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Your ref: Docket No. 52-006
Our ref: DCP/NRC2285

November 6, 2008

Subject: AP1000 Response to Request for Additional Information (SRP6.2.2)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 6.2.2. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP6.2.2-CIB1-03,-05,-06,-08 thru -11,-14, and -17 thru -19, RAI-SRP6.2.2-SPCV-06,-07,-08,-10, and -11, and RAI-SRP6.2.2-SRSB-01,-04,-06,-07,-12, and -15 as sent in an email from Billy Gleaves to Sam Adams dated August 14, 2008. This response completes twenty-six of forty-four requests received to date for SRP Section 6.2.2. A response for RAI-SRP6.2.2-SPCV-01,-02,-04, and -05 was submitted under letter DCP/NRC2209 dated July 18, 2008.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Donald H. Ahle for

Robert Sisk, Manager
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/Enclosure

1. Response to Request for Additional Information on SRP Section 6.2.2

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NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 6.2.2

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-03
Revision: 0

Question:

Please discuss the amounts of qualified vs. unqualified coatings in containment and the assumptions made about failure of qualified and unqualified coatings during a LOCA. This distinction between qualified and unqualified coatings does not appear to be addressed in the DCD or in TR 26, Revision 3. Please discuss the basis for any differences between the AP1000 and operating pressurized water reactors in the way unqualified coatings are addressed.

Westinghouse Response:

The use of coatings that are not fully qualified is addressed in the DCD. Section 6.1.2.1.5 provides a safety evaluation of coatings used in the AP1000. This section addresses both:

- Coatings applied to containment internal structures such as walls, floors, structural steel, and the polar crane are service level II coatings with requirement for a minimum dry film density. These coatings are procured under Appendix B to CFR part 50 but otherwise are treated as Service Level II.
- Coatings applied to engineered components are not controlled for the responses specified in this DCD section.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-05
Revision: 0

Question:

Section 6.1.2.1.2 of the DCD states the gutters will be made of either stainless steel or epoxy-coated steel without primer. Please discuss how degraded coatings in the gutters have been considered as a potential debris source in the analysis for long-term recirculation cooling following a LOCA.

Westinghouse Response:

If the gutter were constructed of epoxy coated steel, the epoxy would be procured as a high density coating. If the coating did fail it could be transported into the IRWST but it would settle out before being transported to the IRWST screens due to the very low velocity in the IRWST.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-06
Revision: 0

Question:

Please provide a quantitative discussion of the basis for assuming there is no transport of epoxy coating debris to screens due to the high density of the coatings. In addressing coatings debris, page 14 of 19 of the RG 1.82 Assessment Matrix indicates non-safety coatings inside containment are specified with a high density, and therefore the debris from these coatings does not transport in the post-LOCA water. Section 6.1.2.1.5 of Rev. 16 of the AP1000 DCD states that the density specification is 100 lb/ft^3 and, qualitatively, that the transport under these conditions is "limited."

Westinghouse Response:

This aspect of the AP1000 design was reviewed by the NRC and approved in the Design Certification granted on DCD Rev 15. The protective plates provided above the containment recirculation screens are defined in the DCD in section 6.3.2.2.7.3. Technical Report 147, APP-GW-GLN-147, Revision 1 "AP1000 Containment Recirculation and In-Containment Refueling Water Storage Tank (IRWST) Screen Design" March 2008 provides additional detail. The effectiveness of these plates with the high density coatings has been demonstrated in a calculation note that supports the DCD. This calculation note is available for review by the NRC.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-08
Revision: 0

Question:

Address the plugging and wear of components in the downstream flow paths for a limiting direct vessel injection (DVI) line break. For the DVI line break LOCA in the AP1000 design, the water level in containment permits direct entry of debris laden water into the DVI line at the break location. This could result in a significantly higher concentration of debris and larger pieces of debris into the core cooling flow path than if all cooling water first passed through the screen.

Westinghouse Response:

The only components that would see the unfiltered containment water during a DVI line break are the DVI pipe (8 in schedule 160 pipe, 6.813 in ID) and the reactor vessel DVI nozzle which has a venturi with a 4 in ID. Wear of the venturi is not an issue since the only purpose of the venturi is to limit blowdown from the RCS when the RCS pressure is high. Plugging is not considered an issue because of the large ID. This was evaluated in the downstream evaluation of the PXS using the applicable methods of WCAP-16406-P-A, Revision 1.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-09
Revision: 0

Question:

Address the effects of debris in the recirculation water during a LOCA on the accuracy of instruments strapped to the outside of the PXS piping. Such instruments make use of the velocity of sound through the fluid medium, which could be affected by the type and quantity of suspended debris, chemical composition, and presence of gases.

Westinghouse Response:

The only sensors strapped on to these lines are temperature sensors which do not rely on the velocity of sound to function.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-10
Revision: 0

Question:

Address the effects of PXS flow rates which could be less than the minimum value assumed for assessing debris settling. For flow rates less than the minimum assumed value (e.g. during system flow initiation or realignment), could significant debris settlement occur which would prevent necessary system core cooling flow? The PXS is a gravity-driven system that uses little differential head to force flow. If any condition (such as system startup or realignment) could result in a momentary, relatively small flow, this could result in increased settling of suspended debris. Increased settling would produce additional system resistance to flow, with a possible result being a negative feedback condition wherein decreased flow produces increased resistance that, in turn, produces further decreased flow.

Westinghouse Response:

The calculations of latent containment debris and chemical effects for the AP1000 demonstrate the amount of debris in the AP1000 recirculation pool is small. The piping on the PXS system is large, having a diameter of about 4 inches or greater. With a low concentration of debris from either latent containment debris or chemical effects, and comparatively large diameter piping, debris settle-out due to a momentary and relatively small flow resulting from either system start-up or realignment would have negligible affect on flow resistance in the PXS piping.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-11
Revision: 0

Question:

Provide an evaluation of the effects of settling or precipitation of boric acid and other chemicals on possible blockage of the downstream flow path prior to entering the vessel.

Westinghouse Response:

Prior to entering the reactor vessel the boron concentration will be low, less than the initial IRWST boron concentration. At this concentration, there is no mechanism that would cause precipitation of boron. Similarly, calculations for other post-accident chemicals up stream of the core demonstrate their concentration is low throughout the 30-day period considered for the calculation. Considering the low concentration of post-accident chemical products, the solubility limits of the chemical products is not challenged. Thus, there is no mechanism that would cause their precipitation out of solution.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-14
Revision: 0

Question:

Discuss the difference in the temperature transients for the AP1000 post-LOCA water pool and the testing range in WCAP-16530. How did you conclude this did not affect the applicability of WCAP-16530?

Westinghouse Response:

The discussion of applicability of the methods of WCAP-16530-NP-A that extends from the bottom of page 9 to the top of page 10 provides the rationale for the applicability of WCAP-16530-NP-A to the AP1000. The recirculation pool temperature of the AP1000 was calculated to remain within the limits of the test data upon which the methods of WCAP-16530-NP-A were based for 99.5% of the time. For this and the other reasons identified in this section, the test data and spreadsheet developed for WCAP-16530-NP-A are applicable to the AP1000 design.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-17
Revision: 0

Question:

Please clarify how the amounts of Al-containing precipitates were calculated. Table 4 of TR 26, Revision 3, includes 19.7 Kg of AlOOH and 1.5 Kg of $NaAlSi_3O_8$ as chemical precipitates in the recirculating water. The associated text states that although the only source of aluminum is the excore detectors that will be enclosed in stainless steel to isolate the aluminum from the containment water, a limited amount of aluminum was arbitrarily included in the calculations. In addition, explain the basis for the selection of 53 pounds for the amount of aluminum assumed in the analysis of downstream effects.

Westinghouse Response:

The types and amounts of post-accident chemical precipitants that might form in the AP1000 coolant inventory in the reactor building pool were determined in TR 26 (reference 1) and its supporting calculation notes. The amount of chemical debris produced is maximized in the chemical model by assuming that the entire sump liquid volume is homogeneously mixed and reacts chemically with all materials located within the flooded volume of the containment. The specified amount of aluminum assumed in the debris evaluations is considered sufficient to bound small pieces that may have to be made of aluminum. Generally the use of aluminum is prohibited inside containment, especially in the areas that are flooded post accident.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-18
Revision: 0

Question:

Please discuss how your analysis of chemical effects includes the possibility that coatings could dissolve and produce material that affects head loss.

Westinghouse Response:

As shown in DCD table 6.1-2, the coatings used inside containment are qualified for use inside containment. As a result, they will not dissolve and produce chemical debris. These coatings are the same Design Basis Accident Qualified (DBA-Qualified) coatings materials currently used inside reactor containment buildings of operating PWR's. The dissolution and leaching of DBA-Qualified coatings resulting in chemical impurities in the post-accident recirculation fluid was evaluated by the PWR Industry in WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191" and determined to not be subject to dissolution, and to be an insignificant source of chemical impurities. Therefore, these coatings are not a significant source of chemical impurities.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-CIB1-19
Revision: 0

Question:

Please discuss your analysis of the potential for chemical precipitates to affect flow to the core following a LOCA. The discussion of "In-Vessel (Core) Downstream Effects" in TR 26, Revision 3 addresses the potential for deposition of chemical precipitates on fuel, but it does not appear to address the potential for chemical precipitates to block the core inlet.

Westinghouse Response:

Westinghouse submitted a report (APP-FA01-T2R-001, Revision 0, "Evaluation of Debris Loading Head Loss Tests for AP1000 Simulated Fuel Assembly During Post-Accident Recirculation", August 2008.) that provides data from a test that determined the head loss across a simulated AP1000 fuel assembly. This report shows that the head loss across resident and chemical debris is significantly less that what has been shown to be accepted in the LTC sensitivity analysis (APP-PXS-GLR-001, Revision 0, "Impact on AP1000 Post-LOCA Long-Term Cooling of Postulated Containment Sump Debris," April 2008).

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SPCV-06
Revision: 0

Question:

Per 10CFR50.34(b)(2), the FSAR must include the evaluations required to show that component safety functions will be accomplished. When and how will the FSAR be updated to include a complete description of the sump design basis and safety analysis?

Westinghouse Response:

Westinghouse identified the DCD updates associated with the screens in APP-GW-GLE-002, Revision 1, "Impacts to the AP1000 DCD to Address Generic Safety Issue (GSI)-191, June 2008. DCD Revision 17 (DCP/NRC2266, September 22, 2008) included these updates to the DCD. The updates include some changes to the DCD and the ITAAC. The updates also include the addition of references to proprietary design and test data.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SPCV-07
Revision: 0

Question:

Compare the testing done for the AP1000 with the guidance in NRC GR on Head Loss and identify any differences. For the differences please provide an explanation why the testing done remains acceptable. Specifically,

a. Provide the minimum submergence of the screens under small-break loss of coolant accident (SBLOCA) and large-break loss of coolant accident (LBLOCA) conditions and explain if vortexing is possible and any effects. Do the IRWST screens remain submerged throughout all accidents? If not, explain the impact on recirculation performance.
b. Provide the basis for the selection of the head loss test termination criteria.
c. State whether temperature/viscosity was used to scale the results of the head loss tests to actual plant conditions. If scaling was used, provide the basis for concluding that boreholes or other differential-pressure induced effects did not affect the morphology of the test debris bed.
d. How was the operation of the non-safety related injection systems considered in the testing?

Westinghouse Response:

a. The limiting break location is a DVI break in PXS room B. This break location results in flooding an additional room (the PXS B room) that does not flood for other break locations including a large break LOCA. During a DVI LOCA the containment water level is at least 10 feet above the top of the containment recirculation screens as stated in DCD section 6.3.2.2.7.3. During this limiting DVI LOCA the water level in the IRWST will be just above the top of the IRWST screen. Note that the testing performed on the AP1000 screens (reference 9) showed no vortex formation with the water level equal to the top of the screen. During a large break LOCA the water level in the containment and in the IRWST will be about 9 inches higher.

b. The basis for the head loss termination criteria for the test was an observed steady state pressure drop across the recirculation screens. Tests were run for approximately two (2) hours after the last addition of chemical material. The volume of the flume was 80 gallons, and the flow rate was 50 gpm. This provided for about 75 turnovers of the flume volume between the last debris addition and the time of test termination.

c. Scaling for the recirculation tests did not take into account either temperature or viscosity. Using ambient temperature water provided for a larger viscosity than would be experienced in the AP1000, resulting in a conservatively large pressure drop across the recirculation screens for a given debris load.

d. The flow rate used in the test bounds the operation of the non-safety RNS.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SPCV-08
Revision: 0

Question:

Provide a summary of the containment housekeeping programmatic controls in place to control or reduce the latent debris burden. The programmatic controls need to assure that design-basis assumptions regarding debris sources and transport remain valid. Specifically, provide a description of programmatic controls to maintain the latent debris fiber source term into the future to ensure assumptions and conclusions regarding inability to form a thin bed of fibrous debris remain valid.

Westinghouse Response:

The AP1000 cleanliness program is the responsibility of the COLA and as a result the DCD contains a COL item (6.3.8.1) that requires this program to be consistent with the evaluation Westinghouse has performed on the amount of resident debris.

As identified in DCD subsection 6.3.2.2.7.1, General Screen Design Criteria, a commitment for cleanliness program to limit debris in containment is provided in DCD subsection 6.3.8.1. DCD subsection 6.3.8.1, Containment Cleanliness Program. This section states:

The Combined License applicants referencing the AP1000 will address preparation of a program to limit the amount of debris that might be left in the containment following refueling and maintenance outages. The cleanliness program will limit the storage of outage materials (such as temporary scaffolding and tools) inside containment during power operation consistent with COL item 6.3.8.2. The cleanliness program will be consistent with the containment cleanliness program used in the evaluation discussed in subsection 6.3.8.2.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SPCV-10
Revision: 0

Question:

Provide a description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.

Westinghouse Response:

Maintenance activities including associated temporary changes are the responsibility of the COL applicant or licensee. They are not within the scope of the DCD.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SPCV-11
Revision: 0

Question:

TR 147, Revision 1, Section II, page 4 identifies design requirements for both sets of screens including SSE seismic loads and application of jet impingement forces. It does not address design requirements for head loss or protection from missiles or other large debris, as required by RG 1.82, revision 3, C-1.1.1.6. How will it be demonstrated that screens meet this regulatory position?

Westinghouse Response:

The AP1000 design precludes the generation of missiles as discussed in DCD Section 3.5.1.2. In addition, the cleanliness program required for the AP1000 should exclude large debris. Note that the AP1000 screen vendor has installed numerous screens for U.S. operating plants. The screen design is a robust design; considering its design as described in TR 147 and that it is designed for seismic and jet impingement, it is able to withstand the affect of large debris.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-01
Revision: 0

Question:

In the AP1000 DCD Section 6.3.2.2.7.3, Westinghouse stated that:

> "When the recirculation lines initially open, the water level in the IRWST is higher than the containment water level and water flows from the IRWST backwards through the containment recirculation screen. This back flow tends to flush debris located close to the recirculation screens away from the screens."

The back flow of water through the recirculation screens may cause a significant amount of water to be injected into the sump cavity. Although this flow through both recirculation screens causes the materials to be flushed from the screens, the backflow could cause enough turbulence in the cavity to lift up the debris from the bottom of the cavity, which collects during the early part of the LOCA, and once the water flow reverses into the screens this debris is available to be collected on the screens.

a. Describe the potential for blockage with the addition of uplifted debris.
b. Identify whether or not the addition of the zinc coatings or the higher density epoxy coatings, that were assumed to be collected at the bottom of the cavity, provide a source of blockage to the screens.
c. Identify whether these coatings add to the chemical impurities that could enter the core region.

Westinghouse Response:

a. The calculated reverse velocity is very low, less than 650 gpm. This flow rate results in a velocity of less than 0.006 ft/sec across the front face of the recirculation screen. Note that the reverse flow is elevated 2 feet above the floor due to the curb that is located in front of the recirculation screens. All of the resident debris that is involved with post accident flows is assumed to be transported to the screens; none of this debris is assumed to settle out. As a result, the only debris that may be on the floor in front of the recirculation screens is MRI and high density coatings. This high density debris will not be uplifted by the very low / elevated reverse flow through the recirculation screens.

b. The zinc coating material is elemental zinc having a density of 457 lbm/ft3. Due to the high density of the zinc coating material and the low velocity of flows in the reactor containment building pool, the zinc coatings will not transport to the recirculation screens.

   By the requirements of the DCD, epoxy coatings have a density of 105 lbm/ft3. Calculations of paint debris chip transport have been performed and demonstrate that chips of the size necessary to block the recirculation screens will not transport to the screens. These calculations are available for NRC review.

Therefore, these coatings are not considered a source of blockage to flow through the recirculation screens.

c. The zinc and epoxy coatings used inside the AP1000 reactor containment building are the same Design Basis Accident Qualified (DBA-Qualified) coatings materials currently used inside reactor containment buildings of operating PWR's. The dissolution and leaching of DBA-Qualified coatings resulting in chemical impurities in the post-accident recirculation fluid was evaluated by the PWR Industry in WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191" and determined to not be subject to dissolution, and to be an insignificant source of chemical impurities .Therefore, these coatings are not a significant source of chemical impurities.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-04
Revision: 0

Question:

In TR 26, Revision 3, on page 9, in the "Evaluation Approach" subsection, Westinghouse states that the post-accident chemical products were estimated using a tool generated by the PWR Owners Group and design features of the AP1000.

Since the amount of post-accident chemical products is an important contributor to plugging, debris build-up and scaling in the core, the software and/or analytical tools used to assess the impact of debris on the AP1000 strainers and core should be identified and validated.

Identify the software and/or analytical tools used to perform these evaluations and describe how the software/tools have been validated to perform chemical evaluations using the design features of the AP1000.

Westinghouse Response:

The discussion on page 9 of TR 26, Revision 3, is directed at the prediction of chemical products in the post-accident liquid pool in the reactor containment building floor of the AP1000. The tool used to perform the chemical evaluations is the spreadsheet that was developed to accompany WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191." The spreadsheet was validated as part of the effort to publish and support the NRC review of WCAP-16530-NP-A. The applicability of the spreadsheet to the AP1000 design is stated at the bottom of page 13 and the top of page 14 of TR 26, Revision 3.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-06
Revision: 0

Question:

In TR 26, Revision 3, on page 11 in the "Break Selection Criteria" subsection, Westinghouse indicated that it applied applicable portions of the guidance in NEI 04-07 for the selection of break location within a PWR and its effect on debris generation and composition to AP1000, and that because of different design in AP1000, it modified the selection criteria to determine the maximum amount of latent debris that can be transported to the containment recirculation, IRWST screens as well as to the core. Westinghouse also listed the following three break locations that resulted in the limiting amount of debris to be transported to the containment recirculation and IRWST screens and the core: a break of a DVI line at the reactor vessel, a break in the automatic depressurization system stages 1, 2, and 3 lines near the top of the pressurizer, and a break on the inlet line of the core makeup tank.

a. Identify the applicable portions of NEI 04-07, Revision 0, "Pressurized Water Reactor Sump Performance Evaluation Methodology," and the modifications to the break selection criteria that were applied to the AP1000.
b. Identify whether the study correlating the AP1000 to current PWRs on break selection is documented. Provide the assumptions used for the amount of debris that is transported into the screens and core region for each selected break location for AP1000.

Westinghouse Response:

a. TR 26 explains the break selection criteria used for AP1000 and how it differs from the guidance in NEI 04-07. As explained in this TR, the difference is due to design differences between the AP1000 and the operating plants. NEI 04-07 requires an evaluation of different break locations in order to determine which break produces the limiting amount / types of debris that results in the maximum head loss. In the operating plants, this is necessary because LOCA jets generate debris and different break locations generate different amounts and types of debris. The situation is much simpler in AP1000 because LOCA jets do not generate debris that reaches the screens. As a result it is not necessary to evaluate different break locations to evaluated debris generation. The debris that is applicable to the AP1000 is latent debris and post accident chemical effects.

   As explained in the TR, the break selection process used for AP1000 determined the maximum amount of latent debris that could be transported to the recirculation screens, the IRWST screens and the core. The process mechanistically evaluated the area of the plant that could be involved with water that could flow to one of the screens or to the core following a LOCA. Consideration was given to LOCA blow down jets, containment floodup, and condensation from the containment dome. The latent debris associated with these areas is assumed to be transported; none is assumed to settle out.

This discussion is contained in TR 26.

b. TR 26 provides an explanation of the break selection criteria and its use on the AP1000. In addition, supporting calculation provide additional detail on the distribution of latent debris in different areas of the plant. These calculations also document which areas are involved with different break locations.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-07
Revision: 0

Question:

In TR 26, Revision 3, in the "Break Selection Criteria" subsection on page 12, Westinghouse states:

> "As the tables show, approximately 24 lbm of latent debris would be expected to be transported to the AP1000 Containment Recirculation Screens through direct impingement, immersion or from being washed down during a high energy line break."

As stated in NUREG-1793, Section 6.2.1.8.3, "Pool Transport and Head Loss Evaluation of the Containment Recirculation Screens, the staff noted that Westinghouse's analysis assumed a mass of resident debris in the containment of 227 kg (500 lb) and that was consistent with estimates made with current generation PWRs in the GSI 191 parametric study (NUREG/CR-6772). In TR-26, Revision 3, on page 16, Westinghouse identified 200 lbm of latent containment debris based on an NRC safety evaluation performed on NEI 04-07. The staff, in its review of the NRC safety evaluation performed on NEI 04-07 (ML043280007), does not find the reference of 200 lbm that Westinghouse identifies in TR-26. Further, the staff notes that the total debris of 24 lbm and .24 ft^3 that were referenced in Table 1 of TR-26 is a very small amount of mass and volume from the whole containment (500 lbs) that may accumulate at the recirculation screens.

a. Explain the apparent discrepancy between the mass of resident debris in the containment of 227 kg (500 lb) in NUREG-1793 Section 6.2.1.8.3 and the 90.8 kg (200 lb) identified in TR-26, and justify the TR-26 number, as it is not included in the referenced SER.
b. Explain how the volumetric values of debris presented in Tables 1 & 2 were derived. For example, how was the .01 cubic foot of epoxy coatings derived given all of the coatings in the containment that can flow into the sump region? Provide a basis for each of the volumetric values given. Include identification of areas assumed for each break path by type of surface (horizontal, walls, equipment or piping), area of surface, and average volume of debris from operating plant. Identify the operating plant walkdown and actual debris values used to determine the average volume of debris for each area. Identify how and where the "25% conservatism" identified in TR 26 is added.
c. The epoxy density is given as 94 lb/ft^3 in Tables 1 and 2, but as 105 lb/ft^3 in DCD Rev. 16, Table 6.2.1.1-8. Explain the difference between these two values.
d. Section 3.6 of the NRC safety evaluation on NEI 04-07 discusses debris transport methodology. Provide the criteria and methodology used in TR 26, including debris transport factors and flow velocities. Identify model for debris transport off the protective plates and the basis for associated calculations and assumptions.

Westinghouse Response:

a. As discussed in TR 26, the total amount of latent debris in the AP1000 was calculated based on operating plant walk down debris loading data and AP1000 surface areas. This calculation was performed for two cases. One case was a best estimate case and one was a bounding case. The bounding case resulted in a total of about 100 pounds of latent debris in the containment. This is about 50% more debris than is typically seen in operating plants based on walk down data.

   To demonstrate that there is not a "cliff" near the bounding case, a sensitivity case was defined that used 200 pounds of latent debris. As discussed in TR 26, the 200 pounds was based on the NRC recommended value for latent debris in their safety evaluation of NEI 04-07. A value of 500 pounds of latent debris was not assumed in the AP1000 long-term cooling evaluations.

b. The general description of how the values listed in Tables 1 & 2 were calculated are given at the bottom of page 9 and the top of page 10 of TR 26. The details of how the values were calculated are documented in a calculation note. This calculation note is based on information that is proprietary, including operating plant names, but can be made available for review by NRC representatives at the Westinghouse Washington Office.

c. The use of 94 lb/ft^3 in Tables 1 and 2 is a conservatively low density for epoxy coatings. The use of a lower density was used in conjunction with maximizing the potential for transporting the coatings debris to the recirculation screens.

d. All latent debris in areas that could communicate with the recirculation screens was conservatively assumed to be transported to the recirculation screens. Therefore, in TR 26, the transport factors for latent containment debris, both fibrous and particulate, were taken to be "1.0".

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-12
Revision: 0

Question:

TR 26, Revision 3, relies on the NUREG/CR-6224 correlation for head loss calculation in the reactor vessel without supporting analytical data. The NRC safety evaluation of NEI 04-07 recommends the correlation be validated using head-loss data from tests performed on the particular type of insulations and range of parameters to ensure its applicability. Additionally TR 26 concludes that there would not be continuous fiber debris bed on the fuel bottom nozzles without data supporting this assertion.

Provide a rationale that is supported by data that demonstrates that the NUREG/CR-6224 correlation is applicable to the AP1000 and the conclusion that the resulting head loss at the bottom of the fuel is negligible.

Westinghouse Response:

Testing was performed on a simulated AP1000 fuel assembly and reported to the NRC in APP-FA01-T2R-001, Revision 0, "Evaluation of Debris Loading Head Loss Tests for AP1000 Simulated Fuel Assembly During Post-Accident Recirculation", August 2008. This test showed that the resulting head loss will have no impact on core flow rates and that the head loss is less than 10% of what has been shown to be acceptable in long-term core cooling sensitivity studies.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP6.2.2-SRSB-15
Revision: 0

Question:

In APP-PXS-GLR-001, Revision 0, "Impact on AP1000 Post-LOCA Long-Term Cooling of Postulated Containment Sump Debris," Westinghouse states, on page 2, the following:

> "Also note that during recirculation, water from the IRWST continues to flow into the PXS room and maintains its level; the water flow from the IRWST passes through the IRWST screen, which would remove the debris that would be in the water."

In TR-26 evaluations, all velocities through the screens were considered to be low. The break in the PXS room causes the velocity through the IRWST screen to increase significantly. Additionally, with this significantly higher velocity through the screen, the latent debris in the IRWST has a greater probability of being swept away and into the IRWST screens, which causes a greater chance of debris passing the screens and directly into the core through the break.

Provide the analysis for this additional debris bypass concern and the impact on core cooling and chemical deposits on the fuel. Discuss, in the analysis, the potential for scaling build-up on the fuel from the new chemical products from the AP1000, and if they could impede the heat transfer characteristics of the fuel.

Westinghouse Response:

The results of the three clad heat-up evaluations performed for the AP1000 are listed in Table 9 on page 26 of Technical Report 26 ,APP-GW-GLR-079, Revision 3, "AP1000 Verification of Water Sources for Long-Term Recirculation Cooling Following a LOCA", March 2008. The third case in Table 9 provides for a minimum recirculation pool volume (resulting in maximum chemical product concentration and therefore chemical deposition on cladding) and an adder (bump-up factor) that models all latent containment debris fiber to be deposited on the clad. The results of this case demonstrate that the total chemical buildup is less than 50 mils, and the resulting calculated clad temperature is unaffected and remains nearly 500°F below the acceptance temperature identified in TR 26. This result is documented in a calculation note that can be made available for review by NRC personnel.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None