KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Wednesday, July 08, 2015 5:53 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Yunho Kim; Seung Choi
Cc: Strnisha, James; Clark, Theresa; Umana, Jessica; Lee, Samuel
Subject: Corrected RAI Number...RE: APR1400 Design Certification Application RAI 63-7983 (06.02.02 - Containment Heat Removal Systems)
Attachments: APR1400 DC RAI 63 MEB 7983.pdf; image001.jpg

KHNP,

Attached is the same RAI I issued Final yesterday, however it now has the correct RAI number which is 63-7983, and not 63-7893.

Thanks,

From: Ciocco, Jeff
Sent: Tuesday, July 07, 2015 1:39 PM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Yunho Kim; Seung Choi
Cc: Strnisha, James; Clark, Theresa; Umana, Jessica; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 63-7893 (06.02.02 - Containment Heat Removal Systems)

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. However, KHNP requests, and we grant, the following days to respond to the RAI's questions. We may adjust the schedule accordingly.

06.02.02-12: 30 days
06.02.02-13: 30 days
06.02.02-14: 60 days
06.02.02-15: 30 days
06.02.02-16: 60 days
06.02.02-17: 30 days
06.02.02-18: 30 days
06.02.02-19: 30 days
06.02.02-20: 60 days
06.02.02-21: 60 days
06.02.02-22: 60 days
06.02.02-23: 30 days
06.02.02-24: 60 days
06.02.02-25: 30 days
06.02.02-26: 60 days
06.02.02-27: 30 days
06.02.02-28: 60 days
06.02.02-29: 60 days
06.02.02-30: 30 days

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

Hearing Identifier: KHNP_APR1400_DCD_RAI_Public
Email Number: 69

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Sent Date: 7/8/2015 5:52:59 AM
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From: Ciocco, Jeff

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REQUEST FOR ADDITIONAL INFORMATION 63-7983

Issue Date: 07/07/2015
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

06.02.02-12

Technical Report APR1400-E-N-NR-14001-P , Section 4.2, "Introduction," states the objective of ex-vessel downstream effects evaluation is to assess the systems and components of the APR1400 emergency core cooling system (ECCS) and the containment spray system (CSS) to "guarantee" that these systems are designed to be operable under post loss-of-coolant accident (LOCA) conditions. "Guarantee" is not a defined term with respect to assessment of the operability of systems and components. The applicant is requested to define or revise the use of the term "guarantee" in Section 4.2 of the technical report.

06.02.02-13

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.2.3, "Components of Interest," states that Table 4.2-1, "Components in the Flow Path during an LBLOCA," of Technical Report APR1400-E-N-NR-14001-P lists the ECCS/shutdown cooling system (SCS)/in-containment refueling water storage tank (IRWST) components in the downstream effects evaluation. The components in the ECCS flow path during small break LOCA (SBLOCA) and large break LOCA (LBLOCA) operations include pumps, heat exchangers, valves, orifices, containment spray nozzles, and piping. The NRC staff reviewed the components of interest and identified the following inconsistencies:

1. The applicant states that Table 4.2-1 lists ECCS/SCS/IRWST components in the downstream effects evaluation. However, Table 4.2-1 lists only components in the safety injection system (SIS) and CSS. The applicant is requested to clarify ECCS/SCS/IRWST components in the downstream effects evaluation in the technical report.
2. Table 4.2-1 lists valves in the CSS miniflow line but does not include the CSS miniflow heat exchangers or the 4-inch miniflow recirculation piping. The applicant is requested to clarify in the technical report whether these components are required to be included in the downstream effects evaluation. Also, the applicant is requested to review and confirm that all applicable SI and CS components required to be included in the downstream effects evaluation are included in Table 4.2-1 with any changes to the table as appropriate.

06.02.02-14

Review procedure #9 of SRP 6.2.2, "Containment Heat Removal Systems," addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.2.4, "Post-LOCA Fluid Constituents," describes the total amount of debris generated during an LBLOCA and the methodology to determine the amount of debris that passes through the IRWST sump strainer. For reflective metal insulation (RMI), the applicant states the following:

> Results of the NRC debris generation test documented in NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump performance", show that RMI debris size distribution ranges from 6.35 mm (0.25 inch) to 152.4 mm (6 inch). RMI debris will not bypass the sump screens and enter the ECCS because the size of the RMI debris is greater than the perforated plate hole diameter of the sump strainer. As a result, this evaluation assumes no RMI passes through the sump strainer.

The NRC staff requests that the applicant describe and provide technical justification in the technical report that the RMI testing referenced in NUREG/CR-6808 is applicable to the APR1400 reactor and provides reasonable assurance that RMI in the APR1400 reactor will not pass through the IRWST sump strainer. Also, the applicant is requested to describe in the technical report any specific RMI testing in addition to that referenced in NUREG/CR-6808.

06.02.02-15

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.2.5, "ECCS Flow Rate and Flow Velocity," lists the flow rates used for the evaluation of debris settlement and component wear during an LBLOCA and states that the minimum flow rate of the SIS and CSS pumps at shutoff head conditions will be verified during component procurement. However, items 8 and 9 in Section 4.2.3.1 states that both shutoff head and run-out conditions for SIS and CSS pumps will be verified by the vendor. For consistency, the NRC staff requests that the applicant revise Section 4.2.2.5 in the technical report to specify that flow rates at run-out conditions will be verified during procurement.

06.02.02-16

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.2.6, "Summary of Assumptions and Conservatisms," states that concentration of the post-LOCA fluid constituents listed in Table 4.2-5 is conservatively estimated based on the assumption that the IRWST contains 946.4 m3 (250,000 gallons) of water during post-LOCA operation, which is less than the minimum IRWST water volume of 993.2 m3 (262,388 gallons). The applicant also states that estimating the debris concentration at less than the expected IRWST volume yields a more concentrated debris-laden fluid for confirmatory tests, and produces conservative test results. In this section, the applicant described the IRWST water volume used in determining the concentration of the post-LOCA fluid constituents listed in Table 4.2-5. To support the conclusion that a conservative water volume was used, the NRC staff requests that applicant describe in the technical report (a) the total volume of water that is being recirculated by the SIS and CSS from all sources (e.g., reactor coolant system, safety injection tanks, etc.), (b) the volume from each source, and (c) the calculations used in determining the debris concentrations.

06.02.02-17

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.1, "SI and CS Pump Evaluation," states that the SIS and CSS pumps and associated mechanical seals will be qualified to operate with the post-LOCA fluids for at least 30 days, using the qualification guidance of ASME Standard QME-1-2007 as endorsed by RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Revision 3. RG 1.100, Revision 3, states that ASME QME-1-2007 is an NRC staff approved methodology for the qualification of pumps

and valves, and when a licensee commits to the use of QME-1-2007 for qualification of pumps and valves, the criteria and procedures become part of the basis for the qualification program. Therefore, the staff does not consider referencing QME-1-2007 alone as a "guide" to be sufficient in specifying the qualification methodology. Therefore, the NRC staff requests that the applicant revise the technical report to specify that the pump and valve qualification will be "in accordance with" ASME QME-1-2007 as accepted in RG 1.100, Revision 3. The same revision should be made wherever QME-1-2007 is referenced in the report, including the wear rate evaluation description in Section 4.2.3.3.2.

06.02.02-18

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.1, states that as part of the qualification process, the pump vendor, at a minimum, will fulfill specific pump qualification criteria. The pump criteria specify that qualification will be performed using tests and/or analyses. However, to be consistent with ASME QME-1-2007 as accepted by RG 1.100, Revision 3, the criteria should specify qualification of pumps by test or a combination of test and analysis. Therefore, the NRC staff requests that the applicant revise the technical report to specify that the qualification of pumps will be accomplished by test or a combination of test and analysis. The same revision should be made wherever qualification using this standard is referenced in the report, including the wear rate evaluation description in Section 4.2.3.3.2.

06.02.02-19

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.2.1, "Heat Exchanger Plugging," states that the flow velocity through the heat exchanger tubes is significantly greater than the terminal settling velocity of the debris. Therefore, the applicant concludes that debris will not settle in the heat exchanger tubes. However, the Technical Report does not specify the minimum flow velocity through the heat exchanger tubes. To provide assurance that debris settling will not occur in the heat exchanger tubes, the NRC staff requests that the applicant specify the minimum flow velocity through the heat exchanger tubes in the technical report.

06.02.02-20

Review procedure #9 of SRP 6.2.2, "Containment Heat Removal Systems," addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.2.2, "Heat Exchanger Performance and Wear," states that the CSS heat exchanger is sized and designed with a fouling factor of 0.000088 m^2-K/W (0.0005 hr-ft^2-°F/Btu) to maximize heat transfer efficiency and performance. The applicant also states that potential heat exchanger plugging, fouling, and wear are considered as part of the equipment specification. The NRC staff requests that the applicant specify in the technical report that heat exchanger plugging, fouling, wear and heat transfer performance in the presence of post-LOCA debris will be evaluated by the vendor during the procurement process with a certificate of compliance to provide verification that the heat exchanger meets procurement specifications.

06.02.02-21

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.1, states that the containment main spray nozzles and auxiliary spray nozzles have an orifice diameter of 13.1 millimeter [mm] (0.516 inch) and 5.6 mm (0.22 inch), respectively. The orifice is the smallest portion of spray nozzle. The strainer hole size is 2.38 mm (0.094 inch). Containment spray nozzles are significantly larger than the strainer hole size. Their one-piece design provides a large, unobstructed flow passage that resists clogging by particles. Therefore, the applicant states that the potential of spray nozzle plugging is very low. The NRC staff has the following requests regarding the spray nozzles:

a. The performance of the spray nozzles in accomplishing their necessary safety functions may be affected by changes to the CSS fluid physical or chemical properties, even though the flow rate through the nozzles is not restricted. The staff requests that the applicant describe in the technical report the evaluation of the effects of entrained debris, chemicals, and gases on the performance of the CSS spray nozzles, especially regarding the effects on spray droplet size distribution for containment pressure suppression and removal of fission products from the containment atmosphere.
b. The staff requests that the applicant provide a drawing of the main and auxiliary spray nozzles to confirm the large, unobstructed flow passage that resists clogging by particles.

06.02.02-22

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.1, “Blockage and Debris Settling Evaluation for Valves, Orifices and Pipes,” evaluates debris settling for valves, orifices, pipes and spray nozzles. The velocity of the debris in the post-LOCA fluid is assumed equal to the velocity of the fluid. If the fluid velocity is greater than the terminal settling velocity of the debris, the debris will not settle. Technical Report Technical Report APR1400-E-N-NR-14001-P, Table 4.2-6, “Affected Equipment /Flow Rates,” lists the size, flow rate and maximum settling velocity for the orifices, spray nozzles and piping in the downstream ex-vessel effects evaluation. The applicant compared the actual flow velocities with the maximum settling velocity of 0.70 ft/sec for latent debris as calculated in Table 4.2-4 and determined that flow velocities are above the settling velocities in all components except the following:

- 61.0 cm (24 inch), 50.8 cm (20 inch), and 30.5 cm (10 inch) SI pump suction lines and
- 25.4 cm (12 inch) SI pump discharge line

In cases where the flow velocity is less than the terminal settling velocity, the applicant states that debris settling is a longer term phenomenon and has no short term impact on flow and, therefore, the potential of piping plugging or blockage and its impact on system operation is very low. The NRC staff requests that the applicant to provide technical justification in the technical report that debris settling will not occur or affect system operation in piping and any associated valves where the flow velocity for latent debris is less than the terminal settling velocity. As part of this evaluation, the applicant should identify any valves

located in the piping where the flow velocity for latent debris is less than the terminal settling velocity, and provide justification that debris settling will not occur in these valves.

06.02.02-23

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.1 addresses debris settling evaluation for valves (including gates valves, check valves and globe valves). For gate and check valves, the applicant states that the flow velocities in all cases are above the settling velocities and, therefore, these valves are not expected to clog because of post-LOCA insulation debris. However, for globe valves, the applicant does not address flow velocity being above the settling velocity. Therefore, the NRC staff requests that the applicant address debris settling in globe valves in the technical report.

06.02.02-24

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.2, “Wear Rate Evaluation for Valves, Orifices and Pipes,” describes the wear rate evaluation for valves, orifices, and pipes during operation with post-LOCA fluids. Technical Report APR1400-E-N-NR-14001-P, Table 4.2-7 contains a summary of the piping and orifice wear calculation. Based upon the results of wear evaluation for piping and orifice, the report concludes that the system piping and component flow resistances will change minimally during the course of the LOCA. Therefore, flow balances and system performance are not affected in an appreciable manner. The resulting flows and pressures are consistent or conservative with respect to the accident analysis. The minor resistance changes do not affect the system flow calculations and design basis analysis. An analysis will be provided to confirm that the overall system resistance/pressure drop across the ECCS is consistent with the safety analysis results for the 30 day mission time. The NRC staff requests that the applicant describe the analysis in the technical report to confirm that the overall system resistance/pressure drop across the SIS and CSS is consistent with the safety analysis results for the 30-day mission time. Also, the applicant is requested to describe in the technical report the analysis documentation that will provide verification of acceptable SIS and CSS operation.

06.02.02-25

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.2, “Wear Rate Evaluation for Valves, Orifices and Pipes,” states that the wear rate of ECCS (SIS) valves will be provided by the vendor and describes the qualification process. This section does not address CSS valve qualification. The staff requests that the applicant address CSS valve qualification in the technical report.

06.02.02-26

Review procedure #9 of SRP 6.2.2, “Containment Heat Removal Systems,” addresses performance evaluations for equipment downstream of the IRWST sump strainer with regard to debris ingestion. To complete this review, additional information is needed. Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.3.2, “Wear Rate Evaluation for Valves, Orifices and Pipes,” describes the wear rate evaluation for valves, orifices, and pipes during operation with post-LOCA fluids and states that the vendor will provide tests and/or analysis to support acceptable wear rates of valves, pipes and orifices. The wear rate evaluation is performed using the post-LOCA fluid constituents listed in Technical Report APR1400-E-N-NR-14001-P, Table 4.2-5, and the flow velocities listed in Technical Report APR1400-E-N-NR-14001-P, Table 4.2-6. However, the technical report does not identify the material properties (e.g., abrasiveness) for the vendor to evaluate the wear rate. The NRC staff requests that the applicant describe in the technical report the material properties used to determine wear rate of the components.

06.02.02-27

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.4, “Instrument Tubing Clogging Evaluation,” states that when the instrument tubing lines maintain a solid state prior to emergency core cooling operation, it is determined that tubing integrity is not affected because there is almost no possibility of debris ingestion, and the evaluation shows there are no effects from flow blockage and wear because flow velocities in all cases are above the settling velocities of the post-LOCA fluid. Also, all instrument connections used in the APR1400 reactor are located either at the horizontal or above. The NRC staff requests that the applicant specify in the technical report that all instrument connections are at the side or at the top of the pipe and confirm that the SIS and CSS systems do not contain any bottom-mounted instrument connections.

06.02.02-28

The NRC staff requests that the applicant identify in the technical report any instruments strapped or externally mounted to the outside of the SIS or CSS piping. Strapped or externally mounted instruments that make use of the velocity of sound through the fluid medium could be affected by the type and quantity of suspended debris, chemical composition, and presence of gases. If strapped or externally mounted instruments are used, provide justification for their accuracy with suspended debris, chemical composition, and presence of gases.

06.02.02-29

Technical Report APR1400-E-N-NR-14001-P, Section 4.2.3.5, Chemical Effects Evaluation,” states that the qualification of the ECCS (SIS) pumps, performed with conservative amounts of post-LOCA debris in accordance with ASME QME-1-2007, will

include confirmation that the internal running clearance of the ECCS pumps is sufficiently large enough to avoid clogging, and supports acceptable pump and seal operation during the 30-day post-LOCA mission time. However, this section only addresses the SIS pumps and not the CSS pumps. Also, this section does not address the chemical effects for the CSS spray nozzles. The NRC staff requests that the applicant address chemical effects evaluation for the CSS pumps and CSS spray nozzles in the technical report.

06.02.02-30

APR1400 DCD Tier 1, Table 2.11.2-4, “Containment Spray System ITAAC,” does not contain an ITAAC to confirm the functional qualification of the CSS pumps similar to ITAAC 9.b in APR1400 DCD Tier 1, Table 2.4.3-4, “Safety Injection System ITAAC,” for the SIS pumps. The NRC staff requests that the APR1400 design certification applicant specify its plans to update DCD Tier 1, Table 2.11.2-4, to include ITAAC for the functional qualification of CSS pumps.


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