KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Tuesday, September 13, 2016 9:43 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Jungho Kim (jhokim082 @gmail.com); Andy Jiyong Oh; David Wagner (david.wagner@aecom.com)
Cc: Makar, Gregory; Mitchell, Matthew; Umana, Jessica; Ward, William
Subject: APR1400 Design Certification Application RAI 520-8693 [06.02.02 - Containment Heat Removal Systems)
Attachments: APR1400 DC RAI 520 MCB 8693.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

Jeff Ciocco
New Nuclear Reactor Licensing
301.415.6391
jeff.ciocco@nrc.gov

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From: Ciocco, Jeff

Created By: Jeff.Ciocco@nrc.gov

Recipients:
"Makar, Gregory" <Gregory.Makar@nrc.gov>
Tracking Status: None
"Mitchell, Matthew" <Matthew.Mitchell@nrc.gov>
Tracking Status: None
"Umana, Jessica" <Jessica.Umana@nrc.gov>
Tracking Status: None
"Ward, William" <William.Ward@nrc.gov>
Tracking Status: None
"apr1400rai@khnp.co.kr" <apr1400rai@khnp.co.kr>
Tracking Status: None
"KHNPDCDRAIsPEm Resource" <KHNPDCDRAIsPEm.Resource@nrc.gov>
Tracking Status: None
"Jungho Kim (jhokim082@gmail.com)" <jhokim082@gmail.com>
Tracking Status: None
"Andy Jiyong Oh" <jiyong.oh5@gmail.com>
Tracking Status: None
"David Wagner (david.wagner@aecom.com)" <david.wagner@aecom.com>
Tracking Status: None

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Request for Additional Information 520-8693

Issue Date: 09/13/2016
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 06.02.02 - Containment Heat Removal Systems
Application Section:

QUESTIONS

06.02.02-41

Chemical reaction products have the potential to combine with other post-LOCA debris to cause sump strainer and core inlet blockage, and to form deposits on the fuel. Blockage of flow and loss of heat transfer may affect the ability to maintain emergency core cooling, containment heat removal, and long-term core cooling, as required by Title 10 of the Code of Federal Regulations Part 50 (10 CFR 50), Appendix A, General Design Criterion (GDC) 35, GDC 38, and 10 CFR 50.46(b)(5). The staff is reviewing the application of the methodology the applicant used for calculating the design basis chemical precipitate quantity, the use of chemical precipitates in sump strainer and core inlet head-loss testing. The applicant has not demonstrated that its analysis and testing are conservative with respect to demonstrating that chemical precipitates will not cause unacceptable flow blockage or heat transfer. This regulatory basis applies to all questions in this Request for Additional Information (RAI).

The chemical effects analysis for addressing Generic Safety Issue 191 (GSI-191) assumes the amount of aluminum in containment is 2,326 square feet. This is identified in several places in the GSI-191 Technical Report, “Design Features to Address GSI-191,” APR1400-E-N-NR-14001-P/NP, Rev. 0 (e.g., Section 3.5.1, Table 3.8-2, and Table 3.8-3). However, FSAR Section 6.1.1.2.1 states that the surface area of aluminum inside containment is limited by design to less than 3,034 square feet. Since the amount of chemical precipitate from aluminum is directly proportional to the surface area, the design limit in DCD Section 6.1.1.2.1 would allow significantly more chemical precipitate than was included in the testing performed to demonstrate acceptable strainer and fuel assembly debris head loss.

The staff requests a discussion of the applicant's plan to make the design limit for both submerged aluminum and sprayed aluminum consistent with the amount analyzed for chemical effects. Alternatively, the staff requests justification for the allowance of more aluminum in containment than the amount evaluated, including the effects on strainer and fuel assembly testing.

06.02.02-42

In RAI 391-8462, Question 06.02.02-37, the staff asked about the basis for the statement in Section 3.8.2 of the APR1400 GSI-191 technical report (APR1400-E-N-NR-14001-NP, Rev. 0, “Design Features to Address GSI-191”) that using the maximum in-containment refueling water storage tank volume rather than the effective water volume is conservative for determining the amount of chemical precipitate. The response, dated July 1, 2016 (ML16183A314), explains that the larger water volume would result in more precipitation because it would allow more corrosion and dissolution before solubility limits for the debris-forming elements are reached. The staff

understands the principle but does not understand how it was applied in the applicant's analysis.

The WCAP-16530-NP-A basic calculation uses pH- and temperature-dependent release rates to calculate the amount of aluminum, silicon, and calcium released into solution, without considering the concentration or solubility of those elements. As the response indicates, the WCAP-16530 methodology assumes that all of the dissolved elements form precipitates. For the WCAP-16530 methodology, parameters such as the material quantities, temperature profile, and pH profile can be used to ensure a conservative analysis, as discussed in the APR1400 GSI-191 technical report. The design does not appear to propose a refinement to this methodology by applying a concentration or solubility limit.

The staff requests that the applicant clarify if and how the water volume was used to maximize material dissolution and quantity of precipitates in its methodology.

06.02.02-43

In RAI 391-8462, Question 06.02.02-35, the staff requested information about the source of the temperature profiles used in the chemical effects analysis, including the treatment of submerged vs. unsubmerged aluminum and the LOCADM calculation for deposition of chemical precipitates on the fuel. The response, dated August 10, 2016 (ML16223A976), described the source of the temperature profiles as DCD Figure 6.2.1.-4 extended to 30 days. The response did not identify how the profiles in Figure 6.2.1-4 were extended. Since those profiles end at 10^6 seconds (approximately 11.6 days), the extended profile has a significant effect on the amount of chemical precipitate calculated for 30 days. Although the response includes a temperature column in the proposed revision to Table 3.8-5 of the APR1400 GSI-191 technical report (APR1400-E-N-NR-14001-NP, Rev. 0, "Design Features to Address GSI-191"), it does not provide the 30-day pool and containment temperature profiles used in the chemical precipitate calculations. The staff requests the following information:

a) a description of how the sump and containment temperature profiles in FSAR Figure 6.2.1-4 were extended from 10^6 seconds to 30 days,
b) a description of how the extension of the temperature profiles was documented, and
c) the 30-day sump and containment temperature profiles used in the chemical precipitate calculations.

06.02.02-44

In RAI 391-8462, Question 06.02.02-40, the staff requested information about the preparation and testing of the surrogate chemical used in strainer head-loss testing. The response, dated July 1, 2016 (ML16183A314), made the following main points:

- The surrogate chemical precipitate was prepared at a concentration of 11 grams per liter (g/L) in the mixing tank.
- The intent was to keep the surrogates suspended during head-loss testing.
- The surrogate solution was mixed continuously in the mixing tank prior to addition to the testing tank.
- When testing the settling properties of the surrogate solution, dilution of the samples to 2.2 g/L was not required based on Section 4.4 of the NRC Safety Evaluation Report for WCAP-16530-NP-A.

Staff determined that the response did not provide all of the information requested, and that the response may reflect a misunderstanding about the 2.2 g/L dilution requirement. Specifically, staff notes the following:

- Section 4.4 in the SER on WCAP-16530-NP-A refers to diluting the surrogate to 2.2 g/L for certain types of strainer testing. Question 06.02.02-40 refers to Section 7.3.2 of WCAP-16530-NP-A, which states that the surrogate should be diluted to 2.1 to 2.3 grams per liter for the settling test.
- Continuously mixing the surrogate solution in the mixing tank before addition to the test is good practice, but it does not ensure that the surrogate has adequate settling properties for strainer testing to be performed in accordance with staff guidance.

Based on the applicant's July 1, 2016 response and the information in the GSI-191 technical report, it is the staff's understanding that the aluminum oxyhydroxide chemical surrogate was prepared in the mixing tank at a concentration of 11 g/L, and that the settling tests were performed without dilution. If the surrogate was prepared immediately before the strainer testing, and it passed the settling test at the higher concentration (11 g/L vs. 2.2 g/L), then adequate settling properties were demonstrated for the strainer testing.

The staff is requesting applicant confirmation or clarification to the staff's understanding that the surrogate solution passed the settling test at a concentration of 11 g/L according to the acceptance criteria in WCAP-16530-NP-A.


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