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

June 18, 2009

Mr. Joseph N. Jensen
Senior Vice President and
Chief Nuclear Officer
Indiana Michigan Power Company
Nuclear Generation Group
One Cook Place
Bridgman, MI 49106

SUBJECT: DONALD C. COOK NUCLEAR PLANT (CNP), UNITS 1 AND 2 – REQUEST FOR ADDITIONAL INFORMATION REGARDING SUPPLEMENTAL RESPONSES TO GENERIC LETTER (GL) 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED WATER REACTORS" (TAC NOS. MC4679 and MC4680)

Dear Mr. Jensen:

By letters dated February 29, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080770407), and August 29, 2008 (ADAMS Accession No. ML082520026), Indiana Michigan Power Company (I&M, the licensee) submitted supplemental responses to GL 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," for CNP, Units 1 and 2.

The U.S. Nuclear Regulatory (NRC) staff reviewed I&M's submittals. The process involved a detailed review by a team of 10 subject matter experts, focusing its review on the areas described in the NRC's "Content Guide for Generic Letter 2004-02 Supplemental Responses" (ADAMS Accession No. ML073110389). For its review, the NRC staff used review guidance from several sources, including Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated March 28, 2008 (ADAMS Accession No. ML080230234), and the NRC safety evaluation (SE) dated December 6, 2004, (ADAMS Accession No. ML043280641) associated with the Nuclear Energy Institute document "Pressurized Water Reactor Sump Performance Evaluation Methodology," dated May 28, 2004 (ADAMS Accession No. ML041550661). The process also included a separate review of the licensee's submittal informed by inputs from the subject matter experts that focused on whether I&M had demonstrated overall that its corrective actions for GL 2004-02 were adequate. Finally, the NRC staff re-evaluated the draft RAIs sent to your staff prior to the public meeting with them on April 16, 2009 (ADAMS Accession No. ML091200377) based on the written and verbal information your staff provided at that time.

Based on its review, the NRC staff has concluded that additional information is required to determine with reasonable assurance that CNP has satisfactorily addressed GL 2004-02. Accordingly, the finalized RAIs are issued as an enclosure to this letter.

The NRC staff desire to receive only one response letter for all the RAIs. The staff requests that you respond to these RAIs within 90 days of their formal transmittal. If your staff concludes that more than 90 days is required, then any request for additional time should include a basis for why such time is needed.

As a follow-up to the April 16, 2009 public meeting, the NRC staff would like to have a phone conference with your staff to further discuss any questions on I&M's proposed path forward. The NRC staff may also request an additional public meeting with your staff should any remaining areas of significant disagreement need to be addressed. The goal is to ensure that your staff understands any regulatory concerns the NRC staff may have with the planned approach.

As part of the written response to the additional RAIs, we request that your staff include a safety case. This safety case should describe how the measures credited in the CNP licensing basis demonstrate compliance with the applicable NRC regulations as discussed in GL 2004-02. This safety case should inform I&M's approach toward responding to the RAIs, as well as the staff's review of the RAI responses. As appropriate, it may describe how I&M reached compliance even in the presence of remaining uncertainties. The NRC staff sees the safety case as informing, not replacing, responses to the RAIs. We recognize that I&M submitted a document at the recent public meeting intended to provide this type of argument. The NRC staff will review that document, and any update to it, which your staff might choose to make based on the perspective in this letter and the attached RAIs, in conjunction with its review of your RAI responses.

Your staff should be aware that the NRC has not yet issued a final SE on WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff believes that the likelihood for unacceptable in-vessel debris impact at CNP is very low because of the low debris loading and the in-vessel effects testing your staff have sponsored, so no RAI is included regarding that issue. However, since I&M's submittals reference WCAP-16793-NP, you may either 1) wait for the in-vessel downstream effects issue to be resolved through the WCAP process, or 2) demonstrate that in-vessel downstream effects issues are resolved for CNP by demonstrating without reference to WCAP-16793, or 3) wait for the NRC staff SE that in-vessel downstream effects have been addressed at CNP.

Please feel free to contact me if you need further clarification or have any comments.

Sincerely,

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

Enclosure:
As stated

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REQUESTS FOR ADDITIONAL INFORMATION

DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

SUPPLEMENTAL RESPONSES TO GENERIC LETTER (GL) 2004-02

Debris Generation/Zone of Influence

1. a) Please identify what zone of influence (pipe diameters) was determined for the new D. C. Cook Rubatex/Armaflex configuration and how it was arrived at from the referenced Wyle Labs test report data.

   b) Please state whether there were any potential break locations within the zone of influence for this material. If so, please describe how much debris would be generated from this source, how much would be expected to arrive at the strainers, and what its contribution would be to strainer blockage and head loss.

Debris Characteristics

2. Please describe the scaling process used to apply the results of the debris generation testing of the Marinite, Armaflex, fire barrier tape, and other materials to the plant condition. In particular, the NRC staff noted that the size of the nozzle (2.45 inches) used for the testing resulted in a significantly smaller jet than would be created by a large-break loss-of-coolant accident (LOCA). As a result, large test targets may only have been exposed to the peak pressure at the jet centerline over a limited area due to the radial decay of the jet pressure. Thus, a significant area of the target material could have been exposed to much lower jet pressures than this peak pressure.

   a) As a result, the significant portion of the targets away from the centerline of the test jet would have experienced reduced fragmentation than had they been exposed to the jet from a prototypically sized LOCA jet.

   b) This radial pressure decay effect could be significant, not only with respect to ablation of base material by the impinging jet, but also to applying the total force necessary to rip off insulation jacketing or break insulation banding.

   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.

   In light of the discussion above, please describe how the radial decay of the jet pressure was accounted for in the analysis of the test results, specifically addressing items (a), (b), and (c) to demonstrate that the ZOI test results have been prototypically or conservatively scaled to the plant condition.

3. Please identify which destruction test or tests were used as the basis for the Marinite size distribution given in Table 3c1-2 of the supplemental response. Please further discuss the applicability of these tests to provide a basis for characterizing the size of the Marinite debris within the entire 9.8D ZOI, recognizing that increased fragmentation of debris could occur at radial distances less than those tested.

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.

Debris Transport

5. Please describe the basis for considering the Loop 4 break to be bounding, not only from the standpoint of transporting the greatest quantity of problematic debris, but also from the standpoint of the degree of uniformity in the debris distribution (i.e., in terms of debris quantities per unit strainer surface area) between the main and remote strainers.

6. Please provide adequate basis for the following assumptions made in the debris transport analysis in deriving the flow and debris distributions between the main and remote strainers.

   a) During pool fill up, the flow resistance on the main strainer is assumed to be negligible, even though a substantive amount of debris is assumed to accumulate there during fill up. Given the reduced water levels and high flow velocities, along with the fact that static head is the only driving force to move water through the main strainer at this time, the neglect of this flow resistance could have a non-negligible impact on the flow distribution during fill up, resulting in increased flow to the remote strainer.

   b) Ten percent of the area of the main strainer is assumed to remain clean during recirculation, even though large-scale test results for D. C. Cook suggest a greater degree of flow resistance consistent with the formation of a continuous debris bed over the entire strainer flow area. In addition to this plant-specific evidence from the D. C. Cook testing, a significant number of head loss tests with a variety of different strainer geometries have similarly demonstrated the potential for debris to form a continuous bed over the entire strainer surface area rather than leaving part of the strainer area open (presuming a sufficient quantity is available). Therefore, a more representative analytical model of head loss at the main strainer during recirculation would likely result in significantly larger flow and debris fractions arriving at the remote strainer.

   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.

As a result of these observations, the NRC staff does not consider the flow and debris distributions to the main and remote strainers (including the time-dependent transport modeling used to determine these distributions) to be adequately justified. The measured flow rates to the main and remote strainers in the large scale tank tests performed at Control Components Inc. (CCI) further provide support to the NRC staff's view that the fractions of flow and debris transport to the main strainer were overestimated by the transport analysis. The NRC staff believes the flow distribution between the two strainers would be more uniform because, as demonstrated in the head loss testing conducted by D. C. Cook as well as other pressurized-water reactor licensees, as debris accumulates on strainer surfaces and increases the local flow resistance, the flow and suspended debris tend to redistribute to more open areas of the strainer. Since non-uniformity of the flow and debris loading tends to reduce the overall system head loss, this overestimate of flow and debris transport to the main strainer appears non-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.

   b) The basis for not including the plant buffer materials in the test fluid.

   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.

   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.

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.

9. Please clarify how debris transport percentages greater than 100% for a number of debris types were computed, to the extent the licensee credits these percentages as conservatisms in its transport calculations. In Table 3e6-4 in the supplemental response dated February 29, 2008, a number of debris types have transport percentages exceeding 100%, for example latent fiber (108%) and flexible conduit PVC jacketing (130%). However, when considering the quantities of debris generated versus the quantities transported to the main and remote strainers in Tables 3e6-6 and 3e6-7, it appears that the transport fractions should be computed as 100% (for latent fiber out of 12.5 ft^3 generated, 6.5 ft^3 reaches the main strainer and 6 ft^3 reaches the remote strainer; for flexible conduit PVC jacketing, 1.57 ft^2 is generated, 1.57 ft^2 reaches the main strainer and 0 ft^2 reaches the remote strainer).

Head Loss and Vortexing

10. According to the licensee's supplemental response, the debris was added directly in front of the strainer to reduce near-field settling. The NRC staff has found that this debris introduction method can result in non-prototypical bed formation and non-conservative head loss values during testing. Please provide justification that the debris introduction methods used during head loss testing resulted in prototypical or conservative head loss results.

11. The licensee's supplemental response stated that the fibrous debris was shredded, and then blasted with a water jet to render it into fine debris. The submittal stated that the fibrous debris was verified to be less than 10 mm in size. It is not clear that the debris was easily suspendable, which is the primary consideration for fine fibrous debris. In addition, the submittal did not state the extent to which the fibrous debris was diluted. Therefore, agglomeration of debris could have occurred resulting in non-prototypical debris bed formation and non-conservative head losses.

12. Please provide information that shows that the debris preparation and introduction methods used during head loss testing were conducive to prototypical debris arrival at the strainer and resulted in prototypical or conservative head loss results, or evaluate the effects of the non-prototypical debris on the head loss results. Specifically, please explain how the fibrous debris was verified to be easily suspendable and how agglomeration was prevented.

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.

14. During head loss testing the flow rate was started at between 38% and 60% of the maximum scaled flow rate, depending on the test. Additionally, 60% of the debris was added during the fill-up phase during some testing. This amount of debris was greater than that calculated to be at the strainer during this phase. During the event sequence testing debris was added so that RMI was introduced between fibrous and particulate debris additions. These practices can result in non-conservative head loss test results. Low test flow rates can result in non-conservative results due to lower bed compression. Overestimating debris addition during the fill-up phase is likely nonconservative because it would result in less uniform debris bed formation and reduced debris bed compression as compared to a more prototypical addition sequence. Also, since the plant water level was not modeled in the head loss test, the lower pool velocity in the test may have non-conservatively affected the accumulation of debris on the strainer as well as the bed compression. Introducing RMI between fibrous and particulate debris additions can result in a stratified bed that would affect head loss non-conservatively. Please provide information that justifies that these test practices did not result in non-conservative head loss results or provide information that shows that the potential non-conservatism of these practices were offset by other conservatisms contained in the test protocol.

15. The test sequences that resulted in the maximum tested head losses for the double-ended guillotine break and debris generation break size scenarios were different. The double-ended guillotine break (DEGB) limiting head loss was attained by adding a homogeneous debris mixture in steps of 60%, 80%, and 100% while increasing flow in the same steps. The debris generation break size (DGBS) limiting head loss was attained during a sequence intended to mimic the flows that would occur through the strainer following a LOCA. The tests resulted in the following head losses (approximately):

    DEGB – 27 mbar
    DGBS – 13 mbar
    DEGB Event Sequence – 22 mbar
    DGBS Event Sequence – 20 mbar

    There is no apparent reason that different test sequences would result in the limiting head loss for these breaks.

    Please provide an evaluation of why similar test sequences would result in different relative head losses (i.e., differences between the nominal and event sequence tests for a given test scenario). Given this apparent disparity, please explain how the test results are repeatable. Provide the results of any tests run at 100% flow throughout larger portions of the test. If no other tests were run, then state this.

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.

    a) Please provide an explanation for the higher non-chemical debris head loss.

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.

c) Please provide a justification for the licensee's choice not to apply the chemical test head loss directly to the net positive suction head and vortexing/air entrainment evaluations.

17. Please provide an evaluation of the sensitivity of overall system head loss to various debris loads split between the main and remote strainers as predicted by the transport evaluation. Because it is difficult to determine how much debris will arrive at each strainer, this information is needed to establish confidence in the licensee's head loss results.

18. The submittal (pg 227) stated that the debris-only head loss would be considered to be 1.57 ft after being increased by 50%. It was not clear that the clean strainer head loss was included in this value. Please provide the total head loss including the clean strainer portion or confirm that this value includes the clean strainer head loss.

19. The head loss charts for the chemical effects testing show a large rapid increase in head loss immediately following non-chemical debris addition. The increase is followed by an immediate decrease in head loss to a significantly lower value, then a slower decrease until chemical precipitates are added (see pages 303 and 304). This behavior is unexpected and has not been observed previously by the NRC staff.

a) Please provide an explanation for the rapid increase and decrease in head loss that occurred during this testing. Provide justification that this behavior would not occur in the plant or justify that the head losses observed during the initial spike would not adversely affect the response of the plant to a LOCA.

b) Please provide justification that the chemical precipitates were added at a time such that a prototypical or conservative bump-up factor would be calculated. The NRC staff considers that adding chemicals when baseline head loss is continuing to decrease would likely result in a non-conservative bump-up factor because the decreasing non-chemical debris bed head loss could counteract and thereby obscure the measurement of the full head loss impact of the chemical precipitates. Therefore, to accurately measure the ratio of chemical to non-chemical head loss (bump-up factor), stability of the non-chemical debris bed head loss should be ensured prior to the addition of chemical precipitate.

20. The submittal stated that the design maximum head loss is 2.8 ft for a large-break LOCA based on the available driving head of water at the recirculation sump. This limit was based on NUREG-CR-6808 guidance that head loss should not exceed ½ of the strainer height (or in this case submergence above the bottom of the strainer). A slightly lower limit for the debris generation break size was also listed. No limit was provided for the small-break LOCA, and no calculation of potential head losses associated with a small break was provided. Please provide this information or otherwise justify that the strainer will maintain its function under all required scenarios including a small-break LOCA.

21. Please provide the basis for the comparison being made on page 306 of the licensee's supplemental response, that the resulting head loss for the large-scale head loss on the main strainer only is 3 ft, which compares favorably to the MFTL debris only head loss of 2.67 ft. This basis is needed since the statement referenced helps to undergird the bump-up factor approach.

    Please address in your response whether the scaling back of this head loss result based on the reduced flow rate can be justified because flow rate determination in the large-scale tank was based ultimately on arbitrary assumptions made during the transport analysis. The discrepancy in flow rate for this test indicates that too little debris may have been assumed to transport to the remote strainer (versus the main strainer) and that a higher flow rate would occur at the main strainer, presumably with slightly less debris. In other words, it appears to be a non-converged solution.

<u>Coatings Evaluation</u>

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.

23. a) Please provide the characteristics of the paint chip surrogate including the density and type of paint used.

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

<u>Downstream – in vessel</u>

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.

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

NPSH

25. The submittal stated that the minimum water level calculation included ½ of the RCS volume and the volume of the accumulators. It is not clear that these volumes should be credited for all breaks. For example a small-break LOCA could result in the accumulators remaining full for an extended period and the RCS maintaining more than ½ of its volume. In addition, the RCS would accommodate a larger mass of water as it cooled off due to increased water density with lower temperature. Based on these observations it is not clear that the levels used in the vortexing evaluation are conservative. It was not clear that the increasing density of RCS inventory as it cooled was considered in the sump level calculations.

a) Please provide information that justifies that the sump pool level calculations resulted in realistic or conservative levels for the large- and small-break LOCAs.

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.

c) If entry into shutdown cooling is being used as a basis to avoid analyzing certain small-break LOCAs, then please verify that operators have the ability to cooldown and depressurize in sufficient time to prevent switchover for all breaks for which less inventory from the RCS and accumulators would reach the sump than was assumed in the licensee's analyses. Please explain how a single failure and the use of non-safety-related equipment are accounted for in this analysis.

d) If the currently calculated minimum water levels require revision as a result of addressing the above questions, please provide updated vortexing and air entrainment evaluations using conservative submergence values.

Chemical Effects

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.

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.

VUEZ Testing

The NRC staff performed a detailed review of the test procedures used by Alion at the small loops at the VUEZ test facility in Slovakia. The NRC staff concluded (e.g., ML082560233) that it was highly unlikely that the plants relying on this testing could use it as a basis for demonstrating strainer design adequacy to resolve Generic Letter 2004-02. The NRC staff's review did not specifically address testing performed in the larger loop at VUEZ that was used for the D. C. Cook testing. Although some similarities existed in the small-scale and larger-loop test programs, there were also some significant differences. If VUEZ testing is being used as part of the basis to demonstrate the adequacy of the D. C. Cook strainers, then please address the following requests for additional information on this testing below. If VUEZ testing is not being used in the licensing basis for addressing Generic Letter 2004-02, the licensee should state that, in which case the licensee need not address the RAIs that follow.

28. Please provide the following additional information concerning the modeling of debris transport for the VUEZ testing:

    a) Please explain the basis for the minimum flowrate of 1 L/min to preclude stagnant regions in the test tank.

    b) Please provide a basis for the statement on pages 56 and 64 of 100 of the VUEZ appendix that the water volume was much smaller than the actual plant condition, and therefore the turbulence and velocity in the (test) pool is higher. The relative size of the fluid volumes does not appear to the NRC staff to be directly related to the velocity and turbulence.

       Please compare the test tank flow characteristics to the velocity and turbulence contour plots for the plant condition provided in the February 2008 supplemental response.

    c) Please state whether agitation or manual stirring of the tank was performed during the testing, and please describe the direction that the recirculation discharge flow entered the large tank relative to the opening of the pocket strainer.

    d) Please provide photographs of the tank floor at the completion of the test. Please provide the estimated quantity of the debris that settled on the tank floor, and state whether any of the settled debris was manually pushed into the strainer pockets.

    e) Please discuss how the reduced velocities used during debris bed formation affected the settling of debris in the test tank. For instance, the licensee's supplemental response (e.g., page 74 of 100) indicates that debris settled in tank, particularly prior to the initiation of full recirculation flow. Please state the basis for allowing debris settlement at strainer approach velocities that are significantly less than the prototypical value.

29. Please explain how the containment spray flow for the first 25 minutes of the experiment was scaled, and the basis for the flow rate that was chosen.

30. Debris does not appear to be prepared as fines in the photograph provided in the Alion test report (pg. 66). Fiber is conservatively expected to be only individual fibers because it is all latent debris. Calcium silicate insulation at the strainer is analytically expected to be 86% fines and 14% small pieces. Similar observations can also be made for Marinite debris. These important debris sources do not appear to have been prepared per the plant-specific debris transport results.

Please demonstrate that the debris sources used for the VUEZ testing were eventually prepared into a representative form. Photographs, if available, showing the as-prepared debris slurries or of the debris during the addition process that show an appropriate form of this debris immediately prior to the addition to the tank would be helpful in making this demonstration.

31. Debris predominately entered the bottom row of pockets as evidenced in the photo on Page 67 of the Alion test report. The debris used for this testing should have been very nearly 100% fines (although some calcium silicate is small pieces). Although there may be some bias toward the bottom pockets during a LOCA even for fines, based on the photo, the biasing toward the bottom pockets seems much more pronounced than expected by the NRC staff. Such significant non-uniformity can be attributed to either non-representative debris preparation or the non-prototypical introduction of the debris so close to the bottom strainer pockets that it approached the strainer on a non-representative flowstream into the bottom pockets nearest the debris addition line.

a) Please provide additional photos of the debris accumulation on the strainer that more clearly show the distribution of the accumulated debris on the strainer.

b) Please identify the level the water was when the debris was being added, and identify whether the water level was representative of the plant condition at that time.

32. All of the debris for the VUEZ test appeared to be added during the pool-fill phase. This approach appears to be non-conservative because of the lower velocities during the fill-up phase (2/3rds of the value during recirculation). This lower flow rate through the strainer would lead to reduced debris bed compression. Furthermore, it is not clear whether a representative water level modeling was used. The use of a non-representative water level would further reduce the velocity during bed formation and further contribute to reduced bed compression. Additionally, due to pump cavitation, the flow in the VUEZ loop had to be substantially reduced during the debris bed formation process, which resulted in a bed being formed at velocities substantially lower than even the reduced velocities during pool fill.

a) Please address the potential for a non-prototypical non-uniform debris distribution on the 2x2 pocket strainer module as a result of the above debris addition practice, with more debris going toward the bottom pockets as well as some piling of debris at the pocket openings rather than the formation of a thin bed.

b) Please also address the potential for reduced debris bed compression due to non-representative test conditions that had the potential to underestimate the potential limiting head loss for the plant condition.

33. Similar to a staff observation for the small-scale VUEZ test loops, when taken in aggregate, uncertainties are not negligible on the VUEZ large scale test apparatus:

    a) Approximately 1% of volume is discarded due to sampling

    b) Approximately a 3% reduction in head loss because less calcium silicate debris was added to test than revised calculations showed.

    c) Temperature uncertainty is +/-5°F

    d) Flow measurement uncertainty is 5%

    e) Pump flow uncertainty is 5%

    Please explain how uncertainties have been accounted for in the application of the head loss results from the VUEZ testing.

34. Please explain why the head loss increased early in the head loss test to a fraction of a kPa (see figure 7.2-14) before the official start of the test.

35. Please identify the concentration of the debris slurry used for the VUEZ tests and the degree to which agglomeration of the debris in the slurry affected the prototypicality of the test debris.

Please feel free to contact me if you need further clarification or have any comments.

Sincerely,

/RA/

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

Enclosure:
As stated

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