UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 16, 2009

LICENSEE: Indiana Michigan Power Company

FACILITY: Donald C. Cook Nuclear Plant, Units 1 and 2

SUBJECT: SUMMARY OF AUGUST 26, 2009, CATEGORY 1 PUBLIC MEETING VIA CONFERENCE CALL TO DISCUSS RESPONSES TO GENERIC LETTER 2004-02 REQUESTS FOR ADDITIONAL INFORMATION (TAC NOS. MC4679 AND MC4680)

On August 26, 2009, a Category 1 public meeting was held via conference call between the U.S. Nuclear Regulatory Commission (NRC) and representatives of Indiana Michigan Power Company (the licensee) at NRC Headquarters, One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to provide an opportunity for follow-up discussion from the public meeting held on August 12, 2009, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092310309). During the meeting, the NRC staff provided the licensee with additional information regarding its proposed response to requests for additional information (RAI) associated with Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" (ADAMS Accession No. ML091490421). The licensee also provided supplemental information for NRC staff review and comment. A list of attendees is provided in Enclosure 1.

The licensee presented information (see Enclosure 2). The information included proposed responses to select RAIs that were discussed at the August 12, 2009, meeting, and were intended to provide further clarification to some of the NRC staff's concerns.

The licensee and NRC staff discussed the proposed RAI responses. The results of the discussion are provided below.

Question 2.a), 3 – The licensee will clarify its responses by providing additional information. The NRC staff indicated that the responses to these questions appear to adequately address the staff's concerns. The staff noted that the licensee could develop debris characteristics for sub-regions within the zone of influence for the material. Alternatively, the licensee could show that there was no Marinite material located within close proximity to any break location.

Question 5 – The NRC staff stated that the principle being used by the licensee to evaluate the issue is acceptable, but also found that it is not appropriate to maintain a design basis quantity of fibrous debris that is greater than the actual quantity in the plant and claim the difference as conservatism.

Question 6 – The NRC staff does not have a basis to close this question.

Question 13 – The NRC staff required additional information (licensee analysis). This information will be presented in a future public meeting, tentatively scheduled for October 14, 2009.

Question 21 – The NRC staff will modify the RAI to provide further clarification. The proposed RAI wording was subsequently discussed with Mr. Joe Waters and Mr. Paul Leonard of the licensee's staff. Mr. Waters and Mr. Leonard agreed that the proposed wording was acceptable, and that the RAI could be formally submitted (ADAMS Accession No. ML092400075).

Question 26 – The licensee's response to this issue appears to adequately address the staff's concerns. The staff requested that the licensee provide minor clarifications to the information provided in the handout when submitting the final RAI response.

Question 27 – The NRC staff requested that the licensee's response be expanded. Specifically, more information is needed to justify that the lack of head loss increases late in the test even after additional precipitate addition. The staff understands that this phenomenon could be expected based on the debris bed composition.

Prior to concluding the meeting, it was agreed that an additional conference call will be held in mid-September to provide clarification on any outstanding concerns.

A public meeting will be held at NRC Headquarters on October 14, 2009, for the licensee to present its final presentation and to finalize the proposed RAI responses. The scope of this meeting will address the more significant NRC concerns, which currently include the licensee's proposed responses to Questions 2.c), 5, 6, 13, 14, 16.b), 17 and 21.

One member of the public was in attendance at this meeting. The public did not have comment.

Any inquiries can be directed to me at (301) 415-3049.

Terry A. Beltz, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosures:
1. List of Attendees
2. Clarified Proposed Responses to Select Requests for Additional Information

cc w/encls: Distribution via Listserv

LIST OF ATTENDEES

AUGUST 26, 2009, TELECONFERENCE WITH INDIANA MICHIGAN POWER COMPANY

TO DISCUSS REQUESTS FOR ADDITIONAL INFORMATION

ASSOCIATED WITH GENERIC LETTER 2004-02

FOR THE DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

NRC	Indiana Michigan Power Company	Public
Michael Scott	Michael Scarpello	Russell Lytton
John Lehning	Joe Waters	(Duke Energy, McGuire)
Steve Smith	Paul Leonard	
Paul Klein	William Knous *	
Chris Hott	Tim Sande *	
Terry Beltz		

* Alion Science & Technology

Enclosure 2

Clarified Proposed Responses to
Select Requests for Additional Information

DRAFT

Response to June 18, 2009 Request for Additional Information (RAI) To Support August 26, 2009 Teleconference Between Nuclear Regulatory Commission (NRC) And D. C. Cook Nuclear Plant (CNP)

This document contains the following information:

- Attachment 1: Clarified Proposed Responses to Select RAIs

Draft
Attachment 1

REQUESTS FOR ADDITIONAL INFORMATION

DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

SUPPLEMENTAL RESPONSES TO GENERIC LETTER (GL) 2004-02

Debris Characteristics

2.c) The much larger forces from a LOCA jet could also create a higher proportion of fine debris by imparting significant energy to dislodged debris pieces, resulting in further fragmentation of larger pieces through impacts with solid structures in containment, an effect that is not modeled in the licensee's ZOI tests.

Response:

As part of the test setup that was utilized for destruction testing, a solid steel backstop and screen material was placed downstream of the nozzle to minimize the potential for debris to be blown into the field beyond the test facility. Refer to the picture below that shows this configuration.

Following the testing of the materials, in particular the Marinite, some of the larger pieces (> ≈ 4 in.) were found on the concrete between the nozzle and the backstop, at about the end of the steel plate that supported the test fixture, as seen in the photo above. A few small pieces of the Marinite had impacted the steel backstop as seen in the picture below, reducing them to fines. Some of the other pieces had traveled at an angle to the test fixture, sliding along the concrete, going underneath the bottom edge of the screen and ending up in the field beyond the test area slab. This test configuration provided for further degradation of the pieces of debris as they impacted the test fixture, concrete, or backstop.

As can be seen from the test setup pictures, the test setup was designed to model the result of dislodged debris as a result of impact with other solid surfaces. With this test setup, dislodged debris had the potential to be reduced in size due to impact with the test fixture, backstop or concrete. From the post-test observations, smaller pieces of debris had the greatest potential for traveling larger distances from the test stand. Larger pieces were typically within a few feet of the test stand.

The assembled test targets were subjected to the summertime humidity in northern Alabama and were weighed prior to the test. Following the test, all pieces of the Marinite were dried in an oven at 200°F for 8 hours and then weighed upon removal from the oven. All post-test weights were less than the pre-test weights, even for those tests where there was no observed loss of material. This method for determination of the fines provided additional conservatism.

Based on the established test configuration and results of the testing, I&M judges that the results of the testing conservatively bounded the potential for fine debris generation for the test materials.

4. *Please provide description and results of verification or analysis done to ensure similarity between the calcium silicate at D. C. Cook and the material tested for both erosion and for the jet destruction testing performed by Ontario Power Generation that is reference in the licensee's submittal.*

Response:

During the extended shutdown for Cook in the 1997 to 2000 time frame, substantial work was performed on the installed insulation systems. This included replacing existing hot pipe fiberglass insulation in potential HELB areas with Cal-Sil or RMI, and reworking a substantial portion of the Cal-Sil insulated piping. The replacement Cal-Sil that was used was Johns-Manville Thermo-12 Gold. The OPG tests were performed with Thermo-12 Gold with aluminum jacketing, as confirmed through discussions with one of the individuals involved with the OPG testing and review of the test report. All metal jacketing used inside the CNP containments is stainless steel jacketing as required by our insulation design specification. The ALION erosion testing performed for CNP also utilized this pre-2002 Thermo-12 Gold insulation, as supplied by CNP.

Debris Transport

6.c) Water draining into the containment pool during the fill-up phase is assumed to be clean. This assumption contributed to the overestimation of debris transport to the main strainer (and underestimation of debris transport to the remote strainer) because the licensee's transport calculation predicted a significant amount of debris transport to the main strainer during the pool-fill phase of the LOCA (and none to the remote strainer). Assuming that water draining into the containment pool is clean is not realistic, and the time dependence of blowdown, washdown, and pool-fill-up transport modes is not well known and can vary significantly from one accident scenario to the next. For this reason, conservatively estimating time-dependent debris transport is very challenging.

Response:

It is acknowledged that there are some important differences in debris transport for different accident scenarios that would affect time dependent transport during the pool fill phase. For example, a large break LOCA (LBLOCA) would result in more rapid ice melt than a medium or small break LOCA (MBLOCA or SBLOCA), the pool would rise faster, the break flow may be higher, etc. However, the quantity of debris generated and transported to the strainers for a LBLOCA far outweighs any potential differences in the time dependent transport that would be associated with a MBLOCA or SBLOCA.

During the blowdown phase, a large portion of the debris that is generated would be blown into the ice condenser where it would be captured by the ice baskets. The ice condenser is designed so that all of the steam blown into it will be condensed. This means that the debris that is blown into the ice condenser will be captured by the ice baskets rather than being blown all the way to upper containment. The tremendous transfer of heat from the steam blowdown to the ice condenser for a LBLOCA would result in a large quantity of ice melting immediately and approximately 80,000 gal of water washing back into the pool in less than 15 seconds (Ref. ALION-CAL-AEP-3085-15, Attachment D). Since the debris blown into the ice condenser would be trapped on the outside of the ice, as the ice melts the debris would be washed back down to the loop compartment. Therefore, essentially all of the debris that is blown into the ice condenser would immediately be washed back into the pool. Therefore, it is reasonable to assume that the debris blown into the ice condenser would be in the containment pool at the beginning of the pool fill phase, and the additional ice melt flow draining into the pool is essentially clean.

The unqualified coatings are assumed to fail after the pool fill phase is over and therefore were treated as being washed into the containment pool in the appropriate locations during the recirculation phase. Also, the latent debris, and other miscellaneous debris sources in upper containment were treated as being washed down more gradually by the containment sprays during the recirculation phase.

Although it is acknowledged that the water entering the containment pool during the pool fill phase would not actually be perfectly clean, the physical phenomena that affect debris transport during the blowdown, washdown, pool fill, and recirculation phases were reasonably accounted for to ensure that the overall transport fractions to both the main and remote strainers are conservative.

7. *Please provide additional information concerning the erosion testing of calcium silicate insulation and Marinite board, including the following items:*

   a) *The basis for not accounting for erosion and dissolution effects in combination. The presence of chemicals in the test fluid may enhance the erosion rate, and, conversely, a high erosion rate may lead to increased dissolution.*

Response:

ALION-REP-AEP-4462-02, "D. C. Cook Material Transport, Erosion and Dissolution Report", a Cook Specific report, summarizes the results of the testing performed by Alion to measure the erosion and dissolution of Cal-Sil insulation material and the erosion of Marinite I insulation material as described in detail in the following Alion proprietary reports:

1. ALION-REP-LAB-2352-101, "Flow Erosion Testing of Cal-Sil Insulation Debris":
   This testing used Alion obtained Thermo-12™ Gold from the Industrial Insulation Group (IIG) as the standard and tested four other types of plant provided Cal-Sil samples. Approximately 3"x3"x1" pieces of Cal-Sil insulation, each weighing approximately 35 to 40 grams were tested for erosion at a constant flow velocity of 0.4 ft/s.

2. ALION-REP-LAB-2352-218, "Marinite I Flow Erosion Testing Report":
   This report compares the limited testing of four Marinite I samples with the results presented in the Cal-Sil Flow Erosion Report.

3. ALION-REP-LAB-2352-76, "Calcium Silicate Insulation Debris Dissolution Report":
   This report describes the dissolution testing of Thermo-12™ Gold Calcium Silicate insulation manufactured by IIG and aged Thermo-12® Gold Calcium Silicate insulation manufactured by Johns Manville (CNP specific material).

The data collected during Thermo-12™ Gold flow erosion testing was analyzed in the Cal-Sil Flow Erosion Testing Report. The data in Figure 7.a-1 represents the rate of erosion of Thermo-12™ Gold Cal-Sil as presented in Figure 3.2-3 of Cal-Sil Flow Erosion Testing Report. The equation from 3.2-3 (i.e. $y = 1.3286x^{-0.816}$) is used to calculate the cumulative % weight loss data and the curve generated from this data is presented in Figure 7.a-1 as well.

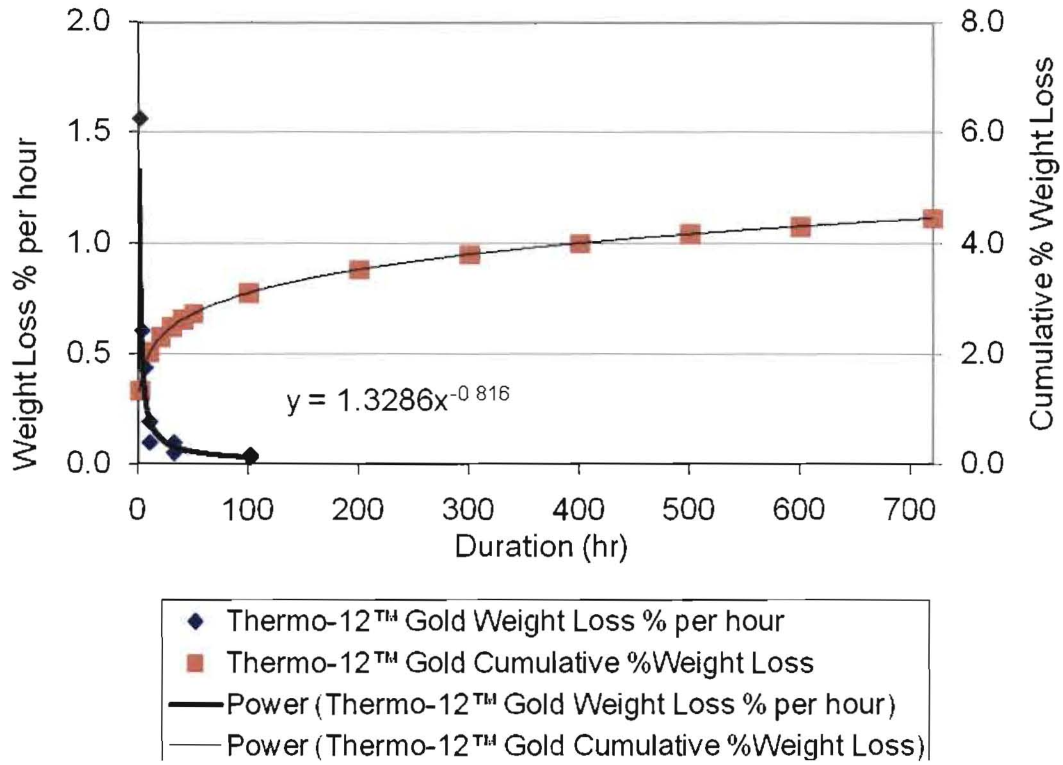

Figure 7.a-1: Data Erosion Rate and Predicted Cumulative % Weight Loss Curve (Thermo-12™ Gold)

During the conduct of the testing, one of the overall observations made was that during the initial stages of all tests, small amounts of particles detached from the samples. This behavior is most likely due to the washing of loosely attached pieces. The graph above shows the behavior that the majority of flow erosion occurs in the initial hours and then the rate of erosion continuously declines as time increases.

Extending the curve for cumulative % weight loss, the weight loss at 720 hours is 4.46%. Although the data plotted above indicates that the erosion rate may decrease with time, a linear curve fit was applied to the data as a more conservative method of extrapolation due to its application of a constant erosion rate as opposed to a power curve fit. Figure 3.2-2 of Cal-Sil Flow Erosion Testing Report (Figure 7.a-2) represents the linear curve fit. In addition to Thermo-12™ Gold Cal-Sil cumulative erosion, also displayed are values for four types of plant provided Cal-Sil cumulative erosion.

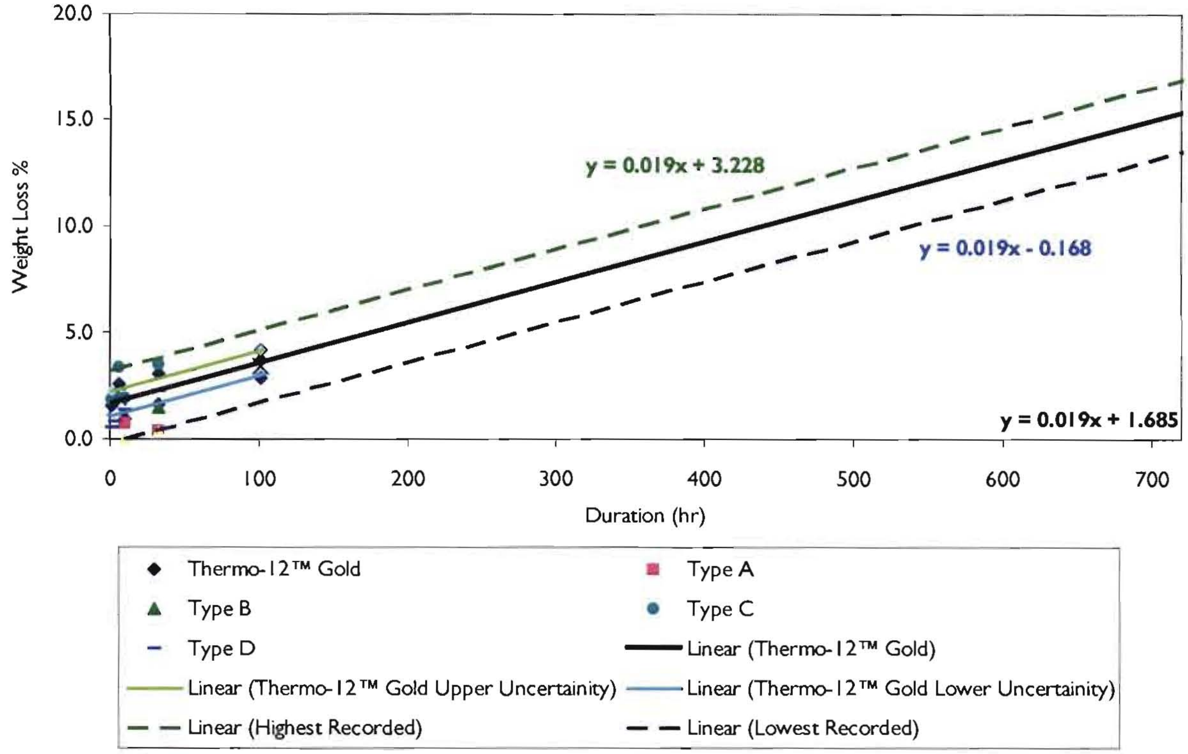

Figure 7.a-2: RMS Error and Bounding Curves for Cal-Sil Flow Erosion

The curve fit of Thermo-12™ Gold was used to determine the total Thermo-12™ Gold erosion at the recirculation mission time of 30 days (720 hours) as obtained by extrapolation. The total weight loss of Thermo-12™ Gold Cal-Sil samples at 30 days is (15.37 ± 0.59)% (using the equation y= 0.019x + 1.6854).

The upper and lower bounds of the weight loss as a function of time are calculated by sliding the linear curve fits up and down to the points that have the greatest difference between the measured value and the linear curve fit. These upper and lower bounding curve fits are used to determine the upper and lower bounding values of total Cal-Sil erosion at the recirculation mission time of 30 days (720 hours) i.e. 13.512% to 16.91% of initial mass.

Dissolution testing as discussed in the Alion Cal-Sil Dissolution Report was performed in solutions that modeled expected plant conditions of pH and temperature and included the principal constituents that are resident in the containment sump pool; boric acid, sodium tetraborate, and sodium hydroxide. This testing concluded that the primary mechanism for weight loss was due to the handling of the small samples, not the interaction of the chemicals with the materials. It was Alion's observation that Cal-Sil appears to gain weight when subjected to tap water or chemistry. Therefore, any long term test that requires material that could be absorbed by Cal-Sil would be non-conservative. Since this mechanism in not applicable to erosion testing, the determination was made that the dissolution test results and erosion test results need not be added to each other. The Cal-Sil insulation dissolution testing in post-LOCA chemical conditions has concluded that large scale dissolution will not occur.

The Marinite I Flow Erosion Testing Report shows that Thermo-12™ Gold weight loss test results bound the weight loss test results obtained under similar conditions for Marinite I (See Table 7.a-1).

Table 7.a-1: Marinite I and Thermo-12™ Gold Cal-Sil Flow Erosion Results

Material	Test Duration (hrs)	Sample Weight Loss Average (%)
Thermo-12™ Gold	10	1.44
Marinite I	10	0.43
Thermo-12™ Gold	32	2.35
Marinite I	32	1.18

Thus, the value of 16.91% can be used conservatively as the maximum flow erosion for Marinite I as well.

The following is a summary of bases (as discussed above) for not accounting for erosion and dissolution effects in combination:

1. Cal-Sil insulation and Marinite board dissolution testing in post-LOCA chemical conditions concluded that the large scale dissolution of Cal-Sil will not occur.

2. The method of calculating the Cal-Sil and Marinite flow erosion at 30 days is highly conservative:

    a. Extending the curve for cumulative weight loss, the weight loss at 30 days for Thermo-12™ Gold is 4.46% (As shown in Figure 7.a-1).

    b. Although the data plotted in Figure 7.a-1 indicates that the erosion rate may decrease with time, a linear curve fit that was applied to the data as a more conservative method of extrapolation due to its application of a constant erosion rate as opposed to a power curve fit (As shown in Figure 7.a-2). The total weight loss of Cal-Sil samples calculated in this manner at 30 days is (15.37 ± 0.59)%.

    c. These upper and lower bounding curve fits are used to determine the upper and lower bounding values of total Cal-Sil erosion at the recirculation mission time of 30 days i.e. 13.512% to 16.91% of initial mass.

    d. Therefore, approximately 17% of the initial mass is used conservatively as the maximum flow erosion for the long term recirculation mission time of 720 hours for both Cook Specific Cal-Sil and Marinite I insulation debris. This assures that all types of Cal-Sil represented are conservatively bounded.

3. The percentage erosion data that appears in the results of flow erosion testing was conservatively obtained from the differential sample weight. However, a portion of the erosion would have been in particulate form and another portion of it would have

dissolved. The small portion of dissolved Cal-Sil / Marinite I would be considered to combine with other materials to form chemical precipitate and would not be available for direct input for debris only head loss across the strainer. The percentage erosion data obtained from the differential sample weight conservatively includes this portion of dissolved material.

4. There are additional conservatisms associated with Cal-Sil flow erosion testing:

    a. During testing it was observed that approximately 30% of the flow screen area exposed to flow velocity was blocked by the test samples. At a constant flow rate, this means that the local velocity around the test samples is 30% greater than the flow velocity. This increases conservatism of testing since this effect would not be possible in the containment pool due to the large volume of water.

    b. It is possible that local flow acceleration occurs due to the partially closed area of the screen on which the test material is placed. This means that the local velocity around the test samples is greater than the intended flow velocity which increases conservatism of testing.

Therefore, because of conservatisms associated with the established 17% as the maximum flow erosion for the long term recirculation mission time of 720 hours for both Cook Specific Cal-Sil and Marinite I insulation debris and the negligible dissolution values, effects of erosion and dissolution were not considered to be additive.

c) The basis for using a velocity of 0.4 ft/s, since calcium silicate pieces larger than those tested (i.e., in the large piece category) would not transport at this velocity based on the metric of 0.52 ft/s cited in Table 3e1-5 in the February 29, 2008 supplemental response. As a result of exposure to higher velocity flows than tested, erosion from settled large pieces of calcium silicate could be underestimated.

Response:

The tumbling velocity that was used for small pieces of Cal-Sil and Marinite debris is 0.33 ft/s, and the tumbling velocity that was used for large pieces of Marinite debris is 0.52 ft/s. Since these pieces of debris would transport in any regions of the pool where the velocities are higher, the erosion would apply to debris that does not transport in the lower velocity regions. The recirculation pool CFD results from the limiting break case (Loop 4) were analyzed to determine the average velocity in the non-transport regions. As shown in Figure 7.c-1 and Figure 7.c-2, the average velocity in the non-transport regions was determined to be 0.11 ft/s for small pieces of Cal-Sil and Marinite, and 0.18 ft/s for large pieces of Marinite. Since these velocities are significantly lower than the 0.4 ft/s velocity used for the erosion tests, the erosion testing can be conservatively used for both the small and large pieces of Cal-Sil and Marinite at D.C. Cook.

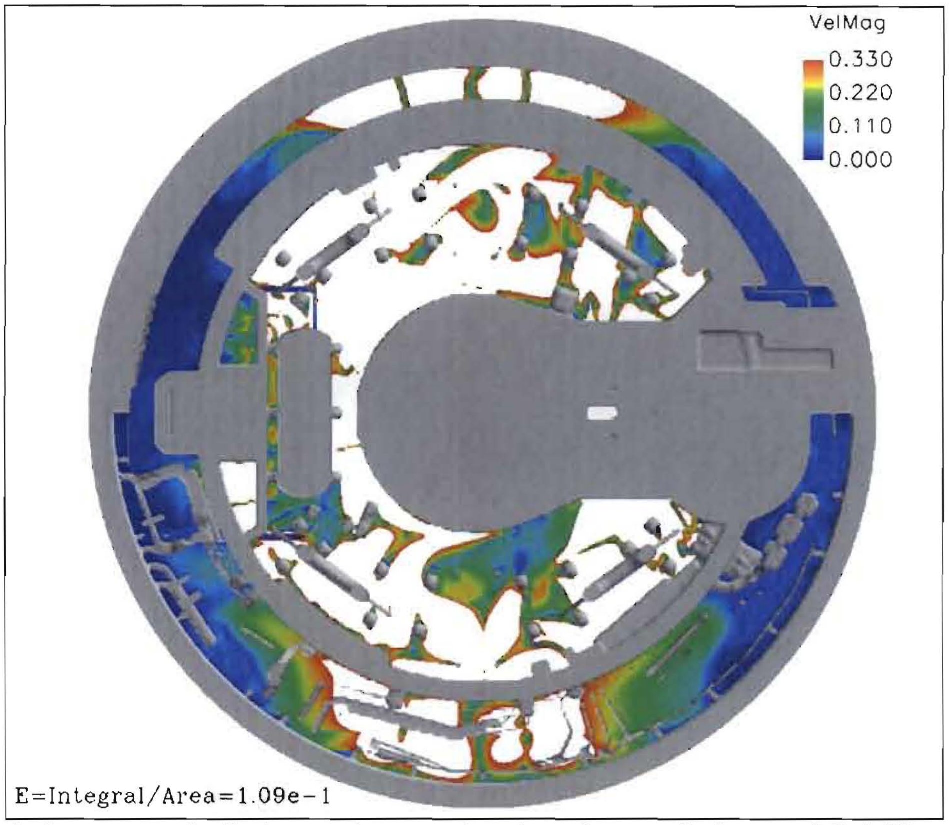

Figure 7.c-1: Average velocity in non-transport regions for small pieces of Cal-Sil and Marinite

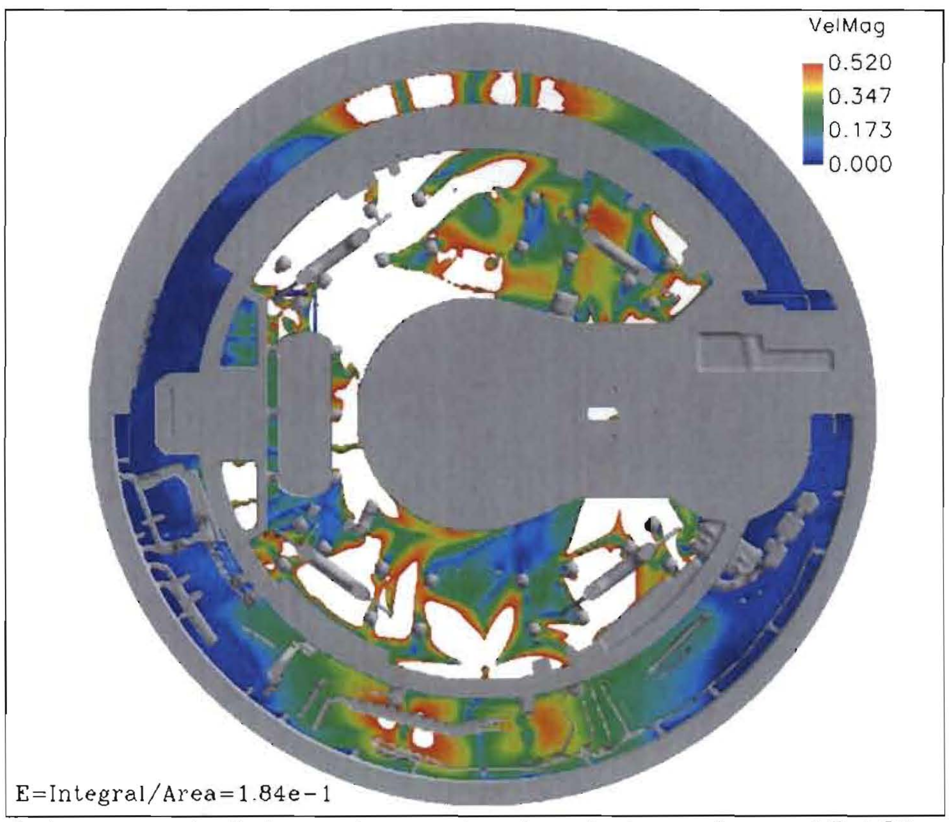

Figure 7.c-2: Average velocity in non-transport regions for large pieces of Cal-Sil and Marinite

d) *The basis for considering the turbulence conditions prototypical or conservative, since defining a limiting condition for turbulence is difficult given that a variety of conditions may exist throughout the containment pool at different times following a LOCA.*

Response:

This RAI is still under evaluation. As provided in the response to RAI 7.c, the CFD model establishes significant areas in containment that have average velocities substantially below the transport velocity required to move the Cal-Sil and Marinite to the strainers. Even though these plots do not provide the relative turbulence values, velocity can be correlated to turbulence. Where there is low velocity, there will also be low turbulence conditions. Once a piece of debris is moved to a location where it ceases to move due to the decreased velocity, there will be insufficient turbulence to further disturb the material. To address this RAI, a comparison of the turbulence in the vertical loop during the erosion tests (determined by running a CFD model of the vertical loop) to the average turbulence in the D.C. Cook containment pool in regions where the pieces of debris would not transport and would be subject to erosion is being performed. It is expected that the results will demonstrate the testing that was performed is sufficiently prototypical of the containment pool.

8. *Please provide the basis for the assumed calcium silicate tumbling transport velocity metrics for small pieces (0.33 ft/s) and large pieces (0.52 ft/s) and state whether these metrics were based on measurements of incipient tumbling, bulk tumbling, or some other criterion. The metrics cited were larger than the reported values in NUREG/CR-6772, which identifies an incipient tumbling velocity of 0.25 ft/s for small pieces of calcium silicate.*

Response:

The tumbling velocities used for the small and large pieces are based on flume testing performed by Alion. These velocities are incipient tumbling velocities. Table 8.1 shows the various incipient and bulk tumbling velocities that were measured [ALION-REP-AEP-4462-02, "D. C. Cook Material Transport, Erosion and Dissolution Report"].

Table 8.1 – Cal-Sil Tumbling Velocity Test Results

Sample Size	Incipient Tumbling Velocity (ft/s)	Bulk Tumbling Velocity (ft/s)
< 1"	0.23	0.35
1"-3"	0.33	0.45
>3"	0.52	0.68

The incipient tumbling velocity is the flow velocity at which a piece first starts to move, and the bulk tumbling velocity is the velocity that causes continuous tumbling or sliding of the debris to the end of the flume.

The size distribution for the Cal-Sil at D.C. Cook is based on the OPG destruction testing described in NUREG/CR-6808. Based on this testing, the pieces of Cal-Sil range in size from chunks smaller than 1 inch to chunks larger than 3 inches with the majority of the pieces being in the 1 to 3 inch range or larger than 3 inches. The three categories of pieces from the OPG testing were combined together as small pieces in the D.C. Cook debris generation calculation. Since most of the debris classified as small pieces is larger than 1 inch, using the 1"-3" incipient tumbling velocity metric is reasonable. Note also that the incipient tumbling velocity for this category is lower than the bulk tumbling velocity for pieces smaller than 1 inch. Since the bulk tumbling velocity is representative of the velocity required to transport debris all the way to the strainer, the velocity metric that was used for small pieces is also reasonably considered to be appropriate for the small portion of Cal-Sil debris that is smaller than 1 inch.

The debris transport metrics for Cal-Sil were assumed to be applicable to the marinite debris also. This is a conservative assumption since the Marinite debris at D.C. Cook is more dense than Cal-Sil (36-46 lb_m/ft^3 for marinite versus 14.5 lb_m/ft^3 for Cal-Sil), and therefore would be less likely to transport in the containment pool.

The tumbling velocity cited in NUREG/CR-6772 for small pieces of Cal-Sil is for chunks that were about 1 inch in size. As shown in Table C.19(a) in this NUREG, the incipient tumbling velocity was determined to be 0.25 ft/s and the bulk tumbling velocity was determined to be 0.35 ft/s. These results are very similar to the results for the <1" samples in the Alion testing (see Table 8.1).

<u>*Head Loss and Vortexing*</u>

13. Reflective metallic insulation (RMI) debris was added to the head loss tests. In pictures of the chemical testing in the multi-functional test loop (MFTL), the RMI was piled up in front of the strainer and transported into the bottom several rows of the strainer. The NRC staff considers this non-prototypical for the flow conditions specified for the plant in the licensee's submittal because of the known transport properties of RMI, and it could result in non-conservative head loss values. In particular, some of the RMI added during the licensee's testing was part of the earlier-transported "pool-fill" transported debris. This resulted in an RMI layer being formed between the fibers and particulate added early (representing pool-fill transport) and that which was added later (representing recirculation transport). Please justify that RMI would always arrive at the strainer, or describe what the head loss result would be if little or no RMI arrived at the strainer.

<u>Response:</u>

I&M is continuing to evaluate the available industry information regarding non-RMI chemical effects head loss testing and the impact of the RMI debris bed on the test results obtained. The response to this RAI will be updated to support the proposed public meeting to be held near the end of September 2009.

16. During the chemical effects testing, non-chemical head losses were significantly greater than large-scale non-chemical head loss testing with a similar debris mixture.

b) *Please provide justification that a higher non-chemical debris head loss, attained prior to adding chemical debris, would not affect the calculated bump-up factor. In general the NRC staff has considered that chemicals should be added to the non-chemical debris bed with the highest head loss to attain the most limiting total head loss for a plant. However, this is for tests that are applied directly to the head loss and vortexing evaluation. For tests that determine bump up factors, the considerations are different and more complex. One example: If a non-chemical debris bed is generally packed with particulate the addition of chemical debris may not have as significant an effect on head loss as if the bed had a lower particulate to fiber ratio. This would likely result in a lower calculated bump up factor than if the chemical debris was added to a debris bed with a relatively low particulate to fiber ratio.*

Response:

The originally proposed response to this RAI is provided in the two paragraphs following this one. I&M is continuing to evaluate the available industry information regarding chemical effects head loss testing and the impact of low fibrous debris on the test results obtained. The response to this RAI will be updated to support the proposed public meeting to be held near the end of September 2009.

Based on the testing performed, we judge that the approach used for developing the bump-up factor was reasonable and conservative. A highly compacted bed, as was developed during our chemical effects testing, limited the flow paths through the debris bed. Introduction of the chemical precipitates into the bed resulted in an approximate 50% increase in the overall head loss. Since we are a low fiber plant, decreasing the particulate to fiber ratio would be expected to result in a more porous bed and resultant lower head loss, decreasing the effect of chemical precipitate on strainer head loss. To address potential uncertainty with the results, the head loss increase factor attained through testing was further increased by 17% to bring the total chemical effects bump-up factor to 70%.

To provide further justification that the overall testing sequence resulted in significantly conservative results, in addition to those described above, the debris quantities for the fibrous and particulate debris sources used for establishing debris loads for testing were significantly greater than those that are expected to exist in the plant. If testing had been performed with those reduced quantities, we fully expect that the debris beds would have been substantially more porous, resulting in a significantly smaller increase in head loss due to chemical effects. The basis for this assertion is that particle size for the chemical precipitates is significantly smaller than the particle size of the particulate debris and there would have been substantially less fibrous debris for interacting with the chemical precipitate.

Coatings Evaluation

22. *In the licensee's supplemental response, non-original equipment manufacturer alkyds and epoxies are treated as failing as chips in accordance with Keeler and Long Report No. 06-0413. However, the Keeler and Long report is only applicable to degraded qualified epoxies and not unqualified epoxies or alkyds. Please provide additional justification for the assumption that unqualified non-original equipment manufacturer alkyd and epoxy coatings would fail as chips.*

Response:

The Keeler and Long report specifically applies to the epoxy coatings identified as Non-OEM epoxy coatings. These coatings are the qualified coating systems that were applied to substrates (copper and galvanized steel) that renders them as degraded or non-conforming. We fully expect that their failure mode will be as chips of the epoxy system, as demonstrated in the Keeler and Long report. Plant walkdowns did not identify failure of the epoxy coatings applied to these substrates except where mechanical damage had occurred. The Non-OEM alkyd coatings were observed in the plant to be failing as chips where these coatings were applied as color coding to the galvanized steel splice plates of safety related cable trays and galvanized steel conduits. The Non-OEM alkyd coatings represent less than 0.4% of the total coatings debris that was used for testing for both the DEGB and DGBS. This quantity is judged to be insignificant when compared to the total coatings debris quantities that were used for testing which were in excess of the quantity of material determined to be available with the CNP containments.

23. *b) Please clarify how the paint chip surrogate simulates the expected coating debris.*

Response:

It is expected that the actual epoxy coatings in the plant would fail in chip sizes larger than were assumed in the analysis based on observations and the Keeler and Long report. Since the epoxy coatings have fully developed bond strength within the coatings material itself, it is reasonable to conclude that the failure mechanism of loss of adhesion to the substrate material would result in relatively large chips of this material. Due to the expected size of these chips, there would be less of this material that would transport to the strainers as compared to what was used for strainer testing. It was conservatively decided to have the majority of the chips smaller than the strainer openings for the strainer testing. Due to the relatively small quantity of this coatings debris source as compared to the other coatings that are included in the head loss testing (< 0.8%), it was judged that it was not unreasonable to include coating chips of this size in the strainer head loss testing. The Non-OEM alkyd coatings represent less than 0.4% of the total coatings debris that was used for testing for both the DEGB and DGBS. Since the coatings debris quantities that were used for testing were significantly greater than the quantity that would be expected to be available, it is judged that the use of the chips did not significantly alter the head loss test results.

Downstream – in vessel

24. *Based upon the information provided in the response, it appears that the potential exists for a break location to be submerged by the water in the containment pool, potentially resulting in a flow path for unfiltered pool water to enter the reactor vessel. The centerline for the reactor inlet nozzle is at 614 ft elevation. The maximum containment pool water level is also 614 ft elevation.*

    a) Please address whether the potential for debris bypass into the reactor vessel through this pathway has been analyzed.

Response:

A specific analysis of the potential for debris introduction into the reactor vessel due to a break location that could be below the maximum flood elevation in containment was not performed. We believed that such an analysis was not necessary since the water will be flowing out of the break location due to ECCS injection flow. At no time is core cooling suspended, by procedure, to allow water to flow back into the vessel. The containment maximum water level analysis utilizes assumptions that maximize the potential containment water level, which is the opposite of the assumptions utilized for the containment minimum water level analysis. Utilizing more realistic inputs for the containment maximum water level analysis in the areas of available ice in the ice condenser, volume of water available and the expected temperature for the refueling water storage tank (RWST), the expected temperature of the accumulators water, the quantity of core voiding that would be expected to exist at this later stage in the event, quantity of structural items available below the maximum expected water level to displace water, and the reduction in containment pool temperature to the expected temperature resulted in a significant decrease in maximum water level. The estimated maximum water level considering more realistic inputs is approximately 612.3 ft. For the 29 in. inside diameter hot leg, this places the water level approximately 6 inches below the opening of the pipe. At the later stages of the event when injection flow is minimized to maintain core cooling, all debris within the sump pool will have either been filtered by the recirculation sump or settled to the floor of containment. This combination of conditions would prevent debris in the sump pool from entering the reactor vessel.

b) *Are there any adverse debris effects from submerging other reactor coolant system (RCS) break locations?*

Response:

There are no adverse debris effects as a result of submerged RCS break locations. The only known debris effect from a submerged break location will be the increased turbulence at the break location which results in increased potential for debris transport, which was accounted for in the debris transport analysis as reported on in Section 3.e of the February 29, 2008 supplemental response. For other break locations that are below the expected maximum pool water level (as described in the response to RAI 24.a), the blowdown of the RCS that occurs from this break location would remove water from upper levels of RCS piping which would result in the loss of capability to form a siphon to pull debris laden water into the reactor vessel. The expected water level would not produce a driving head sufficient to force sump pool water into the reactor vessel.

NPSH

25. b) Please provide the basis for concluding that there are no small breaks near the top of the pressurizer that should be analyzed for sump performance.

Response:

The debris that would be generated from a break near the top of the pressurizer is expected to be bounded by the debris that is generated for the DGBS. Additionally, the maximum break that can occur at the top of the pressurizer is a 6 in. single ended guillotine break at the supply piping for the pressurizer power operated relief valves and safety valves. This break size is bounded by the 2 in. SBLOCA minimum water level (5.1 ft) since this break will result in increased ice melt. The minimum water level for a 6 in. break is approximately 5.3 ft. The 6 in. break assumes that RCS refill is somewhat effective resulting in reduced water inventory for the containment sump.

We will provide additional supporting information for this RAI through revalidation of the Operator response to a break in this location or determination of the specific debris quantities that could be generated to demonstrate that a break in this location is bounded by the DGBS debris quantities, considering the potential for increased hold-up of water in the RCS.

When this was first evaluated four years ago, based on the ability of the Operators to respond, it was concluded that for the maximum 6 in. break, transfer to recirculation would not be required. Discussions with members of the Licensed Operator Training staff confirmed the original conclusion. Even if a break did occur near the top of the fully enclosed pressurizer enclosure, due to the size of the break, its location, and significant structural members within the enclosure, the quantity of debris that would be available for transport to the recirculation sump strainers is expected to be significantly less than that available for the breaks that were specifically analyzed and reported in the February 29, 2008 supplemental response.

<u>*Chemical Effects*</u>

26. The licensee's submittal states that D. C. Cook uses both sodium tetraborate in the ice and sodium hydroxide in the containment spray. Tables 3o1-1 and 3o1-2 indicate that only sodium tetraborate is added to the multi-functional test loop for in-situ chemical precipitate formation in the chemical effects head loss testing. Please provide a justification for not including sodium hydroxide in these tests.

<u>Response:</u>

The addition of NaOH was unnecessary for this test. Ample quantities of Na and OH existed in the test solution as a result of the sodium aluminate and sodium tetraborate additions to the test loop. The sodium aluminate is a strong alkaline which maintains the pH at the specified level of 8.9.

A pH level of 8.9 is justified for the testing based on the assumptions utilized in the CNP containment spray and recirculation sump pH calculation, MD-12-CTS-118-N. Within this calculation, there are three key assumptions that limit the quantity of sodium tetraborate (STB) within the recirculation sump fluid. These key assumptions and their basis is provided below:

1. The minimum concentration of STB in the ice per Technical Specifications (1800 to 2300 ppm) is used.

   Basis: Since the STB in the melted ice will buffer the sump solution pH towards a value of 9.2, minimizing the amount of STB is conservative for predicting pH.

2. The minimum amount of ice melt is credited at various stages of the event regardless of the total available ice per Technical Specifications.

   Basis: Since the STB in the melted ice will buffer the sump solution pH towards a value of approximately 9.2, minimizing the ice melt (and thus STB) is conservative for predicting pH.

3. Any flow from the containment sump to isolated volumes of containment, such as to the reactor cavity via the nuclear instrumentation system penetrations in the primary shield wall, is conservatively neglected.

   Basis: If the boric acid, sodium hydroxide, and STB solution were to flow from the containment sump pool, the incoming STB from the ice condenser would be a larger fraction of the fluid in the sump. Since the STB in the melted ice will buffer the sump solution to a pH approaching 9.2, minimizing the influence of the ice melt with this assumption is conservative.

The pH calculation establishes pH values for LBLOCA conditions which utilizes these assumptions, among others that either minimize or maximize pH values. For the LBLOCA case that establishes the maximum pH values for the case where both trains of ECCS and CTS operate throughout the event, the calculated pH values range between 8.79 and 8.91. This case is representative of the pH value that was used for the chemical effects testing.

27. *Please explain why the late additions of chemicals into the multi-functional test loop do not impact the measured head loss. These late chemical additions are stated to provide conservatism in that they exceed the calculated plant loading of chemical precipitates. If the chemical additions do not impact the measured head loss, as indicated by the test data, describe what actions were taken to verify that later additions of chemicals were actually forming the intended chemical precipitates.*

Response:

As can be seen in the head loss plots for the chemical effects tests, there were significant increases in head loss up to and including the 100% chemical addition. The head loss plots being referred to are Figures 3o13a-1 and 3o13a-2 on pages 303 and 304 of the February 29, 2008 supplemental response.

The additions of chemicals beyond the 100% value were determined, through analysis to have formed the necessary precipitates. Due to bed morphology at the time of these additions, sufficient flow areas existed through the bed to not result in a significant increase in head loss. As previously stated in response to these RAIs, the debris bed formed with CNP debris loads does not have sufficient fiber to completely interlace the primarily particulate debris bed. In other words, a thin bed condition will not develop. For the additions up to and including the 100% chemical additions, the head loss did increase significantly. At these additions, existing flow paths through the primarily particulate debris bed were blocked resulting in the increased head loss. It should also be noted that an analytical evaluation has been performed that demonstrates that the type and amount of chemical precipitates would have formed under the test conditions. The strainer vendor did not include post-test analysis of the chemical composition of the solution as part of their test sequence.

Question 21 – The NRC staff will modify the RAI to provide further clarification. The proposed RAI wording was subsequently discussed with Mr. Joe Waters and Mr. Paul Leonard of the licensee's staff. Mr. Waters and Mr. Leonard agreed that the proposed wording was acceptable, and that the RAI could be formally submitted (ADAMS Accession No. ML092400075).

Question 26 – The licensee's response to this issue appears to adequately address the staff's concerns. The staff requested that the licensee provide minor clarifications to the information provided in the handout when submitting the final RAI response.

Question 27 – The NRC staff requested that the licensee's response be expanded. Specifically, more information is needed to justify that the lack of head loss increases late in the test even after additional precipitate addition. The staff understands that this phenomenon could be expected based on the debris bed composition.

Prior to concluding the meeting, it was agreed that an additional conference call will be held in mid-September to provide clarification on any outstanding concerns.

A public meeting will be held at NRC Headquarters on October 14, 2009, for the licensee to present its final presentation and to finalize the proposed RAI responses. The scope of this meeting will address the more significant NRC concerns, which currently include the licensee's proposed responses to Questions 2.c), 5, 6, 13, 14, 16.b), 17 and 21.

One member of the public was in attendance at this meeting. The public did not have comment.

Any inquiries can be directed to me at (301) 415-3049.

/RA/

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Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosures:
1. List of Attendees
2. Clarified Proposed Responses to Select Requests for Additional Information

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Package: ML092610246 Meeting Notice: ML092250002 Meeting Summary: ML092400299

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DATE	09/01/09	09/11/09	09/08/09	09/16/09

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