

# REQUEST FOR ADDITIONAL INFORMATION 280-2060 REVISION 1

3/17/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 09.03.04 - Chemical and Volume Control System (PWR) (Including Boron Recovery System)

Application Section: 9.3.4

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

09.03.04-1

Provide additional detail concerning the mixing and storage of the boric acid solutions, particularly with respect to avoiding precipitation of boric acid. The following items should be addressed:

- a) How are solutions in boric acid (BA) storage tanks made up?
- b) Is the mixing process for boric acid solutions a batch process or continuous process?
- c) What are the ingredients and how are they added?
- d) When is sampling done?
- e) What is the nominal temperature at which these tanks are maintained?
- f) Are there any checks for precipitation (of BA or other solids)?
- g) How is mixing monitored and ensured?
- h) What solutions actually involve 4 % (by weight) BA?
- i) How are the 4% boric acid solutions monitored?

## Background

SRP 9.3.4 (Areas of Review 4) requires a review to ensure that precipitation of boric acid is avoided. This requirement is based on GDC 14, as it relates the CVCS to maintaining RCS water chemistry (Acceptance Criteria 4), and GCD 29, as it relates the CVCS to provide negative reactivity using borated water (Acceptance Criteria 5). BA tank inventories are specified as 7000 ppm (about 2.4 % by weight). If solutions are formulated by mixing solid BA with water, then it is essential to ensure complete dissolution. It is mentioned in DCD 9.3.4.2.3.1 that the BA transfer pump is used to circulate solution in the BA tanks, but this action is not described in any detail at all.

## REQUEST FOR ADDITIONAL INFORMATION 280-2060 REVISION 1

Also, it is mentioned in several subsections that tanks or pipes containing 4 % BA solutions will be heated to at least 65°F, but the BA tanks are not that high in concentration. At 65°F (18.3°C) the solubility of BA is about 4.9 % (Linke, Solubilities, Vol. 1, 1958), which suggests that a 4% solution is close to its solubility limit. Hence, it is necessary to have more information about how they will be monitored and controlled. It is mentioned that there is a filter to collect sediment that accumulates in BA tanks (DCD 9.3.4.2.6.19), which suggests that settling or precipitation is possible.

09.03.04-2

- a) How and when is concentration in the BA mixing tank monitored?
- b) Is there continuous monitoring of BA solution injected into RCS?

### Background

SRP 9.3.4 (Areas of Review 4) requires this review to ensure that precipitation of boric acid is avoided. This requirement is based on GDC 14, as it relates the CVCS to maintaining RCS water chemistry (Acceptance Criteria 4), and GCD 29, as it relates the CVCS to provide negative reactivity using borated water (Acceptance Criteria 5). From DCD Table 9.3.2-6, it appears that occasional grab samples are taken. From the description in DCD Sect. 9.3.4.2.3.1, it appears that concentration in the mixing tank is set solely by control of the inlet streams (from BA tanks and makeup water). There is possible uncertainty in such a system, since inlet flows can be impeded by sediment or precipitation, or pump irregularities. It is essential that outlet flow should be monitored rigorously.

09.03.04-3

- a) What are concentration limits for Li and radioactive ions exiting the BA recycle demineralizer (DCD 9.3.4.2.3.2)?
- b) How are the concentration limits for Li and radioactive ions exiting the BA recycle demineralizer monitored?
- c) What fraction of water is removed by the evaporator?

### Background

GDC 14 requires that the CVCS maintain proper RCS chemistry limits. Since the exit stream from the demineralizer will be further concentrated in the evaporator, the RCS limits (as specified in the EPRI Guidelines) are not adequate. They must be more stringent, depending on the amount of water removed in the evaporator.

## REQUEST FOR ADDITIONAL INFORMATION 280-2060 REVISION 1

09.03.04-4

The staff requires the following additional details regarding the boric acid recycle system:

- a) Is the evaporator in the BA recycle system (DCD 9.3.4.2.3.2) a batch process or continuous?
- b) How is the concentrate sampled and how often?
- c) What provision is made to ensure that excessive concentration does not result, which could result in precipitation of the concentrated BA solution as it cools in pipes and the BA tank?

### Background

SRP 9.3.4 (Areas of Review 4) requires a review to ensure that precipitation of boric acid is avoided. This requirement is based on GDC 14, as it relates the CVCS to maintaining RCS water chemistry (Acceptance Criteria 4), and GCD 29, as it relates the CVCS to provide negative reactivity using borated water (Acceptance Criteria 5). The evaporator produces a concentrated BA solution at high temperature (not specified, but probably close to the boiling point of water), where the solubility of BA is quite high (about 6 times the solubility at 65°F, from Linke, Solubilities). Cooling will occur in pipes as solution is transported to BA storage tank. If the solution is concentrated too much in the evaporator, precipitation could result in a cooler location. The description in the DCD (9.3.4.2.6.24) is very brief, but appears to be a batch process rather than continuous. Table 9.3.2-6 mentions grab samples on evaporator inlet and outlet, but doesn't mention how often or what limits are required.

09.03.04-5

The staff requires the following additional information regarding "pre-selected" quantities such as amounts of makeup water and flow rate mentioned in the discussion of boron dilution events in DCD Section 9.3.4.2.7.6:

- a) How and by whom are the pre-selected values chosen?
- b) Who initiates the action?
- c) What monitoring is done to follow the progress of such events?

### Background

GDC 29 requires assurance (with extremely high probability of success) that BA concentration will be adequate for reactivity control. If the operator does the "pre-selecting" and continuously monitors the system while boron dilution progresses, then there is little likelihood of excessive dilution. However, if automatic "pre-selection" is implemented with no approval or monitoring by the operator, then excessive dilution could result.

## REQUEST FOR ADDITIONAL INFORMATION 280-2060 REVISION 1

09.03.04-6

- a) Provide design details on how workers will be protected from toxic and/or explosive chemicals (including fission products) prior to entry into the CVCS areas.
- b) Describe the possible threats, including a listing of toxic chemicals and locations where they may be present, and protective controls to prevent exposure.

### Background

SRP 9.3.4 (Areas of Review 4) requires this review to ensure the adequacy of the system design to allow personnel access considering the effects of toxic, irritating, or explosive chemicals. GDC 21 requires that reactivity control systems be designed to permit periodic testing even when the reactor is in operation. There is no mention in DCD Section 9.3.4 of any protective features or controls.