REQUEST FOR ADDITIONAL INFORMATION 803-5891 REVISION 3

8/11/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 06.02.05 - Combustible Gas Control in Containment
Application Section: 6.2.5

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

06.02.05-44

Clarify if the US-APWR Hydrogen igniters are needed for compliance with 10 CFR 50.44(c)(1); Clarify how accident sequences were selected to demonstrate compliance with 10 CFR 50.44.

In RAI Number 751-5709 Question 06.02.05-43, the staff requested you clarify how the structures, systems and components used to fill the RSWP act to be reliable, redundant, single-failure proof, able to be tested and inspected and remain operable with a loss of onsite or offsite power.

In your response you state the following:
"10CFR50.44(c)(1) and (c)(2) require that a mixed atmosphere be provided to prevent local elevated hydrogen levels and control hydrogen levels by limiting the overall (uniformly distributed) hydrogen concentration. The US-APWR design features to achieve these requirements are the containment spray system and the hydrogen igniters, as discussed in DCD Subsection 6.2.5 Rev.3"

In this RAI response you also propose the following change to DCD Subsection 6.2.5 to clarify how Containment Mixing is accomplished:
"The containment spray system, in conjunction with convective heat transfer and hydrogen diffusivity, performs atmospheric mixing to ensure uniform distribution of hydrogen and contact with the installed hydrogen igniters. Figure 6.2.5-2 presents the typical air-hydrogen flow patterns within the C/V. The containment spray system is a design-basis safety-related system which is reliable, redundant, single-failure-proof, able to be tested and inspected, and remains operable with a loss of onsite or offsite power per RG 1.7. Rev. 3. The technical report "US-APWR Probabilistic Risk Assessment" Section 15.3.3 (Ref. 6.2-37) demonstrates that the atmospheric mixing provided by the containment spray system as well as the combustible gas control provided by the hydrogen igniters ensures 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."

Based on the review of the RAI response, the response to RAI Number 627-4926 Question 19-449, and the proposed DCD text, the staff understands that the regulatory requirement for a mixed containment is accomplished with the following systems and design features:

- Large containment/open spaces (passive)

· Containment Spray (active; safety related)
· Components used to fill the RWSP(active)

Therefore the staff requests the following information:

1) Please clarify DCD Subsection 6.2.5 to clearly discuss those systems that are credited to satisfy 10 CFR 50.44(c)(1). I.e., discuss all systems used to provide the capability for ensuring a mixed atmosphere during design-basis and significant beyond design-basis accidents.

2) The staff notes that the above draft language omits the role of components used to fill the RWSP to satisfy 10 CFR 50.44(c)(1). In your response to RAI Number 627-4926 Question 19-449, you state that, although unlikely, there is the potential for buildup of hydrogen concentrations in the RWSP to combustible or detonable levels in a severe accident scenario, and you have proposed a severe accident mitigation strategy where the RWSP is filled by means of manual operator actions. Based on this proposed strategy, the staff would consider those SSCs use to eliminate this high hydrogen concentration potential (the components used to fill the RWSP with firewater) as those subject to design criteria stated in RG 1.7 Section C3.
    a. Please clarify the functions of the firewater system in Tier 2 and Tier 1 of the DCD to include this severe accident insight, and clarify the design basis of the US-APWR containment mixing system to include the role of the firewater system. Alternatively, propose an alternate method of ensuring a fully mixed containment using those systems you currently credit for this function, with respect to the RWSP compartment.
    b. Please clarify the design basis functions of the Containment Spray system to include the role of ensuring a mixed atmosphere in the containment in the Containment Spray System Section of the DCD Tier 1 and Tier 2.

3) With regard to the hydrogen control function and objectives 10 CFR 50.44(c)(2). The staff notes that in the above DCD draft language, you include the hydrogen igniter function in the discussion of how the US-APWR achieves both mixing and control. As discussed above, the staff requests you clarify if your intent is that that design utilizes the igniter function to achieve the requirements for a mixed containment (10 CFR 50.44(c)(1)) as well as hydrogen control (10 CFR 50.44(c)(2)), or is the igniter function not needed to meet the requirements for a mixed containment.
    a. The staff has reviewed the PRA, MUAP -07030 (R2) and notes that in paragraph 15.3.3.2, where you discussed the selection of PRA scenarios used as a basis for satisfying 10 CFR 50.44(c)(1) and (c)(2), the condition of the containment spray is important. You note that when spray is operable, (which is likely since this is a safety-related system), the hydrogen percentage by volume increases since the steam inventory in containment is suppressed by spray. You state that the operation of containment spray needs to be considered for a conservative estimation. The staff notes that for the station blackout scenario discussed in your response to RAI Number 627-4926 Question 19-449, both the spray system and the Igniters are not available for first several hours (AP102S-NG and AP102S-IG).

The staff reviewed accident sequence AP105, which is a scenario where spray is available and igniters are not available due to LOOP, and they are not powered by DC or alternate AC sources. In chapter 14 of the PRA page 14-75, hydrogen concentration appears to exceed 10 CFR 50.44 (c)(2) criteria.

The staff reviewed accident sequence AP205, which is a scenario where spray is available. In chapter 14 of the PRA page 14-99, hydrogen concentration exceed 10 CFR 50.44 (c)(2) criteria.

The staff reviewed accident sequence AM008, which is a scenario where Sprays come on late, and igniters are not available due to LOOP. In chapter 14 of the PRA page 14-135, hydrogen concentration appears to exceed 10 CFR 50.44 (c)(2) criteria.

In regard to these Severe accident sequences, please clarify how the US-APWR Combustible Gas Control system (igniters) satisfy 10 CFR 50.44 (c)(2) criteria, and why one of these scenarios were not chosen as the most conservative analysis with respect to conditions to demonstrate compliance with 10 CFR 50.44.

As you discussed in your response to RAI 270-1898, Question 6.2.5-24, careful operator action is required to manage containment hydrogen concentration when steam-inerted conditions are no longer present. And these severe accident procedures will be the responsibility of the COL applicant in COL item 19.3(6). You provide a general description of accident management and the importance of hydrogen in section 19.2.5. This description indicates that high hydrogen concentrations are reached when CSS fails and the containment vessel pressure is high. The description does not seem to address PRA sequence AP 105 or AP 205, which are sequences where CSS does not fail, steam inerted conditions are not reached for any significant length of time, and the hydrogen concentration reaches above 10% by volume for sustained periods of time.

Please describe severe accident management for these cases. In your discussion, please also address the merits of any severe accident strategies that are needed to restore power to the hydrogen igniters in containment to provide confidence that igniters will have power and be available for severe accident management and to minimize the potential for the inability to manage the accumulation of combustible or detonable quantities of hydrogen in the containment. Revise DCD chapter 19 paragraph 19.2.5 as needed.

06.02.05-45

Clarify the DCD to provide the results of type tests and analyses that assure that the equipment that is identified as critical equipment in the Severe Accident Survivability Assessment is capable of withstanding the environmental conditions of a severe accident.

In RAI 748-5593, question 06.02.05-42, the staff requested you clarify the DCD to indicate whether it was the responsibility of the plant designer (MHI) or an applicant that references the US-APWR design, to justify the applicability of prototypical survivability studies is representative of the procured equipment.

In part 1 of the RAI response, you clarified that it is the responsibility of MHI to provide such verification, and the type tests and analyses necessary to assure functionality of the severe accident mitigation components will be conducted in the "DCD design certification phase by MHI."

Therefore the staff understands that there will be forthcoming design information that will be documented in a future revision of the DCD that provides assurance that the prototypical studies (e.g. US-APWR Reference 19.2-11) are applicable to the equipment identified in the DCD as severe accident mitigation components. The current description of procurement information in DCD Tier 2 Section 19.2.3.3.7 describes future actions to be performed by the plant designer to define the procurement specification. The staff does not consider this description of future analyses sufficient to provide assurance that the procured equipment will survive a severe accident, in accordance with 10 CFR 50.44(c)(3).

If such studies are to be performed in the Design Certification stage, as indicated in your RAI response, the staff considers that the results of the analysis, along with a justification that it envelops the calculated plant equipment temperature is to be documented in the DCD and reviewed by the staff in the DC stage, prior to certification of the standard design.

The staff requests you provide details of the analysis and the schedule to provide this information. As detailed in Section 6, of US-APWR Reference 19.2.-11, prototypical test results can be applied to support demonstration of equipment survivability by means of "Environment Enveloping" or "Thermal Analysis".

If the "Environment Enveloping" approach is used by MHI, the staff requests you clarify Tier 2 of the DCD to indicate that:

1) This method was used to apply the prototypical test results to the USAPWR design.
2) The procured equipment is:
    a. of the same type (manufacturer and model) as the equipment used in the prototypical study, or
    b. that you state in Tier 2 of the DCD that that the equipment is functionally similar and at least as thermally rugged as the tested equipment types. If you state, this, please include supporting evidence that provides assurance that this is the case.

If the "Thermal Analysis" approach is used by MHI, the staff requests you clarify Tier 2 of the DCD to indicate:

1) This method was used to apply the prototypical test results to the USAPWR design.
2) That the manufacturer/model number of the equipment used in the thermal analysis is the same, as that used in the US-APWR design.
3) The results of the thermal analysis including, a comparison of analysis results vs. calculated plant equipment temperature, which demonstrates survivability.