REQUEST FOR ADDITIONAL INFORMATION 764-5805 REVISION 3

6/6/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19.2.4.2

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)

19-527

Technical report MUAP-10018-P (R0), "US-APWR Containment Performance for Pressure Loads," Section 3.2, states that the effects of pre-stressing were considered in the analysis of the PCCV. Further, Section 3.4, states that the level of pre-stressing is deemed an important parameter in determining the pressure capacity from the global modeling. The applicant indicates that effects of tendon relaxation, concrete creep, and loss of pre-stress at anchorage are factors in pre-stress level. However, no description of these effects is provided in MUAP-10018-P (R0).
To address this issue, staff requests the applicant to provide additional information relating to how the effects of tendon relaxation, concrete creep, concrete shrinkage, and loss at anchorages are considered in the analysis of the PCCV.

19-528

In technical report MUAP-10018-P (R0), "US-APWR Containment Performance for Pressure Loads," Section 3.2, Section 3.9, the applicant describes the reinforced concrete failure criteria used in evaluating the pressure capacity for the containment system. For reinforced concrete, failure is assumed to occur when tensile loads cause rebar to yield and then rupture, or when shear forces across a section exceed the shear capacity. Concrete shear capacity is defined as section shear strains reaching a level of 0.55 percent. While the applicant has cited references for the basis for the 0.55 percent shear strain value, it is not clear to what extent those references are applicable to US-APWR PCCV design.
To address this, the staff requests the applicant to include in the report a summary of the basis for the failure criterion of 0.55 percent shear strain and describe the applicability to the design and loading condition(s) of the US-APWR PCCV.

19-529

Staff reviewed the applicant's analysis results documented in report MUAP-10018-P (R0) and found them to be incomplete. As stated in RG 1.216, Section 1 (c), the pressures corresponding to initial yielding of the liner, reinforcing steel, and pre-stressing tendons should be recorded. Further, the applicant did not address the acceptance criteria defined in RG 1.216 for demonstrating that the containment will remain essentially leak tight for the first 24 hours. RG 1.216, Section 3.1(d) states that the use of ASME Code service level C limits for metal containments or the factored load category for concrete

containments is acceptable to demonstrate the deterministic performance goal for the first 24 hours. RG 1.216, Sections 1(d) and 2(a) states that these analyses should be based on ASME code specified minimum strengths for the specific grades of steel with temperature effects considered. ASME Boiler and Pressure Vessel Code, Section III, Division 2, Subarticle CC-3720, Table CC-3720-1, indicates that for the factored load category, the maximum allowable membrane strain in the liner is 0.003 (tensile) and 0.01 for combined membrane and bending strains. The applicant has not shown how the above acceptance criteria are satisfied. In addition, the applicant also has not indicated if the above acceptance criteria are satisfied for the period following the initial 24 hours after the onset of core damage as per RG 1.216, Section 3.2(a)(2).
To address the above issues, staff requests the applicant to (a) provide pressure corresponding to initial yielding of the liner, reinforcing steel, and pre-stressing tendons, and (b) address the acceptance criteria defined in ASME Boiler and Pressure Vessel Code, Section III, Division 2, Subarticle CC-3720, factored load category, considering pressure, dead and temperature loads. A summary of the supporting analyses and results should be included in DCD Section 19.2.4.

19-530

Staff review of the analysis model finds that while the applicant's model of the PCCV indicated the limiting failure mode to be liner tearing, the applicant did not perform a detailed analysis of the equipment hatch and personnel airlocks to verify that these components do not fail at a lower pressure. RG 1.216, Section (1)(g), states that a complete evaluation of the internal capacity should address major containment penetrations such as equipment hatches, personnel airlocks, and major piping penetrations. The stress analysis results for steel components should be compared to the ASME Code service level C limits.
To address this issue, staff request the applicant to identify a COL action item for the COL applicant to address the severe accident analysis (corresponding to more likely severe accident challenges) of major penetrations such as the equipment hatch, personnel airlock, and major piping penetrations and document comparison to ASME Code limits.

19-531

Staff notes that in SER Section 6.2.5 there is a concern (RAI-449) regarding the potential for hydrogen accumulation within the RWSP. The applicant, in response to RAI 19-449, described several additional analyses on the RWSP sub-compartment. These analyses indicated that hydrogen concentrations greater than 10% by volume may occur. A staff scoping calculation of a hydrogen detonation scenario within the RWSP sub-compartment indicates that a high level of reflected pressure could occur on the adjacent PCCV wall.
Based on the above, staff requests the applicant to perform a structural calculation to demonstrate that the containment structural integrity requirements of 10 CFR 50.44 (c)(5) are satisfied. The applicant's analysis method should be consistent with the methods described in RG 1.216 and account for dynamic effects and material nonlinearities.