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March 4, 2009

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Request for Additional Information: Supplemental Response to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors

REFERENCE: (a) Letter from Mr. D. V. Pickett (NRC) to Mr. J. A. Spina (CCNPP), dated December 4, 2008, Request for Additional Information Re: Supplemental Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors" -- Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – (TAC Nos. MC4672 and MC4673)

Reference (a) requested additional information related to our supplemental responses regarding Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors. Attachment (1) contains our response to the request.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-5219.

Very truly yours,

JAS/PSF/bjd

Attachment: (1) Request for Additional Information: Generic Letter 2004-02

cc: D. V. Pickett, NRC
S. J. Collins, NRC
Resident Inspector, NRC
S. Gray, DNR

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NRR

ATTACHMENT (1)

REQUEST FOR ADDITIONAL INFORMATION:

GENERIC LETTER 2004-02

RAI 1:

Please state whether the testing identified in the WCAP-16710-P and WCAP-16720-P test reports was specific to the Calvert Cliffs insulation systems named below. If not, please provide information that compares the Calvert Cliffs encapsulation and jacketing systems structures with the systems that were used in the WCAP testing showing that the testing conservatively or prototypically bounded potential damage to the Calvert Cliffs insulation materials. Please provide information relative to impact of differences in jet size and target size, geometry, materials, and methods of construction in the WCAP-16710-P and WCAP-16720-P testing versus those which will be in effect during loss-of-coolant accidents (LOCAs) at Calvert Cliffs. In doing so, please provide a basis for the debris generation conclusions reached for Calvert Cliffs NUKON, Transco Thermal wrap, calcium silicate, generic fiberglass and Temp Mat insulation systems.

CCNPP Response:

Calvert Cliffs' insulation systems were representative of the testing results provided in WCAP-16710-P and WCAP-16720-P. The exceptions would be the Transco reflective metal insulation, the generic fiberglass insulation and the Temp Mat insulation. These materials referenced the Nuclear Energy Institute (NEI) generic guidance in the Calvert Cliffs September 2008 submittal.

RAI 2:

Page 2 of the supplemental response states that the debris generation analysis is being revised. When the final supplemental response is submitted, please include a discussion of any changes that have been made that are associated with debris characterization at a level of detail consistent with the NRC [Nuclear Regulatory Commission] supplemental response revised content guide. The staff will review this information when the licensee submits it, and as a result of such review, the staff could request additional information in this subject area if needed.

CCNPP Response:

As requested, when we provide a final response it will include a discussion of changes associated with debris characterization at an appropriate level of detail for staff review.

RAI 3:

The supplemental response states that the Marinite board is currently assumed to be 100% small fines, but that a revision will be made that will reduce the assumed quantity of small fines. Please provide the revised size distribution for the Marinite board and provide a justification for the assumed size distribution.

CCNPP Response:

Calvert Cliffs uses References 1 and 2 to determine the fraction of small fines of Marinite board that could be generated during a LOCA. Marinite board within a zone of influence (ZOI) of 9.8D is predicted to produce 5% small fines. This is conservative with respect to the test results provided in References 1 and 2, which showed that a minimal amount of fines are created by jet impingement (0.87% -1.37% - depending on orientation of the Marinite board to the jet).

RAI 4:

Please explain the determination of 4.29 ft^3 of latent particulate and 0.57 ft^3 of labels particulate from the walk down assessment of 20 lbm of latent debris and 270 ft^2 of sacrificial area. The walkdown assessed the containment latent debris quantity as 20 lbm. However the debris generation table included 4.29 ft^3 of particulate and zero latent fibers. This equates to 420 lbm of latent particulate. Further, the *procedure for calculating miscellaneous debris sacrificial area is not completely described and insufficient to judge the adequacy of the calculation. 0.57 ft^3 of label particulate was assumed, which equates to 57 lbm of labels which become particulate. The physical process by which labels become particulate is not understood. Please provide an explanation for material condition conversion.*

CCNPP Response:

The summary of LOCA generated debris table referred to in this Request for Additional Information (RAI) was revised and provided in the September 30, 2008 submittal. Please refer to Table 3b4-1 on page 7 of the September 30, 2008 Supplemental Response to see the most recent data.

Calvert Cliffs no longer uses the assumption in its debris generation calculation that labels are destroyed to particulate.

See the response to RAI 9.

RAI 5:

Please provide a detailed summary of the methodology for estimating the latent fiber and particulate total masses. Please include a description of surface types sampled and extrapolation methods.

CCNPP Response:

The containment was sampled via a walk down procedure developed by Sargent & Lundy. The walk down was performed to collect latent debris samples from the various surfaces in containment. The surface types sampled included: 1) containment liner, 2) floor, 3) stair grating, 4) walls, 5) horizontal cable trays, 6) vertical cable trays, 7) horizontal piping, 8) vertical piping, 9) horizontal ducting, 10) vertical ducting, 11) horizontal equipment, and 12) vertical equipment. A minimum of four samples were taken from each surface type. The area of each sample was recorded along with the weight of latent debris in the sample area. The average and maximum weight per unit surface area were recorded. The averages were then multiplied by the horizontal and vertical surface areas that might have latent debris accumulate on them which resulted in the latent debris loading for containment. The latent debris load results used the maximum sample for each surface type with the exception of the grating of stairs where it was determined that a non-representative sample existed.

RAI 6:

Please identify the percentage of fiber and the percentage of particulate in the collected latent debris samples.

CCNPP Response:

Since Calvert Cliffs is considered a high fiber plant, the latent debris was considered all particulate since it would not have resulted in a significant percentage increase in fiber.

RAI 7:

Please provide a description of the tag, label and placard latent debris walk down procedure.

CCNPP Response:

There was no specific tag, label, and placard latent debris walk down completed at Calvert Cliffs.

See the response to RAI 9.

RAI 8:

Please provide the total areas of tags, labels and placards latent debris that were found in containment.

CCNPP Response:

There was no specific tag, label and placard latent debris walk down completed at Calvert Cliffs.

See the response to RAI 9.

RAI 9:

Please provide a technical justification for neglecting the valve tag labels and placards in the latent debris walk down results.

CCNPP Response:

The strainer design allows for 375 ft^2 of sacrificial surface area. This is to account for the stick-on type of labels applied to items such as cable trays. Valve tag labels are made of materials that will sink intact and procedures require that all placards be chained so they won't transport to the sump strainer.

RAI 10:

Page 2 of the supplemental response states that the containment debris transport analysis is being revised. When the final supplemental response is submitted, please include a discussion of the changes that have been made to the transport calculation at a level of detail consistent with the NRC supplemental response content guide. The staff will review this information when the licensee submits it, and as a result of such review, the staff could request additional information in this subject area if needed.

CCNPP Response:

As requested, when we provide a final response it will include a discussion of the changes made to the transport calculation at an appropriate level of detail for staff review.

RAI 11:

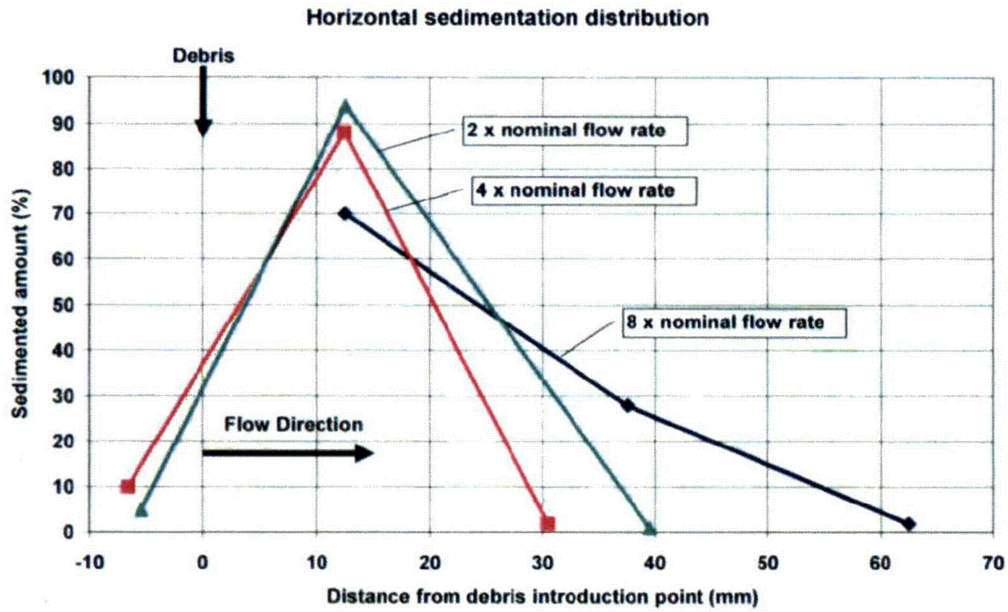
The supplemental responses indicates that, while a computational fluid dynamics analysis of the containment pool during recirculation was not performed, coating chips were observed to fall to the flume floor during head loss testing. Therefore, a lack of transportability for coatings was assumed in the containment pool, and the NUREG/CR-6916 results were assumed to be applicable to Calvert Cliffs. Please identify the size range of the coating chips that were tested and provide a basis for considering the fluid velocity and turbulence in the head loss test flume as being similar to the range of values expected in the Calvert Cliffs containment pool. This will enable the NRC staff to evaluate the technical basis and methodology used to derive the unqualified coating transport fraction of 0.0624.

CCNPP Response:

The test of transportability of coatings chips used coating chips size distribution of 1-4 mm.

Results of transport test for these coating chips are provided in Figure 11-1 below. These results show that at high flow rates, 8 times nominal, average transport is well under 1 meter (40 inches) from the introduction point for the entire depth of the containment pool. Therefore, the test flow rates were much greater than expected in the plant post-LOCA. Corresponding turbulence levels were not measured nor are they calculated for the plant. Transport distances are negligible for the size of the containment at Calvert Cliffs.

Figure 11-1. Coatings Transport Test Results



RAI 12:

A two-category debris size distribution (small fines and large pieces) was assumed for the debris characteristics and transport analyses. Please identify how debris was categorized into sizes for head loss testing and provide a technical basis for concluding that a prototypical or conservative quantity of fine (readily suspendable) debris was included in the head loss testing for Calvert Cliffs.

CCNPP Response:

Calvert Cliffs uses the guidance provided by NEI in NEI 04-07, Revision 0.

This results in the following assumptions:

- 60% of the destroyed NUKON, Thermal Wrap, and Temp-Mat insulation are considered fines and transportable.
- 100% of Mineral Wool and Generic Fiberglass insulation are considered fines and are transportable.

Test procedures in use at Control Components, Incorporated (CCI) reduce insulation to fines, which are introduced into the test flume. Bounding quantities of insulation were used in head loss testing. Therefore, conservative quantity of insulation fines were used in head loss testing, including chemical effects head loss testing.

All particulate debris (coatings, latent dust and dirt, and Marininte board) are assumed to be fully transportable. Particulates were selected to mimic the particulate sizes. Bounding masses of particulate were selected when test materials were identical to plant materials. When surrogates were used, the volumes were identical to provide an appropriate numbers of particles.

RAI 13:

Please provide details of the debris preparation and additional procedures used. Please include a description of fibrous concentration during debris addition, the debris addition location, the method of adding fibrous debris to the test tank, and the sequence of debris addition. Please provide verification that the debris preparation and introduction processes did not result in non-prototypical settling, agglomeration, or deposition of debris.

CCNPP Response:

The debris preparation and additions methods used by CCI for Calvert Cliffs are identical to those witnessed by the NRC in Spring 2008 at CCI's laboratory in Switzerland.

Fibrous debris for use in tests was prepared by the following method:

- Bake all fibrous insulation except generic fiberglass at 250°C for 24 hours
- Segment the insulation into small pieces approximately 50 mm cubed
- Add about 25% of the all types of insulation to a small amount of water to wet the insulation
- Blast the slurry with a heated water jet at about 100 bar (1,500 psi) for at least 4 minutes
- Visually inspect the resultant debris suspension to verify complete destruction to fines. Repeat water jet blast if not fully fines.

Fibrous concentration of the insulation debris suspension was about 0.4 pounds per cubic foot. Particulate debris was added to a suspension via mixing at a concentration of about 0.003 cubic feet of particulate per cubic foot of water. Neither type was mixed together, there were no mixed mode suspensions during preparation and addition. Both debris types were further diluted during the addition process but not uniformly. Fibrous and particulate debris were added to the test flume about 1 to 1.5 meters upstream of the strainer under test. The normal test sequence was to alternate fibrous insulation additions and particulate additions during a single batch add. That is, one batch might consist of several containers of fibrous debris and several of particulate debris; additions of each type would be alternated until all of the batch was added.

Chemical precipitate was added about 3 meters upstream of the strainer.

Agglomeration was not observed. All debris was transported the strainer either directly or via resuspension in the flume flow through the action of agitation methods. Calvert Cliffs test methods are conservative in the delivery of material to the strainer.

RAI 14:

The NRC staff noted that for a small-break LOCA, strainer submergence could be as little as 1 inch. Please describe the results of the vortexing evaluation for both the limiting small-break and large-break LOCA cases, and please provide a technical basis to demonstrate that vortexing will not occur for the Calvert Cliffs strainer. Please include a discussion of how the vortexing analysis accounts for the potential for non-uniform flow (caused by both the suction force applied at the suction pipe inlets and the external containment pool flow pattern) to result in increased flow rates for some strainer modules.

CCNPP Response:

Vortexing was investigated at both minimum submergence depths, 1 inch for a small-break LOCA and 6.3 inches for a large-break LOCA. The flow rates investigated range from 80% of the design flow rate to more than 500% of the design flow rate. No vortexing was seen in any tests. The large extreme in flow rates with no evidence of vortexing provides that assurance that variations in flow across the strainer will not result in vortexing.

RAI 15:

In light of the potential for strainer submergence depths as little as 1 inch for small-break LOCAs, please discuss whether any significant sources of water drainage could enter the containment pool directly above or in the immediate vicinity of the strainer, and whether this drainage could result in significant splashing and/or disturbances at the containment pool surface and therefore lead to unacceptable air entrainment through the strainer surface. In addition, please clarify whether the top surface of the strainer modules (i.e., the upper face of the cartridges) is perforated or solid plate.

CCNPP Response:

The "C" Row (see Figure 15-1) is exposed to some overhead drainage and to a minor amount of direct spray flow. Some spray flow collects on concrete surfaces and drains directly onto part of the strainer. The majority of the "A" and "B" Rows are sheltered from sprays, drainage, and direct blowdown by the concrete structures in Containment. The ends of rows "A" and "B" are uncovered, but the tops of the strainers are solid, not perforated. Therefore, no flow enters the strainers directly downward.

The strainer is about 1 meter tall and is underwater even for a small-break LOCA. No significant air ingestion is expected, even with splashing, due to the following: the water depth, the low flow induced head loss across the strainer in a small-break LOCA, and the test results when looking for air ingestion (at least four-times normal flow with 1-inch submergence and no air ingestion).

Figure 15-1. Strainer Rows

RAI 16:

Please provide the results and methodology for the final strainer qualification testing for head loss and vortexing with a level of detail consistent with the information requested in the NRC staff's content guide for supplemental responses. The staff will review this information when the licensee submits it, and as a result of such review, the staff could request additional information in this subject area if needed.

CCNPP Response:

The abbreviated procedure for performance of the tests is provided below. The results for one of the tests, specific to use of sodium tetraborate decahydrate (STB), is provided. Maximum head loss observed was nearly 700 millibar and is used as the design head loss across the strainer for debris laden conditions, including chemical effects. Initial flow rates are nearly 700% of the nominal and provide (along with additional non plant-specific CCI vendor test data) a clear basis supporting no vortex formation. Flow sweeps are performed at the conclusion of the test to demonstrate stability of the bed.

Please note that recent aluminum solubility test results, which show little to no aluminum based precipitates are expected for Calvert Cliffs, would provide for much reduced chemical effects and hence much lower head losses. Therefore, the design basis head loss including chemical effects is expected to be reduced for containment sump high temperature conditions once all relevant testing is complete.

The STB test results are bounding for both buffer conditions [currently installed trisodium phosphate dodecahydrate (TSP) in Unit 1 and STB to be installed in Unit 2 during the 2009 Refueling Outage].

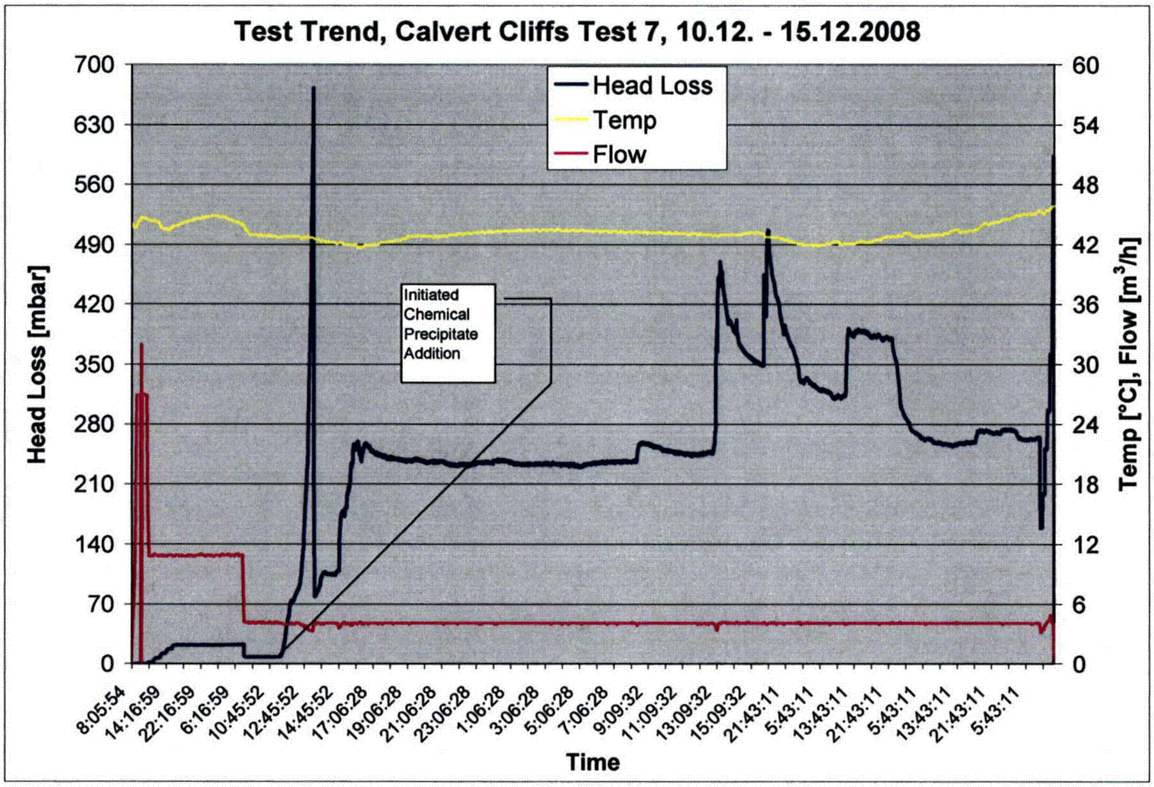
Further, the response to RAI 31 presents discussion pertinent to the design basis head loss specific to the TSP conditions of Unit 1. Some design bases analyses are still being completed.

1. Perform Clean Head Loss Test at 80% to 500% nominal flow rate.
2. Prepare fibrous insulation debris. Use heated water jet blasting for at least four minutes in each batch. Verify fines with no clumps remaining.
3. Prepare particulate by soaking in water.
4. Fiber / Particulate Debris Introduction
   a. Ensure appropriate flow rate and water temperature per test plan.
   b. Add combined fiber and particulate debris about 1.5 meters in front of the strainer.
   c. Ensure transport to the strainer by appropriate agitation. Ensure appropriate distribution of debris across the strainer without center weighting.
   d. Add debris per plan for thin bed investigation or for normal bed investigations as required in the test plan.
   e. Alternate fibrous and particulate additions per test plan.
5. Maintain water level within tolerance.
6. Chemical Precipitate introduction
   a. Adjust flow rate per test plan.
   b. Add sodium aluminum silicate precipitate immediately adjacent to the sparger (return of flow from the heater to the test flume) per test plan. Use of a peristaltic pump is permitted and encouraged.
   c. Addition rate is specified in the plan but is intended to be slow enough to prevent spikes in the head loss measurements caused by overly rapid additions.
   d. Ensure transport of the debris bed by appropriate agitation.
7. Test termination Criteria are specified below:
   a. The test strainer head loss has stabilized and is not increasing and a minimum of 48 hours has elapsed since the final chemical addition was completed.
   b. After 96 hours has elapsed since the final chemical addition was completed with head loss still increasing.

c. At the discretion of the Test Director for safety of personnel or equipment only.

8. Perform a flow sweep at the end of the test to demonstrate bed stability.
   a. Reduce flow rate to 80% nominal.
   b. Increase flow rate in increments to at least 120% of nominal. A few tests investigated flow rates as high as 250% of nominal.

Figure 16-1. Head Loss Test Results Including Chemical Effects Specific for STB Buffer



Note: Agitation performed at about 13:00, 18:00 Day 2 and about 08:00 Day 3.

RAI 17:

The supplemental response's discussion of previously conducted testing for Calvert Cliffs indicates that debris settling was observed in the test flume. However, a sufficient basis for demonstrating the prototypicality of this observed settling was not provided, such as a comparison of the velocity and turbulence in the test flume to the velocity and turbulence fields in containment predicted by computational fluid dynamics. Please estimate the quantity of debris that settled in the flume during the final qualification head loss testing for Calvert Cliffs and provide a technical basis to justify any significant quantities of settled debris (including chemical precipitates).

CCNPP Response:

Current test methods produce no sedimentation or settling distant from the strainer test module. All debris types (i.e., particulate, insulation, and chemical precipitate) are transported to the strainer. Some of this transported debris enters the strainer pockets. Some adheres to the strainer face, and some transports to the base of the strainer where it is partially attached to the strainer face and partially supported by the flume floor. The portion that is partially supported by the flume floor is generally about 20% of the total.

The balance is in the pockets or attached to the face of the strainer, (about 72%) or has settled on top of the strainer test module (about 8% of the total). Figure 17-1 illustrates the location of the debris.

See the response to RAI 18.

Figure 17-1. Photograph of Debris Laden Test Strainer Module

Note the debris transported to the base of the strainer.

RAI 18:

If agitation was utilized to prevent debris settling in the final strainer qualification testing, please verify that the debris bed on the strainer was not non-conservatively disturbed by the agitation and that non-prototypical transport in the flume did not result.

CCNPP Response:

Agitation was used to ensure transport of all forms of debris. Since no sedimentation occurred in the tests, all debris calculated to be at and on the strainer actually is on the strainer under test. Bounding debris transport was achieved in the head loss testing.

Great care was used to prevent debris bed disturbances. Photographic and videographic records show that the test debris beds remain undisturbed during agitation.

RAI 19:

The supplemental response states that head loss results will be scaled by viscosity to a temperature of 100°C. However, the supplemental response also states that previous testing identified borehole formation in the debris bed, a condition under which viscosity scaling is considered inappropriate. Please state whether boreholes were observed during the final strainer qualification testing and state whether viscosity scaling was used. Technical justification should be provided if boreholes were observed and viscosity scaling was performed.

CCNPP Response:

Boreholes or other break-through phenomena were observed in the final head loss testing., Calvert Cliffs does not credit viscosity scaling as a temperature correction methodology

RAI 20:

The supplemental response states that containment accident pressure is not credited in evaluating whether flashing would occur across the strainer surface. Final head loss results were not provided in the supplemental response, but the staff noted that the minimum submergence of the strainer is only 1 inch for a small-break LOCA and 7 inches for a large-break LOCA. Please provide an updated discussion of the strainer flashing analysis when the final head loss results are submitted.

CCNPP Response:

Calvert Cliffs test results show that the clean strainer head loss is nearly immeasurable at about 0.1 to 0.2 millibar even at more than 5 times the nominal flow rate. With the full debris added to the strainer, the flow rate test result is about 5 millibar (about 2 inches WC) at nominal flow rate and 12 millibar (5 inches WC) at 270% of nominal. The large-break LOCA submergence, which is 6.3 inches submergence, is greater than these values. Therefore, no flashing would occur in a large-break LOCA condition at the start of recirculation.

Small-break LOCAs are expected to generate little debris. Therefore, their lesser submergence, which is greater than the clean strainer head loss, will not cause flashing to occur at the start of recirculation.

Once chemical effects are assumed to affect the head loss and, hence, the head loss is potentially much greater, the avoidance of flashing requires sub-cooled margin where the water in the sump is sufficiently cooler to avoid vapor formation even at the high head losses.

RAI 21:

Please provide the test termination criteria and the methodology by which the final head loss values were extrapolated to the emergency core cooling system (ECCS) mission time or some predicted steady state value. Please provide a graph of head loss versus time from the design basis head loss test and discuss the application of the extrapolation methodology to the data.

CCNPP Response:

Head loss testing test termination criteria were to have stable or not increasing head loss at termination. This provides assurance that extrapolation of results will be bounding and conservative.

The peak head loss seen in testing occurred early in the test and is about 700 millibar (23.5 feet WC). Subsequent results were declining and much lower than the peak value. Extrapolation of results to address long term operation is not required. Flow sweeps performed at the end of the test results in a high head loss as seen in Figure 16-1.

A graph of head loss test results is provided in the response to RAI 16.

RAI 22:

Please identify the debris loading conditions for which the final strainer maximum head loss occurs and confirm that testing has been performed to verify that the strainer, when laden with a thin bed or maximum debris loading, will not result in unacceptable head losses. In particular, based on Item 3f6 in the supplemental response, it is unclear to the staff that the thin bed test protocol for Calvert Cliffs examined the most limiting thin bed condition. Although some complex strainer surfaces may resist the formation of a uniform debris bed with only enough debris introduced to form a theoretical thickness of 1/8 inch, the introduction of additional debris can still result in thin bed formation.

CCNPP Response:

Calvert Cliffs thin bed testing included beds as thin as 1/16 inch up to a nominal full load of debris and included a wide range of simultaneous particulate loading. This ensures that the maximum head loss condition for the CCI strainers and for the Calvert Cliffs debris loads is identified. Maximum head loss occurs with maximum debris. The CCI strainer exhibits no thin bed effect.

RAI 23:

Please provide complete detail concerning the potential impact and mitigation of the single failure assumptions relevant to pump operation and sump performance at Calvert Cliffs. Specifically, the supplemental response indicated that failure of a low pressure safety injection pump to stop at the initiation of recirculation was identified as the worst-case single failure at Calvert Cliffs, and that a future supplemental response would provide supporting information as to how this failure would be mitigated successfully.

CCNPP Response:

The single-failure assumption referred to in this RAI was revised and provided in the September 30, 2008 submittal. Please refer to Response to Issue 3g7 on page 21 of the September 30, 2008 Supplemental Response.

RAI 24:

Please confirm and justify that the degraded qualified coatings systems used at Calvert Cliffs are of a comparable nuclear grade to the coatings systems tested by Keeler and Long (K&L Report No. 06-0413) in order to show that the degraded qualified coatings fail completely as chips. The degraded qualified coating chips were assumed by the licensee to settle in the pool based on NUREG/CR-6916 for certain chip sizes and flow velocities. However, the chip sizes were not provided in the supplemental response. Please provide the size distribution of the degraded qualified coatings chips.

CCNPP Response:

Degraded qualified coatings systems used at Calvert Cliffs are of a comparable nuclear grade to those tested by Keller and Long. However, the inorganic zinc primers will fail as particulates and the epoxy top coats will fail as chips. The epoxy top coat chips will all fail to a size greater than 1/32". Calvert Cliffs obtained a copy of K&L Report No. 06-0413 and verified it's applicability to the coatings at Calvert Cliffs. The conclusion of the verification was that the coatings applied were of a comparable nuclear grade as to those in the K&L Report.

RAI 25:

If it is determined that degraded qualified coatings debris at Calvert Cliffs is in the form of particulates, please provide the quantity of this material that is generated during a LOCA.

CCNPP Response:

It has been determined that the degraded qualified coating debris from the inorganic zinc primers at Calvert Cliffs will be in the form of particulates. Calculations identify that the conservative bounding quantity of particulate-form degraded coatings in Containment is 3.827 ft^3.

RAI 26:

Please describe how the Calvert Cliffs containment cleanliness and foreign material exclusion (FME) programs assure that latent debris in containment will be monitored and maintained below the amounts and debris characterization assumed in the ECCS strainer design. In particular, what monitoring and cleaning is planned for areas/components that are normally inaccessible or not normally cleaned (containment crane rails, cable trays, main steam/feed water piping, tops of steam generators, etc.)?

CCNPP Response:

Calvert Cliffs has numerous procedures in place to monitor and manage cleanliness inside Containment. These procedures and practices will be continued in the future to ensure the current standard of cleanliness is maintained. These include:

- OP-6, "Pre-Startup Checkoff," specifically Sections 6.2, *Mode 4 Containment Closeout Inspection*, Section 6.5, *Mode 2 Containment Closeout*, and Section 6.6, *Quick Trip Recovery Cntmt Closeout Inspection*. These sections characterize inspections as "intense searches." The procedure specifically includes instructions to look for items "...which could clog the sump screens..." and include loose lagging, dirt and debris. All deficiencies are required to be documented.
- CNG-MN-1.01-1001, "Foreign Material Exclusion," which classifies the containment sump as a Special Foreign Material Exclusion Area – "Special Foreign Material Exclusion Area (SFMEA) – A Zone 1 FMEA for which predetermined FME restrictions apply."
- NO-1-103, "Conduct of Lower Mode Operations," contains the statement, "Containment cleanliness during the outage is a prime concern...", and Section 5.1M dedicated to *Containment Cleanliness.* This section contains the following note: "The containment emergency sump is required by several AOPs to be OPERABLE. Containment cleanliness is necessary to support recirculation. Floatable debris within the containment may clog the sump if recirculation is initiated."
- NO-1-104, "Containment Access," discusses the visual inspections that must take place when leaving containment.

During the outage, there are also scheduled walk downs twice daily of containment which includes cleanliness. The polar crane is inspected along with the rails and any areas that require cleaning receive it. The steam generators were recently replaced. Most areas are accessible and are inspected and cleaned if necessary during each outage. The most remote areas are the top of the safety injection tanks that are monitored via remote camera. There are plans to clean the outside of the safety injection tanks in future outages.

RAI 27:

The supplemental response dated September 30, 2008, indicates that two refueling pool compartments could retain water up to the level of the refueling pool seal ring since the drain to these compartments is a 1-inch drain. Once the water level reaches the level of the seal ring, the response notes that water *would spill into the reactor cavity. The response indicates that the reactor cavity is drained through a 2-inch pipe that contains a valve. The supplemental response did not provide adequate basis to conclude that debris washed down by spray drainage (which could include reflective metallic insulation, fiber, particulate, foreign materials, etc.) would be precluded from blocking the drains to the refueling pool compartments or the reactor cavity. Instead, a water volume of 3,792 ft^3 was assumed to be trapped in the reactor cavity and an unspecified volume of water was assumed to be trapped in the refueling pool below the seal ring elevation. However, based on the information in the supplemental response, the staff noted that, if the refueling pool and reactor cavity drains (or drain valve) become blocked and the reactor cavity fills with water, it is unclear that additional water would not subsequently be held up in the refueling pool in excess of the quantity assumed by the licensee to be retained in the two compartments below the seal ring elevation. Please provide adequate technical basis to demonstrate that the assumed quantity of water hold up for the refueling pool is conservative.*

CCNPP Response:

The flow path is water from the Containment Spray System is sprayed from the containment dome area and falls into the refueling canals. The canals then overflow to the reactor cavity since the drains are very small and assumed to be clogged with debris. The reactor cavity fills since it has a 4-inch drain that drains to the normal containment sump through a 2-inch drain line with a 2-inch valve that is also assumed to become clogged. The water spilling from the refueling canals flows down into the reactor cavity through the hatches or doors in the permanently installed seal between the reactor upper flange and the reactor cavity wall. When the cavity water level reaches the hot leg penetration, increasing water then spills out into the pump bays and hence to the 10 foot level and the recirculation pool. There is about 6 inches of clearance between the hot leg penetration and the hot leg so there is adequate flow passage to prevent additional filling to occur. See Figures 27-1 and 27-2 below.

Figure 27-1. Cross-section of Containment

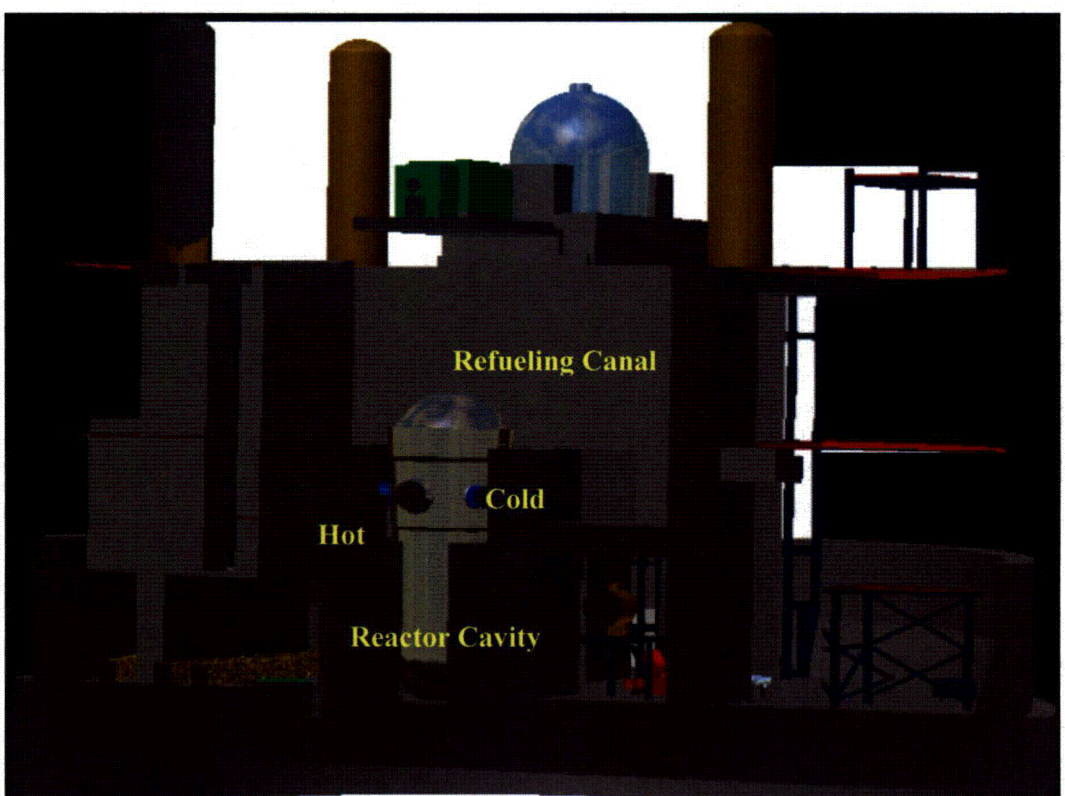
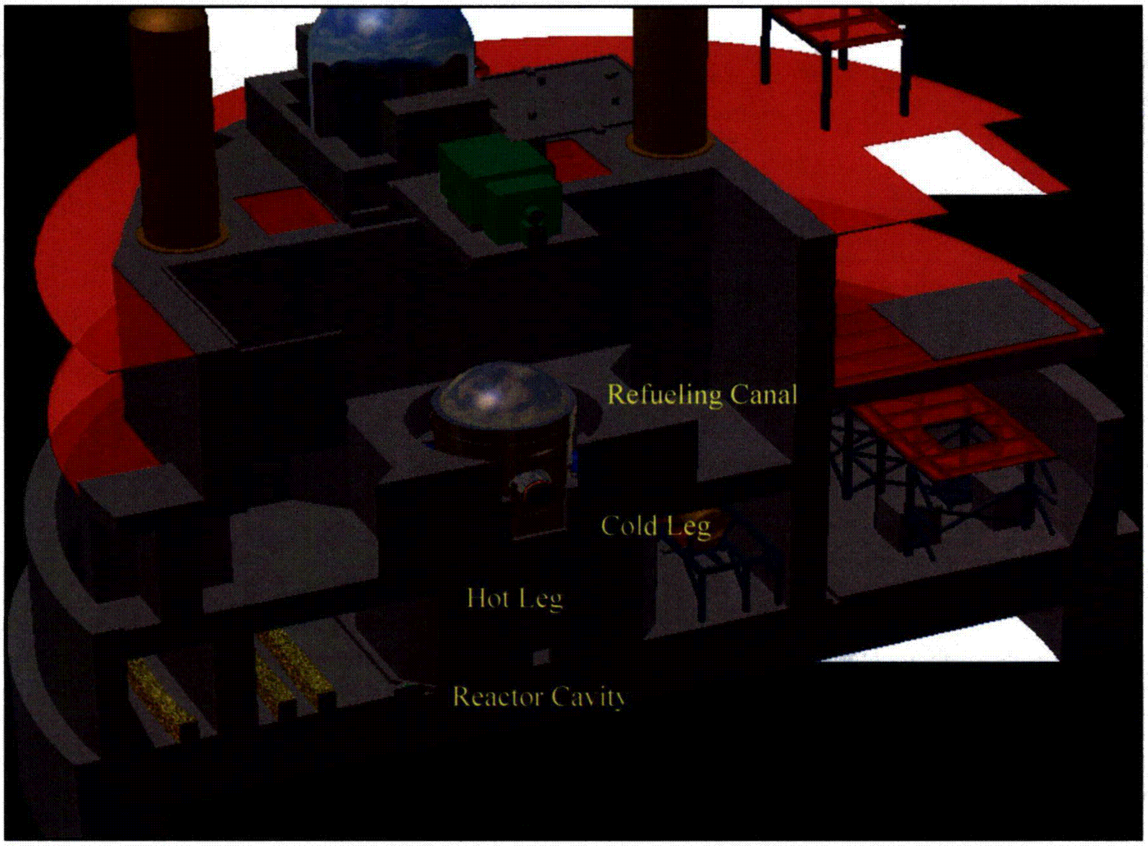


Figure 27-2. Cross-section of Containment



RAI 28:

The NRC staff considers in-vessel downstream effects to not be fully addressed at Calvert Cliffs, as well as at other PWRs. Constellation Energy's submittal refers to draft WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff has not issued a final SE for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for Calvert Cliffs by showing that the licensee's plant conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. The licensee may alternatively resolve this item by demonstrating, without reference to WCAP-16793-NP or the staff SE, that in-vessel downstream effects have been addressed at Calvert Cliffs. In any event, the licensee should report how it has addressed the in-vessel downstream effects issue within 90 days of issuance of the final NRC staff SE on WCAP-16793-NP. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the staff's expectations and plans regarding resolution of this remaining aspect of GSI-191.

CCNPP Response:

Calvert Cliffs plans on demonstrating that in-vessel downstream effects are resolved by showing that Calvert Cliffs' plant conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC Safety Evaluation.

RAI 29:

The NRC staff has been interacting with Control Components, Incorporated (CCI), the Calvert Cliffs chemical test vendor, to better understand the precipitation process that occurs in the multi-function test *loop (MFT). In the CCI letter dated April 29, 2008, "Position Paper on Evaluation of Chemical Effects; Precipitates formed by adding Chemicals to Borated Test Loop Water" (ADAMS Accession No. ML081360162), the table on the last page of the document identifies a significant loss of boron and silica from solution in MFT Test 3 on March 23, 2007. The amount of dissolved material that is captured by the debris (0.546 Kg for boric acid and 0.1 Kg for silica for the 200 L loop) does not seem consistent with other industry tests performed with similar chemical systems. The November 2007 test without debris did not have the same loss of soluble boron and silica. If these test results are relevant to the Calvert Cliffs chemical effects testing at CCI, please discuss what precipitates may be forming to cause the decreased boron and silica measured in solution. Also, please discuss why the November test results may be different from the March 2007 test results.*

CCNPP Response:

The CCI testing for Calvert Cliffs does not use the in-situ chemical method described in this RAI any longer. The change was made after February 2008. All tests of record since then use a simpler method to create the chemical precipitates as described in Chapter 7 of WCAP-16530-NP. The issues described in this RAI are no longer applicable.

RAI 30:

Please estimate the percentage of chemical precipitate that settled in the test flume at CCI relative to the percentage that was contained in the strainer pockets.

CCNPP Response:

The testing at CCI has virtually no sedimentation on the floor of the test flume. Agitation as performed by CCI during testing for Calvert Cliffs is successful at moving all debris including chemical precipitate to the strainer. Separate estimates are not made for chemical and mechanical debris. Some debris does settle against the strainer at its lower section. Some debris settles on top of the test module. Both locations are considered prototypical because both are available in the design of the strainer as installed in the plant.

The test specification requires estimates of the debris which accumulates in the following locations: on the faces and inside of the strainer, on top of the strainer test module, and in the region immediately in front of and touching the strainer. In the test which concluded in January 2009, about 8% was found on top of the strainer, about 20% on the floor of the test flume immediately in front of the strainer, and about 72% on the strainer face and in the pockets.

Please also see the response to RAI 16.

RAI 31:

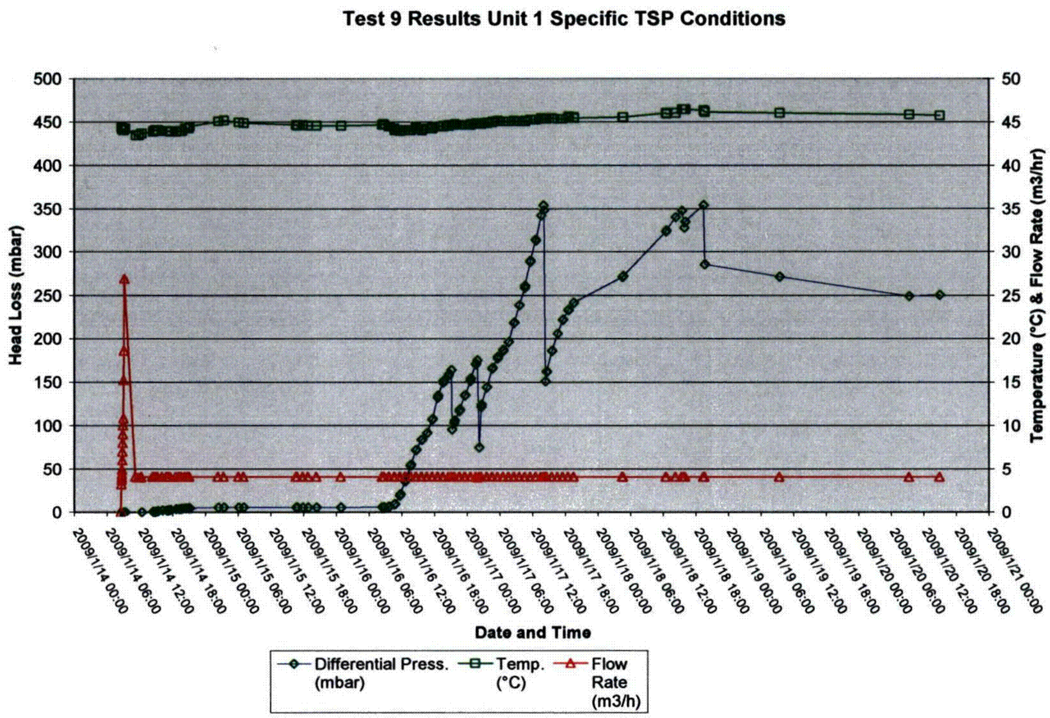
In Attachment 1 to the Constellation letter to the NRC dated June 18,2008 (ADAMS Accession Number ML081710105), you indicated that Calvert Cliffs may be taking additional actions, such as switching the buffer used for control of pH following a LOCA, that would change potential chemical effects. Therefore, please provide the results (e.g., a head loss plot) from any additional chemical effects testing and analysis that has not been previously provided. Please discuss why the overall plant-specific chemical effects evaluation is conservative.

CCNPP Response:

Test methods and results discussed in the responses to RAIs 13, 14, 16, 17, 18, and 21 are for the plant condition assuming the buffer change is already completed. These tests were performed with debris and chemical precipitates appropriate to the post modification condition.

Additionally, a test specific to the current state of Unit 1, with TSP buffer, was performed in January 2009. The results of that test are provided below. The test design used the aluminum solubility results provided by Alion testing to assume no sodium aluminum silicate precipitate. The test used only calcium phosphate precipitate. These results demonstrate adequate net positive suction head (NPSH) margin early in the post-LOCA period and beyond.

Figure 31-1. Test Results for Unit 1 Specific Testing with TSP Conditions



Note: The chemical precipitates addition began on January 16, 2008 slightly before the head loss began increasing.

The overall plant specific chemical effects evaluation is conservative because every input to the test and calculations that support the test or that incorporate test results are conservative. For example, the temperatures used to calculate the quantity of calcium phosphate expected in the plant are bounding. The temperature of the sump water and containment atmosphere used in the chemical precipitate calculation use Technical Specification minimum spray flow for the entire period in the containment response calculation when the containment spray flows are significantly greater than the minimum required by the Technical Specifications. So, bounding high temperatures provide greater thermo-chemical dissolution and corrosion rates than would be expected. In each calculation, these types of inputs use only bounding, conservative values.

The major conservatisms in use at Calvert Cliffs are as follows:

- Bounding zones-of-influence for debris generation are used
- Use of NEI-04-07 (including NRC Safety Evaluation conditions) for debris transport fractions
- Use of WCAP-16350-NP-A to determine the quantity of chemical precipitates
- No temperature corrections to head loss based on viscosity variations dependent on temperature

- No accident overpressure is credited in the NPSH margin calculation
- Use of head loss due to full debris load without chemical effects at the start of recirculation in NPSH margin calculations

The NPSH margin calculation demonstrates that the minimum margin occurs immediately after recirculation starts due to the elevated temperature at that time. The high temperature reduces the effect of sub-cooling of the sump fluid and hence reduces the NPSH available at the containment spray or high pressure safety injection pumps. At recirculation actuation signal, the margin is about 70 millibar (about 2 feet WC) and increases thereafter. As the sump fluid is cooled, the effect of cooling below the saturation temperature of the containment pressure (assumed to be atmospheric pressure in the NPSH margin calculations) provides increasing available NPSH and hence provides increasing NPSH margin. The test results show that the head loss across the debris-laden strainer also increases with increasing calcium phosphate production and accumulation. This effect counters the sub-cooling effect. However, the limiting NPSH margin is immediately after recirculation starts when the temperatures are high. Use of the head loss due to the full debris load (no chemical effect) at the start of recirculation adds conservatism. Debris only starts to accumulate on the strainer at the start of recirculation. Calvert Cliffs' calculations use an assumption that it is complete at the start of recirculation.

Based on the results of the testing in January 2009 and the resultant NPSH margin calculations, Calvert Cliffs has demonstrated that the strainer design installed in Unit 1 will perform its safety function considering the concerns of Generic Letter 2004-02 with the existing buffer material installed in Containment. This considers the balance of conservatisms in the testing and supporting calculations, with the preliminary nature of the aluminum solubility testing results.

References

1. Wyle Laboratories Report No. 54497R07, "Jet Impingement Test of Electromark Labels and Thermal and Fire Barrier Insulation," Revision B, dated August 31, 2007
2. Sargent & Lundy Report Number SL-009195, "Wyle Jet Impingement Testing Data Evaluation," Project No. 12105-506, Revision 0, dated November 9, 2007