KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Friday, August 21, 2015 9:07 AM
To: KHNPDCDRAIsPEm Resource
Subject: FW: APR1400 Design Certification Application RAI 155-8167 (06.02.05 - Combustible Gas Control in Containment)
Attachments: APR1400 DC RAI 155 SCVB 8167.pdf; image001.jpg

From: Ciocco, Jeff
Sent: Tuesday, August 18, 2015 6:01 AM
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Subject: APR1400 Design Certification Application RAI 155-8167 (06.02.05 - Combustible Gas Control in Containment)

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, 60 days, 60 days, 45 days, 45 days, and 45 days for the 5 RAI questions. We may adjust the schedule accordingly.

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

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 155-8167

Request for Additional Information 155

Issue Date: 08/18/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 06.02.05 - Combustible Gas Control in Containment
Application Section: 6.2.5

QUESTIONS

06.02.05-1

10 CFR 52.44(c)(1) requires that a standard design certification applicant must ensure a mixed atmosphere in containment during design-basis and significant beyond design-basis accidents. A mixed atmosphere means that the concentration of combustible gases in any part of the containment is below a level that supports combustion or detonation that could cause loss of containment integrity.

Acceptance Criteria 4 of Standard Review Plan (SRP) Section 6.2.5, “Combustible Gas Control in Containment,” and Regulatory Position C.3 of Regulatory Guide (RG) 1.7, “Control of Combustible Gas Concentrations in Containment,” Revision 3 state that all containment types should have an analysis of the effectiveness of the method used for providing a mixed atmosphere and that this analysis should demonstrate that combustible gases will not accumulate within a compartment or cubicle to form a combustible or detonable mixture that could cause loss of containment integrity.

APR1400 Design Control Document (DCD), Tier 2, Section 6.2.5.3 states that mixing is achieved by natural convection processes. In addition, DCD, Tier 2, Section 19.2.3.3.2.2 states that the APR1400 hydrogen control analyses were performed using the Modular Accident Analysis Program (MAAP) to determine hydrogen mixing, distribution, and combustion inside containment. KHNP’s “Severe Accident Analysis Technical Report,” APR1400-E-P-NR-14003-P, Revision 0, provides the results of these MAAP analyses and describes that the containment model consisted of 36 nodes.

In order for the staff to reach a conclusion of reasonable assurance that the requirements for mixing are met, the staff needs to review the calculation which demonstrates mixing in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, either on the licensing docket or in the electronic reading room. The calculation should include:

- Hydrogen distribution and deflagration to detonation transition (DDT) potential for at power operation analysis for each of the 36 nodes, and at least 5 scenarios, showing the hydrogen, oxygen, and steam concentration for all nodes. Identify and address any nodes where the hydrogen concentration is greater than 10%. Identify and address any nodes with DDT potential, quantitatively and or qualitatively.

- The hydrogen generation curves versus time for each of the scenarios analyzed.

- The assumptions for crediting the hydrogen mitigation system. For example, provide the performance of the passive autocatalytic recombiners (PAR) and/or hydrogen igniters (HI). Include the PAR efficiency, number and locations of PARs and HIs credited.

- The criteria for the selection of the accident scenarios.

- DCD Tier 2, Figures 19.2.3-3 through 19.2.3-6 are labelled with scenario success criteria abbreviations. For each selected scenario, identify the mitigation systems or equipment credited, and to

what extent. Elaborate on the success criteria for each scenario. For example, does HI credit all 8 igniters? Does 3WV credit both three way valves as being aligned to relieve in the steam generator compartments? A table of scenarios with corresponding assumptions with credited mitigating systems would be helpful.

This question is based upon material found in DCD Tier 2 Sections 6.2.5 (Combustible Gas Control in Containment), 19.2 3 (Severe Accident Mitigation), Tier 1 Section 2.11.4 (Containment Hydrogen Control System), and the Severe Accident Analysis Report, APR1400-E-P-NR-14003-P, Rev. 0.

06.02.05-2

10 CFR 52.44(c)(1) requires that a standard design certification applicant must ensure a mixed atmosphere in containment during design-basis and significant beyond design-basis accidents. A mixed atmosphere means that the concentration of combustible gases in any part of the containment is below a level that supports combustion or detonation that could cause loss of containment integrity. 10 CFR 52.44(c)(2) requires all non-inerted containments to limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, uniformly distributed, to less than 10 percent (by volume) and maintain containment structural integrity and appropriate accident mitigating features.

Acceptance Criteria 2 of Standard Review Plan (SRP) Section 6.2.5, “Combustible Gas Control in Containment,” states that the applicant should demonstrate by analysis, for non-inerted containments, that the design can safely accommodate hydrogen generated by an equivalent of a 100 percent fuel clad-coolant reaction, while limiting containment hydrogen concentration, with the hydrogen uniformly distributed, to less than 10 percent (by volume), and while maintaining containment structural integrity.

KHNP’s “Severe Accident Analysis Report,” APR1400-E-P-NR-14003-P, Rev.0, provides the hydrogen concentration versus time for 24 hours for each of the five selected scenarios and for all of the 36 nodes in the MAAP4 containment analysis. This report identified certain nodes, such as the reactor cavity and the reactor cavity annulus, whose hydrogen concentration exceeds 10% for a period of time. The potential for deflagration to detonation transition (DDT) exists for any of the nodes where the hydrogen concentration exceeds 10%. Section 4 of the report states that “Evaluations of (1) AICC pressure, (2) hydrogen distribution and (3) potential of DDT for APR 1400 containment have been performed in three separate calculation notes, respectively.” In order for the staff to reach a reasonable assurance finding that the mixed atmosphere criteria are met, please identify and provide these three calculation notes for staff review, either on the licensing docket or in the electronic reading room.

06.02.05-3

10 CFR 52.44(c)(1) requires that a standard design certification applicant must ensure a mixed atmosphere in containment during design-basis and significant beyond design-basis accidents. A mixed atmosphere means that the concentration of combustible gases in any part of the containment is below a level that supports combustion or detonation that could cause loss of containment integrity.

APR1400 Design Control Document (DCD) Tier 2, Section 6.2.5 credits the passive autocatalytic recombiners (PAR) with meeting the above criteria. DCD Tier 2, Table 3.2-1, Tier 2, Section 19.2.3.3.2.1, and Tier 1, Table 2.11.4-1 all describe the PARs and the hydrogen igniters (HI) as being designed to Seismic Category I criteria.

However, in DCD Tier 2, Table 19.1-42, “Seismic Equipment List,” the PARs and the HIs are not described as being designed to Seismic Category I criteria.

Please clarify the seismic design category for the PARs and the His and revise all of the affected DCD text and tables accordingly.

In addition, the following DCD sections and figures contain inconsistencies regarding the location of the PARs with respect to the in-containment refueling water storage tank (IRWST).

- Tier 2, Section 6.2.5.2.1 describes PAR(s) inside the IRWST.

- Tier 2, Table 6.2.5-1 identifies 4 PARs at the IRWST vent stack area.

- Tier 2, Figure 19.2.3-1 and Tables 19.2.3-1 and 19.2.3-2 indicate that 4 PARs are inside the IRWST.

- Tier 2, Figure 6.2.5-1 shows the PARs outside and above the IRWST.

- Tier 2, Section 6.8.2.2.5, “IRWST Pressure Devices,” states “The PARs are located at the vent stack area to prevent an accumulation of hydrogen in the IRWST.”

- Tier 1, Figure 2.11.4-1, “Containment Hydrogen Control System Functional Arrangement”, shows some PARs inside the IRWST.

Please clarify the location of the PARs with respect to the IRWST and revise all the affected DCD text, tables, and figures accordingly.

06.02.05-4

PAR recombination rates

10 CFR 52.44(c)(1) requires that a standard design certification applicant must ensure a mixed atmosphere in containment during design-basis and significant beyond design-basis accidents. A mixed atmosphere means that the concentration of combustible gases in any part of the containment is below a level that supports combustion or detonation that could cause loss of containment integrity.

APR1400 Design Control Document (DCD) Tier 2, Section 6.2.5 credits the passive autocatalytic recombiners (PAR) with meeting the above criteria.

However, in DCD Tier 1, Table 2.11.4-1, “Containment Hydrogen Control System ITAAC,” there is insufficient information to determine that the containment hydrogen control system design meets the above criteria. In DCD Tier 2, Table 6.2.5-1, “Location of PARs and His,” PAR and hydrogen igniters (HI) locations in containment are provided. This information should either be included in Tier 1, Table 2.11.4-1, or a link to Tier 2, Table 6.2.5-1 should be provided in Tier 1, Table 2.11.4-1.

Also, DCD Tier 2, Table 6.2.5-1 describes the PARs as “small, middle, large.” The actual PAR recombination rates which form the basis of the hydrogen containment analysis should be provided in the DCD, either:

- Into both Tier 2, Table 6.2.5-1 and Tier 1, Table 2.11.4-1, or

- Into just Tier 2, Table 6.2.5-1 with a link to Tier 2, Table 6.2.5-1 being provided in Tier 1, Table 2.11.4-1.

Please provide the recombination rates of the PARs, and revise all the affected DCD text, tables, and figures accordingly.

06.02.05-5

10 CFR 50.44(c)(4) (ii) Equipment must be provided for monitoring hydrogen in the containment. Equipment for monitoring hydrogen must be functional, reliable, and capable of continuously measuring the concentration of hydrogen in the containment atmosphere following a significant beyond design-basis accident for accident management, including emergency planning. In addition, 10 CFR 52.47(b)(1) requires that a design certification application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification.

Acceptance Criteria 6.B of Standard Review Plan (SRP) Section 6.2.5, “Combustible Gas Control in Containment,” states that combustible gas control system designs should include instrumentation needed to monitor system or component performance under normal and accident conditions. The instrumentation should be capable of determining that a system is performing its intended function, or that a system train or component is malfunctioning and should be isolated. The instrumentation should have readout and alarm capability in the control room and the containment hydrogen and oxygen monitors should meet the provisions of Regulatory Position C.2 of Regulatory Guide (RG) 1.7, “Control of Combustible Gas Concentrations in Containment,” Revision 3.

In APR1400 Design Control Document (DCD) Tier 1, Table 2.11.4-2, there is insufficient information about the identity, capability and location of the instrumentation provided to monitor hydrogen concentration in the containment to determine that the combustible gas control system designs meets the above criteria and guidance. However, only some of this information is provided in Tier 2, Section 6.2.5.2.3. Tier 2, Section 6.2.5.2.3 should be revised to also include specific information regarding the capability of the monitors, including concentration range, pressure range, etc. In addition, all of this information should also be provided in Tier 1, Section 2.11.4, and in Tier 1, Table 2.11.4-3 as an ITAAC item to be satisfied as part of the certified design.


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