due to abrupt head loss decreases during testing which indicates borehole formation.

During the Spring 2008 testing (and previous testing) the borehole effect has been detected via sharp drops in head loss followed by gradual increases in head loss back to/near to the original peak head loss. This is believed to be an accurate representation of what will occur across the strainer filter surface during actual plant conditions. Calvert Cliffs investigated the impact that a lower test temperature may have had on the propensity for boreholes to develop and determined that boreholes may be probable with the CCI strainer design and low flow rates at Calvert Cliffs.

Response to Issue 3f14:

Containment accident pressure is credited in evaluating whether flashing occurs across the strainer surface. The containment accident pressure was taken from the Updated Final Safety Analysis Report Chapter 14 accident analysis.

NRC Issue 3g:

Net Positive Suction Head (NPSH)

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

1. *Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level.*
2. *Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.*
3. *Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.*
4. *Describe how friction and other flow losses are accounted for.*
5. *Describe the system response scenarios for LBLOCA and SBLOCAs.*
6. *Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.*
7. *Describe the single failure assumptions relevant to pump operation and sump performance.*
8. *Describe how the containment sump water level is determined.*
9. *Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.*
10. *Describe whether and how the following volumes have been accounted for in pool level calculations: empty spray pipe, water droplets, condensation and holdup on horizontal and vertical surfaces. If any are not accounted for, explain why.*
11. *Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.*
12. *Provide assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.*

13. *If credit is taken for containment accident pressure in determining available NPSH, provide description of the calculation of containment accident pressure used in determining the available NPSH.*
14. *Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.*
15. *Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.*
16. *Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.*

Response to Issue 3g1:

The containment sump feeds both trains of the ECCS and CS system. When the ECCS switchover from the refueling water tank (RWT) to the sump is completed, the HPSI pump and the CS pump take suction from the sump. The maximum flow rate from the sump occurs when both trains of HPSI and CS pumps take suction from the sump.

Maximum HPSI pump flow rate = 1060 gpm (two pumps operating)
Maximum HPSI pump flow rate = 650 gpm (one pump operating)
Maximum CS pump flow rate = 1730 gpm per pump, maximum two pumps operating

Strainer design flow = 5000 gpm

Maximum post-recirculation actuation signal (RAS) sump temperature
= 196.4°F for cold leg break LBLOCA with two safety trains operating
= 212.8°F for cold leg break LBLOCA with one safety train operating
= 213.6°F for hot leg break LBLOCA with one safety train operating

Minimum Containment water level = 3'-6.3" (LBLOCA)
Minimum Containment water level = 3'-1" (LOCAs smaller than 0.08 ft^2)

Response to Issue 3g2:

The assumptions used for the above analysis are:

- HPSI flow rate is throttled as directed by procedure
- CS flow rate is that predicted by a hydraulic flow model where the containment spray flow rate is upgraded 10% above the vendor pump curve
- The diesel generator is assumed to be at 2% over-frequency

Response to Issue 3g3:

The NPSH required values are provided on the vendor pump curve as a function of flow rate.

Original test data for the CS pumps was used to determine the NPSH. The CS pump was tested at decreasing NPSH available values at a given flow rate. The last data point taken during testing was that NPSH available value where a decrease in total developed head was observed.

The NPSH required value was then established as the second to last tested NPSH available value (i.e., the lowest one for which no decrease in total developed head was detected).

Similar data on our HPSI pumps could not be recovered from plant history records. However, correspondence with the HPSI pump vendor (Sulzer) regarding testing they did for another client having an identical pump indicates that the NPSH required values on the pump curve are based on a 3% degradation in the pump total developed head. The 3% degradation point is a pump industry standard for reporting NPSH required.

Response to Issue 3g4:

Hydraulic friction losses in the strainer flow channels are accounted for as described in the Response to Issue 3f9. Hydraulic friction flow losses in the ECCS recirculation piping are computed using a hydraulic model of the ECCS piping.

Response to Issue 3g5:

The ECCS consists of three HPSI pumps, two LPSI pumps, and four safety injection tanks (SITs). Each HPSI pump injects into one of two high pressure injection headers, both of which feed each cold leg. The LPSI pumps inject into a low pressure injection header that feeds each cold leg. Each SIT injects into a single cold leg. Two HPSI pumps and the LPSI pumps are automatically actuated by a safety injection actuation signal that is generated by either a low pressurizer pressure (<1725 psia) or a high containment pressure signal (>4.75 psig). The SITs automatically discharge when the RCS pressure decreases below the SIT pressure.

The CS system consists of two CS pumps, each of which inject into a spray ring near the containment dome. There are approximately 90 spray nozzles in each spray ring. The CS pumps automatically start on a high containment pressure signal (> 4.75 psig).

LBLOCA

The HPSI and LPSI pumps automatically start when the pressurizer pressure is less than or equal to 1725 psia, or containment pressure is greater than or equal to 4.75 psig. Actual HPSI pump flow to the core will not begin until the pressurizer pressure is approximately 1270 psia, and actual LPSI pump flow to the core will not begin until the pressurizer pressure is approximately 185 psia.

The CS pumps automatically start at a containment pressure of 4.75 psig. Flow to the containment environment is delayed only by the time required to fill the empty CS headers. Containment air coolers will also start to control the air temperature in Containment.

The SITs automatically discharge to the RCS at an RCS pressure between 200 – 250 psig.

All pumps take suction from the RWT. When the RWT is depleted, a RAS is generated, and HPSI and CS pump suction transitions from the RWT to the containment sump. The LPSI pumps are automatically stopped when the RAS is generated.

High pressure safety injection pump flow is throttled post-RAS, and decreases as decay heat decreases. Containment spray flow continues until the containment atmosphere temperature is below 120°F or less.

SBLOCA

The same automatic actuations exist for a SBLOCA. However, for a SBLOCA where the pressurizer pressure remains high for an extended period of time, the Operators may take actions to secure the LPSI pumps to avoid running on mini-flow recirculation for an extended period of time. Also, for SBLOCAs the SITs may be isolated prior to these tanks injecting into the RCS.

Response to Issue 3g6:

Pump	Injection Phase	Recirculation Phase
HPSI	On	Throttled
LPSI	On	Off
CS	On	On

Response to Issue 3g7:

Three cases are currently analyzed to determine the maximum sump temperature. Both a hot leg break and a cold leg break are analyzed assuming the failure of a diesel generator (and therefore, the failure of a safety train) as the limiting single failure. A cold leg break is also analyzed assuming the failure of a train of the Service Water System, resulting in reduced cooling. The results of these cases are given in the Response to Issue 3g1.

Response to Issue 3g8:

The containment sump water level assumes minimum inventory from the RWT drains to the RCS. Water lost due to fill up of the containment spray and other piping is considered. The RCS volume is not assumed to empty into the sump pool. Hold up of water in the refueling pool cavities is assumed to occur. Safety injection tank inventory is considered for LOCAs greater than 0.08 ft^2.

Response to Issue 3g9:

The conservatism of the minimum containment water level is maintained by minimizing the sources of water and by maximizing the volume of water entrapment. Some of the specific examples of water sources that are minimized are given below:

- Minimum RWT inventory
  - minimum initial RWT volume allowed by Technical Specifications
  - RAS occurs at earliest point in setpoint band
  - no water transfer from RWT post-RAS even though it is the preferred source for over one more minute due to valve stroke times
- RCS inventory assumed to remain in RCS (very conservative for a LBLOCA).
- The sump piping assumed empty up to sump valves.
- The current sump level calculation assumes the reactor cavity holds up water even though a 4" drain that drains through a 2" valve and pipe exists in this compartment.

Response to Issue 3g10:

The containment spray pipe and other selected pipes are assumed to be empty for the water level calculation.

The hold up of water on horizontal surfaces was investigated and it was found that a 1/16" film would account for approximately 450 gallons. This was considered to be bounded by the assumption that no RCS volume contributes to the sump pool volume.

The outer wall of Containment is not close enough to the spray nozzles for the containment spray to effectively reach them. The surface areas of the other vertical surfaces that could be sprayed are not significant to affect the water level calculation.

Response to Issue 3g11:

In the sump water level calculation, the volume occupied by concrete pillars is considered in the displacement of water. No other equipment or structures in the sump pool are assumed to displace the water.

Response to Issue 3g12:

The following water sources are considered as contributors to the containment post-accident pool volume:

- RCS - The RCS inventory assumed to remain in RCS and does not contribute to the containment post-accident pool volume.
- RWT – It is assumed that the RWT provides 49,921 ft^3 of water that empties to the lower level of Containment. This assumes the RWT is at the minimum water level allowed by the low-level alarm setpoint (including uncertainty) at the start of the accident. It also assumes that RAS occurs at the highest value in the setpoint band, and furthermore that no water transfers from the tank after a RAS is reached even though the RWT will be discharging inventory to the RCS for over a minute after that time.
- Safety Injection Tanks – For LOCAs greater than 0.08 ft^2 in size it is assumed that the inventory from four SITs inject into the RCS. The minimum volume per SIT of 1113 ft^3, specified by Technical Specification 3.5.1, is assumed to inject into the core. Since only passive components separate the SITs from the RCS at the start of an accident the inventory from all four SITs is assumed to empty to the RCS.

Response to Issue 3g13:

Credit is not taken for containment accident pressure in determining the available NPSH.

Response to Issue 3g14:

Containment pressurization is not considered in our sump NPSH evaluations. The containment initial pressure is assumed to be the minimum allowed by Technical Specifications.

The sump pool temperature calculation assumes a single failure of one emergency diesel generator resulting in a loss of one ECCS train (including HPSI and CS pumps and containment air cooler), or the loss of both Containment air cooler trains. There is no sump cooling since heat transfer to the containment basemat is not credited in the analysis. The sump pool temperature analysis also neglects any cooling from the sump pool by means of evaporation. Finally, a containment pressure of 14.7 psia (as compared to 16.5 psia) is assumed along with 100% humidity.

Response to Issue 3g15:

For the NPSH evaluation, the minimum containment initial pressure is used as the containment pressure during a LOCA.

Response to Issue 3g16:

Below is the minimum NPSH margin (NPSH Available minus NPSH Required):

Pump	**$NPSH_A$**	**$NPSH_R$**	**Margin**
HPSI	16.0 ft	15.0 ft	1.0 ft
CS	21.5 ft	22.7 ft	-1.2 ft

The margins above include the head loss across the strainer and strainer filter including debris bed and chemical effects.

These margins also include the pressure difference between the initial containment pressure and the vapor pressure of the sump water (sub-cooled margin) when applicable.

The negative margin for the CS pumps is the primary reason for the requested license amendment (Reference 23) to replace the containment buffer material.

***NRC Issue 3h*:**

Coatings Evaluation

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

1. *Provide a summary of type(s) of coating systems used in containment, e.g., Carboline CZ 11 Inorganic Zinc primer, Ameron 90 epoxy finish coat.*
2. *Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.*
3. *Discuss suction strainer head loss testing performed as it relates to both qualified and unqualified coatings and what surrogate material was used to simulate coatings debris.*
4. *Provide bases for the choice of surrogates.*
5. *Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on zone of influence size for qualified and unqualified coatings.*
6. *Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.*
7. *Describe any ongoing containment coating condition assessment program.*

Response to Issue 3h1:

A Bechtel construction specification was used to specify the coatings used during plant construction. It identifies the original primers used in Containment as Dimetcote No. 6 (also known as D6) and Mobilzinc 7. The original topcoats were Amercoat 66 and Mobil 89 Series.

Coatings that have been used at Calvert Cliffs since construction are identified in internal plant documents. These documents identify the primer, topcoat, and application standard to be used on the various surfaces inside Containment. A primer of Ameron D6 and a topcoat of Ameron 66 are the primary coatings referenced; however, Valspar 13F12 is used as a primer on some surfaces and Valspar 89 is used as the corresponding topcoat. Valspar 13F12 is the same as Mobilzinc 7 and Valspar 89 is the same as Mobil 89 Series.

New coatings are listed as Ameron 90, and Carboline 890. An additional update lists the metal primer as Carboline Carboguard 890, the concrete primer as Carboline Starglaze 2011S, and the topcoat as Carboline Carboguard 890.

Response to Issue 3h2:

All coatings in the zone of influence and all coatings of unknown pedigree (i.e., no proof it was ever qualified) are assumed to fail as 10 μm particles and transport to the sump. As discussed in Response to Issue 3c4 and Issue 3e1, for coatings that were installed as qualified, but subsequently found to be degraded per site inspection procedures, a portion of the coatings are assumed to fail as chips. Credit was then taken, as applicable, for the Reference 14 study that demonstrated paint chips will not transport in sump pool velocities less than 0.2 ft/sec.

Response to Issue 3h3:

The head loss testing used scaled quantities of coatings as part of the strainer debris load. Stone flour was used as a surrogate material for unqualified coatings that were assumed to fail as 10 μm particles. Epoxy particulate with a median particle size of 10 microns was used to simulate qualified coatings that are destroyed within the zone of influence. During the initial and scoping testing actual paint chips made of Carboline Carboguard 890 were placed in the test tank to assess the effect of these chips on the debris bed. Since these chips fell directly to the bottom of the tank even when introduced right at the face of the strainer, it was concluded that the Reference 14 coatings transport test data which showed the non-transportability of paint chips at velocities less than 0.2 ft/sec were applicable to our strainer installation. No further introduction of paint chips into the test was considered.

Response to Issue 3h4:

Stone flour was used because its size (average of 10 μm), and its high degree of transportability matched that of the coatings it represents. Epoxy particulate was used to simulate epoxy coatings within the zone of influence.

Response to Issue 3h5:

Calvert Cliffs has followed the guidance from Reference 4 for determining the quantity of coating debris. Per Reference 4, Section 3.4.2.1:

- All coating (qualified and unqualified) in the zone of influence will fail,
- All qualified (design basis accident-qualified or acceptable) coating outside the zone of influence will remain intact,
- All unqualified coatings outside the zone of influence will fail.

From Reference 7, a zone of influence of 4.0 L/D was used for epoxy-based coatings, and a zone of influence of 5.0 L/D was used for un-topcoated inorganic zinc primer. All unqualified coatings (including degraded qualified coatings) were assumed to fail.

Response to Issue 3h6:

See the Response to Issue 3h2 above.

Response to Issue 3h7:

Calvert Cliffs conducts condition assessments of Service Level I coatings inside the Containment once each refueling cycle at a minimum. Generally, all of the accessible areas within the Containment are visually inspected. As localized areas of degraded coatings are identified, those areas are evaluated and scheduled for repair or replacement, as necessary. The periodic condition assessments, and the resulting repair/replacement activities, assure that the amount of Service Level I coatings that may be susceptible to detachment from the substrate during a LOCA event is minimized and is identified and tracked by the plant coatings condition assessment program.

***<u>NRC Issue 3i</u>*:**

Debris Source Term

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

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

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

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

2. *A summary of the containment housekeeping programmatic controls in place to control or reduce the latent debris burden. Specifically for RMI/low-fiber plants, provide a description of programmatic controls to maintain the latent debris fiber source term into the future to ensure assumptions and conclusions regarding inability to form a thin bed of fibrous debris remain valid.*
3. *A summary of the foreign material exclusion programmatic controls in place to control the introduction of foreign material into the containment.*
4. *A description of how permanent plant changes inside containment are programmatically controlled so as to not change the analytical assumptions and numerical inputs of the licensee analyses supporting the conclusion that the reactor plant remains in compliance with 10 CFR 50.46 and related regulatory requirements.*
5. *A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.*

If any of the following suggested design and operational refinements given in the guidance report (guidance report, Section 5) and SE (SE, Section 5.1) were used, summarize the application of the refinements.

6. *Recent or planned insulation change-outs in the containment which will reduce the debris burden at the sump strainers*
7. *Any actions taken to modify existing insulation (e.g., jacketing or banding) to reduce the debris burden at the sump strainers*
8. *Modifications to equipment or systems conducted to reduce the debris burden at the sump strainers*
9. *Actions taken to modify or improve the containment coatings program*

<u>Response to Issues 3i1 and 3i2</u>:

Several Calvert Cliffs' site procedures and practices are in place to insure containment cleanliness is maintained and that debris inside Containment is identified and minimized prior to power operations. Site procedures require that specific inspections be performed and documented for loose debris prior to containment closeout and an "intense" search be made of Containment prior to entering Mode 4 for sources of loose debris and corrective actions taken. Another site procedure assigns specific ownership responsibilities for plant areas including containment when accessible, and requires weekly cleanliness inspections and prompt actions to remediate. Calvert Cliffs has also developed a good practice of performing daily containment walk downs during refueling outages specifically for cleanliness issues and generating daily containment cleanliness key performance indicators which are tracked, reported on, and managed.

Response to Issue 3i3:

A Constellation Energy fleet procedure contains guidance specifically addressing foreign material exclusion (FME) concerns in areas like the containment, and the containment sumps. It classifies the containment sumps as a Special Foreign Materials Exclusion Area, and requires an FME project plan for any entry into the sumps. Foreign material exclusion project plans are prepared, reviewed, and approved. The requirements of this procedure are stringent with regard to standards but allow flexibility for adapting an FME project plan for any kind of maintenance evolution. This procedure also requires FME training for all personnel working in containment.

Response to Issue 3i4:

A Calvert Cliffs site procedure contains specific guidance in the impact screening process for analyzing the impact of changes that could affect thermal insulation and containment response to accidents. Another site procedure controls the requirements for research on the part of maintenance planners for maintenance which could introduce new debris sources into Containment. The procedure is being revised to require that for any maintenance activity that will install any materials in either Unit 1 or Unit 2 Containments expected to remain there during Mode 4 or higher operations, engineering reviews the installation details for impact on the containment sump strainer analyses and must approve the usage of these new materials.

Response to Issue 3i5:

A Calvert Cliffs site procedure establishes requirements for effective implementation of the Maintenance Rule program at the site. It describes approved methods to monitor, trend, establish and modify goals for system, structures and components. Additional site procedures for integrated work management and integrated risk management provide specific guidance on risk assessment and scheduling of maintenance and temporary changes.

Response to Issues 3i6 and 3i7:

For Units 1 and 2, calcium-silicate pipe insulation within 17 L/D of the RCS piping was banded on 3" centers to reduce the zone of influence to 3 L/D. Any calcium-silicate insulation within 3 L/D of the RCS piping was replaced on Units 1 and 2 with fiberglass insulation.

Response to Issue 3i8:

Valve equipment tags are now made of materials that would sink in water and not transport to the containment sump. In addition, the tags will not delaminate in a post-accident environment. Calvert Cliffs investigated re-coating the reactor coolant pump motors with qualified coatings to reduce the unqualified coating debris load (approximate surface area is 2000 ft^2 per Unit). The reactor coolant pump motor coating was verified to be qualified and no further action is required.

Response to Issue 3i9:

Calvert Cliffs has an existing coatings program that monitors and controls the quantities and types of coatings installed inside Containment. As noted in Reference 17, Calvert Cliffs has implemented controls for procurement, application, and maintenance of qualified coatings used inside Containment that are consistent with the licensing basis and regulatory requirements. This program conducts periodic condition assessments, typically each outage, to verify the adequacy of existing coatings and direct repair/replacement, as necessary. The quantity of unqualified coatings that are added inside Containment is tracked. This program is adequate in its current form to ensure coatings are properly controlled, and that future installations of unqualified coatings are quantified.

***<u>NRC Issue 3j</u>*:**

Screen Modification Package

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

1. *Provide a description of the major features of the sump screen design modification.*
2. *Provide a list of any modifications, such as reroute of piping and other components, relocation of supports, addition of whip restraints and missile shields, etc., necessitated by the sump strainer modifications.*

<u>Response to Issue 3j1</u>:

In Calvert Cliffs Units 1 and 2, a strainer of 6000 ft^2 filtration surface area (nominal) has been installed. The strainer is CCI's cassette pocket strainer design. The hole size through the filtration surface is 1.6 mm (1/16") with no more than 3% larger holes and no holes larger than 2 mm (0.08"). There are 33 strainer modules divided among three strainer rows. These modules are approximately 3' high. There are 324 pockets in 29 of the strainer modules, and 252 pockets in four of the strainer modules. The pocket dimensions are 70.4 mm x 70.4 mm in cross-section, and 200 mm deep. The strainer rows tie into a common duct which directs the flow to the existing containment sump. The containment sump is a concrete curb with a steel roof, and contains the inlet to both recirculation headers. See Figure 3j1-1.

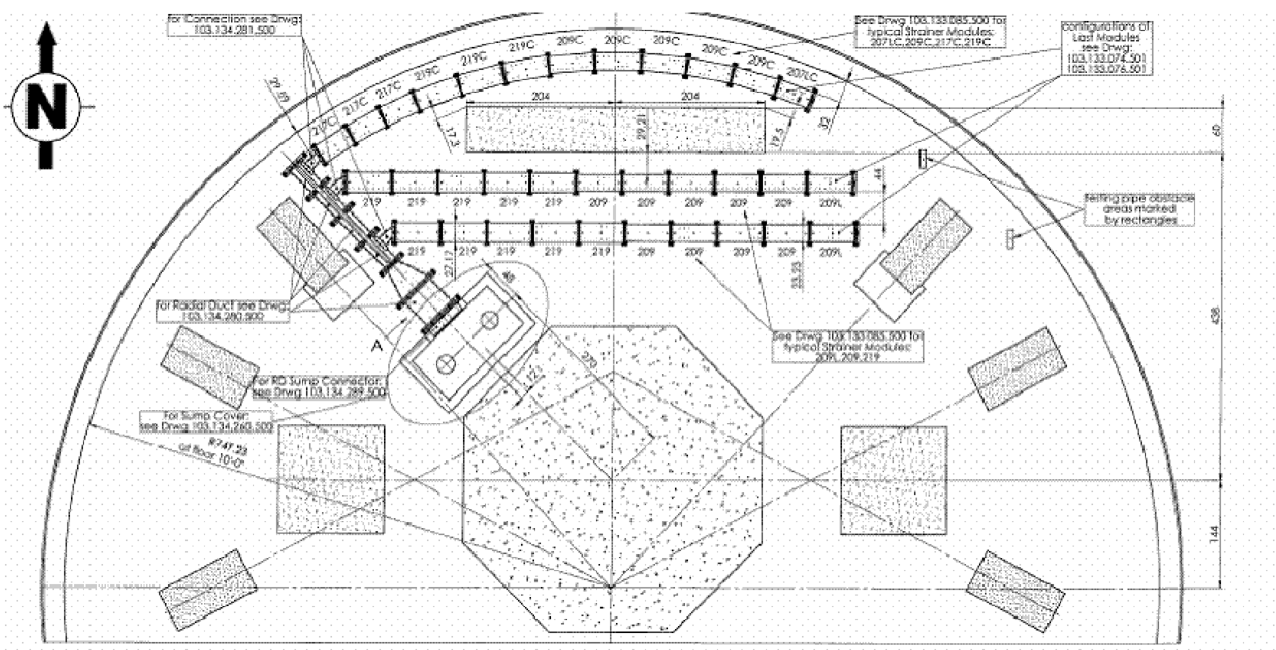


Figure 3j1-1
Strainer Arrangement

Response to Issue 3j2:

A 16" feedwater pipe support was modified on Unit 2 to allow clearance for one of the strainer rows. A cable tray support was also modified on Unit 2 to allow clearance for the radial duct. These modifications were not required on Unit 1. In addition, the 6" curb around the ECCS sump was notched to allow for installation of the common duct to the sump.

NRC Issue 3k:

Sump Structural Analysis

The objective of the sump structural analysis section is to verify the structural adequacy of the sump strainer including seismic loads and loads due to differential pressure, missiles, and jet forces. Provide the information requested in GL 2004-02, "Requested Information," Item 2(d)(vii), that is, provide verification that the strength of the trash racks is adequate to protect the debris screens from missiles and other large debris. The submittal should also provide verification that the trash racks and sump screens are capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under flow conditions.

1. *Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.*
2. *Summarize the structural qualification results and design margins for the various components of the sump strainer structural assembly.*
3. *Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable).*
4. *If a backflushing strategy is credited, provide a summary statement regarding the sump strainer structural analysis considering reverse flow.*

Response to Issue 3k1:

Classical and finite-element (ANSYS) methods were used to analyze the following parts of the strainer:

- Standard cartridges (cartridge depth 200 mm)
- Support structure and duct of a standard module
- Radial duct
- Sump cover

The strainers and their supports were analyzed to according to the rules of Reference 18 for Class 2 components. These rules were chosen to provide a recognized standard for structural analyses, however, the strainer components are non-American Society of Mechanical Engineers code items, Seismic Category 1.

The standard module analysis assumes an 18 cartridge design which envelopes the smaller 14 cartridge design.

The design codes used for the sump structural strainer analysis are References 19 and 20.

Design Inputs

Total weight of modules (2 support structures, duct, cover plate, and cartridges)

18 Cartridge Module 906.9 lbm (411.37 kg)
14 Cartridge Module 767.9 lbm (348.30 kg)

Total debris mass transported to sump = 10,782.81 lbm (4891 kg)
(Note: this is an enveloping value used for structural analyses only)

Conservative differential pressure = 2.103 psi (.0145 MPa) at 220°F (104.4°C)
Standard differential pressure = 1.949 psi (.01334 MPa) at 212°F (100.0°C)

Operating Basis Earthquake
Maximum Horizontal Acceleration ≈ 1.96 g at ≈ 5 Hz
Maximum Vertical Acceleration ≈ 0.59 g at ≈ 10 Hz

Safe-Shutdown Earthquake
Maximum Horizontal Acceleration ≈ 2.73 g at ≈ 5 Hz
Maximum Vertical Acceleration ≈ 1.11 g at ≈ 10 Hz

Additional load from shielding blankets = 885.91 lbf (3940.76 N)

Summary of Design Load Combinations

The load combinations are summarized in Table 3k1-1 below.

In addition to these loads a sloshing load was computed and included to account for the impact of water sloshing in the sump pool.

Table 3k1-1
Load Combinations and Acceptance Criteria Used in ECCS Sump Screen Verification

#	**Load Combination Type**	**Temperature (°F)**	**Temperature (°C)**
1	W(pool dry)	280	137.8
2	W+OBE(pool dry)	280	137.8
3	W+SSE(pool dry)	280	137.8
4	W+OBE(pool filled)	280	137.8
5	W+SSE(pool filled)	280	137.8
6	W+WD+OBE(pool filled)+ΔPD	70(220)	21(104.4)
7	W+WD+SSE(pool filled)+ΔPD	70(220)	21(104.4)
8	W+AddL	70	21

Variables:

W	weight of strainers & supporting structures
WD	weight of debris
ΔPD	pressure differential
OBE	operating basis earthquake
SSE	safe-shutdown earthquake
AddL	additional load caused by radiation shielding blankets

Response to Issue 3k2:

The ECCS sump strainer structure consists of two separate structures: the floor structures, and the sump pit structures.

The floor structures consist of the strainer modules themselves which provide the filtration surface area, and a radial duct which channels the flow from the three rows of strainer modules to the sump pit. The radial duct consists of six segments each approximately 4' long. There are 29 strainer modules that are approximately 5' long, and four strainer modules that are approximately 4' long. Each of these strainer modules/radial duct segments are anchored to the concrete floor via an anchor plate at each end. There are four anchor bolts (½" Hilti bolts at 3½" minimum embedment torqued to 40 ft-lbs) on each anchor plate. A retaining structure is mounted on top of each anchor plate. This retaining structure provides the mounting frame for the radial duct segments and the interior duct of the strainer modules. The various connections are made using M12, M16, and M20 bolting hardware. The retaining structures are attached to the anchor plates using two M30 bolts. The strainer cassettes (filter surface) attach to the strainer interior duct, and are covered with a deck plate.

The sump pit structure consists of cover plates, and support beams fixed on and about a concrete curb which covers the sump pit. Two pairs of mounting brackets are anchored to the concrete curb using four anchor bolts (½" Hilti bolts at 3½" minimum embedment torqued to 40 ft-lbs) on each bracket. A pair of posts is also anchored to the sump pit floor in a similar fashion. A 140 mm x 140 mm I-beam is fastened to these mounting brackets/mounting posts (one on each end). A series of 12 plates (0.59" thick) are laid on top of the I-beams, and are located in place by a set of locating pins fixed to the I-beams.

Ratios of design stress and corresponding allowable stress for various components of the ECCS sump strainer structural assembly are given below. The figures illustrate the component analyzed.

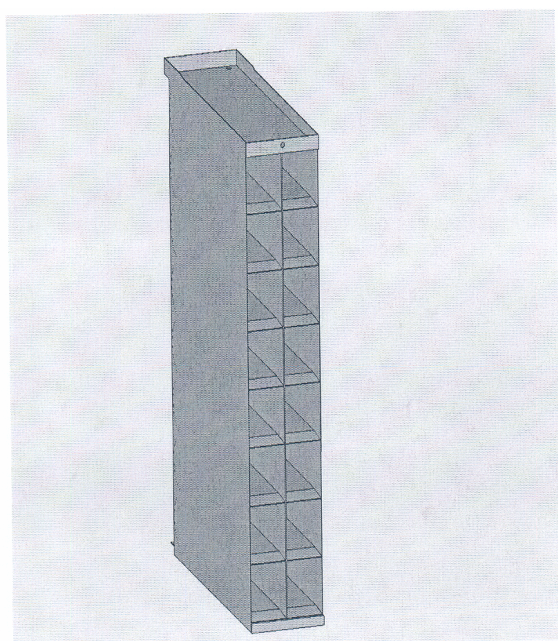


Figure 3k2-1
Cartridges

Table 3k2-1
Cartridges

Ratio	Calculated MPa	Allowable MPa	Stress Location and Type
0.436	133.92	306.9	Sidewall global + local bending stress
0.024	2.90	122.76	Sidewall connection to coverplate shear stress
0.014	2.79	204.6	Sidewall connection to coverplate tension
0.270	45.5	168.5	Upper cover plate bearing stress
0.117	14.32	122.76	Upper cover plate shear stress
0.402	123.3	306.9	Upper cover plate bending stress
0.427	72.0	168.5	Lower cover plate bearing stress
0.322	108.93	338.03	Cartridge pocket bending stress
0.131	1.63	12.41	Cartridge pocket compression stress
0.008	0.93	122.76	Cartridge pocket shear stress

Figure 3k2-2
Standard Strainer Module

Table 3k2-2
Standard Module Support Structure

Ratio	Calculated MPa	Allowable MPa	Stress Location and Type
0.556	64	115.1	Maximum principle stress intensity – Load 1
0.759	196.6	259	Maximum principle stress intensity – Load 7
0.913	157.56	172.65	Maximum principle stress intensity – Load 8
0.116	30	259	Welded joints
0.023	6.56	279.77	M16 leveling screws compression stress
0.045	12.65	279.77	M20 leveling screws compression stress
0.426	101.9	239.04	M16 bolt membrane & bending stress
0.058	5.24	89.82	M16 bolt shear stress
0.013	1.21	92.68	M20 screws shear stress
0.005	1.2	246.64	M12 head screws normal stress – Load 7
0.005	0.48	92.68	M12 head screws shear stress – Load 7
0.349	20.9	59.88	Pin Ø 12/M8 screws shear stress
0.038	9.8	259.0	Closure plate of the duct bending
0.042	64.2 lbf	1515 lbf	Loads on anchorage – normal
0.030	92.55 lbf	3040 lbf	Loads on anchorage – shear

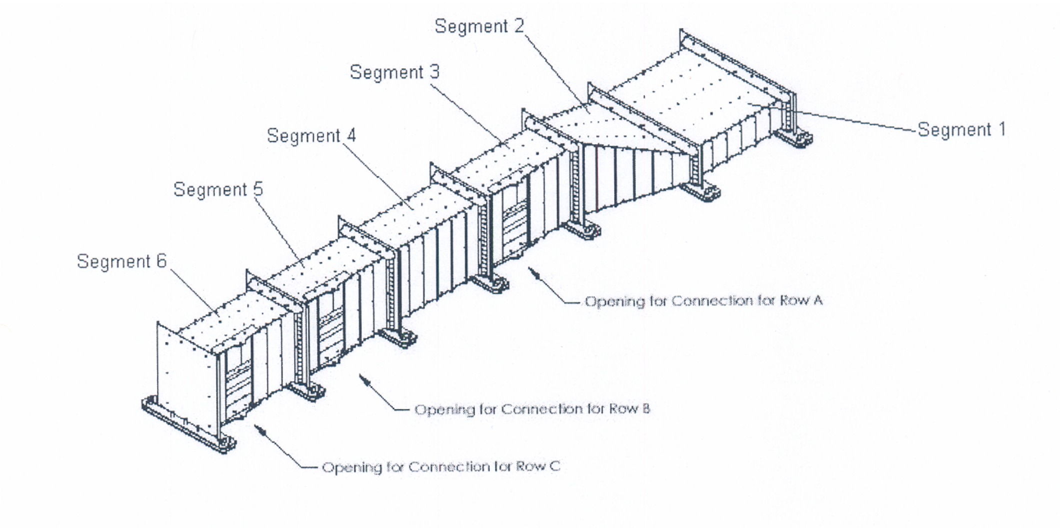


Figure 3k2-3
Radial Duct

Table 3k2-3
Radial Duct

Ratio	Calculated MPa	Allowable MPa	Stress Location and Type
0.002	0.18	82.74	Global bending of duct shear stress – Load 8
0.003	0.7	206.85	Global & local bending of cover plate – Load 8
0.007	0.434	61.03	Sidewalls compression stress – Load 8
0.002	0.21	122.76	Global bending of duct shear stress – Load 7
0.003	0.43	124.11	Loads in horizontal directions shear stress – Load 7
0.003	0.67	306.9	Global bending due to Weight & Earthquakes - Load 7
0.024	7.25	306.9	Local & global bending of cover plate – Load 7
0.004	0.36	101.1	Membrane stress in compression – Load 7
0.013	0.815	61.03	Axial compression of the sidewalls – Load 7
0.270	82.75	306.9	Global & local bending sidewalls – Load 7
0.009	0.71	76.86	Inner duct walls – Load 7

Table 3k2-4
Analysis of Retaining Structure of Radial Duct Segment 4

Ratio	Allowable MPa	Calculated MPa	Stress Location and Type
0.002	239.04	0.7	Support plate w/anchorage M30/M16 tension
0.185	89.82	16.6	Support plate w/anchorage M30/M16 shear stress
0.019	92.68	1.77	Connection duct to retaining structure shear stress
0.012	246.64	3.0	Cylinder head screw M12 normal stress
0.024	92.68	2.2	Cylinder head screw M12 shear stress
0.360	259	93.14	Support legs membrane bending stress
0.018	103.6	1.83	Support legs shear stress
0.027	259	7.1	Closure plate of the duct bending stress
0.008	1515 lbf	12.51 lbf	Anchor plate w/4 Hilti Kwik Bolts 111 tension
0.096	3040 lbf	292.5 lbf	Anchor plate w/4 Hilti Kwik Bolts 111 shear

Table 3k2-5
Analysis of the Duct Structure of Radial Duct Segment 1

Ratio	Allowable MPa	Calculated MPa	Stress Location and Type
0.002	82.74	0.18	Global bending of duct shear stress
0.002	206.85	0.35	Global & local bending of cover plate
0.004	114.56	0.449	Sidewalls compression stress
0.001	122.76	0.17	Global bending of duct shear stress
0.001	124.11	0.13	Loads in horizontal directions shear stress
0.001	306.9	0.4	Global bending due to Weight & Earthquakes
0.084	306.9	25.87	Global and local bending of cover plate
0.017	15.78	0.27	Membrane stress in compression
0.014	141.2	1.96	Axial compression of the sidewalls
0.046	306.9	14.2	Global & local bending sidewalls
0.735	11.15	8.2	Inner duct walls

Table 3k2-6
Analysis of Retaining Structure of Radial Duct Segment 1

Ratio	Allowable MPa	Calculated MPa	Stress Location and Type
0.138	89.82	12.4	Support plate w/anchorage M30/M16 shear
0.014	92.68	1.32	Connection duct to retaining structure shear
0.012	246.64	2.95	Cylinder screw M12 normal stress
0.023	92.68	2.16	Cylinder screw M12 shear stress
0.116	259	30.0	Support legs membrane bending stress
0.013	103.6	1.37	Support legs shear stress
0.072	3040 lbf	218.8 lbf	Anchor plate w/4 Hilti Kwik Bolts 111 shear stress

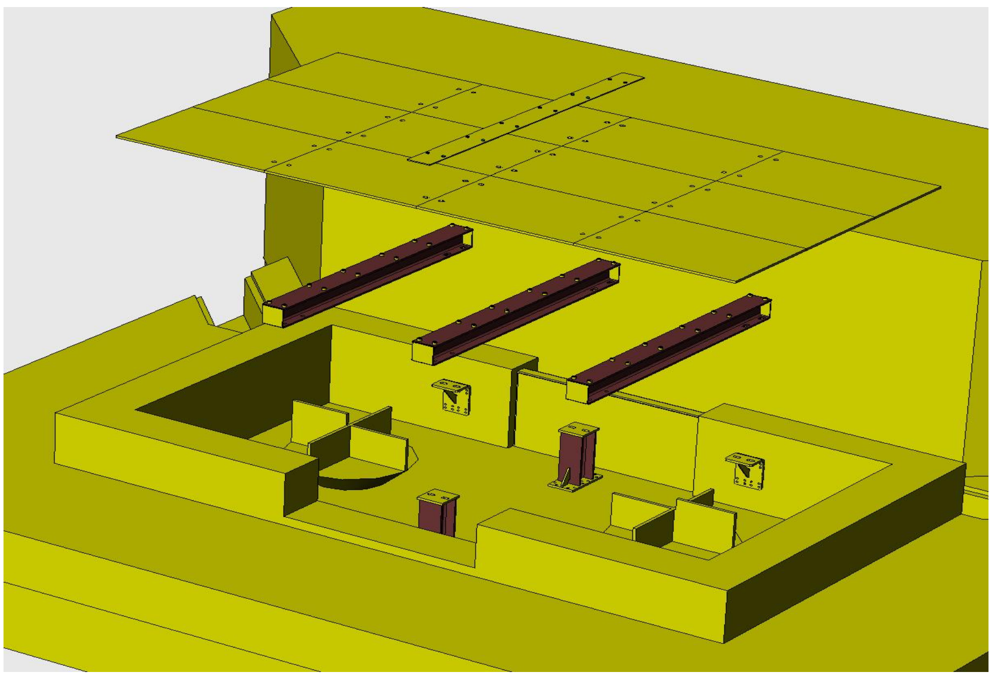


Figure 3k2-7
Sump Cover

Table 3k2-7
Sump Cover

Ratio	Allowable	Calculated	Stress Location and Type
0.406	0.0380 MPa	0.0154 MPa	Grating bearing bar size load
0.154	197.7 MPa	30.5 MPa	Stresses in support beam I-HEB140
0.480	9065.4 N	4352.5 N	Bolted support shear load per bolt
0.603	6740 N	4069 N	Tension per bolt
0.121	296.6 MPa	35.8 MPa	Cover plate bending stress
0.141	155.8 MPa	21.9 MPa	I-beams (IPB140) bending stress
0.32	177.1 MPa	5.71 MPa	Support columns bending stress
0.018	177.1 MPa	3.27 MPa	Support columns compression stress

Response to Issue 3k3:

Calvert Cliffs has approval to use leak-before-break methodology so that the dynamic effects of a LOCA do not need to be considered in the design of structures and components. Emergency Core Cooling System sump recirculation is not required for breaks in other piping systems.

Response to Issue 3k4:

The Calvert Cliffs ECCS sump strainer design does not incorporate a backflushing strategy.

***NRC Issue 3l*:**

Upstream Effects

The objective of the upstream effects assessment is to evaluate the flowpaths upstream of the containment sump for holdup of inventory which could reduce flow to and possibly starve the sump. Therefore, provide a summary of the upstream effects evaluation including the information requested in GL 2004-02, "Requested Information," Item 2(d)(iv) including the basis for concluding that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

1. *Summarize the evaluation of the flow paths from the postulated break locations and containment spray washdown to identify potential choke points in the flow field upstream of the sump.*
2. *Summarize measures taken to mitigate potential choke points.*
3. *Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.*
4. *Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.*

Response to Issue 3l1:

The lower level of Containment is open and contains no compartment or choke point which could prevent water from flowing to the sump.

The two refueling pool compartments have the potential to fill with water from the CS system because the drain to these compartments is a 1" drain which is not sufficient to prevent a back-up of water in these compartments. Once these compartments fill up to the level of the refueling pool seal ring, water could fall into the reactor cavity, and potentially be trapped there.

The reactor cavity region has a 4" drain that drains to the normal Containment sump through a 2" valve and a 2" pipe. The current sump pool water level height calculation assumes this drain is blocked, and the computed water holdup in the reactor cavity region is 3,792 ft^3. The cavity is inspected for debris during each refueling outage, and the only insulation inside this compartment is reflective metal insulation.

The containment water level calculation assumes all of these compartments are filled with water thereby reducing the predicted sump water height.

Response to Issue 3l2:

A drain cover is placed on the 1" drain line of the refueling pool compartment, but even if this drain does not clog, as mentioned in Response to Issue 3l1, this size drain line is insufficient to prevent this compartment from filling up with water. The reactor cavity area is periodically inspected for debris, and the 4" drain line is of sufficient size to drain the water from the refueling pool cavity to the sump pool.

The only debris that could be generated in the refueling pool is reflective metal insulation which would not likely block the 4" reactor cavity drain in the event of a break near a reactor vessel nozzle. However, at this time no inspection of the drain valve and piping is performed for personnel dose reasons. Therefore, this drain is assumed to be blocked.

Response to Issue 3l3:

There are no curbs of sufficient dimension to impact water flow to the sump. The design of the debris interceptors in Unit 1 allow water flow over the top of the debris interceptors.

Response to Issue 3l4:

See the Response to Issue 3l1 above.

***NRC Issue 3m*:**

Downstream effects - Components and Systems

The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the containment sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams. Provide the information requested in GL 04-02, "Requested Information," Item 2.(d)(v) and 2.(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the sump. If approved methods were used (e.g., WCAP-16406-P), briefly summarize the application of the methods. The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the ECCS Sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams. Provide the information requested in GL 04-02 Requested Information Item 2(d)(v) and 2(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the ECCS Sump.

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

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

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

Verification that the close-tolerance subcomponents in pumps, valves and other ECCS and CSS components are not susceptible to plugging or excessive wear due to extended post-accident operation with debris-laden fluids.

3m1. If NRC-approved methods were used (e.g., WCAP-16406-P with accompanying NRC SE) briefly summarize the application of the methods. Indicate where the approved methods were not used or exceptions were taken, and summarize the evaluation of those areas.

3m2. Provide a summary and conclusions of downstream evaluations.

3m3. Provide a summary of design or operational changes made as a result of downstream evaluations.

Response to Issue 3m1:

Debris loads for the downstream analytical evaluations are based on bypass testing of the CCI strainer. The sump strainer opening consists of 1.6 mm (1/16") diameter holes. A post-installation examination inspects for gaps at all strainer interfaces/joints. The acceptance criterion is no gap greater than 1/32" can remain. These small openings will ensure no large particles enter the downstream recirculation piping.

Reference 12 is used to evaluate the downstream components for the effects of plugging/erosion. All particulate (10 µm) debris is assumed to transport through the system, and not deplete over 30 days. The amount of fiber bypass is in accordance with Reference 12 with the appropriate prototypical testing done to establish the strainer bypass fraction. The amount of fiber that transports through the system is computed to deplete with time in accordance with this WCAP.

Valves, pumps, heat exchanger tubes, orifices, containment spray nozzles were evaluated for plugging and erosion based on the concentrations and maximum particle size as determined by the Reference 12 methodology.

Response to Issue 3m2:

Testing of a replacement HPSI pump cyclone separator was performed by Wyle Labs in May and June 2008. The testing demonstrated that the selected replacement cyclone separator would not plug and would not erode sufficiently to defeat its function. Replacement of all HPSI cyclone separators with the tested unit was completed by June 30, 2008.

The HPSI, LPSI, and CS pumps were evaluated for erosive and abrasive (including packing) wear. The effect on pump curve performance was computed. The degraded pump curve will be evaluated to ensure the required pump flows can still be provided.

A determination was made that the HPSI and CS mechanical seals testing was not needed.

All piping components pass the evaluation for plugging except for three components: the regenerative heat exchanger, a 12" swing check valve, and a 24" swing check valve. The regenerative heat exchanger experiences debris laden flow on the shell side. The minimum tube spacing is about twice the maximum bypassed debris size. The standard methodology of Reference 12 suggests that openings smaller than about three times the debris is susceptible to plugging. Engineering judgment was used to determine that plugging of the shell side of a heat exchanger is highly unlikely and is not credible. The large swing check valves may experience flow speeds that are below the transport speeds for the bypassed debris. The methodology of Reference 12 suggests that such flow may allow debris to settle and ultimately plug components. Engineering judgment was used to evaluate the potential of such large check valves to plug with the small amount and size of bypassed debris. That judgment determined that it is unrealistic for debris to accumulate in significant quantities behind these large check valves and then prevent the valve disk from opening (should it be shut first).

All piping components pass the evaluation for wear except the following: the charging flow orifice in the core flush path, the containment spray nozzles, and the control valves in the HPSI and CS systems. The charging flow orifice can tolerate wear from core flush flows less than 240 gpm. The design core flush flow is greater than 150 gpm but has no upper design limit. Operations procedures and training targets a maximum of 200 gpm but requires specific flow to be greater than 150 gpm only. Judgment is used to determine that the orifice likely would perform adequately for up to 30 days because the tolerated flow of 240 gpm is enough greater than the operational targets to give reliable margin for operator action credit. The containment spray nozzles can tolerate average flow of 1850 gpm per CS pump for a 30 day mission time with less than 10% flow rate degradation (increase in flow due to larger open area). The Updated Final Safety Analysis Report notes that the CS pump flow could be as high as 2300 gpm. At this flow rate the nozzles would last for 23 days with less than 10% flow rate degradation. The NPSH calculations have determined that the maximum CS pump flow with unworn nozzles would be less than 1750 gpm per pump. The CS nozzles would likely provide their safety function for a 30 day mission time based on these facts. The CS flow control valves are under operator control and would be adjusted to maintain the target flow rates even in a worn condition. With a 25% open valve, the wear would be greater than 3% over a 30 day mission time. With a 50% open valve, the wear would be less than 3% over the same time. Because of the operator control, the CS control valves would perform their safety function even in a worn condition.

<u>Response to Issue 3m3</u>:

No design or operational changes are anticipated as a result of our downstream effects evaluations.

***<u>NRC Issue 3n</u>*:**

Downstream Effects - Fuel and Vessel

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

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

<u>Response to Issue 3n1</u>:

Calvert Cliffs analyzed in-vessel downstream effects by using the methods contained WCAP-16793-NP, Revision 0 (Reference 21).

***<u>NRC Issue 3o</u>*:**

Chemical Effects

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

1. *Provide a summary of evaluation results that show that chemical precipitates formed in the post-LOCA containment environment, either by themselves or combined with debris, do not deposit at the sump screen to the extent that an unacceptable head loss results, or deposit downstream of the sump screen to the extent that long-term core cooling is unacceptably impeded.*
2. *Content guidance for chemical effects is provided in Enclosure 3 to a letter from the NRC to NEI dated September 27, 2007 (ADAMS Accession No. ML072600372).*
   - *2.1 Sufficient 'Clean' Strainer Area: Those licensees performing a simplified chemical effects analysis should justify the use of this simplified approach by providing the amount of debris determined to reach the strainer, the amount of bare strainer area and how it was determined, and any additional information that is needed to show why a more detailed chemical effects analysis is not needed.*
   - *2.2 Debris Bed Formation: Licensees should discuss why the debris from the break location selected for plant-specific head loss testing with chemical precipitate yields the maximum head loss. For example, plant X has break location 1 that would produce maximum head loss without consideration of chemical effects. However, break location 2, with chemical effects considered, produces greater head loss than break location 1. Therefore, the debris for head loss testing with chemical effects was based on break location 2.*

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

2.4 Approach to Determine Chemical Source Term (Decision Point): Licensees should identify the vendor who performed plant-specific chemical effects testing.

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

2.6 AECL Model: Since the NRC USNRC is not currently aware of the testing approach, the NRC USNRC expects licensees using it to provide a detailed discussion of the chemical effects evaluation process along with head loss test results.

2.7 AECL Model: Licensees should provide the chemical identities and amounts of predicted plant-specific precipitates.

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

2.9 WCAP Base Model: List the type (e.g., AlOOH) and amount of predicted plant-specific precipitates.

2.10 WCAP Refinements: State whether refinements to WCAP-16530-NP were utilized in the chemical effects analysis.

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

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

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

2.14 Solubility of Phosphates, Silicates and Al Alloys: Licensees should list the type (e.g., AlOOH) and amount of predicted plant specific precipitates.

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

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

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

2.18 Chemical Injection into the Loop: Licensees should indicate the amount of precipitate that was added to the test for the head loss of record (i.e., 100%, 140%).

2.19 Pre-Mix in Tank: Licensees should discuss any exceptions taken to the procedure recommended for surrogate precipitate formation in WCAP-16530.

2.20 Technical Approach to Debris Transport (Decision Point): State whether near field settlement is credited or not.

2.21 Integrated Head Loss Test with Near-Field Settlement Credit: Licensees should provide the one-hour or two-hour precipitate settlement values measured within 24 hours of head loss testing.

2.22 Integrated Head Loss Test with Near-Field Settlement Credit: Licensees should provide a best estimate of the amount of surrogate chemical debris that settles away from the strainer during the test.

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

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

2.25 Test Termination Criteria: Provide the test termination criteria.

2.26 Data Analysis: Licensees should provide a copy of the pressure drop curve(s) as a function of time for the testing of record.

2.27 Data Analysis: Licensees should explain any extrapolation methods used for data analysis.

2.28 Integral Generation (Alion):

2.29 Tank Scaling / Bed Formation: Explain how scaling factors for the test facilities are representative or conservative relative to plant-specific values.

2.30 Tank Scaling / Bed Formation: Explain how bed formation is representative of that expected for the size of materials and debris that is formed in the plant specific evaluation.

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

2.32 30-Day Integrated Head Loss Test: Licensees should provide the plant-specific test conditions and the basis for why these test conditions and test results provide for a conservative chemical effects evaluation.

2.33 30-Day Integrated Head Loss Test: Licensees should provide a copy of the pressure drop curve(s) as a function of time for the testing of record.

2.34 Data Analysis Bump Up Factor: Licensees should provide the details and the technical basis that show why the bump-up factor from the particular debris bed in the test is appropriate for application to other debris beds.

<u>Response to Issue 3o1</u>:

Debris and other containment sources which could contribute to the formation of chemical precipitants in the sump pool were evaluated using the methodology of Reference (22). The results of this evaluation showed the elemental amounts of calcium (Ca), silicon (Si), and aluminum (Al) expected to be released into the sump pool as well as the expected quantities of precipitates: $Ca_3(PO_4)_2$, $NaAlSi_3O_8$, AlOOH.

Head loss testing with chemical precipitants was originally conducted in November 2007, and extremely high head losses were encountered. Inputs to the evaluation which supported this test were based on accurate sources. However, actions have been taken to reduce these sources or mitigate their effect. For instance, the quantity of aluminum inside containment was taken from the Updated Final Safety Analysis Report as 13,000 ft^2. A subsequent review (confirmed by walkdown during the 2008 refueling outage) shows that this value can be reduced by approximately 90% if aluminum scaffolding is removed from Containment. This reduction was achieved for Unit 1. Reduction of aluminum inside Containment will be achieved for Unit 2 during the 2009 refueling outage as described in Reference 24.

Testing was performed in May 2008 to demonstrate head loss across the strainer and debris bed. This testing included the appropriate chemical precipitates and especially the effects of aluminum reduction. The maximum head loss determined by the quality-assured test was 59.1 millibar (23.82 inches). That head loss was subsequently used in NPSH calculations for the ECCS and CS pumps.

The quantities of fibrous and particulate debris used in the quality-assured testing were estimated prior to testing and found to be bounding when debris generation and transport calculations were completed later. The quantities of the precipitates mentioned above were estimated based on the estimated debris, water volume, spray duration, water temperature, exposed concrete, and water chemistry. The total quantity of chemical precipitates was found to be bounding when the calculations were finalized later.

Acceptable NPSH margin cannot yet be demonstrated for the CS pumps. Therefore, a containment buffer material change is being pursued (see Response to Issue 1).

Response to Issue 3o2.1:

Calvert Cliffs is not performing a simplified chemical effects analysis.

Response to Issue 3o2.2:

Calvert Cliffs selected bounding quantities of all type of debris. For instance, if a cold leg break produced more Marinite board debris and less NUKON insulation debris than a hot leg break, the greater fibrous debris from the hot leg break and the Marinite debris from the cold leg break were used. Therefore, the debris for head loss testing with chemical effects was based on a composite of debris from all break locations.

Thin bed effects were investigated by using low quantities of the postulated fibrous debris and the entire particulate loading to verify that the CCI strainer does not produce a thin bed effect for the debris from Calvert Cliffs. This also ensures that a break that produces little debris does not produce an unexpectedly high head loss.

Response to Issue 3o2.3:

The following assumptions or results of calculations were used to determine the chemical effects loading used in quality assured testing and to be used in future testing related to buffer replacement:

- pH = 7.3 for the May tests (assumed), pH = 7.75 for testing related to future testing with sodium tetraborate conditions (determined by chemical modeling for the maximum pH condition with the new buffer).

- Temperature of containment sprays, sump water, and containment gas volume based on a recent containment accident analysis which showed the maximum sump water temperature to be about 275°F and the temperature at the start of recirculation to be about 214°F (noted in Response to Issue 3g1).
- Containment spray duration of 30 days.
- Total quantity of water (both minimum and maximum possible as determined in recent calculations).
- Materials in Containment considered in the evaluation of chemical effects precipitate with quantity of each as determined in Calvert Cliffs calculations.
  - Aluminum metal exposed to sprays and submerged
  - Fibrous debris, especially E-glass and mineral wool
  - Exposed concrete
  - Calcium silicate from Marinite boards

Response to Issue 3o2.4:

CCI performed quality-assured chemical effects testing for Calvert Cliffs.

Response to Issue 3o2.5:

The plant-specific chemical effects were assessed by test. The methods of Reference 22 were used to assess the plant specific chemical effects precipitate loading and testing. Chemical precipitates were produced using the methods of Reference 22. A debris bed of fibrous and particulate debris was developed by adding debris to the test flume where the strainer captured and retained the bulk of the debris. Precipitates were added after the debris bed was formed.

Response to Issue 3o2.6:

Calvert Cliffs did not use an AECL model.

Response to Issue 3o2.7:

Calvert Cliffs did not use an AECL model.

Response to Issue 3o2.8:

Calvert Cliffs did not deviate from the WCAP base model spreadsheet.

Response to Issue 3o2.9:

The predicted amount of plant-specific precipitates is provide in the table below.

Table of Base Model Chemical Precipitates for Calvert Cliffs		
Precipitate	**Quantity for TSP Buffer**	**Quantity for STB Buffer**
$Ca_3(PO_4)_2$ (calcium phosphate)	140.73 lbs	0 lbs
$NaAlSi_3O_8$ (sodium aluminum silicate)	118.65 lbs	106.8 lbs
AlOOH (aluminum oxy-hydroxide)	0 lbs	0 lbs

Response to Issue 3o2.10:

Calvert Cliffs does not use refinements to the methods of WCAP-16530-NP (Reference 22).

Response to Issue 3o2.11:

The quantity of damaged insulation and coatings exposed to spray or sump water is used in the calculation of chemical precipitates. Exposed concrete, including any exposed by failed coatings post-LOCA, and metals within containment also are considered.

Response to Issue 3o2.12:

Inhibition or passivation of aluminum was not used in determining aluminum corrosion and the resultant chemical precipitates.

Response to Issue 3o2.13:

No reduction of chemical precipitates was achieved by crediting solubility.

Response to Issue 3o2.14:

See the table in Response to Issue 3o2.9.

Response to Issue 3o2.15:

Precipitates are formed in a separate mixing tank.

Response to Issue 3o2.16:

Precipitates were not formed by injection into the test loop.

Response to Issue 3o2.17:

Precipitates were not formed by injection into the test loop.

Response to Issue 3o2.18:

Precipitates were not formed by injection into the test loop.

Response to Issue 3o2.19:

No exceptions to the procedures of Reference 22 were taken.

Response to Issue 3o2.20:

Credit for near-field settlement in the plant is not intentionally taken. Near-field settlement of fibrous debris in the test was observed and could not be eliminated even with agitation and with debris additions immediately adjacent (within 15 cm) of the strainer module under test. Two tests were performed to demonstrate repeatability. Similar quantities of settled debris were observed in both tests.

Near-field settlement of chemical precipitates was not intentionally credited in the tests. Some chemical precipitates accumulated on the settled fibrous debris similar to the accumulation on the debris bed captured by the strainer.

Response to Issue 3o2.21:

See the Response to Issue 3o2.24 below for the one-hour settlement values of the chemical precipitates.

Response to Issue 3o2.22:

No chemical precipitate settled away from the strainer. Some settled on the settled fibrous debris immediately in front of the test strainer. No separate estimate of chemical precipitates settled was provided in the test report from CCI. However, their overall estimate for all debris including precipitates was 40-45% settled. A reasonable assumption is that the chemical precipitates settled in the same proportion as the other debris.

Response to Issue 3o2.23:

CCI estimated that about 45% of the debris settled to the test flume floor immediately adjacent to the strainer in Test 2 of the May 2008 tests. Test 3 had about 40% settling.

The strainer pockets appeared full of fibrous and particulate debris immediately before chemical precipitate addition. Agitation was unable to move more debris into the strainer pockets because of the low flow rates at and into the strainer. The strainer face flow speed is about 0.002 feet per second and the approach speed for the strainer as it transitions to a more simple shape once it is full is about 0.02 feet per second. Neither flow rate is adequate to maintain debris in suspension for long. Debris that does not get into the pockets during initial loading and subsequent agitation cannot move into pockets later.

The strainer pockets generally were full of fibrous debris and chemical precipitates at the end of the tests. Increased head loss due to the chemical precipitates caused an increase in head loss but did not appear to significantly compress the debris filling the strainer pockets.

Response to Issue 3o2.24:

One hour precipitate settling for the quality-assured tests is provided in the table below.

Table of Base Model Chemical Precipitates Settled Volume for Calvert Cliffs		
Precipitate	**Settled Volume Quantity for Test 2 Chemical Precipitates**	**Settled Volume Quantity for Test 3 Chemical Precipitates**
$Ca_3(PO_4)_2$ (calcium phosphate)	56%	48%
$NaAlSi_3O_8$ (sodium aluminum silicate)	90%	90%
AlOOH (aluminum oxy-hydroxide)	NA	NA

Response to Issue 3o2.25:

The quality-assured tests were terminated by test director discretion. As can be seen in the figure in Response to Issue 3o.2.26, the head loss across the strainer and debris bed at termination was substantially less that the peak head loss. Furthermore, the head loss generally was decreasing but unsteadily. No further test effects were planned. No effects were expected which would cause the head loss to begin to generally increase.

Response to Issue 3o2.26:

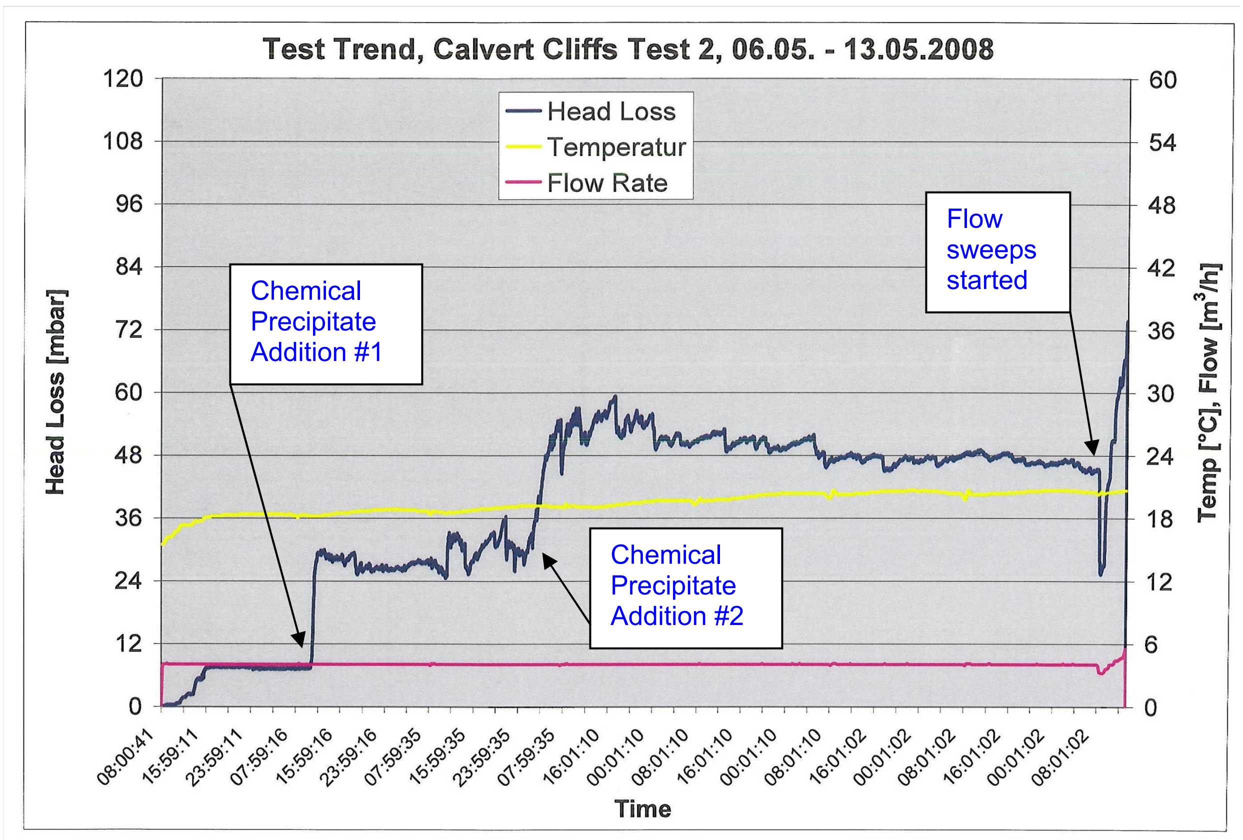
The following figure presents the test results from the May 2008 tests.

The tests concluded with a flow sweep where the flow was varied in discreet steps from 80% to 120% of the nominal design flow rate. These variations were performed to investigate the following:

- The effect that flow fluctuations would have on the stability of the debris bed formed on the strainer, and

- The effect flow speed variations would have on the head losses across the strainer and debris.

At the far right of the figure, one can see the flow variations and the resultant head losses. Prior to the start of the flow sweeps, the head loss across the strainer and debris was about 45 millibar. When the flow was restored to 100% of the design flow during the flow sweep, the head loss was about 47 millibar. Such behavior indicates that the debris bed was stable and was not easily disturbed by flow fluctuations. At a flow rate of 120% of design rate, the head loss was about 68 millibar or about 45% greater than the head loss at the design flow rate. This change is consistent with turbulent flow head loss theory where head loss is proportional to the square of the flow speed: increase flow by 20% and achieve 44% increase in head loss (120% x 120% = 144%).



Response to Issue 3o2.27:

Calvert Cliffs uses no data extrapolation methods at this time. Calvert Cliffs uses area-based scaling between the test and the plant design for debris quantities, chemical precipitate quantities, and flow rate through the strainer. Calculations dependent on head loss testing use the head loss test results without modification. The scaled test parameters were bounding on the containment sump strainer especially for debris loading and flow.

Response to Issue 3o2.28:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.29:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.30:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.31:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.32:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.33:

Calvert Cliffs did not perform Alion style testing.

Response to Issue 3o2.34:

Calvert Cliffs did not perform Alion style testing.

***NRC Issue 3p*:**

Licensing Basis

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

Response to Issue 3p:

The Calvert Cliffs licensing basis will be updated in accordance with the requirements of 10 CFR 50.71 to reflect the results of the analyses and the modifications performed to demonstrate compliance with the regulatory requirements. Calvert Cliffs has requested a license amendment to change the containment buffer material from trisodium phosphate to sodium tetraborate (Reference 23). The requested buffer material change will reduce the chemical effects on the strainers by eliminating the calcium phosphate precipitate, thereby reducing the assumed head loss across the strainer.

REFERENCES:

(1) Letter from Mr. J. A. Spina (CCNPP) to Document Control Desk (NRC), dated December 10, 2007, Request for Extension for Completion of Activities Related to Generic Letter 2004-02

(2) Letter from Mr. J. A. Spina (CCNPP) to Document Control Desk (NRC), dated December 20, 2007, Request for Additional Information – Request for Extension for Completion of Activities Related to Generic Letter 2004-02

(3) Letter from Mr. D. V. Pickett (NRC) to Mr. J. A. Spina (CCNPP), Dated December 27, 2007, Extension for Completion of Activities Related to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors"

(4) Letter from Ms. S. C. Black (NRC) to Mr. A. R. Pietrangelo (NEI), dated December 6, 2004, Pressurized Water Reactor Containment Sump Evaluation Methodology

(5) WCAP-16710-P, Revision 0, dated October 2007, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON Insulation at Wolf Creek and Callaway Nuclear Operating Plants"

(6) WCAP-16720-P, Revision 0, dated March 2007, "Jet Impingement Testing to Determine the Zones of Influence for Diablo Canyon Power Plant"

(7) WCAP-16568-P, Revision 0, dated June 2006, "Jet Impingement Testing to Determine the Zones of Influence (ZOIs) for DBA-Qualified/Acceptable Coatings"

(8) SL-009195, Revision 0, dated November 9 2007, "Wyle Jet Impingement Testing Data Evaluation"

(9) NUREG/CR-6808, dated February 2003, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance"

(10) NEI 04-07, Revision 0, December 2004, "Pressurized Water Reactor Sump Performance Evaluation Methodology"

(11) Keeler & Long PPG Report No. 06-0413

(12) WCAP-16406-P, Revision 1, dated August 2007, Evaluation of Downstream Debris Effects in Support of GSI-191

(13) NEI 02-01, April 2002, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments"

(14) NUREG/CR-6916, dated December 2006, "Hydraulic Transport of Coating Debris"

(15) I.E. Idlechik, "Flow Resistance, a Design Guide for Engineers"

(16) NUREG/CR-6224, dated April 2005, "Correlation and Deaeration Software Package"

(17) Letter from Mr. C. H. Cruse (CCNPP) to Document Control Desk (NRC), dated November 13, 1998, Response to Generic Letter 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Deficiencies and Foreign Material in Containment"

(18) ASME Section III, Subsection NF, "Supports"

(19) ASME B&PVC Section III, Division I, Subsection N, "Supports," 2004 Edition including 2005 Addenda

(20) ASME B&PVC Section II, Part D, "Properties," 2004 Edition including 2005 Addenda

(21) WCAP-16793-NP, Revision 0, dated May 2007, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid"

(22) WCAP-16530-NP, Revision 0, dated February 2006, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Supports GSI-191"

(23) Letter from Mr. D. R. Bauder (CCNPP) to Document Control Desk (NRC), dated August 27, 2008, License Amendment Request: Replacement of the Trisodium Phosphate Buffer with a Sodium Tetraborate Buffer

(24) Letter from Mr. J. A. Spina (CCNPP) to Document Control Desk (NRC), dated June 18, 2008, Request for Extension for Completion of Activities Related to Generic Letter 2004-02

(25) Letter from Mr. D. V. Pickett (NRC) to Mr. J. A. Spina (CCNPP), dated June 30, 2008, Extension for Completion of Activities Related to Generic Letter 2004-02