RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**391-8462**
SRP Section:	**06.02.02 - Containment Heat Removal Systems**
Application Section:	
Date of RAI Issue:	**02/01/2016**

Question No. 06.02.02-32

FSAR Subsection 6.8.4.5.3 (“Debris Characteristics”) and GSI-191 technical report Section 3.3 (“Debris Characteristics”) state that coating debris was assumed to be in the form of small particles based on Subsection 3.4.3.2 of NEI 04-07, “Pressurized Water Reactor Sump Performance Evaluation Methodology,“ and the staff’s corresponding Safety Evaluation Report (SER). However, in its SER on NEI 04-07, the staff stated that small particles should be assumed when a plant can “substantiate the formation of a thin bed” of fibrous debris on the strainers. For plants that can “substantiate that the formation of a thin bed which can collect particulate debris will not occur,” the staff found that “that coating debris should be sized based on plant-specific analyses for debris generated from within the ZOI [zone of influence] and from outside the ZOI, or that a default area equivalent to the area of the sump-screen openings, be used for coatings size.” The staff reaffirmed this approach in its supplementary guidance for coatings (ADAMS No. ML080230462).

Therefore, revise the FSAR and GSI-191 technical report to justify how it is conservative for the APR1400 design to assume that all coating debris is in small particulate form.

Response

A stated in Section 2.6 of the GSI-191 technical report, there are no unqualified coatings in the APR1400 containment building; all coatings are of the qualified coating type which is qualified and an acceptable coating system in a design basis accident. Therefore, only qualified coatings located within the zone of influence (ZOI) of each break are postulated to fail during a HELB. The size distribution of these failed coatings follows the guidance given in NEI 04-07 which applies a debris size distribution of 100% 10-micron diameter particle size. This represents the coating particle size due to erosion by the steam jet which is the failure mode of the qualified coating systems within the ZOI. This application is based on the constituents of the APR1400 coatings system. The coating system includes inorganic zinc (for steel surfaces) or epoxy primers, epoxy intermediate coats (for concrete surfaces), and epoxy finishing coats.

Most industry testing has been performed on unqualified or indeterminate coatings; however, there is limited data on coating failures inside the ZOI for tests which were performed to support a reduced ZOI for inorganic zinc and epoxy coatings. These industry tests further concluded that epoxy and zinc coatings fail through wear and abrasion of the jet impingement.

Any chips that are produced as a result of the impingement would have a difficult path to the IRWST and would most likely settle and not accumulate on the large strainer in such a manner as to block the holes. Numerous tests with paint chips have been performed and found that coating chips are difficult to maintain in suspension or on the strainer.

The design of the APR1400 strainer followed the NRC clean plant criteria, which required consideration of paint chip impact on available strainer area for strainers in pits only. The APR1400 strainer is not located in a pit.

In summary, the APR1400 strainer is not susceptible to coating debris in the form of chips since chips will settle and not accumulate in such a way to block the strainer (such as in a pit configuration), and the failure characteristic of inorganic zinc and epoxy coatings from industry experience is erosion resulting in very small particulates from the substrate due to the jet impingement. This justification will be added to Subsection 6.8.4.5.3 of the DCD and to the GSI-191 technical report.

Impact on DCD

DCD Tier 2, Subsection 6.8.4.5.3 will be revised as indicated in Attachment 1.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Technical report APR1400-E-N-NR-14001-P/NP, Section 3.3 will be revised as indicated in Attachment 2.

and coating debris, the diameter of the ZOI is defined as 2 and 4 (10 for IOZ) times of diameter of the broken pipe respectively.

For latent debris, 90.72 kg (200 lbs) of latent debris with a 7.5 percent / 92.5 percent (fiber to particulate) spilled is assumed as latent debris loads. To deal with the quantity of miscellaneous debris, a 9.29 m^2 (100 ft^2) penalty of sacrificial strainer surface area per sump is applied.

Total amount of debris generated during an LBLOCA are provided in Table 6.8-3.

6.8.4.5.3 Debris Characteristics

Three potential sources of debris are evaluated for their impacts on the APR1400 recirculation flow path and LTCC.

All fibrous latent debris within containment is assumed as fines easily remains suspended in water (even relatively quiescent water) and collected in the sumps following the SE for Nuclear Energy Institute (NEI) 04-07 (reference 8).

For RMI, it is assumed to consist of 75 percent for small fines and 25 percent for large pieces as the size distribution of any type of RMI inside a pipe break ZOI in accordance with NEI 04-07 guideline (Reference 7). RMI is sufficiently dense and the flow rates are also sufficiently small so that the RMI debris is considered as non-suspended and is not transported to the strainer.

For coatings, all qualified coatings within the ZOI are considered small fine particles based on Section 3.4.3.2 of NEI 04-07 (Reference 7). All coating debris will be suspended and transported in the recirculating water along with the latent debris to the strainers.

For chemical precipitates, detail information is provided in Subsection 6.8.4.5.7.

The size range of the debris materials is based on (i) the assumption that 100 percent of particulates will bypass the ECCS strainers, and (ii) guidance from NEI 04-07 Volume 2 Appendix V (Reference 7). The concentration of the post-LOCA fluid constituents is

The APR1400 strainer is not susceptible to coating debris in the form of chips since chips will settle and not accumulate in such a way to block the strainer (such as in a pit configuration), and the failure characteristic of inorganic zinc and epoxy coatings from industry experience is erosion resulting in very small particulates from the substrate due to the jet impingement.

turbulence are sufficient

4) Intact debris that readily sinks in hot water and can transport along the floor when velocity and pool turbulence are sufficient

Therefore, all latent fibrous debris assumed as fines easily remains suspended in water (even relatively quiescent water) and collects in the sumps.

NEI 04-07 (Reference [3-2]) guidance is 75% fines and 25% large pieces as the size distribution of any type of RMI inside a pipe break ZOI. The evaluation of the APR1400 design follows the guidance in NEI 04-07 (Reference [3-2]) of 75 percent small fines and 25 percent large pieces as the size distribution of any type of RMI inside a pipe break ZOI.

Subsection 3.4.3.2 of NEI 04-07 (Reference [3-2]) describes of the debris size distributions that have been used in various studies and specifies a two-size distribution for material inside the ZOI of a postulated break for the evaluation. The two sizes are fines (< 4 inch) and large pieces (> 4 inch). Fines are defined as any material that could transport through gratings, trash racks, and/or radiological protection fences by blowdown, containment sprays, or post-accident pool flows. Fines are assumed to be the basic constituent of the material for latent debris (for fibers and particles), and coatings (in the form of individual fibers, particles, and pigments, respectively). RMI debris is sufficiently dense and the flow rates are also sufficiently small to prevent the RMI debris from being transported to the APR1400 strainer. RMI is composed of thin layers of stainless steel foil. Stainless steel has a density of 7.85 g/cm^3 (490 lbm/ft^3).

NEI 04-07 (Reference [3-2]) and the SE for NEI 04-07 (Reference [3-3]) indicate the following coating effects:

1) All coatings in the ZOI will fail.

2) All qualified coatings outside the ZOI remain intact unless damaged or degraded.

3) All unqualified coatings in containment will fail.

Per Subsection 3.4.3.2 of NEI 04-07 (Reference [3-2]), all qualified coatings within the ZOI are considered fine particles with a size of 10 μm (0.394 mil). All coating debris is suspended and transported in the recirculating water along with the latent debris to the strainers.

The debris characteristics used in the APR 1400 evaluation are presented in Tables 3.3-1 and 3.3-2.

The APR1400 strainer is not susceptible to coating debris in the form of chips since chips will settle and not accumulate in such a way to block the strainer (such as in a pit configuration), and the failure characteristic of inorganic zinc and epoxy coatings from industry experience is erosion resulting in very small particulates from the substrate due to the jet impingement.

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Question No. 06.02.02-34

The APR1400 Generic Safety Issue 191 (GSI-191) technical report, "Design Features to Address GSI-191," APR1400-E-N-NR-14001-P, Rev. 0, ADAMS No. ML15009A323, and FSAR do not reference the staff's most recent guidance on chemical effects.

> "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Plant-Specific Chemical Effects," Enclosure 3 to Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors", March 28, 2008, ADAMS No. ML080380214.

Please discuss your plans to revise the FSAR and GSI-191 technical report to discuss how this guidance was used in the APR1400 chemical effects evaluation, and to identify any exceptions to this guidance. Add references to the NRC guidance documents to the FSAR and/or GSI-191 technical report, if appropriate.

Response

For resolution of GSI-191, the APR1400 followed the NRC's Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors", U.S. Nuclear Regulatory Commission, March 2008 without taking exceptions. KHNP will update the applicable sections of the DCD and GSI-191 technical report to reference this document and specifically Enclosure 2 for coatings and Enclosure 3 for chemical effects.

Impact on DCD

The DCD, Subsections 6.8.4.5, 6.8.4.5.2, 6.8.4.5.7, and 6.8.7 will be revised as indicated in Attachment 1.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Technical report APR1400-E-N-NR-14001-P/NP, Section 2.6, 3.8, and 6 will be revised as indicated in Attachment 2.

source pressure of the air bubble are developed based on the boiling water reactor (BWR) test results. Pressure calculations are performed based on a source pressure of 1.49 kg/cm^2D (21.2 psid). The dominant bubble frequency is scaled as range of 4 to 14 Hz. Predictions include the effect of the asymmetry in the sparger location relative to the boundaries of the IRWST.

6.8.4.4 Pool Temperature of IRWST

The spargers are designed to effectively condense the steam and to minimize the loads on the structure. However, if the pool temperature of the IRWST increases, significantly high loads on the IRWST structure may occur due to unstable steam condensation. Therefore, for the APR1400 design, the following regulatory requirement has been selected, so the limited pool temperature of each type of sparger in the IRWST is specified to prevent unstable steam condensation phenomena and as the most conservative pool temperature condition in the condensation sump of the BWR: "The local suppression pool temperature should not exceed 93.3 °C (200 °F)" (ASME Section XI).

In the event of the inadvertent operation of the POSRV as the DBA, the analyses of average and local pool temperature are performed. The analysis of the average pool temperature is conducted using analytical calculations, and the local pool temperature analysis is conducted using the ANSYS-CFX code (Reference 5). According to the results, both of average and local pool temperature in the IRWST are maintained less than 93.3 °C (200 °F). The local pool temperature is set as the temperature of the node above the spargers, corresponding to the definition of local pool temperature in NUREG-0783 (Reference 6).

6.8.4.5 Performance of the IRWST Sump Strainer

The performance evaluation of IRWST sump strainer during a LOCA and long-term post-LOCA related to Generic Safety Issue (GSI)-191 is described in Reference 4 in accordance with NRC RG 1.82 (Reference 3). The following subsections are the summary of key information to address GSI-191.

and Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02 (References 16).

6.8.4.5.1 Break Selection

The design basis accidents (DBAs) requiring engineered safety features (ESF) system action result in full ESF initiation, which initiates four safety injection pumps (SIPs), and two containment spray pumps (CSPs). The shutdown cooling pumps (SCPs) may be initiated when the CSP is not available.

The design basis accidents that result in debris generation are categorized as 3 scenarios, Large Break loss-of-coolant accident (LBLOCA), Small Break loss-of-coolant accident (SBLOCA), and other high-energy-line break (HELB).

Break location is selected considering the determination of the size and location of HELBs that produce debris and potentially challenge the performance of the IRWST sump strainers. Based on the pipe break sizes and locations which are determined as a result of the above reviews of the accident analysis and operational procedures that require the ECCS and CSS to take suction from the IRWST sumps, the postulated break location is selected by considering the guidance recommended in NEI 04-07 (Reference 7) and Safety Evaluation (SE) for NEI 04-07 (Reference 8).

Based on the break criteria in SE for NEI 04-07, the junction of the RCS HL pipe (42 in) and SG included in LBLOCA was selected as the postulated limiting break location. This selection for break location is reasonable because the SGs have a larger volume of insulation applied to them than does RCS piping and most of the primary system piping is located in this compartment. The larger amount of insulation presents and volume of debris are transported to the IRWST sump strainer comparing to other scenarios. This results in the maximum head loss across the IRWST sump strainer.

6.8.4.5.2 Debris Generation

The sources of debris in the APR1400 are insulation debris, coating debris, and latent debris. For the insulation debris, the Reflective Metal Insulation (RMI) is considered as a potential debris source following a HELB.

In estimating the debris generation, the spherical ZOI is used. All significant debris sources (e.g., insulation, fixed debris) within the ZOI were evaluated. For insulation (RMI)

Coatings are evaluated with consideration of the coating type, condition assessment program, generation assumption, assumed characteristics, transport assumption, and head loss testing in accordance with Enclosure 2 of Reference 16.

6.8.4.5.6 Vortexing, Flashing, and Deaeration

Vortexing, flashing and deaeration is one of the primary safety concerns about long-term recirculation cooling following a LOCA in RG 1.82 (Reference 3). Visual observation and analysis were conducted to verify the IRWST sump strainer performance.

For vortexing, visual observation during the strainer head loss test was performed at the submergence requirement of 0.61 m (2 ft) submergence and no vortices were observed. Additionally, there is no possibility to occur vortexing and air ingestion geometrically because the IRWST sump strainers are mounted at the top of the pit with the suction taken at the bottom of the pit.

For flashing, the strainer flashing requirement is conservatively met if the pressure drop across the debris bed is less than the submergence. Based on the IRWST minimum water level for ECC/CS pump NPSH, 0.61 m (2 ft) submergence under LOCA conditions is obtained and the maximum strainer head loss is 32.32 cm (1.06 ft) at 60 °C (140 °F) as result of the strainer head loss test. Therefore, flashing will not occur across the strainer surface.

For deaeration, the IRWST sump strainer submergence during post-LOCA is greater than the observed head loss under loss of coolant conditions. Since solubility of gas in water is directly proportional to the fluid pressure, the increase in solubility of air due to the static pressure increase of the water above the strainer is more than enough to compensate for the decrease in solubility of air due to the head loss across the strainer. Therefore, deaeration of fluid will not occur.

A chemical effects evaluation is performed following the chemical effects evaluation process shown in Figure 1 of Enclosure 3 of Reference 16.

6.8.4.5.7 Chemical Effects

In order to assess potential chemical effects in the APR1400 sump, the materials in the containment building that may react with coolant in the post-accident containment environment have been identified. The primary corrosion products contributing to these chemical precipitates are calcium, silicon and aluminum, and the precipitates that can form are aluminum oxy-hydroxide, calcium phosphate and sodium aluminum silicate.

15. Regulatory Guide 1.54, “Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants,” Rev. 2, U.S. Nuclear Regulatory Commission, December 2010.

16. Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02," Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors", U.S. Nuclear Regulatory Commission, March 2008.

2) Pipe lines

RMI is applied to all pipes inside the containment for heat conservation, personal protection, and anti-sweet. Particulate insulations for equipment and pipe are not used in the APR1400.

2.6 Coatings

No unqualified coatings are to be used inside containment.

The coating on structures, system, and components within containment shall use only qualified coating type which is qualified and acceptable coating system in a DBA.

The criteria for coating are addressed in NRC RG 1.54, Rev.2, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants" (Reference [2-1]) and ASTM D 3911-08 (Reference [2-2]), "Standard Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions". ~~There is no unqualified coating inside the containment~~.

Coatings are evaluated with consideration of the coating type, condition assessment program, generation assumption, assumed characteristics, transport assumption, and head loss testing in accordance with "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation," Enclosure 2 to Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02 (Reference [2-3]). These evaluations are described in the pertinent sections of this report and DCD (Reference [3-1]). No exception is taken with regard to the guidance.

3.8 Chemical Effects

A chemical effects evaluation is performed following the chemical effects evaluation process shown in Figure 1 of Enclosure 3 of Reference [2-3]. No exception is taken with regards to the guidance provided.

In order to assess potential chemical effects in the APR1400 sump, the materials that are in the containment building that may react with coolant in the post-accident containment environment have been identified. Reactive plant materials in the containment building are categorized as metallic and non-metallic items and generally include insulation and concrete, as well as other potential sources of aluminum. The materials inventory includes the overall mass, location in containment and potential for being sprayed with or immersed in coolant following a LOCA.

The WCAP-16530-NP methodology (Reference [3-11]) referenced in NRC RG 1.82 (Reference [1-1]) provides a conservative model to predict the corrosion and dissolution of containment materials in a post-LOCA environment and the formation of chemical precipitates for participating PWRs. The primary corrosion products contributing to these chemical precipitates are calcium, silicon, aluminum, and the precipitates that can form aluminum oxy-hydroxide, calcium phosphate, and sodium aluminum silicate. Surrogate suspensions of chemical precipitates representing this chemical debris can be included as an additional debris source to the strainer testing program to qualify the strainer for “chemical effects.” The quantities of chemical precipitates are based on reactive material surface areas and quantities, temperature, water level, pH, and other parameters related to the plant specific environment and post-accident evolution.

3.8.1 Containment Spray pH Control

The pH of IRWST water is evaluated to provide reasonable assurance that the calculated minimum and maximum pH values under any possible water chemistry conditions caused by a LOCA are between 7.0 and 8.5. The calculated minimum and maximum IRWST pH during operation of the CSS is 7 and 10, respectively. The minimum time to reach a minimum pH of 7.0 is 157 minutes, as shown in Figure 3.8-1. The IRWST pH ranges are included in Table 3.8-1.

3.8.2 Assumptions

1) The maximum IRWST water volume is used for the chemical effects analysis. Using the maximum water volume ensures that the maximum material dissolution and quantity of precipitates are analyzed.

2) Temperature data is only available from zero to 1,000,000 seconds post-LOCA. Since the mission time is 30 days (2,592,000 seconds), the containment air temperature and IRWST temperatures are extrapolated using a logarithmic fit of the last 9 days of available temperature data to predict the containment air and IRWST temperatures from 1,000,000 seconds to 2,592,000 seconds. This time period is chosen due to the consistently logarithmic temperature decrease for the entire time period.

3) The maximum IRWST and spray pH profile is used to conservatively maximize dissolution and precipitate generation.

4) The minimum ECCS flow case is used because it results in the highest sump temperatures, and therefore the highest corrosion rate of reactive materials in the sump. Both the minimum and maximum ECCS flow cases result in the comparable containment air temperature profiles.

6 REFERENCES

1-1 Regulatory Guide 1.82, "Water Sources for Long-term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 4, U.S. Nuclear Regulatory Commission, March 2012.

1-2 SECY-12-0093, "Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance," U.S. Nuclear Regulatory Commission, July 9, 2012.

2-1 Regulatory Guide 1.54 Revision 2, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants," U.S. Nuclear Regulatory Commission, October 2010.

2-2 ASTM D 3911-08, "Standard Test Method for Evaluating Coatings Used in Light-Water Nuclear".

2-3 Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02," Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors", U.S. Nuclear Regulatory Commission, March 2008.

3-1 "Design Control Document for the APR1400," Rev.0, KEPCO & KHNP, December 2014.

3-2 NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Nuclear Energy Institute, May 2004.

3-3 Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Nuclear Energy Institute Guidance Report (Proposed Document Number NEI 04-07), "Pressurized Water Reactor Sump Performance Evaluation Methodology," Nuclear Energy Institute, December 2004.

3-4 NRC Staff Review Guidance regarding Generic Letter 2004-02, "Closure in the Area of Strainer Head Loss and Vortexing," U.S. Nuclear Regulatory Commission, March 2008.

3-5 APR1400-E-A-T(NR)-13002-NP, "APR1400 IRWST ECCS Sump Strainer Prototype Hydraulic Qualification Test Plan," Rev. 1, KHNP, August 2013.

3-6 Regulatory Guide 1.1, Revision 4, "Water Sources for Long-term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 4, U.S. Nuclear Regulatory Commission, March 2012.

3-7 APR1400-Z-A-NR-14007-P, "LOCA Mass and Energy Release Methodology for the APR1400," Rev.0, KHNP, December 2014.

3-8 EPRI, Advanced Light Water Reactor Utility Requirements Documents Vol. II, ALWR EVOLUTIONARY PLANT, Ch 5 "Engineered Safety System," Rev.7, December 1995.

3-9 CRANE , "Flow of Fluids through Valve, Fitting, and Pipe," Technical Paper No. 410, 2009.

3-10 SECY-11-0014, "Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents," U.S. Nuclear Regulatory Commission, January 31, 2011.

3-11 WCAP-16530-NP-A, "Evaluation of post-Accident Chemical Effect in Containment Sump Fluid to Support GSI-191," Rev.0, Westinghouse Electric Corporation, April 2008.

4-1 APR1400-E-A-T(NR)-13003-P, "APR1400 IRWST ECCS Sump Strainer Bypass Test Plan," Rev. 1, KHNP, August 2013.

4-2 NUREG/CR-6808, "Knowledge Base for the Effects of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," U.S. Nuclear Regulatory Commission, February 2003.

4-3 WCAP-16406-P-A, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," Rev. 1, Westinghouse Electric Corporation, March 2008.

4-4 NUREG/CR-6902, "Effects of Insulation Debris on Throttle Valve Flow Performance," U.S. Nuclear Regulatory Commission, March 2006.

4-5 NUREG/CR-6913, "Chemical Effects Head-Loss Research in Support of Generic Safety Issue 191, Argonne National Laboratory," U.S. Nuclear Regulatory Commission, 2006.

4-6 NUREG/CR-6914, "Integrated Chemical Effects Test Project: Consolidated Data Report, Volume 1," U.S. Nuclear Regulatory Commission, 2006.

4-7 WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 2, Westinghouse Electric Corporation, October 2011.

4-8 "Final Safety Evaluation by the Office of Nuclear Reactor Regulation: Topical Report WCAP-16793-NP, Revision 2," U.S. Nuclear Regulatory Commission, April 2013.

4-9 APR1400-F-A-NR-14003-P, Rev. 0, “Post-LOCA Long Term Cooling Evaluation Model,” KHNP, September 2014.

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The November 24, 2015, response (ML15328A218) to MCB Issue #6 (KHNP AI 6-19.6) states that the maximum IRWST water volume was used instead of effective water volume to maximize the material dissolution and precipitate quantity. In order to support the staff's understanding of the APR1400 chemical effects analysis, please describe how this was determined.

Response

Using a higher coolant volume will theoretically produce more dissolution of materials into the coolant due to a longer time to reach the material saturation concentration. Since the WCAP model conservatively assumes that all dissolved species contribute to precipitate, multiplying the concentration of dissolved species times the higher coolant volume will provide a higher mass of precipitate than a lower coolant volume, if there are enough materials in contact with the coolant to contribute continuously to dissolution. This is also conservative treatment with respect to hydraulic qualification since the NPSH evaluations assume the lowest coolant volume (water level).

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

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Question No. 06.02.02-40

Section C.5.1.3 of Technical Report APR1400-E-N-NR-14001-P, Rev. 0, describes the procedure for preparing and testing aluminum oxyhydroxide surrogate for the strainer head-loss testing. The information provided is consistent with the procedures and criteria in WCAP-16530-NP-A, but other information is absent. The description in Section C.5.1.3 does not provide the sample size, nor confirm that the sample was diluted to 2.2 grams per liter. In addition, it does not state whether the sample was evaluated for both settlement criteria (the one-hour settled volume shall be 6 ml or greater and within 1.5 ml of the freshly prepared surrogate.) In order to complete its evaluation of the use of the AlOOH surrogate, the staff requests the sample size, dilution, and the surrogate used for each strainer test met all of the settlement criteria.

Response

The AlOOH precipitates prepared for these tests were prepared at 11 g/L and were intended to remain suspended during head loss testing. According to the SER for WCAP-16530-NP, Section 4.4, the settling volumes for precipitates used in this manner is measured without diluting to 2.2 g/L. CDI continuously mixed the solution prior to addition into the tank for testing. This ensured that no precipitates settled out of solution between chemical debris additions.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.