

# REQUEST FOR ADDITIONAL INFORMATION 416-2912 REVISION 0

6/29/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 06.05.02 - Containment Spray as a Fission Product Cleanup System  
Application Section: 6.5.2

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects)  
(CIB1)

06.05.02-5

## Background

RAI 06.05.02-1 (Reference 1) requested that the applicant explain the rise in pH of the RWSP water under accident conditions. The importance of such a calculation is to ensure that iodine dissolved in RWSP water does not revolatilize, which it could do if the pH is not maintained above 7. In fact, acceptance criterion II.1.G of SRP 6.5.2 requires that pH of 7 should be achieved before the onset of containment sprays. The staff's concern was motivated by the statement in DCD 6.3.2.2.5 that the primary pH control chemical (NaTB) would not be fully dissolved for 12 hours.

In the applicant's response (Reference 2), it was claimed that the pH would be raised above 7 very early in the accident by dissolution of fission product cesium, which would exist primarily as the strong base CsOH. Specifically, it was stated that in about 1 hour, sufficient CsOH would be released from fuel, escape the RCS, and be washed into the RWSP, so as to raise the pH in the RWSP above 7. In fact, a plot prepared of the time-variation of pH indicates that pH will rise above 8, and even to 9, depending on pool temperature.

The staff has been unable to corroborate this calculation, a simplification of which appears here. We assume the data given below:

RCS water =  $510 \text{ m}^3 \approx 5.1 \times 10^5 \text{ kg}$   
RWSP water =  $2810 \text{ m}^3 \approx 2.81 \times 10^6 \text{ kg}$   
Total Cs released to water (30% of core inventory) = 1068 mol  
Concentration of boric acid = 4000 ppm

Assuming that all Cs is CsOH (in reality, about 10% would exist as CsI), concentrations of boric acid and CsOH are about 0.223 m (molal) and 0.0004 m, respectively. Using the methodology of the EPRI Guidelines (Reference 3), the pH of such a solution was calculated to be about 5.75 at 350 K (77°C). This is well below the pH calculated by the applicant in Reference 2.

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### Requested Information

Describe in more detail the calculation that indicates fission product cesium raises containment water pH above 7. Include all amounts of water, boric acid, fission products, and other solutes. Describe assumptions and any factors contributing to the calculation.

### References

1. "Request for Additional Information No. 234-2040 Revision 1, SRP Section: 06.05.02 - Containment Spray as a Fission Product Cleanup System, Application Section: Section 6.5.2" dated February 26, 2009. (ADAMS Accession No. ML0906102970)
2. Letter from Yoshiki Ogata, MHI, to NRC dated April 22, 2009; Docket No. 52-021 MHI Ref: UAP-HF-09199; Subject: MHI's Second Response to US-APWR DCD RAI No. 234 (ADAMS Accession No. ML0911804351)
3. *Pressurized Water Reactor Primary Water Chemistry Guidelines*, Vol. 1, Rev. 6, Electric Power Research Institute (December 2007).

06.05.02-6

### Background

RAI 06.05.02-2 (Reference 1) requested that the applicant explain how "ineffective pools" in containment will affect the dissolution and retention of fission products (particularly iodine). They were asked to explain the pH of such pools, the concentration of borate, and the concentrations of iodine and other fission products. This explanation was desired because there was concern that the pH control chemical (NaTB) might not reach some of these pools, allowing dissolved iodine to revolatilize and evaporate.

The applicant's response (Reference 2) mentions principal locations where ineffective pools would be located. For one (containment recirculation air distribution chamber), it was stated that a connection to the RWSP would ensure that this region would have a pH identical to the RWSP itself. For other regions, it was stated that bulk pH was lower than re-circulating water. However, a numerical pH was not provided. In reference to the ineffective pools the response also stated, "the surface of these pools would be exposed to re-circulating water." This explanation is unclear to the staff. Does the statement imply that some of the ineffective pools will eventually be diluted by higher-pH containment spray water such that their pH will increase with time? Regarding the distribution of borate in ineffective pools, the staff has reworded its question to clarify that a quantitative response is needed. The applicant does provide a good estimate of the distribution of fission product iodine in the various ineffective pool locations.

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### Requested Information

1. Define what is meant by "ineffective pools." Provide a more detailed description of all containment locations containing water that do not directly participate in recirculation through containment sprays. Note how they accumulate water. If water volumes are indirectly connected to the RWSP, provide detail on how they are connected (pipe size, expected flow patterns, etc.). Note any volumes that are completely unconnected to the RWSP, but that still could accumulate spray water.
2. For all volumes not directly a part of the RWSP-spray recirculation loop (i.e., those noted in question 1), provide an estimate of the (time-varying) pH, NaTB concentration, and fission product concentration.

### References

1. "Request for Additional Information No. 234-2040 Revision 1, SRP Section: 06.05.02 - Containment Spray as a Fission Product Cleanup System, Application Section: Section 6.5.2" dated February 26, 2009. (ADAMS Accession No. ML0906102970)
2. Letter from Yoshiki Ogata, MHI, to NRC dated March 24, 2009; Docket No. 52-021 MHI Ref: UAP-HF-09121; Subject: MHI's Response to US-APWR DCD RAI No. 234 (ADAMS Accession No. ML0908502111)