Draft

Request for Additional Information No. 125 (1302, 1440), Revision 0

10/24/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.03.04 - Chemical and Volume Control System (PWR) (Including Boron Recovery System)
Application Section: FSAR Section 9.3.4

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)
QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

09.03.04-1

CVCS-1

Two different terms are used to characterize the same system discussed in various sections of EPR FSAR. EPR FSAR Section 9.3.4, Chemical and Volume Control System (CVCS), page 9.3-47 discusses the Reactor Makeup and Inventory Control System. It states that “A flow diagram of the reactor boron and water makeup system (RBWMS) is shown in Figure 9.3.4-4 – RBWMS Flow Diagram.” Figure 9.3.4-4 is shown on pages 9.3-82 and 9.3-83. The title of this figure is “Reactor Makeup and Inventory Control System.” This title is consistent with the title given in Table 1.7.2 of the FSAR. As stated in Section 1.7.2, the U.S. EPR subscribes to the Kraftwerks Kennzeichen System (KKS) for coding and nomenclature of structures, systems and components which are also used in P&IDs. Therefore, these names appear to be used to refer to the same system. In addition, Table 1.3-1, “Abbreviations and Acronyms List” list Reactor Boron and Water Makeup System as RBWMS; whereas, Reactor Makeup and Inventory Control System is not listed. Also note, for example, Tier 2 Section 14.2, test #007 refers to the reactor boron and makeup water system, as does FSAR Tier 2 Section 6.8, extra borating system. To prevent possible confusion in the FSAR, eliminate one of the two names referring to the same system.

09.03.04-2

CVCS-2

Section 9.3.4, CVCS, does not reference the use of enriched boron. Section 9.3.4.2.1 states “The boric acid solution in the boric acid column is measured and controlled to maintain its boric acid concentration at an approximately constant four percent by weight which corresponds to 7100 ppm ± 100. The boric acid solution is cooled and transferred to the RBWMS storage tanks for reuse in the CVCS makeup. Table 6.8-1 – Extra Borating System (EBS) Design and Operating Parameters states “Boron Concentration in tank 7000 to 7300 ppm”. Based on above, CVCS and EBS have the same boron concentration range. The EBS uses enriched Boron. Table 6.8-1 states “Minimum boron enrichment 37% B-10.” Describe the reasons for the use of enriched boron in

CVCS, including any advantages and disadvantages. Section 9.3.4, does not discuss EBS, and design basis events for which each of these two systems are used. Also interfaces between CVCS and EBS are not being discussed. Describe these interfaces.

09.03.04-3

CVCS-3

In Section 9.3.4.1, Design Basis, one of the stated safety-related functions of the CVCs is:

Mitigate boron dilution event by automatically isolating the charging pump suction from the volume control tank (VCT) and normal letdown path, and automatically aligning the charging pump suction to the in-containment refueling water storage tank (IRWST).

However, in Section 9.3.4.3, Safety Evaluation, it is stated:

GDC 29 requires that safety-related portions of the CVCS reliably provide negative reactivity to the reactor by supplying borated water to the RCS in the event of AOOs if the plant design relies on the CVCS to perform the safety function of boration for mitigation of DBEs.

1. The CVCS is not designed to perform the safety function of RCS boration for the mitigation of DBEs.

2 The CVCS is designed to supply borated water to the RCS during normal power operating conditions….

In addition, the above description of GDC 29, as it relates to the CVCS, contains a conditional statement which is less conservative and not included in the description of GDC 29 provided in Appendix A of 10 CFR Part 50 but is included in SRP 9.3.4. Therefore, provide an explanation for the inconsistency between the 1. above and the statement made in 9.3.4.1 above. Also, confirm the safety-related portions of the CVCS reliably provide negative reactivity to the reactor by supplying borated water to the RCS in the event of AOOs.

09.03.04-4

CVCS-4

In Section 9.3.4.3 and in regards to GDC 29, the applicant states that “The CVCS is not designed to perform the safety function of RCS boration for the mitigation of DBEs”.

However, in section 9.3.4.2.3.4, Abnormal Operation, the applicant states:

“If the boron concentration decreases below a setpoint to indicate **a possible dilution event**, a signal is sent to isolate the charging pump suction. Three MOVs automatically isolate the normal letdown line and the line from the VCT and a valve from the IRWST automatically aligns to the charging pump suction **providing borated water to the RCS**. Simultaneously, the charging line isolation valves are closed and the three way valve to the coolant storage and supply tanks fully opens. The charging flow to the RCP seal water system remains in service during this evolution."

The abnormal scenario is a design basis event (DBE). Therefore, it appears that there is an inconsistency between the two sections. Amend the FSAR to correct this inconsistency.

09.03.04-5

CVCS-5

Two scenaria were identified in Chapter 15 analyses which referred to switchover from VCT to IRWST. The first is mentioned in 15.4.6.1.1 in regards to malfunction of RBWMS or operator error that causes boron dilution. The FSAR states that:

Three motor-operated valves (MOVs) automatically isolate the normal letdown line and the line from the volume control tank (VCT), and a valve from the in-containment refueling water storage tank (IRWST) automatically aligns to the charging pump suction providing borated water to the RCS. Simultaneously, the charging line isolation valves close and the three-way valve to the coolant storage and supply tanks fully opens. The charging flow to the RCP seal water system remains in service during this evolution. This action effectively isolates potential sources of dilution flow to the RCS. No credit is taken in transient analysis for the automatic lineup of boration flow to the RCS since this operation is performed with non-safety-grade equipment.

Explain the purpose of switchover from VCT to IRWST, even though no credit is taken in transient analysis.

The second scenario leading to switchover of the charging pumps from VCT to IRWST is mentioned in 15.6.3, steam generator tube failure. In case of operating charging pumps (bottom of page 15.6-6), automatic switchover from VCT to IRWST seems to be taken credit for on top of page 15.6-7. Clarify and explain the difference from the above position, when credit is not taken.

Finally, boron dilution occurs also during SBLOCA, Section 15.6.5.4, page 15.6-33. IRWST is mentioned in regards to SBLOCA, p. 15.6-25, but is not mentioned in the context of CVCS. Confirm boron dilution is addressed by using Extra Borating System. Amend the FSAR to explain this scenerio.

09.03.04-6

<u>Quality Group Classification</u>

GDC 1 requires that equipment important to safety be designed to quality group standards commensurate with the level of importance. Quality group classifications for the CVCS system are identified in FSAR Tier 1 Figure 2.2.6-1 and FSAR Tier 2 Figure 9.3.4-1. Classifications are also given in FSAR Tier 1 Table 2.2.6-1. The supply piping from the RCS to the CVCS can be isolated by two (in series) motor-operated valves and both return lines to the RCS loops can be isolated by sets of two check valves (also in series). All of these valves are shown in Tier 1 Table 2.2.6-1 as ASME III, Class 1 valves. However, Table 2.2.6-1 does not show the piping between the two motor-operated valves or between the two check valves to be Class 1. Also, the pressurizer auxiliary spray line is isolated from the RCS by a check valve and a motor-operated valve (MOV). The check valve is ASME Class 1 and the MOV is Class 3. Again in this case, the classification of the piping between the check valve and the MOV is not listed on Table 2.2.6-1. In view of the above, respond to the following:

1. Justify not listing the piping between the isolation valves in Table 2.2.6-1.

2. Justify the pressurizer spray isolation valve being Class 3 rather than Class 1.

3. Justify not listing the containment isolation valves in Table 2.2.6-1as Class 2.

09.03.04-7

Charging Pump Suction Swap

GDC 1 requires that equipment important to safety be designed to quality group standards commensurate with the level of importance. When a potential boron dilution event is detected, the chemical and volume control system automatically shifts the charging pump suction from the volume control tank (VCT) and the normal letdown line to the in-containment refueling water storage tank (IRWST). Motor operated isolation valves from the VCT and the letdown line automatically close, and an isolation valve from the IRWST automatically opens. The VCT and letdown isolation valves are shown in FSAR Tier 2 Figure 9.3.4-1 as quality group C and seismic category I. The valve that appears to be the IRWST isolation valve is 30KBA31 AA0031, which is shown on FSAR Tier 2 Figure 9.3.4-1, sheet 4 of 9. However, this valve classified as quality group D and non-seismic.

The Staff recognizes that the design of the U.S. EPR does not credit the CVCS for boration of the RCS during anticipated operational occurrences such as a boron dilution event. At the same time, the operation of the single suction valve from the IRWST is important in that it does align a source of borated water for charging to the RCS whether or not it is credited in the analysis. GDC 29 states "reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences." Since boration is not a CVCS safety function, quality group D and non-seismic are acceptable classifications. However, in view of the benefits of aligning the IRWST to the charging pump suction in a boron dilution event, the applicant should consider making the entire swap-over using safety related valves. In the alternative, indicate if any inspection or testing requirements will be imposed on the IRWST suction valve to provide improved reliability.

In addition to the above, the statement in FSAR Tier 2 Section 9.3.4.1 (2nd bullet under safety-related functions) is not technically correct in that the alignment of the charging pump suction to the IRWST is performed by non-safety grade equipment. Hence, if the isolation valve to the IRWST remains as quality group D and non-seismic, the statement in Section 9.3.4.1 should be corrected.

09.03.04-8

Seismic Design for Non-Safety CVCS

GDC 2 requires that safety related equipment be protected from the effects of natural phenomena, such as earthquakes. FSAR Tier 2 Section 9.3.4.3 states that the safety-related portions of the CVCS meet Position C.1 of Regulatory Guide (RG) 1.29 and the non-safety portions meet Position C.2. Position C.2 of RG 1.29 requires a design that precludes equipment or piping failure during an SSE that can adversely affect safety-related equipment (i.e. Seismic II). However, FSAR Tier 2 Figure 9.3.4-1 identifies non-safety portions of the CVCS as NSC (non-seismic class), which does not imply the protection of Seismic II piping. If the non-safety portions of the CVCS are designed to Seismic II criteria, clarify the seismic classifications shown on FSAR Tier 2 Figure 9.3.4-1. If non-safety portions are not designed to Seismic II, identify any design features supplied to protect safety-related portions from being impacted by NSC piping or components during design basis events.

09.03.04-9

Single Active Failure Considerations

GDC 29 requires protection and reactivity control systems be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences. CVCS has a safety function to isolate charging in order to preclude RCS over fill; however, the FSAR did not provide enough information to determine that this function can be achieved in spite of the failure of a single active component. Justify the non-overfill function can achieve its safety functions concurrent with the most limiting single active component failure.

09.03.04-10

Charging Pump Low Suction-Pressure Trip

GDC 29 requires protection and reactivity control systems be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences. A low charging-pump suction-pressure signal trips the operating charging pumps. However, the FSAR did not provide further details on this trip function and did not explain the control of the trip when suction sources swap.

Describe the control of the charging pump low-pressure suction trip function during an automatic swap of suction sources from the volume control tank to the in-containment refueling water storage tank (IRWST). Specifically, provide the methodology for accommodating the differences in suction pressure sources between the VCT and the IRWST.

09.03.04-11

Station Blackout Capabilities

10 CFR 50.63 requires certain plant design provisions necessary to cope with postulated station blackout conditions. FSAR Tier 2 Section 9.3.4.1 (Design Basis) states that safety-related portions of the CVCS provide capacity and capability to assure the core is cooled in

the event of a station blackout. However, Tier 2 Section 9.3.4.3 (Safety Evaluation) states that CVCS provides no function with regard to RCS makeup or RCP seal injection during an SBO event, and therefore 10 CFR 50.63 is not applicable to CVCS. In addition to these potentially conflicting statements, the station blackout (SBO) coping descriptions of FSAR Tier 2 Section 8.4 are not clear on maintaining the reactor coolant inventory under SBO conditions. Tier 2 Section 8.4 discusses assumptions of RCP seal leakage in a SBO and also discusses the RCP standstill seal system that subsequently terminates seal leakage. However, the issue of makeup and volume control is not fully explained. In view of the above, explain the required functions of the CVCS under station blackout conditions, if any, and the design provisions provided to meet these requirements.

09.03.04-12

Clarification RAI

FSAR Tier 2 Section 9.3.4, page 9.3.4-47, under the heading reactor makeup and inventory control, states that the reactor boron and makeup water system is shown in Figure 9.3.4-4. However, the system name on Figure 9.3.4-4 is shown as the reactor makeup and inventory control system. These names appear to be used to refer to the same system. For example, Tier 2 Section 14.2, test #007 refers to the reactor boron and makeup water system, as does FSAR Tier 2 Section 6.8, extra borating system. To prevent possible confusion, a consistent name should be used throughout the FSAR.

09.03.04-13

GDC 61 requires that the flow rate of the cooling and purification system be appropriately sized to maintain temperatures and radiation levels at acceptable values. The current design may challenge that requirement. Demineralizer beds normally have both inlet and outlet filters with the inlet filter having the large micron size and the outlet filter having the smaller outlet size.

1. Justify the small inlet micron size small, and provide the effects of this micron size on the frequency of require changes of the filter and the increase in the amount of solid radwaste.

2. Provide the reason for having a “resin trap” on the mixed bed effluent versus a filter of 0.1 microns.

3. Provide the mesh size of the ‘resin trap’.

09.03.04-14

The ALARA principle of plant operation (10 CFR 20.1101) can only be achieved if the demineralizer resins for the RCS function properly. Anion resins (principally removing radioiodines) are much more sensitive to temperature than cation resins. The normal upper temperature limit, in the absence of radiation fields is 120 0F. The current description of the CVCS temperature bypass for the CVCS demineralizers would allow temperatures to reach as high as 150°F prior to bypassing the demineralizers.

1. Provide a technical reference that shows the stability of the anion resin material above 120°F in the presence of a radiation field of several thousand rad.

2. Provide the location upstream of the resin beds for performimng the temperature monitoring.

3. Provide the time frame between sensing of the setpoint temperature and the full bypass occurring.

09.03.04-15

The ALARA principle of plant operation (10 CFR 20.1101) can only be achieved if the demineralizer resins for the RCS are operating to maintain a constant equilibrium concentration of radionulcides. Removing a demineralizer from service for short periods (hours to one shift) is not a significant impact to the RCS radionuclide concentrations. However, longer periods of time without clean-up can lead to higher dose rates in low flow areas in the Nuclear Auxiliary Building, and pH excursions that can solubilize soluble and insoluble CRUD.

1. Provide the time to lithiate the hydrogen form mixed bed while at power.

2. Provide the time to sluice the depleted resin and sluice in new, fresh resin.

3. Provide documented evidence of the times of these actions so that it can be assured that lithium will be controlling RCS pH in the correct band.

09.03.04-16

Technical Specification 3.4.15 limits the specific reactor coolant activity for Dose Equivalent ^{131}I and Dose Equivalent ^{133}Xe. These are fuel integrity monitoring parameters. If RCS oxygen is not adequately controlled by having significant enough hydrogen concentrations, the fuel integrity cannot be assured. Control of hydrogen in PWRs is usually performed by 100% of letdown flow through the VCT. The VCT is maintained under hydrogen pressure (only) between 20 and 35 psig. The design identified in the FSAR has a significantly different approach to hydrogen control, that it is not well described.

1. Provide the equations that identify the flow and concentration of hydrogen into the RCS liquid from the letdown system gassifier and VCT.

2. Justify only 10% of the letdown flow being directed through the VCT.

3. In order to assess the concentration of hydrogen in the RCS, the mole fraction of hydrogen in the VCT gas phase must be known. A sample line from the VCT gas space does not appear in the plant design for the NSS. Provide the methodology for determining the %H_2 in the VCT gas phase so that the RCS hydrogen in cc/Kg ca be properly calculated.

09.03.04-17

Technical Specification 3.4.5 identifies the operational requirements for assuring that the boron concentration is “not diluted.” GDC 29 also identifies a function of Chemical and Volume Control System (CVCS) as supplying boric acid solution reliably for negative reactivity in the Reactor Collant System (RCS). This requirement concerns both the total boron and the specific atom % of ^{10}B. The coolant treatment system (CTS) as described in FSAR Tier 2 Section 9.3.4.2 (and accompanying figures 9.3.4-6) uses evaporative techniques to separate pure water from concentrated boric acid solution. The evaporator feed is purified through a demineralizer and then sent to an evaporator where the water is distilled through a series of trays to 'purify' the distillate removing additional boric acid. Concentration of contaminants in the boric acid phase, such as chlorides, silica, sulfate and sodium, and difficulty in maintaining flow continuity at higher boron concentrations and temperatures due to boric acid insolubility at high concentrations, have caused all plants to abandon operations of these systems for recycle purposes. Am/Be neutron sources and their associated BF_3 detectors have been difficult to maintain in the past and most plants have removed these systems from their letdown lines.

1. Provide additional details regarding the 'trays' in the boron evaporator and their physical functionality (e.g., percent boron removed for each tray).

2. Provide the mechanism for removing anionic contaminants from the boric acid concentrate so that it may be reused and still meet the EPRI PWR Primary Water Chemistry Guideline requirements for boric acid solution.

3 Describe the control logic for the four Am/Be neutron sources and their associated detectors for providing auto blended makeup to the RCS: one of four, two of four.

4. Provide the maintenance activities in both calibration and cleanliness of the portion of the letdown line adjacent to the detectors, that will be made to assure their accuracy.

5. Confirm that BF_3 detectors are used for the measurement of neutron flux reduction from the Am/Be sources, and if so describe their placement and maintenance.

6. Provide the methodology for the determination of the ^{10}B concentration (atom %) in the recycled boric acid and provide the frequency of that determination.

09.03.04-18

PWR water chemistry must be maintained to the highest quality to support integrity of the nuclear fuel and thus minimize RCS specific activity as identified in Technical Specification 3.4.15. Additionally, per SRP Section 9.3.4 the latest edition of the EPRI PWR Primary Water Chemistry Guidelines is an acceptable standard for determining whether a primary water chemistry control program is adequate to comply with GDC 14 with respect to minimizing corrosion-induced degradation of the reactor coolant pressure boundary. FSAR Tier 2 Section 9.3.4.6 reference 1 identifies the EPRI PWR Water Chemistry Guidelines Revision 3 (1995). The guidelines have been updated since that time and have significant changes.

1. Confirm that the reference be updated to the latest edition, Revision 6 (2007), of the EPRI Guidelines.

2. If not, provide a detailed explanation of meeting and presenting the changes to the guidelines.

3. The EPRI Primary Water Chemistry Guidelines provide specific Action Level 1, 2 and 3 limits for many primary water chemistry control parameters. Specific actions including

reduced power and/or shutdown are required if these limits are exceeded. Describe the implementation of these action levels.

4. Justify providing a lower range for hydrogen (17-28 cc/Kg) than is in the EPRI PWR Primary Water Chemistry Guidelines.

5. Since the EPRI PWR Primary Water Chemistry Guidelines are periodically updated to reflect evolving industry practices, the staff requests that the applicant consider whether a COL information item should be identified in the FSAR requiring that the COL applicant describe the method for maintaining the primary water chemistry program current with industry best practices, for example, via a commitment to follow the latest EPRI PWR Primary Water Chemistry Guidelines.