Waterford 3
Generic Letter 2004-02
Response to RAIs

March 8, 2010

Agenda

- Introductions
- Meeting Purpose
- RAI Discussion
- Going Forward

Introductions

- Entergy
  - Nicholas Petit – Mechanical Design Engineer
  - Greg Ferguson – Civil Design Engineer
  - Brian Lanka – Design Engineering Manager
  - Michael Mason – Licensing Specialist
  - Robert Murillo – Licensing Manager

Introductions

- Alion Science & Technology
  - Jim Furman – Senior Chemical Engineer
  - Megan Stachowiak – Project Manager

Meeting Purpose

Discuss Waterford 3's responses to NRC Request for Additional Information (RAIs) for GL 2004-02

Note: The information contained in this presentation is intended for discussion purposes only and, as such, has not been through a formal verification process.

A red asterisk (*) has been placed next to RAIs that were identified upon closure of the October 15, 2009 call as requiring further discussion.

RAI #1 - 10

- RAIs 1-10 relate to the reduced zone of influence (ZOI) credited for jacketed fiberglass insulation. The staff has not concluded that the testing conducted under WCAP-16710 provides a realistic or conservative estimation of debris generation.

RAI #1 – 10

- Response
  - Replacement Steam Generators being installed in RF17 (Spring 2011) will be insulated with reflective metal insulation (RMI) along with portions of RCS piping. (Fiber reduction of approximately 47%)
  - Upon replacement, Waterford 3 will no longer utilize WCAP-16710-P, but will use a 17D ZOI for all Nukon insulation as established in the NEI 04-07 document.

RAI #11

- The staff review noted one critical change in the October 23, 2008, supplement versus the February 29, 2008, supplement and the NRC staff's report of its audit of Waterford 3 corrective actions for GL 2004-02. The earlier two documents refer to the metal encapsulated insulation (MEI) debris being 100% fines. However, the October supplement refers to this MEI debris being 20% fines and 80% small pieces. Although the distinction was not used to change the analytical transport results, presumably this information was used to determine debris for head loss testing, and as such is very significant. It is not clear that a debris mix of 20% fines / 80% small pieces is conservative when a 4D ZOI is assumed. The categorization of the debris as 20% fines is based on Drywell Debris Transport Study (NUREG/CR-6369) results from tests with 7–10D ZOIs, and it is an average value, not a maximum value, from these tests. Please substantiate the adequacy of the assumption that no more than 20% of the MEI debris within a 4D ZOI will be destroyed into fines.

RAI #11

- Response
  - The MEI insulation at WF3 is similar in construction to Transco RMI, which has a destruction ZOI of ~2D. WF3 MEI was conservatively assumed to have a destruction ZOI of 4D.
  - Fibrous debris in the ZOI is assumed to fail as 100% “small fines”, ie, the 20/80 mixture of fines and small pieces.
  - 90% erosion factor used for all MEI insulation. Resulted in 92% of MEI debris arriving at strainers. WF3 is investigating using the Alion 10% erosion factor from Nukon fiberglass for the MEI fiberglass.
  - New head loss testing is scheduled to be performed mid 2010. Fibrous debris for testing will be prepared in accordance with the March 2008 guidance.

RAI #12*

- The supplemental response described erosion testing that was used as a basis for the assumption of 10% erosion of small and large pieces of Nukon™ debris.
  a. Please describe the test facility used and demonstrate the similarity of the flow conditions (velocity and turbulence), chemical conditions, and fibrous material present in the erosion tests to the analogous conditions applicable to the plant condition.
  b. Please estimate the quantity of fibrous debris that settled in the test flume and discuss how erosion of this debris was accounted for in the strainer performance analysis. In addition, specific justification should be provided for any erosion tests conducted at a minimum tumbling velocity if debris settling was credited in the test flume for velocities in excess of this value.
  c. Please discuss how the erosion testing conducted for Waterford 3 accounts for the erosion of debris that settles in front of the strainer plenum, which may be exposed to a higher velocity than the incipient tumbling velocity

RAI #12*

- Response
  a. WF3 is participating in the Alion fiber erosion testing that has been recently concluded. The NRC staff have been informed of this testing and have reviewed the test procedures and preliminary results.
  b. WF3 will be performing new head loss testing mid 2010 that will not credit near-field settlement.
  c. WF3 will be performing new head loss testing mid 2010 that will not credit near-field settlement.

RAI #13

- Please identify the size distribution of the metal encapsulated insulation (MEI) calculated as reaching the strainers in Tables 3.e.6.1 through 3.e.6.5. Specifically, identify what fraction of this debris is fines, and what fraction is small pieces. Please also identify the size distribution of MEI added to the head loss tests used for strainer qualification.

RAI #13

- Response
  - MEI transport is based on 20% fines, 80% small pieces, 90% erosion

Fraction of MEI Debris at Sump				
	S6	S5	S1,3 & 4	S7
Fines	0.20	0.20	0.20	0.20
Small	0.72	0.72	0.72	0.80
Large	0.00	0.00	0.00	0.00
Intact	0.00	0.00	0.00	0.00
Sum	0.92	0.92	0.92	1.00

  - New head loss testing is scheduled to be performed mid 2010. Fibrous debris for testing will be prepared in accordance with the March 2008 guidance.
  - WF3 is investigating using the Alion 10% erosion factor from Nukon fiberglass for the MEI fiberglass.

RAI #14*

- The supplemental response stated that module testing credited near-field settlement. Insufficient information was provided in the supplemental response dated October 23, 2008, to provide assurance that the flow conditions simulated in the strainer head loss test flume are prototypical or conservative with respect to the plant conditions. Therefore, please provide the following information regarding the modeling of flow and turbulence in the test and how test flow conditions compared with flow conditions in the plant.

RAI #14*

- Cont,
  a. Please provide contour plots of the velocity and turbulence in the containment pool for Break S7 and the limiting (with respect to strainer head loss) large-break case.
  b. Please provide close-up plots of the velocity and turbulence contours in the vicinity of the strainer for these cases.
  c. Please identify the head loss test flume (average) velocity used for the strainer module testing for these cases and the basis for the velocity chosen.
  d. Please identify the turbulence levels simulated in the test flume for these test cases and provide the basis for considering them representative of the plant condition.

RAI #14*

- Response
  a. Available plots will be provided as part of the formal response
  b. No CFD was performed for the test flume for past testing. There are also no current plans to perform a CFD analysis for the new head loss testing still to be performed.
  c. New head loss testing is scheduled to be performed mid-2010. This testing will follow the standard Alion test protocol, which uses a fully stirred/ agitated tank and does not credit near field settlement. Therefore, RAI is no longer applicable.

RAI #15

- The supplemental response dated October 23, 2008, stated that the test strainer had 10 disks rather than the 17 disks present on the actual plant strainers. Please describe how this difference in strainer size (and total module flow rate) was accounted for in scaling the velocity and turbulence in the head loss test flume based on geometric similarity.

RAI #15

- Response
  - Testing is performed by creating a small-scale plant model with one sump strainer module. The model includes the plenum and one test module with a width and length matching the plant strainer design but with 10 discs rather than the plant design of 17 discs.
  - The plenum height and distance of the strainer above the plenum will be scaled based on the test module height.
  - Walls to the back and sides of the test module will be set to be representative of the plant strainer spacing of 32 inches.
  - New head loss testing is scheduled to be performed mid 2010.
  - The approach velocity of the module will conservatively bound the average bulk approach velocity of the plant strainer.
  - The test circumscribed velocity will also be considered so that it matches or exceeds the plant circumscribed velocity.

RAI #16

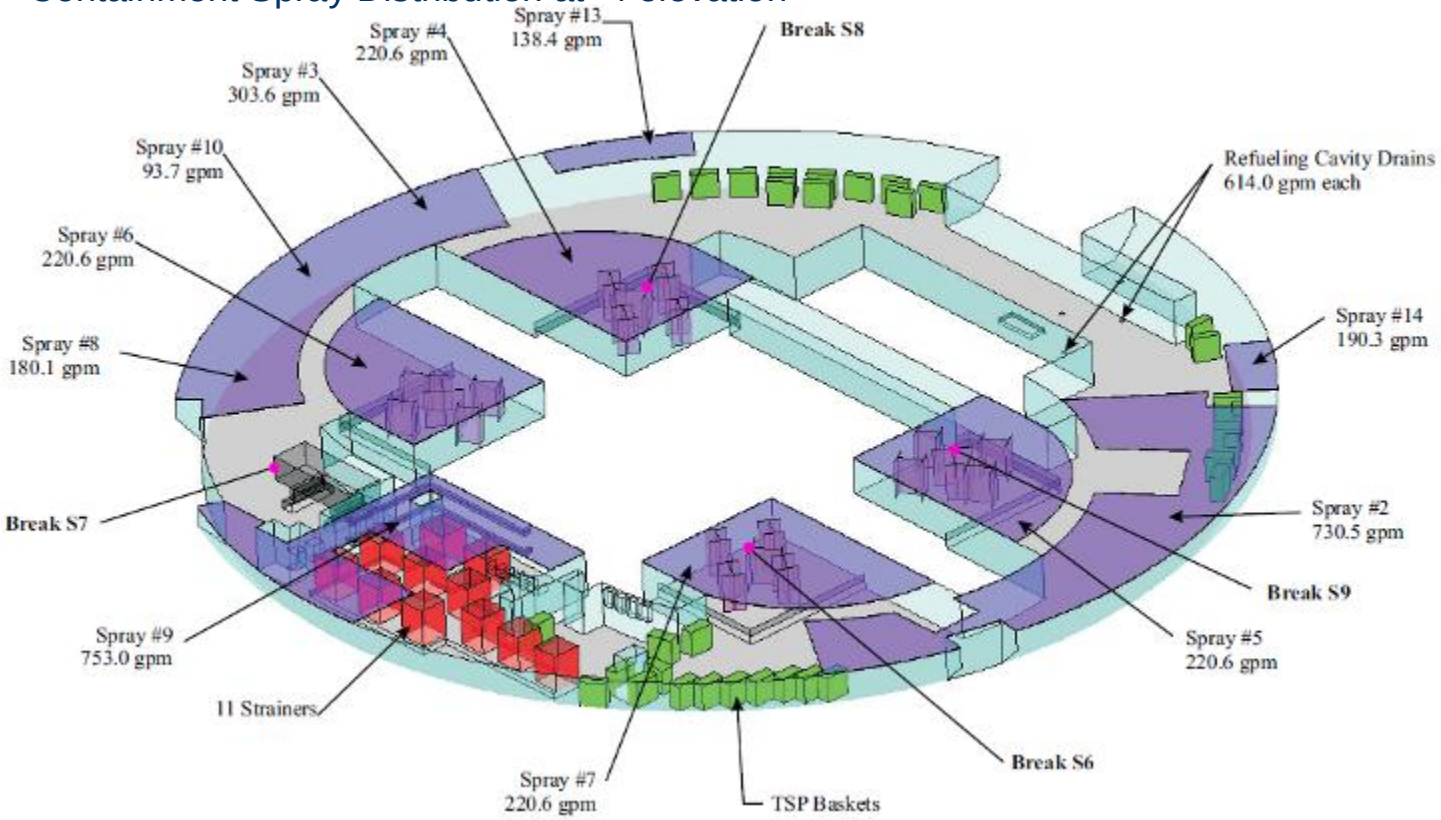
- Please identify the distance from the strainer at which debris was added to the test flume. Please justify the conservatism or prototypically of this distance based on the transport analysis results for blowdown, wash down, and pool-fill transport. Please specifically discuss consideration of the debris addition in the head loss testing for the fraction of paint chips and other containment debris that would have the potential to wash down onto the strainers from upper containment elevations, and would thus not have to climb over the suction plenum to reach the strainer surface.

RAI #16

- Response
  - WF3 will be performing new head loss testing in 2010.
  - New head loss testing will be performed as set forth in the NRC March 28, 2008 head loss testing guidance and consistent with previously NRC reviewed Alion protocols.
  - All but one break is at a significant distance from the sump.
  - For the S7 break, a concrete wall separates blowdown from the sump
  - Wash down will only come from Containment Spray in a very limited area over the sump. See attached sketch of +46 elevation of RCB
  - Transport is based on all debris starting on the containment floor

RAI #16

- Containment Spray Distribution at -4 elevation



RAI #17

- Please describe how the potential for debris transport in the vicinity of the strainer via floatation was considered in the head loss tests for Waterford 3.

RAI #17

- Response
  - The only debris types with potential floatation concerns are closed cell type materials (i.e. foam) that would never be saturated by water, pieces of high density fiberglass (i.e. Temp-Mat or mineral wool) that may not be saturated with water for an extended period of time, and jacketed low density fiberglass since air may be trapped by undamaged jacketing; (note Waterford does not have closed cell materials or high density fiberglass).
  - Small and large pieces of low density Nukon and MEI fiberglass would be quickly saturated by the hot water in the containment pool and would sink (see NUREG/CR-2982 and NUREG/CR-6808 – “Fiberglass insulation readily absorbs water, particularly hot water, and sinks rapidly (from 20 to 60 min in 50°F water and from 20 to 30 s in 120°F water))
  - The top of strainers are not perforated and remain submerged throughout the event

RAI #17

- Cont,
  - The jacketed Nukon insulation and MEI could partially fail as intact blankets that may trap air and float. Given the size of intact blankets, even if this debris floats, it would be easily snagged and held up by miscellaneous structures (equipment supports, grating, etc.) and would likely not transport to the strainers.
  - If any intact pieces did transport all the way to the strainers, they would not cause significant blockage since Waterford's strainers are not pit strainers and the worst case scenario is simply that the intact pieces would rest against the side of the strainers with flow easily passing around them.
  - Fibrous debris for the new Alion testing will be prepared in accordance with the March 2008 guidance.

RAI #18*

- The October 23, 2008, supplemental response identifies on page 59 that the assumptions made concerning the settling of particulate down to 100 microns in size were benchmarked against NRC-sponsored settling tests. Please identify the NRC-sponsored tests being referenced in this discussion.

- Response
  - The “NRC-sponsored settling tests” is referring to NUREG/CR-6916, titled “Hydraulic Transport of Coating Debris”, Naval Surface Warfare Center, Carderock Division.
  - The WF3 Downstream Effects calculation contains the particle settling benchmark against NUREG/CR-6916.
  - The WF3 benchmarking calculation specifically used Table 3-2 of NUREG/CR-6916.

RAI #19

- The staff does not consider the licensee's response to Open Item 4 from the NRC staff audit to be sufficient because (1) the initial containment pool flows during fill-up will be chaotic and may distribute debris unevenly to the two sides of containment, independent of the relative flow split during recirculation, particularly for breaks such as S7, and (2) the response did not appear to discuss the definition of the starting point for the transport paths used for computing debris transport fractions that had been requested. Please provide a response to these remaining issues associated with Open Item 4 from the audit report.

RAI #19

- Response
  - The debris transport analysis assumes that the debris transport begins at the break location. The flow split based on CFD models is used to determine what percentage of debris travels to the sump from the east and west sides.
  - A review of the Debris Transport Logic Trees for the S1, S3, and S6 breaks indicates that the flow split assumption has no impact on the total transported percentages; i.e. 100% transport from the break side results in same amount of debris at sump.
  - Debris transport analysis is being revised to assume 100% transport for the S7 break, which will result in about 79 ft^3 fibrous debris on the screens. This is bounded by other breaks that transport more debris.

RAI #20*

- The supplemental response states that 25% of small debris is treated as lifting onto the sump strainer for one of the computational fluid dynamics scenarios for which less than 25% of the perimeter area around the plenum exceeds the curb lift velocity metric. The staff does not consider the methodology used to determine this percentage of debris lifting over the plenum to be prototypical or conservative because the flow approaching the strainer would be non-uniform. Specifically, most of the post-LOCA debris would approach the plenum from the high flow velocity channel, and very little debris would approach from stagnant regions experiencing low-velocity flows. Please provide a technically defensible basis for the percentage of debris that can be lifted over the strainer plenum for this case.

RAI #20*

- Response
  - The condition described only applies to one break location; S7.
  - The Transport analysis is being revised to assume 100% transport for the S7 break.
  - Debris load of 79 ft^3 is bounded by other breaks that transport more debris.

RAI #21

- The head loss testing conducted for Waterford 3 credited debris settlement. However, it was not clear that the densities of the Min-K and Microtherm debris used for testing were prototypical or conservative with respect to the corresponding materials installed in the plant. The supplemental response dated October 23, 2008, indicates that the test debris for Min-K could be from 1.1 to 4.8 times denser than the plant debris, and that the Microtherm test debris could similarly be from 1.2 to 2.9 times denser than the plant debris. Since denser debris would tend to settle faster, please either (1) provide additional information that demonstrates that the densities of the Min-K and Microtherm at Waterford 3 are reasonably close to the densities of the surrogate debris tested or (2) justify that the potential for significantly higher densities of the test debris did not lead to non-prototypical settling during the strainer head loss testing.

RAI #21

- Response
  - Min-K and microtherm were not previously observed to settle during testing as they were used in the powdered form.
  - Per NEI 04-07, microtherm has a density of 5 -12 lb/ft^3, and Min-K has a density of 8-16 lb/ft^3. 14.5 lb/ft^3 is greater than the density of microtherm and it is in the upper range of densities for Min-K.
  - Amounts of Microtherm and Min-K to be used in the Alion testing will be based on volume of insulation determined in calculations. Higher density results in more fiber being included in the test.
  - Retesting in mid 2010 will continue to use Min-K and Microtherm in the powdered form.

RAI #22*

- The staff does not consider the licensee's response to Open Item 7 from the NRC staff audit to have fully addressed the item. Please provide additional information to address the remaining points specified below regarding this open item.
  a. The response did not provide a technical basis for assuming that plant operators are capable of addressing within 30 minutes the postulated single failure of a low pressure safety injection (LPSI) pump to trip upon the switchover to recirculation. This assumption of 30 minutes to address the single failure significantly affects the determination of debris transport, head loss, and net positive suction head available.

RAI #22*

- Cont,
  b. Thirty minutes would be sufficient time for about one turnover of the containment pool volume. The licensee noted that, during head loss testing, a significant head loss had not occurred within one pool turnover. Therefore, it was concluded that there would be no effect on the strainer head loss from the failure of a LPSI pump to trip. The evaluation did not consider changes that could occur in the transport of debris to the strainer and higher bed compression that could occur due to higher flow rates through the debris bed.
  c. The description of the head loss testing that was used to justify debris bed formation requiring more than 30 minutes did not identify whether all of the debris had been added at the beginning of the test or whether a phased addition of debris had been used. If an arbitrary phased debris addition sequence was used, the time-dependence of the measured test head loss may not correspond to the bounding plant condition.

RAI #22*

- Cont,
  d. The October 23, 2008, supplemental response stated that no tests were run for vortexing-specific assumptions. At the initiation of recirculation, non-uniform flow will occur, with the highest flow rate at the modules nearest to the suction line. It was not clear from the supplemental response that the additional flow associated with the single failure of a LPSI pump to stop was bounded by the vortex testing performed for Waterford 3.

RAI #22*

- Response
  - WF3 will be performing new head loss testing in 2010. Part of this testing will include determining the impact of temporarily increased flow from a LPSI pump failure to trip. This testing will also include an evaluation for vortexing.
  - Emergency Operating Procedures and the Operations Training Program will be revised as appropriate to minimize the increased flow and debris transport/head loss impacts. Revision will be made after testing based on the results.

RAI #23*

- Please provide a general description of the ECCS strainer head loss testing conducted after the Waterford 3 audit. Provide the scope of the test program, a general description of the overall concept of how the testing addressed the audit issues, the location of the testing, and other relevant issues associated with the broad test program. This information is needed because the supplemental responses did not contain adequate detail on the test procedures for the NRC staff to reach conclusions regarding their adequacy. Please include the following information:
  a. description of test facility
  b. general procedure for conducting the test
  c. physical arrangement of the strainer within the pool including any dividers or flow diverters
  d. location of the return header

RAI #23*

- Cont,
  e. location of the stirrers, if used
  f. scaling parameters and methodology (for sector and module tests)
  g. total debris amounts (each debris constituent) and basis for the amount
  h. flow rates
  i. whether debris settlement was allowed
  j. whether flow sweeps were completed to search for bore holes
  k. debris amounts, including chemical debris
  l. description and purpose of each test case
  m. plots of the limiting test cases including annotation of significant events during the testing
  n. comparison and evaluation of pre and post-audit test results (clearly identify pre and post-audit tests)

RAI #23*

- Response
  - WF3 will be performing new head loss testing in 2010. This testing will be performed at the Alion facility near Chicago. The test methodology will be similar to that already observed by NRC staff members. (Trip report ML090500230)
  - Results from testing will be provided once testing is complete.
  - Near field settlement will not be credited in this new head loss testing.

RAI #24*

- Documentation of fiber size distribution used for post-audit head loss testing and how this compares to the fiber size distribution predicted to arrive at the strainer by the transport evaluation was not provided. The supplemental response stated that fiber used in the testing was shredded five times. Please provide a qualitative size distribution for the fibrous debris used in the testing. Please justify that the methodology used to create the debris resulted in acceptable debris sizing.

RAI #24*

- Response
  - All post audit testing used 100% fine fibrous debris consistent with the NRC March 2008 guidance.
  - Fibrous debris for the planned mid-2010 Alion head loss testing will be prepared in accordance with the March 2008 guidance.

RAI #25

- Please verify, for thin bed testing and testing that allowed near-field settling, that all fine fiber was added prior to the addition of coarser fibrous debris. Waterford 3 has predicted sufficient fine fibrous debris to be created, such that all thin bed testing should be conducted with only fine fibrous debris to establish a bounding condition, consistent with the NRC staff's 3/28/08 review guidance (ML080230038), unless the licensee can justify otherwise. This item is associated with audit open item 8, which applied to both thin-bed and higher debris load testing.

RAI #25

- Response
  - WF3 will be performing new head loss testing in 2010. This testing will be performed at the Alion facility near Chicago. The test methodology will be similar to that already observed by NRC staff members. (Trip report ML090500230)
  - Fibrous debris for the planned mid-2010 Alion testing will be prepared in accordance with the NRC March 2008 guidance.
  - Near field settlement will not be credited in this new head loss testing.

RAI #26*

- Audit open item 10 stated that adding all debris prior to starting the recirculation pump could result in agglomeration and excessive settling, and to the formation of a bed that is less dense than one formed by a more gradual arrival of debris. The licensee's supplemental responses did not provide sufficient information for the NRC staff to conclude whether this concern, and others related to the potential for nonconservative debris settling and agglomeration, applied to the post-audit testing. Please provide the following information regarding debris additions during the post-audit testing, including their impact on agglomeration and settling of debris:

RAI #26*

- Cont,
  a. fibrous concentration during addition and method of addition to flume that justifies that debris was not agglomerated
  b. location(s) of debris additions.
  c. amount of each debris constituent in each batch including chemical batches
  d. order of debris batch addition to the test
  e. time between batches
  f. whether the recirculation pump was running during debris additions

RAI #26*

- Response
  - WF3 will be performing new head loss testing in 2010. This testing will be performed at the Alion facility near Chicago. The test methodology will be consistent with that already observed by NRC staff members. (Trip report ML090500230)

RAI #27

- Please provide and justify the method for extrapolation of test results to mission times for the post-audit tests. Note that the tests reviewed during the audit were found to have acceptable final values. Therefore, if the same approach was used during the later testing, and similar head loss trends at the end of the test were observed, a simple statement to that effect is sufficient to address this question.

- Response
  - Extrapolation methodology for all GE head loss testing was consistent between the pre-audit and post-audit testing
  - Alion extrapolation methodology may alternatively be applied for new testing being performed at Alion in mid 2010.

RAI #28

- Please provide and justify the test termination criteria. Please provide data to show that the updated testing met these criteria. Note that the testing conducted prior to the audit was found to be satisfactory in this area. Therefore, if the same approach was used during the later testing, and similar head loss trends at the end of the test were observed, a simple statement to that effect is sufficient to address this question.

- <u>Response</u>
  - Test termination criteria was consistent for all GE head loss testing between the pre-audit and post-audit testing
  - Alion test termination criteria may alternatively be applied for new testing being performed at Alion in mid 2010.

RAI #29

- Please provide the methodology used to revise the plenum portion of the clean strainer head loss to 0.063 ft from 0.41 ft.

- Response
  - During an owner's review of the plenum head loss calculation, it was determined that the analysis used an incorrect equation that did not accurately reflect the velocity in the rectangular plenum.
  - When the correct equation was selected, plenum head loss reduced from 0.41 ft to 0.063 ft.
  - Standard Crane TP-410 head loss methodology was used.

RAI #30

- The audit found that stirring, in combination with the inadequate preparation of fibrous debris, may have affected the test results non-prototypically. Please provide information as to whether stirring was used during post-audit testing and how it was employed, including the duration of the stirring. If stirring was used, provide justification that the testing was conducted in a manner that would prevent non-prototypical debris transport. Also justify that stirring did not prevent debris from collecting naturally on the strainer.

RAI #30

- Response
  - WF3 will be performing new head loss testing in 2010. This testing will be performed at the Alion facility near Chicago. The test methodology will be consistent with that already observed by NRC staff members. (Trip report ML090500230)
  - Agitation will be carefully used to ensure that the debris bed is not disturbed by excessive agitation.

RAI #31

- Pre-audit thin-bed testing was based on a break that resulted in much lower amounts of particulate debris than other identified breaks. The NRC staff's 3/28/08 head loss and vortexing review guidance states that thin-bed testing should identify whether the full-particulate load, with varying fibrous loads, will result in the limiting head loss for the plant. The guidance also states that thin-bed testing with less than the full-particulate load is not generally considered to be conservative. Please provide documentation that shows that the updated thin-bed testing was prototypical or conservative.

RAI #31

- Response
  - WF3 will be performing new head loss testing in 2010. This testing will be performed at the Alion facility near Chicago. The test methodology will be consistent with that already observed by NRC staff members. (Trip report ML090500230)
  - The maximum particulate quantity will be used.
  - All thin-bed testing will be performed in accordance with the 3/28/08 guidance.

RAI #32

- The supplemental response dated 10/23/08 included a scaling equation that included scaling for debris bed thickness and flow velocity, as well as temperature. The scaling of results to different flow velocities or debris bed thicknesses may not follow the scaling equation presented in the supplemental response. Please provide details for any scaling to different velocities or debris bed thicknesses including the test conditions and results, and the plant condition being scaled to. Please provide the same information for any temperature scaling conducted.

RAI #32

- Response
  - WF3 will be performing new head loss testing in 2010.
  - Any increased head loss due to debris bed compaction or turbulent flow will be conservatively included in the final scaled value.
  - Debris bed thickness will not be used for scaling but is included in the equation to show the theoretical relationship.
  - Most tests will be conducted at approximately 80-90°F, and the head loss will be scaled to the full plant containment sump temperature range using the temperature-based viscosity ratio, i.e, Darcy's law, and the laminar/turbulent head loss component distribution will be accounted for.

RAI #33

- The supplemental response dated 10/23/08 stated that flashing at the strainer would not occur because the strainer submergence is 8 inches and the maximum head loss is about 6 inches. This is true for a large-break LOCA, but does not address a small-break LOCA, which has a bounding submergence of about 2 inches. Please provide an evaluation for flashing during a small-break LOCA at the most limiting condition. This may require an evaluation of head loss versus submergence over time or credit for accident-generated pressure.

RAI #33

- Response
  - Credit for 1 psi of containment air pressure will provide > 2 ft flashing margin when submergence is less than the bounding head loss
  - Sump temperature will exceed 210 degrees for only ~11 hrs during event
  - Time to reach 210 post RAS is ~2.2 hrs
    - Maximum temperature profile based on :
      - 1 of 2 Containment Spray Trains operating
      - 1 of 4 Containment Fan Coolers operating
      - Minimum Safety Injection flow
  - Pre-accident containment pressure will be between 14.275 psia and 27 inches water (about 1 psig) per Technical Specifications

RAI #33a

- Please provide an evaluation of gas evolution downstream of the strainer that could reach the pump suction. Please provide the percentage of evolved gas estimated at the pump inlet. Evaluate the effects of any potential gas ingestion to the pumps taking suction from the sump as described in RG 1.82, Appendix A. The staff is concerned that any gasses that are stripped from the fluid as it passes through the strainer could collect within the strainer and eventually transport to the pump suction as larger air pockets. In addition, the staff has not received information that would characterize the re-dissolution of air or gas as the static head on the fluid increases as it flows to the pumps suction. If re-dissolution of air is credited, please provide an evaluation of the variables that could affect the re-dissolution.

RAI #33a

- Response
  - Detailed analysis will be provided with formal response
  - Preliminary simplified analysis shows that void fraction is approximately 0.3%
    - Assumes water is fully saturated with air
    - Assumes head loss across strainer is a bounding 5 ft
    - Assumes 25 °C (77 °F) water
    - Re-dissolution of air is not credited
  - Strainers are located approximately 30 ft above the pump suction which will compress any void formed reducing the void fraction.

RAI #34

- In the head loss table on page 32 of the supplemental response dated 10/23/08, case S7, the pressurizer surge line break is bounding. Page 8 of the supplemental response states that the debris from the S7 break is insignificant. Please provide an evaluation of how the debris generated from the S7 break could result in a higher head loss than a thin bed case from other breaks, considering the much higher particulate debris generation. Based on observations of many strainer head loss tests and theoretical predictions of head loss, the staff believes that a thin-bed test for other break conditions, that would have a comparable amount of fiber plus a significantly larger particulate source term (including microporous insulation), would likely result in higher head losses if testing is conducted in accordance with the existing guidance.

RAI #34

- Response
  - The S7 test results listed on page 32 of the 10/23/08 supplemental report are no longer applicable to WF3 due to refined debris generation and transport calculations.
    - Test S7-2S-100-CS $\Rightarrow$ 100 ft^3 plant fiber (latent fiber not included)
    - Test S7-1S-59.2-CS $\Rightarrow$ 298 ft^3 plant fiber (latent fiber not included)
    - Current debris generation for S7 break $\Rightarrow$ 79 ft^3 fiber
  - New tests will not be run for S7 as previous testing has already concluded that S7 was not bounding.
  - The S7 break generates far less fibrous and particulate debris than the other breaks evaluated.

RAI #35*

- The supplemental response dated October 23, 2008, stated that the minimum water level calculation did not specifically include the potential RCS volume reduction due to cooling of the fluid (part of Audit Open Item 13). Instead, this phenomenon was considered to be bounded by the lack of credit allowed for the reduction in RCS level in the steam generators and pressurizer due to flow from the pipe break. It is not clear to the staff that the credit for RCS inventory can be reasonably assumed for all breaks. One example is that a small break near the top of the pressurizer could result in a condition where the loss of inventory from the RCS is eventually made up for and exceeded by incoming flow from the high-pressure safety injection system.

RAI #35*

Cont,

- In such cases, the RCS could be a net hold up volume, due to the RCS cool down after the LOCA and/or due to the potential for the ECCS to refill the RCS to a pressurizer level beyond the normal operating condition. Please provide information that justifies that neglecting RCS shrinkage due to fluid cooling can be offset by the un-credited margin associated with the RCS inventory from the pressurizer and steam generators. The evaluation should determine the magnitude of the sump level change due to RCS cooling and verify that there is adequate RCS spillage to the containment for all breaks that credit the spilled volume, accounting for the concerns discussed above.

RAI #35*

- Response
  - The Minimum Water Level Calculation will be revised. (To be finalized when all testing is completed.)
  - Two overly conservative assumptions will be revised
    - Assumption that water is held up in the Containment Sump, separate from Safety Injection sump, until it reaches an elevation of +7.5 ft MSL will be eliminated as only one non-debris limiting break has the potential to fill Containment Sump prior to Safety Injection Sump.
    - Saturated steam temperature in atmosphere post RAS will be reduced from 260F to 250F based on review of Containment P&T analysis.
  - Preliminary results show a SBLOCA level of (-)5.81 ft MSL and a LBLOCA level of (-)5.32 ft MSL when free association of the sumps are allowed and the break is at the top of the Pressurizer.
  - Preliminary results show a SBLOCA level of (-)5.38 ft MSL and a LBLOCA level of (-)4.88 ft MSL when free association of the sumps is not allowed and the break is at the Reactor Vessel.
  - Break at top of Pressurizer produces most conservative levels

RAI #36*

- The sump level calculation assumes that no holdup occurs in the refueling canal. Audit Open Item 16 requested that the licensee provide information justifying that the drain lines would not block and provide a holdup volume. The evaluation provided in the supplemental response dated October 23, 2008, was based on judgment and lacked technical basis or any information beyond that provided during the audit. Holdup in the refueling canal will affect sump level, and therefore, net positive suction head margin. Please provide additional information that justifies that the refueling canal drains cannot become fully or partially blocked so that no hold up will occur. Waterford 3 has hundreds of cubic feet of fiber, as well as miscellaneous debris and other materials.

RAI #36*

Cont,

- It is not clear that the upper guide structure lift rig and an access ladder (diver stairs) are sufficient to keep larger debris out of the drains for the refueling canal. The supplemental response does not address why large pieces of debris cannot be blown into the upper containment. If such debris ends up in the refueling cavity, it is not clear that temporary floatation, transport by surface currents over the drain, and subsequent soaking with water, can be ruled out. If drain blockage can be ruled out, then please identify whether any water buildup is necessary to create sufficient driving head for flow to occur through the drain for a clean condition. Alternately, if drain blockage cannot be ruled out, then please evaluate the potential holdup in the refueling canal and its effect on pool water level.

RAI #36*

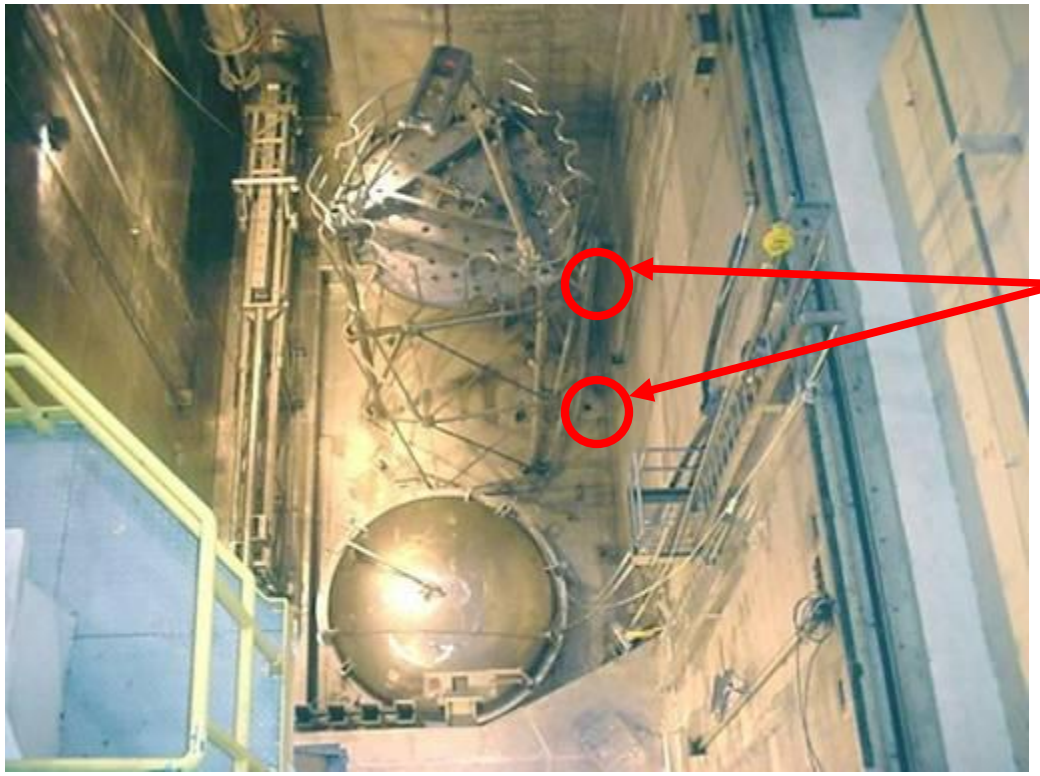
- Response
  - 5 of the 7 breaks analyzed for GSI-191 are below the 14 ft elevation and are inside the containment D-rings. The top of the D-rings are at elevation 62.25.
  - The breaks in the Pressurizer cubicle (S7) and at the reactor (S2) are shielded by physical structures (walls, grating, cavity ring seal) from sending debris in to the upper areas of containment or into the reactor cavity.
  - The 5 breaks in the D-rings would have to project debris larger than 6 inches (drain size) through an obstruction filled D-ring (see attached sketch and pictures) and then over the D-ring wall.
  - The debris would then be required to fall on top of the drain, as debris 6” or larger would not transport in the cavity.
  - Sufficient flow can be achieved through the drains without requiring any measurable level in the pool.

RAI #36*

- Cont;
  - The drains are separated by about 9 feet and are 1 foot from the east cavity wall.
  - One of the drains is near the north wall and below a set of stairs used to access the upper guide structure lift rig. The other drain is near the end of the stairs.
  - Directly to the west of both drains is the upper guide structure lift rig.
  - These obstructions shield the drains and aid in preventing large debris from covering them. (see pictures)
  - Refuel Machine rails will prevent large debris from washing into cavity from +46 floor from the east and west sides of the cavity (see sketch)
  - The rails continue almost all the way to the north edge of the containment vessel, blocking debris from washing into the cavity from the north
  - A handrail with toe plate will prevent material from washing into the cavity from the south side of the +46 floor

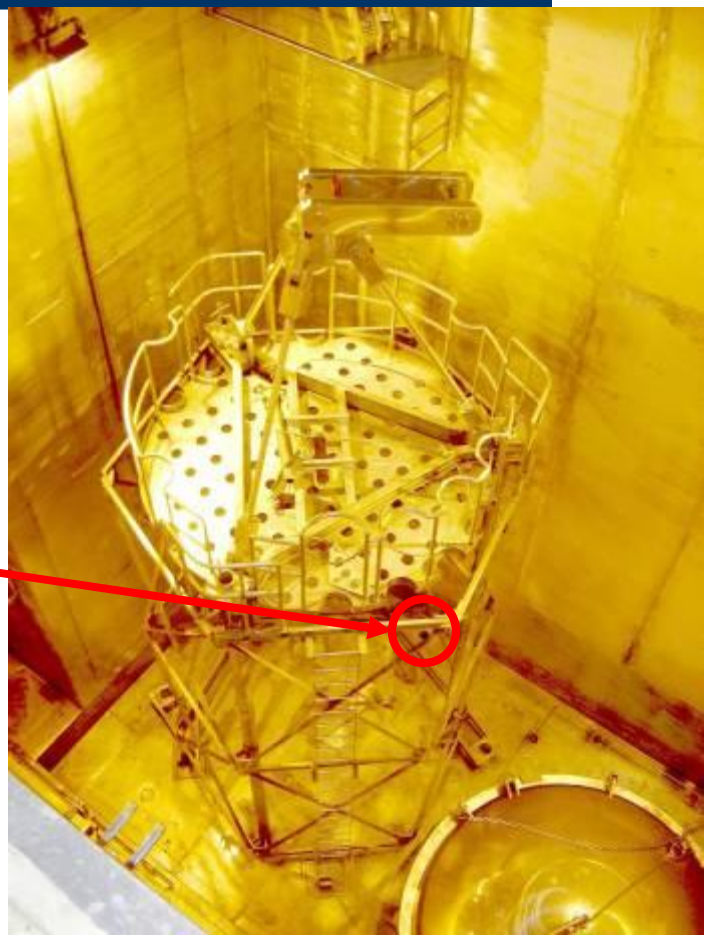
RAI #36*

- Photo looking down into reactor cavity

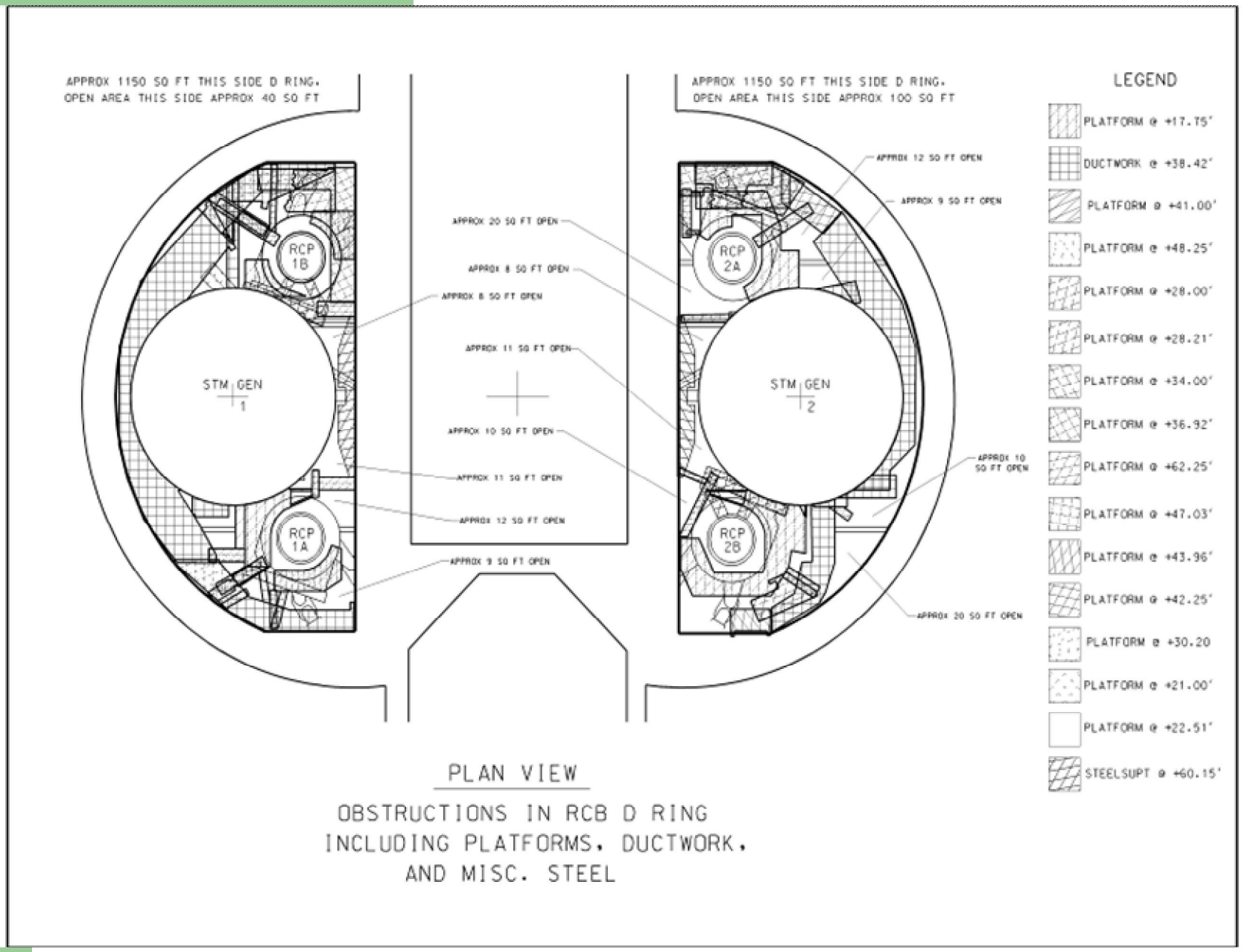


RAI #36*

- Photo looking east towards UGSLR and into Reactor Cavity



March 8, 2010

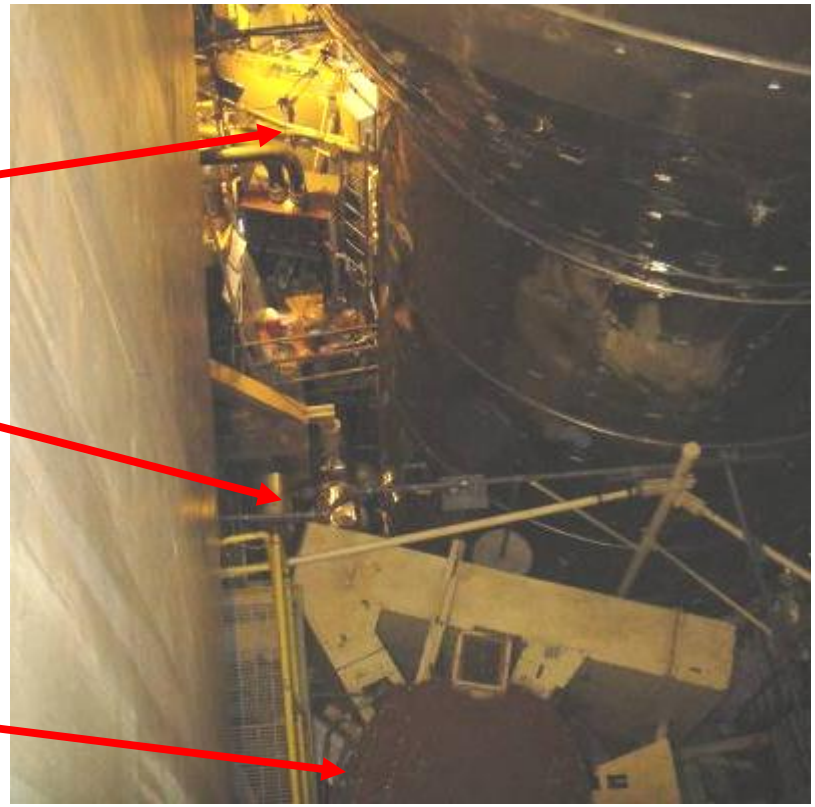


PLAN VIEW

OBSTRUCTIONS IN RCB D RING
INCLUDING PLATFORMS, DUCTWORK,
AND MISC. STEEL

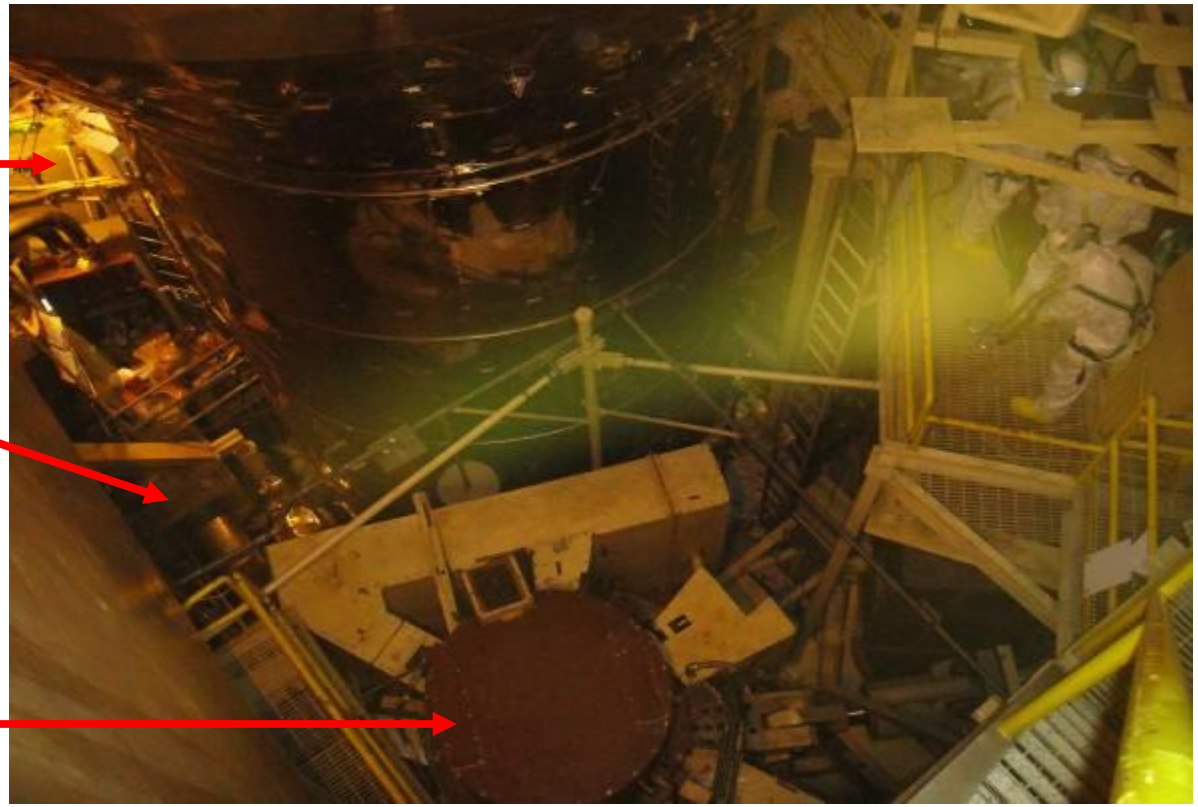
RAI #36*

- View looking down into D-ring



RAI #36*

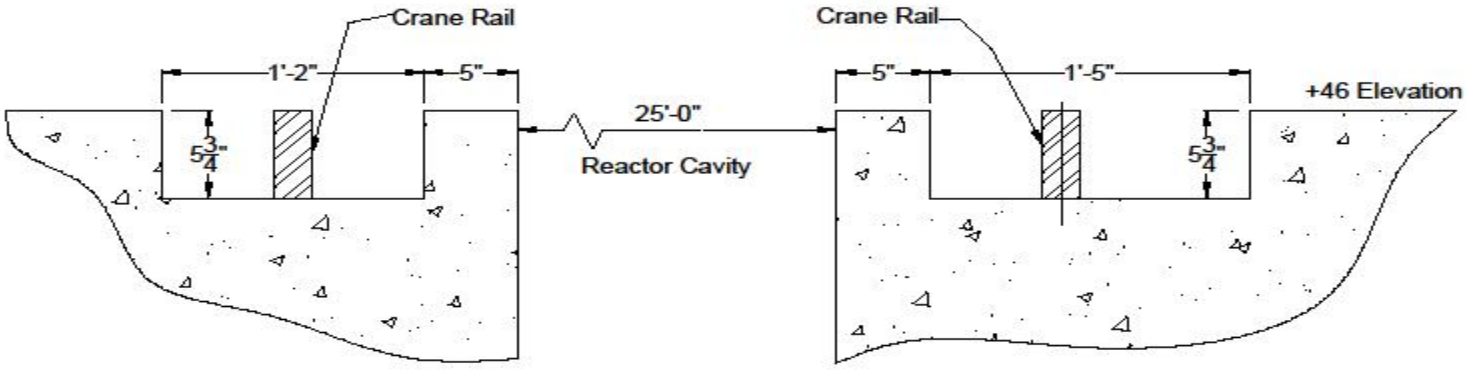
- View Looking Down Into D-Rings



March 8, 2010 Waterford 3

RAI #36*

- Refuel Machine Rails along Refuel Cavity



Elevation View
Refuel Machine Rail on West Side of
Reactor Cavity

Elevation View
Refuel Machine Rail on East Side of
Reactor Cavity

RAI #37

- In the submittal, a 4D ZOI was used for inorganic zinc coatings. Topical report WCAP-16568-P recommends using a 5D ZOI for untopcoated inorganic zinc. Please either confirm that the inorganic zinc is topcoated or justify using a 4D ZOI for untopcoated inorganic zinc coatings.

- <u>Response</u>
  - All inorganic zinc within 4D and/or 5D has an epoxy topcoat.

RAI #38

- The NRC staff does not consider in-vessel downstream effects to be fully addressed at Waterford 3, as well as at other pressurized-water reactors (PWRs). Waterford 3'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 safety evaluation (SE) for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for Waterford 3 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 also resolve this item by demonstrating without reference to WCAP16793 or the NRC staff SE that in-vessel downstream effects have been addressed at Waterford 3. Please 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.

RAI #38

- Response
  - In-vessel downstream effects issue will be addressed within 90 days of issuance of the final NRC staff SE on WCAP-16793

RAI #39*

- The supplemental responses provided insufficient information for the NRC staff to conclude that chemical effects have been satisfactorily addressed at Waterford. Please provide the results from chemical effects tests considering the NRC staff guidance for chemical effects dated 3/28/08 (ML080380214).

RAI #39*

- Response
  - WF3 will be performing new head loss testing in 2010. The test methodology will be consistent with that already observed by NRC staff members. (Trip report ML090500230)
  - This new head loss testing will include full chemical precipitates (Calcium Phosphate and Sodium Aluminum Silicate) as determined by WCAP-16530
  - Chemical precipitates will be added to module test after fiber and particulate head loss has reached stabilization criteria.

RAI #40

- The supplemental response dated 10/23/08 states that 30-day integrated chemical effects testing performed by Alion Science and Technology will be used to determine to head loss contribution due to chemical precipitates. Please describe the methodology for applying the integrated chemical effects testing results to the hydraulic head loss test results.

- <u>Response</u>
  - Please see RAI #39 response.

RAI #41

- The staff has had extensive interaction with Alion regarding the integrated chemical effects testing in the VUEZ loops. During these interactions several technical concerns have been raised. For example, the staff questioned whether a poured debris bed provided a representative baseline head loss from which to calculate a bump up factor. For a complete list of issues see ADAMS accession number ML080510657. Please describe the test protocol for the VUEZ testing conducted for Waterford 3 and address the outstanding staff concerns with the Alion/VUEZ test protocol as applicable to the Waterford 3 testing.
- Response
  - WF3 will not include any of the VUEZ data in the final response.
  - Please see RAI #39 response.

RAI #42

- Please clarify or justify the statement: “The 30 day integrated testing and analyses concluded that no aluminum-based precipitates would form in the Waterford 3 environmental conditions with a pH less than 8.1.” Lower pH would tend to favor precipitation since the aluminum solubility would decrease as the pH decreased below a pH of 8.1.

- <u>Response</u>
  - Please see RAI #39 response.

RAI #43

- Please provide the expected Waterford 3 equilibrium pH range, the projected Waterford 3 aluminum concentration, and the post-LOCA temperature profile used to reach the conclusion that aluminum-based precipitates would not form.

- Response
  - Please see RAI #39 response.

RAI #44

- Please explain what test parameters were measured to determine that no aluminum-based precipitates were formed above 140 °F, and explain whether it is possible that precipitates formed at temperatures above 140 °F but were not detected during the test.

- Response
  - Please see RAI #39 response

Going Forward

- Test protocols developed - May 2010
- Testing scheduled start – June 2010
- Initial results available – August 2010
  - Will be made available to NRC
- Final submittal – October 2010
  - All dates are tentative
  - Contracts are being processed to finalize dates

Conclusion

- Questions?