Draft

Request for Additional Information No. 111 (1446, 1471, 1508), Revision 0

10/20/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.02.02 - Containment Heat Removal Systems
Application Section: FSAR Ch. 6

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)
QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

06.02.02-8

In ANP-10293, dated February 2008, the applicant assesses the U.S. EPR design with respect to RG 1.82 Revision 3 (November 2003). All reference material, used in development of ANP-10293, was published prior to September 2004. Since September 2004, substantial experimental and analytical work has been performed to address the resolution of GSI-191. In December 2004, in an effort to aid resolution of Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance," (issued in September 1996), the NRC staff evaluated industry guidance to resolve GSI-191 that was submitted through NEI. The NEI submission, as approved in accordance with the staff safety evaluation, provides an acceptable overall guidance methodology for evaluation of emergency core cooling system (ECCS) performance following any postulated accident for which ECCS recirculation is required, with specific attention given to the potential for debris accumulation that could impede or prevent the ECCS from performing its intended safety functions.

The applicants' submittal (FSAR) and the subsequent technical report (ANP-10293) provided the staff with a high level overview of sump design features and selected results. However, in accordance with available guidance, more details are needed on AREVAs methods and evaluation techniques, selected to meet NRC's regulations, in order to complete an evaluation of emergency core cooling system (ECCS) performance following any postulated accident for which ECCS recirculation is required, with specific attention given to the potential for debris accumulation that could impede or prevent the ECCS from performing its intended safety functions. As such, several areas require additional information or clarification and form the basis for the following RAIs.

In each area below, the level of detail provided should include a summary, with information needed to address the area, description of the methodology used to reach the conclusion, basis for methods and key assumptions not consistent with NRC-approved guidance, and sufficient information to show correct application of any NRC-approved guidance.

RAI-SRP 6.2.2-SPCV-01

A. Thin Bed effect

AREVA states, in ANP-10293, that no relevant thin-bed effects were observed during AREVA performed strainer validation testing. In addition, AREVA states they will evaluate additional empirical data to further assess the presence or lack of thin-bed effects. ANP-10293 also states in section 3.2.3, under test conditions, a uniform debris bed was formed in all cases on the ECCS sump strainer. Thin-bed effect is discussed in RG 1.82 and NRC SE on NEI 04-07 GR. Thin-bed effect refers to the debris bed condition in a fibrous/particulate bed of debris whereby a relatively high head loss can occur because of a relatively thin layer of debris, by itself or embedded as a stratified layer within other debris, because the bed porosity is dominated by the particulate, and the bed porosity approached that of the corresponding particulate sludge. The latest staff criteria for thin-beds are addressed in "Review Guidance for Strainer Head Loss and Vortexing" (ADAMS ML080230038).

1. What is the calculated thickness of the EPR fiber debris bed? Provide analysis inputs and assumptions. Explain the basis for how these analysis inputs and assumptions are conservative.

2. Does U.S. EPR design have the potential to develop a thin-bed as described in NEI GR and RG 1.82?

3. For those plants that can substantiate that the formation of a thin bed which can collect particulate debris will not occur, the staff finds that coating debris should be sized based on plant specific analyses for debris generated from within the ZOI and from outside the ZOI, or that a default area equivalent to the area of the sump-screen openings, be used for coatings size. Provide details of analysis, as applicable.

4. The testing methodology and guidance on thin beds has improved over the last few years. For thin bed testing, please describe how particulate and fiber debris additions were sequenced. Describe basis for methods and key assumptions not consistent with NRC-approved guidance (e.g. NRC SE on NEI 04-07 GR and Review Guidance for Strainer Head Loss and Vortexing).

B. Break Selection

ANP-10293, states the hot leg is the limiting break location but does not provide justification.

1. Describe and provide the basis for the break selection criteria used in the evaluation.

2. Discuss the basis for reaching the conclusion that break size(s) and location(s) chosen present the greatest challenge to post-accident sump performance.

C. Debris Generation/Zone of Influence (excluding coatings)

ANP-10293 Section 3.1.1.1 states AREVA selected a ZOI that corresponds to a sphere with a radius of seven pipe diameters but does not provide justification.

1. Describe the methodology AREVA used to determine the ZOI for generating debris. Identify which debris analyses used approved methodology default values. For materials with ZOIs not defined in the guidance report/SE, or if using other than default values, discuss methods to determine ZOI and the basis for each.

2. Provide destruction ZOIs and the basis for the ZOIs for each applicable debris constituent. How does AREVA account for two phase jet effects (see SE on NEI GR, section 3.4.2.2)?

3. Identify if destruction testing was conducted to determine ZOIs. If such testing has not been previously submitted to the NRC for review or information, describe the test procedure and results with reference to the test reports(s).

4. Provide the quantity of each debris type generated for each break location evaluated. If more than four break locations were evaluated, provide data for the four most limiting locations.

5. In ANP-10293 AREVA states that reflective metal insulation (RMI) is used extensively on RCS components (section 2.5) and makes up a portion of the debris source term (Table 3-1). In addition, FSAR section 6.3.2.2.2 claims RMI is not subject to transport to the SIS sumps.

    a. Describe testing or evaluations that show that the EPR selected RMI insulation, once it has been damaged by the LOCA, will not become debris that will cause potential plugging of the screens.

    b. Verify that the same degradation for the RMI as described in the NEI 04-07 SE exists in the U.S. EPR or identify what the degradation would be. Describe the impact of the degradation on the debris loading.

c. Did AREVA conduct testing with RMI as part of their limiting fiber and particulate (and chemical) case? If so, what amount of RMI was present on the strainer surface?

d. Is there any chemical residual associated with the RMI that could impact the screen blockage or the downstream blockage in the core? If so, what is the impact to the screens and to the core blockage?

e. Is there any fiber insulation or particulate encased in RMI that could contribute to the debris? If so, are the configurations qualified for jet impingement? Provide the qualification details.

6. Are there any other objects or devices in the zone of influence that can be damaged by jet impingement and contribute to the debris (e.g., cable insulation, instrumentation, hot/cold leg temperature instrumentation and associated insulation, nuclear instrumentation, signs, caulking, fire barrier material…)?

7. How will lack of debris generating materials in the zone of influence (ZOI) be verified?

D. Debris Characteristics

In ANP-10293, AREVA states the assessment of the ECCS sump strainer blockage is conservatively bounded by the assumption that all available insulation and debris within the ZOI is transported to the IRWST. In addition, AREVA states bounding assumptions were assumed for debris. AREVA does not provide a listing of these assumptions to assess if these assumptions are bounding and conservative.

1. Provide the assumed size distribution for each type of debris.

2. Provide bulk densities (i.e., including voids between the fibers/particles) and material densities (i.e., the density of the microscopic fibers/particles themselves) for fibrous and particulate debris.

3. If mainly relying on calculations (limited testing), provide assumed specific surface areas for fibrous and particulate debris.

4. Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.

5. Section 2.5 of ANP-10293, states jet impact resistant, cassette type encapsulated mineral wool is used as RCS insulation. In section 3 the debris source term (Table 3-1) lists mineral wool in cassettes, in fiber glass cloth protected by stainless steel, and in mattress around auxiliary pipes protected by stainless steel sheet. Mineral wool may be manufactured using a number of materials with varying characteristics. What specific type of mineral wool was selected when conducting head loss testing? What type of mineral wool is specified for installation in U.S. EPR? Clarify and differences between tested condition and U.S. EPR design, as applicable.

E. Latent Debris

AREVA assumed 110 lb of latent debris in the analysis. AREVA states the value is conservative and is based upon operating experience and sampling performed on operating plants. No further characterization of the debris was provided.

1. Provide the methodology used to estimate quantity and composition of latent debris.

2. Provide the basis for assumptions used in the evaluation.

3. Provide results of the latent debris evaluation, including amount of latent debris types and physical data for latent debris as requested for other debris under D. above (debris characteristics).

4. Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.

5. 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.

F. Debris Transport

Debris transport analysis estimates the fraction of debris that would be transported from debris sources within containment to the sump suction strainers. AREVA states that conservative bounding assumptions are employed. These assumptions and/or analysis were not provided to assess whether they are conservative or bounding.

1. According to FSAR Chapter 6.3, trash racks and weirs are considered components of IRWST. When AREVA states in ANP 10293 that all debris in ZOI is transported to IRWST, does this include trash racks and weirs or does it indicate all debris enters the water of the IRWST?

2. In ANP 10293, Section 3.0, AREVA states, “It was assumed that all dislodged material is transported to the IRWST and that all of this material is deposited on the strainer of one ECCS train, What debris is included in the term dislodged material? What material is excluded? How is this approach conservative? Is it consistent with NRC guidance?

3. Describe the methodology used to analyze debris transport during the blowdown, washdown (as applicable), and recirculation phases of an accident.

4. Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.

5. Provide a summary of, and supporting basis for, any credit taken for debris interceptors such as weirs, curbs, baskets, trash racks etc.

6. State whether fine debris (individual fibers and fine particulates) were assumed to settle and provide basis for any settling credited.

7. Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the IRWST water.

8. In ANP-10293 Section 3.1.1.2 “Debris Transport Scenarios” latent debris, paint chips, and metal debris are assumed to settle out within the loop area or the IRWST. Settling prior to reaching the strainer represents a non-conservative assumption unless the settling can be shown to be representative of actual plant conditions. Provide basis for crediting settling. Provide a description of the scaling analysis used to justify settling, if used, during head-loss testing.

9. In ANP 10293, AREVA states 1) ”Debris which passes through the retaining baskets will not encounter any turbulence due to IRWST size.” and 2) “…suspended particulates were not directly considered downstream of retaining basket.” (see page A-19 of ANP-10293). Describe testing or analytical tools used to validate these inputs and assumptions.

10. What Non Safety systems, in containment, may be in operation during a LOCA that could contribute to debris transport to either the heavy floor or IRWST? For example, containment spray is a non-safety system and may be placed in service. When this system operates post-LOCA

(operator action), assess its potential impact on debris transport.

G. Coatings Evaluation

Please provide adequate discussion and justification for coatings debris generation (ZOI determination and unqualified coatings), characteristics, transport analysis, and assumptions.

1. The staff position (SE on NEI GR) on ZOI for destruction of coatings is 10D unless plant specific analysis was conducted which is based upon experimental data over the range of pressures and temperatures of concern using coating samples correlated to EPR specified coatings. Based on either approach, what is EPRs worst case coatings ZOI volume and coating debris quantity and characterization of this coating debris?

2. SE on NEI GR requires 100% failure of non qualified coatings inside or outside the ZOI. How are unqualified coatings accounted for in the debris source term for EPR?

3. The debris source term in Table 3-1 of ANP 10293 lists 110 lb of paint chips (separate from latent debris). What is the basis for treating this source term debris as "chips", how are these chips characterised? How is this characterization consistent with recent NRC guidance documents? Does this amount include qualified and unqualified coatings within the ZOI for destruction of coatings? Does it include all unqualified coatings outside the ZOI for destruction of coatings?

H. Head Loss

Please provide additional information related to head loss determinations.

1. Meeting RG 1.82 Regulatory Position 1.3.4.5 requires the head loss caused by debris blocking the sump strainers to be estimated from empirical data. ANP-10293 states in section 3.2.1 that debris addition equivalent to approximately 1/20 of the debris postulated for a LBLOCA was added to a test loop. Table 3-1 lists 1230 ft^3 of mineral wool assumed in the evaluation. 1/20 of 1230 ft^3 = 62 ft^3 of mineral wool. Explain why only 6.2 ft^3 of mineral wool was added? In addition, 220 lb of microporous insulation was assumed in the analysis but only 8.3 lb was used versus 11 lb (1/20 * 220 = 11). Explain the basis for selecting 8.3 lb? Are these values conservative? How large was the heavy floor? This affects the flow velocity and debris settling. What was the debris size distribution in the experiments and how does it correspond to the debris size expected at the plant? The debris size affects debris settling and debris retention by the trash racks. How much debris was retained on the heavy floor and by the trash racks in the experiments? The debris was added to a separate mixing chamber and not directly to the heavy floor,

as in the plant. How much of the debris remained in the mixing chamber without reaching the heavy floor? Much more data is needed about the tests in order to assess their validity.

2. Provide information on how the test debris was prepared and how the debris was prototypical or conservative with respect to the plant design. For example, In ANP-10293 section 3.2.2, AREVA states "…part of the mineral wool would still contain binder…which would reduce the amount of fine debris available for transport". The GR and SE require the 100% of mineral wool to be reduced to small fines – which is the basic constituent – an individual fiber. How was debris added, diluted during addition?

3. Per ANP 10293, maximum sump screen approach velocities of 0.8 inches/sec are assumed in the analysis. What is the basis for selecting this value as conservative and what method was used to determine this value? How does the approach velocity used in the analysis differ from the tested condition? Provide basis for any differences.

4. What is the assumed approach velocity of the fluid transiting from the heavy floor to the trash racks in the analysis? What is the basis for selecting this value as conservative and what method was used to determine this value? How does the approach velocity used in the analysis differ from the tested condition? Provide basis for any differences.

5. Describe the constituent parts of the debris bed? Is the bed stratified or mixed?

6. What amounts, sizes, and types of particulate material are assumed to reach the retaining basket? What is the basis for this assumption?

7. What amounts (if any) and types of particulate material is assumed to reach the sump screen? What is the basis for this assumption?

8. AREVA reports that a strainer testing program validates the design of the EPR ECCS recirculation system. If the testing procedure has not been previously submitted to the NRC for review or information, please provide a copy of the test procedure and completed test report(s). Did the test include chemical effects?

9. AREVA indicated that Alden labs independently concluded that the test loop scaling was conservative and is likely to provide conservative test results. If ALDENs report has not been previously submitted to the NRC for review or information, describe the extent of their review process (to include what was not reviewed by ALDEN) and basis for their conclusions, with reference to the any report(s).

10. AREVA describes test scaling in ANP 10293. Discuss key scaling inputs described and why they are conservative for debris and velocity scaling.

11. In ANP-10293 section 3.2.3, the report states that the head loss across the strainers – with conservative assumptions - only reached about 3% of the design value. Explain conditions and ‘conservative’ assumptions that resulted in 3% head loss and list the design value. How does this compare with the 0.15 psi head loss @ 2.2 psi design value discussed in the same section? (0.15 psi >> 3% of 2.2 psi)

12. Provide the minimum submergence of the strainer under loss of coolant accident conditions. If submergence is not greater than head loss, an evaluation of the acceptability of this circumstance should be included.

13. Provide a summary of the methodology, assumptions and results of the vortexing evaluation to include design considerations for the reduction of vortexing. Provide bases for key assumptions such as minimum submergence, fluid temperature, and flow rate (velocity).

14. Provide the basis for the strainer design maximum head loss.

15. Describe significant margins and conservatisms used in the head loss and vortexing calculations.

16. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.

17. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis on the strainer.

18. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean retaining basket head loss calculation.

19. Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis on the retaining basket.

20. 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.

21. State whether containment accident pressure was credited in evaluating whether flashing would occur across the strainer surface, and if so, summarize the methodology used to determine the available containment pressure.

22. How is operation of the non-safety related injection systems (CSS) considered in the head loss assessment or testing?

23. In ANP 10293 Areva states “Even without crediting debris hold-up by the retaining baskets, the installed strainer has sufficient area to accommodate the maximum amount of debris and still operate within its design envelope?” Please define what is meant by maximum amount of debris and specify the design envelope. For debris, include characteristics such as source, sizing and amount of fiber, particulate and other debris on strainer surface and the corresponding head loss.

24. If the all retaining baskets were deemed inoperable during power operation (loss of filtering function), will the strainer design and performance support continued power operation?

25. If all the strainers were deemed inoperable (loss of filtering function) during power operation, will the retaining baskets design and performance support continued power operation?

I. NPSH

The applicant in Table 3-2 of ANP-10293 provides the NPSH assessment. More details are necessary for the staff to reach a conclusion.

1. Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level and describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.

2. Provide the basis for the NPSH Required values, e.g., three percent head drop or other criterion.

3. Describe how friction and other flow losses are addressed.

4. Describe the operational status for each ECCS and all other pumps whose suction source is the sump, before and after the initiation of recirculation.

5. Describe the single failure assumptions relevant to pump operation and sump performance.

6. Describe how the containment sump water level is determined.

7. Describe how the level in the retaining basket is determined (calculated) or measured.

8. The retaining baskets possibly constitute hold-up volumes should fibers and particulates "coat" the basket mesh. What is the hold-up volume created from the top of the lowest operating level of the retaining baskets to the spill-over level, and is this hold-up volume explicitly considered in the NPSH calculation?

9. Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.

10. Describe whether and how the following volumes have been accounted for in pool level calculations: empty spray pipe, water droplets, hold up in retaining basket and heavy floor, condensation and holdup on horizontal and vertical surfaces. If any are not accounted for, explain why.

11. Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.

12. Provide assumptions made that minimize the containment accident pressure and maximize the sump water temperature.

13. Specify the containment accident pressure (value and units) selected in the NPSH analysis.

J. Upstream Effects

AREVA provided a limited discussion on holdup or choke points, resulting in the following questions.

1. Summarize the evaluation of flowpaths from the postulated break locations (include potential for washdown, as applicable) to identify potential choke points in the flow field upstream of the sump.

2. In several instances, ANP-10293 refers to an annular space that drains to the IRWST. Define the annular space, as used in ANP-10293, and the annular space flowpaths that route water and debris to the IRWST. Describe how blockage of this flowpath has been evaluated, including likelihood of blockage and amount of expected holdup.

3. Summarize measures taken to mitigate potential choke points

4. Summarize evaluation of water holdup at installed curbs, debris interceptors or a full retaining basket.

5. Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.

6. The trash racks form a potential blockage point for all flow in the recirculation system (less that from the annular space). The grid pattern of the trash racks - 4" x 4" - combined with the heavy floor opening size, may sustain complete blockage. Given the stated debris source term analyzed in DCD chapter 6 and ANP 10293, combined with the undocumented effects of the rupture and convection foils, address whether there is enough large debris to theoretically cover the entire set of trash rack openings? Provide an evaluation that shows that the 4”x4” grating will not become blocked to such an extent that prevents adequate water supply/head to ECCS pumps.

K. DCD Section 6.2 and 6.3 and ANP-10293 questions related to GSI-191.

1. No data sheets were provided in Tier 2 of the DCD on the Retaining baskets either as a separate data sheet or as part of the IRWST design parameters data sheet. The baskets are fully contained within the IRWST. If the baskets are credited in debris management for long term core cooling, provide detailed specifications and arrangement within IRWST to allow assessment.

2. No data sheet was provided in Tier 2 of DCD for trash racks/weir installed over the four heavy floor openings as a separate data sheet or as part of the IRWST design parameters data sheet. If these racks/weirs are credited in debris management for long term core cooling, provide listing of specifications. (Note: FSAR 6.3.2.2.2 considers trash racks and weirs as “…components of the IRWST.”)

3. FSAR Section 6.3.2.2.2 discusses buffering solution. Please clarify how chemical buffer (TSP) is arranged within the boundary perimeter of the weir/trash rack.

4. Provide a listing or diagram of all the potential pathways that water and steam exiting the limiting break is routed or returned to the IRWST, post accident. What, if any, paths do not have trash/debris racks? What paths, if any, do not go to a retaining basket?

5. Does water from the limiting break location (a single hot leg), that spills out onto the heavy floor and eventually flows to the IRWST, drain to the IRWST via all four heavy floor openings (via the trash racks)? Or, is the break waters access to the IRWST restricted or constrained to the one heavy floor opening/trash rack that is contained by the structures/components in the loop compartment with the break? Are there any components that are required to operate/actuate in order to allow break water (water spilling from the pipe break onto the heavy floor in one RCS loop vault area) to access all four heavy floor openings to the IRWST?

6. Describe how water spilling out of a break near the pressurizer (within pressurizer compartment) reaches the IRWST?

7. There are four retaining baskets within the IRWST. During a LOCA, baskets receive water flow as it spills through openings from the heavy floor above. Two of the four retaining baskets are split into two compartments, with the smaller compartment dedicated to receive water from the "annular space". What amount of retaining basket surface area is available and credited (for each retaining basket) for flow from the heavy floor. What amount of retaining basket surface area is available or dedicated to the flow from the annular space? In the two compartment retaining basket, is there a common surface area that is credited for heavy floor flow and annular space flow?

8. In ANP-10293 the basket compartment designed for annular space flow has a reduced volume as compared to the other compartment (heavy floor flow) and the other two retaining baskets – 530 ft3 vs. 1766 ft3 and 3000 ft3, respectively. Is the 3000 ft3 a total volume for two baskets or does each basket have 3000 ft3?

9. Per ANP-10293, each of the retaining baskets has approximately the same screen surface area for screening out debris. Please provide a sketch or drawings that outline how these baskets and subcompartments, as applicable, are arranged and highlight credited surface areas used to perform their design functions. What is the minimum basket volume and surface area needed to support flow from the heavy floor? What is the minimum basket volume and surface area needed to support flow into the compartment dedicated to annular flow? Provide the basis for these volumes and surface areas.

10. The basket compartment receiving flow from the annular space is lower in height and is designed to minimize water retention in the annular space. What is the expected water retention in the annular space? What is the expected debris loading into the annular space? How is it transported to IRWST? What is the makeup of this debris loading – fiber, particulate? What are expected flow rates? What happens if the annular space compartment screen surface areas are clogged? Where does it overflow? Can the annular space water bypass the retaining basket compartment screens? Can debris from the heavy floor clog credited screen surface area from the annular compartment?

11. Table 6.3-4—IRWST Design Parameters lists ceiling area, wall area, and bottom area. Please explain the area difference between the IRWST bottom ~ 5800 ft^2 and the ceiling ~ 1800 ft^2.

12. Describe any access to the IRWST water surface or subsurface, during a LOCA, other than through the four trash rack protected heavy floor openings and the annular space drains. Assess potential debris entry into the IRWST through these access points and its impact on sump strainer head loss.

13. In section 2.3.3, "IRWST (ECCS) Sump Strainers, AREVA states a bounding approach was used for sizing the ECCS Strainer. What are the inputs and assumptions selected to size the strainer to achieve a conservative bounding design?

14. FSAR Section 6.2.1 specifies installation of rupture and convection foils. In a response to Question 6.2.1-07a AREVA states: The rupture and convection foils are made of austenitic steel with an intermediate layer of plastic to establish the compartmental atmospheric seal during normal plant operation. Upon rupture, how are the foil materials accounted for regarding their potential to transport and block or clog recirculation water flowpaths to the IRWST leading to water holdup (upstream effects) and possible contribution to strainer head loss or NPSH concerns.

15. Per FSAR section 6.3.2.2.2, the IRWST is connected to the core spreading area by pipes and valves. During a LBLOCA, how is IRWST single failure protection achieved with respect to these IRWST valves and piping components? If a valve or valve(s) were to open, what is the resultant change in IRWST tank level? Would this tank level support NPSH requirements?

16. Meeting RG 1.82 RP 1.1.1.12 requires the downstream effects of the debris passing the sump screen (e.g., damage to the pumps or blockage of flow through the fuel assemblies) to be assessed. The Technical Report ANP-10293 revision 0 states that the components handling IRWST water post-accident include a requirement of being capable of handling particulates of 0.09 inches or less (Appendix A, item 1.1.1.12) or 0.08 x 0.08 inches or less (Section 3.1.1.6). Why is this requirement not included in the FSAR?

06.02.02-9

Provide the limiting characterization and properties of ECCS post-LOCA debris laden recirculation water including the content of latent debris, chemicals, coatings, and other solids. Address the abrasiveness of the debris laden fluid on the wetted ex-vessel downstream components. Also, include the additional amounts of debris and the larger pieces of debris that could be ingested downstream as a result of possible use of the non-safety back flush system.

06.02.02-10

For the limiting debris laden recirculation water conditions, provide the results of a detailed evaluation of the plugging and wear of the ex-vessel downstream ECCS flow path components for their necessary mission time. Describe the plugging and wear models used and their bases. Address all individual components including: piping, valve disks and seats, pump wear rings, pump bearings and seals, pump rotors and shafts, and heat exchanger tubes and shells. Also include the effects of individual equipment strainers, cyclone separators, branch lines, pump recirculation lines, and other components that may become plugged. Provide the limiting assumptions included in the evaluation to address possible variations in operational lineup and use of various systems (e.g., use of either HPSI or MHSI versus using only LPSI for hot leg injection or use of only one train versus multiple trains of ECCS flow).

06.02.02-11

For the limiting debris laden recirculation water conditions, provide an evaluation of changes in system or equipment operation caused by wear of components (e.g., increased pump vibration due to shaft wear or the increase of pump internal bypass flow that decreases performance and may further accelerate internal wear.) Assess whether the system or component flow resistance changes or alters flow balances as a result of wear. Assess whether the system piping vibration response changes due to wear such that system integrity or its safety function may be affected. Address the capability to isolate components under debris laden conditions, including pump seals that encounter excessive wear, such that they will not leak excessively. Include those components in the non-safety SAHRS and CSS that may leak and require isolation as a result of ingesting debris laden water. Address whether leakage through pump seals or other components could increase local dose rates so that credited operator actions, if any, would not be met.

06.02.02-12

Provide the design features of the mechanical seals of the ECCS pumps that will ensure their long term performance with debris laden water containing solid particles greater than 0.08 inches. The ANP-10293 report paragraph 3.1.1.6 states that the downstream components (e.g., ECCS pumps) are designed to accommodate fluid with solid particles having dimensions of 0.08 x 0.08 inches or less. However, the square mesh screen openings of 0.08 x 0.08 inches can allow solid particles that have a major dimension as large as 0.113 inches to pass through on the diagonal. In addition, longer needle-like particles, i.e., metal whiskers, and significantly larger deformable particles can also penetrate the screen. The ECCS pumps have single mechanical seals that could potentially be damaged by particles that have major dimensions greater than 0.08 inches.

06.02.02-13

Address the effects of debris, chemicals, and gases in the ECCS recirculation water on instrument tubing connected to the ECCS piping and on the accuracy of instruments strapped to the outside of the ECCS piping. Instrument tubing will not function properly if plugged, and strapped-on 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.

06.02.02-14

Address the effects of ECCS flow velocities which could be less than the minimum value required to prevent settling of suspended debris in the downstream flow path. For flow velocities less than the required minimum value (e.g. during system flow initiation or realignment), could significant debris settlement occur that would restrict necessary system core cooling flow?

06.02.02-15

Provide an evaluation of the effects of settling or precipitation of boric acid and other chemicals on possible blockage of the downstream ex-vessel flow path. In addition to the flow path leading to the reactor vessel, address the effects of entrained debris, boric acid, and other chemicals in carryover liquid exiting the core that could settle or precipitate in the flow path downstream of the reactor vessel (i.e., the flow path from the vessel back to the break location.)

06.02.02-16

Provide an evaluation of the effects of the possible collection of non-condensable gases in high points in the ECCS flow path, including gases which may be entrained or evolve out of solution in the recirculation water, chemicals that become gaseous, and gases which may form as a result of chemical reactions. Gases in sufficient quantities which collect and are trapped at high points could cause unacceptable pressure losses and restriction of system cooling flow.

06.02.02-17

Containment Atmospheric Circulation System
FSAR Section 6.2.2

1. Instead of active containment atmospheric heat removal and circulation equipment, the US-EPR relies on a system of foils, doors and dampers to promote circulation and to

ensure that the internal containment heat structures are effective in maintaining post accident containment pressure and temperature at acceptable levels. As this equipment is relied upon to mitigate design basis accidents, it should be considered to be safety related as defined in 10 CFR 100 Appendix A Section III.(c) and should conform to all applicable NRC requirements for safety related equipment. Describe the how the design of the containment circulation equipment meets NRC requirements for safety related equipment including those for redundancy, electric power, inspection, testing, environmental qualification and seismicity.

2. The containment circulation dampers are described as being opened by motors and a spring in ANP-10268P or by solenoid operated actuators (FSAR Section 6.2.5). The pressure required for opening is stated to be 0.5 psid or 17 psia in FSAR Section 6.2.5. In the response to RAI No. 1 Table 6.2.1-07-3, the opening differential pressure is stated to be 7.252 psi. In the response to RAI No. 40 Table 06.02-11-3, the opening differential pressure is stated to be 7.25 psi. The MAAP4 input deck which Areva provided to the NRC staff uses opening differential pressures of 7.0 psi. The NRC staff understands that the actual opening differential pressure is 0.7 psi. Describe the design of the dampers including the opening mechanism and the design opening pressure. Provide appropriate corrections to the information previously provided to the NRC staff.