REQUEST FOR ADDITIONAL INFORMATION 234-2040 REVISION 1

2/26/2009

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)

06.05.02-1

a. Under DBA conditions, how long does it take for the RWSP water to reach a pH of 7 due to dissolution of NaTB?

b. What is the dissolution rate of NaTB?

Background

GDC 41 establishes the design requirements for containment atmosphere cleanup systems which function to reduce the concentration and quality of fission products released to the environment following postulated accidents. Compliance with GDC 41 ensures that the containment spray system will accomplish the fission product removal function assumed in the Chapter 15 radiological consequence calculations. To meet this design criterion, fission products must be retained as well as removed by the spray solution.

To control revolution of iodine from the containment sump water following a DBA, SRP 6.5.2 Acceptance Criterion II.1.G (p. 6.5.2-5), recommends that long term iodine retention can only be assured when a pH above 7 is achieved and that this pH should be achieved by the onset of the spray recirculation mode."

The DCD states that sodium tetra-borate decahydrate (NaTB) is added to the spray/sump solution to raise the pH for iodine retention. The mechanism of addition is that baskets of NaTB are placed in the containment where spray water will fall on them, dissolve the NaTB, and drain back into the sump (RWSP). As configured, only a few of the sprays near the outer periphery of the containment will fall into the NaTB baskets (Figs. 6.3-10 and 6.3-11). The DCD (6.3.2.2.5) states that dissolution time for all NaTB is 12 hours, although no calculation is given. This seems to contradict the SRP 6.5.2 Acceptance Criterion II.1.G (p. 6.5.2-5), which says that a pH of 7 should be achieved by the onset of the spray recirculation mode.

06.05.02-2

a. What is the expected pH of water that forms pools in containment but does not drain back to the RWSP?

b. What is the expected concentration of borate (from either original boric acid or dissolved NaTB)?

c. What proportion of iodine and other fission products will accumulate in such pools?

Background

GDC 41 establishes the design requirements for containment atmosphere cleanup systems which function to reduce the concentration and quality of fission products released to the environment following postulated accidents. Compliance with GDC 41 ensures that the containment spray system will accomplish the fission product removal function assumed in the Chapter 15 radiological consequence calculations. To meet this design criterion, fission products must be retained as well as removed by the spray solution.

The SRP 6.5.2 Acceptance Criteria 1.G recommends a pH of at least 7 to assure long-term iodine retention, and the applicant claims the design meets this requirement (DCD 6.5.2.1).

To achieve the required pH, SRP 6.5.2 Acceptance Criteria 1.F recommends that provision should be made for mixing of the ECCS and spray solutions. Drains to the sump should be provided for all regions of the containment which would collect a significant quantity of the spray solution. Alternatively, allowance should be made for “dead” volumes in the determination of the pH of the sump solution and the quantities of additives injected.

For the US-APWR RWST, mixing is achieved by recirculation—the containment sprays draw from the RWST and drain some of the water back into it. However, there is a volume of water from sprays that collects in the containment and does not return to the RWST (the “ineffective pool”), and thus does not participate in the mixing. This is stated in the DCD (Fig. 6.2.1-10 and Table 6.2.1-3) as 297,000 gal, whereas the maximum volume of the RWST (651,000 gal. from Table 6.2.1-5) is barely twice this amount. Furthermore, the value of total volume used for design evaluation is 329,000 gal. (Table 6.2.1-5), which is nearly the same as the ineffective pool. Thus, the ineffective pool contains a very large fraction of the containment water volume. This does not seem to meet the SRP Acceptance Criteria 1.F (p. 6.5.2-5), which states that drains to the sump should be provided for all regions that “ . . . would collect a significant quantity of the spray solution.” Since this water does not recirculate and mix, there is concern that it may not reach a pH of 7, even though it could be a repository for dissolved iodine.

06.05.02-3

a. How is iodine equilibrium partitioning between liquid and air calculated?

b. How was possible iodine revolatilization accounted for?

c. What components are considered in solution?

d. What pH values are typically obtained for example DBA sequences?

e. What partition coefficient is used?

Background

GDC 41 establishes the design requirements for containment atmosphere cleanup systems which function to reduce the concentration and quality of fission products released to the environment following postulated accidents. Compliance with GDC 41 ensures that the containment spray system will accomplish the fission product removal function assumed in the Chapter 15 radiological consequence calculations. To meet this design criterion, fission products must be retained as well as removed by the spray solution.

SRP 6.5.2 Acceptance Criteria 1.G. states that long-term iodine retention can only be assumed if sump solution pH remains above 7. Even if most iodine is removed, SRP Review Procedures 4.C.ii recommends an assumptioin that iodine revolatilization will take place if pH < 7. The analysis that considers the equilibrium partitioning between air and water for I_2 depends strongly on temperature and solution pH. It assumes sufficient mixing by recirculation so that an equilibrium value is a reasonable estimate of the end result of transient dissolution and revaporization processes. SRP Review Procedures 4.C.ii states that the pH calculation must consider all solution components, including fission product oxides, acids generated by radiolysis, and additives. The DCD makes only brief mention of such a calculation, and it is not clear what they would actually calculate (DCD 6.5.2.3.3).

06.05.02-4

a. What numerical values are used for parameters in the particulate removal equation given in DCD Section 15.A.1.2.2: h (spray drop fall height), V (containment volume), F (spray flow rate)?

b. If the model of Powers1 is used, what parameter values are input to the model, and what removal coefficient is calculated?

Background

GDC 41 establishes the design requirements for containment atmosphere cleanup systems which function to reduce the concentration and quality of fission products released to the environment following postulated accidents. Compliance with GDC 41 ensures that the containment spray system will accomplish the fission product removal function assumed in the Chapter 15 radiological consequence calculations. To meet this design criterion, fission products must be retained as well as removed by the spray solution.

The DCD mentions particulate removal (the actual model is described in DCD Section 15A.1.2.2) is calculated by the method of Powers et al, or estimated by the correlation from SRP Review Procedures 4.C.iv. However, the DCD does not provide the actual values of the input parameters that are used.