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Subject: U.S. EPR Design Certification Application RAI No. 175 (1817), FSAR Ch. 9
Attachments: RAI_175_SBPA_1817 (2).doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on January 9, 2009, and discussed with your staff on January 22, 2009. Draft RAI Question 09.02.05-12 was modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
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U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.05 - Ultimate Heat Sink
Application Section: 9.2.5

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

09.02.05-3

Based on a review of the information provided in Tier 2 of the Final Safety Analysis Report (FSAR), Section 9.2.5, "Ultimate Heat Sink," the staff found that the description of the ultimate heat sink (UHS) does not adequately explain the designs satisfication of the design bases considerations, identify the limiting assumptions that apply, provide the excess margin available, include and address relevant operating experience insights and so forth. Consequently, Tier 1 and Tier 2 of the Final Safety Analysis Report (FSAR) needs to be revised to include information that is sufficient to demonstrate that the UHS is capable of performing its design-bases functions, that applicable design considerations are satisfied by the proposed design, and that reasonable assurance exists that the availability and design-bases capability of the UHS will be maintained over the life of the plant. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," provides guidance on the specific information that should be included in the application for evaluation by the staff.

09.02.05-4

The ultimate heat sink (UHS) must be able to withstand natural phenomena without the loss of function in accordance with General Design Criteria (GDC) 2 requirements. The system description does not explain the functioning and maximum allowed combined seat leakage of safety-related boundary isolation valves at the UHS basin to ensure UHS integrity and operability during seismic events and other natural phenomena. Consequently, additional information needs to be included in Tier 2 Section 9.2.5 of the Final Safety Analysis Report (FSAR) to fully describe: (a) the assurance of the UHS integrity and operability by the safety-related boundary isolation valves so that common-cause simultaneous failure of all non-safety-related UHS piping will not compromise the UHS safety functions during seismic events, (b) the maximum allowed combined seat leakage for the safety-related UHS boundary isolation valves and periodic testing that will be performed to ensure that the specified limit will not be exceeded, and (c) a description of any other performance assumptions that pertain to the boundary isolation valves or other parts of the system including blowdown that are necessary to assure the capability of the UHS to perform its safety functions during natural phenomena. In addition, under FSAR, Section 9.2.5.5, "Safety Evaluation," it states that "The UHS pump buildings and cooling towers are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles and other natural phenomena."

However, there is no mention of the piping system being designed to meeting these conditions.

09.02.05-5

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 specifies confirmation of the overall arrangement of the ultimate heat sink (UHS). Revise the description and piping and instrumentation diagram (P&IDs) and the Final Safety Analysis Report (FSAR) to address the following considerations:

a. Pipe sizes are not shown on the P&ID (Figure 9.2.5-1, “Ultimate Heat Sink Piping and Instrumentation Diagram”), and the system description in Section 9.2.5 does not explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).
b. The system description in Section 9.2.5 does not provide design details such as system operating temperatures, pressures, fan speeds, and flow rates for all operating modes and alignments.
c. Figure 9.2.5-1 does not show where indications are displayed (e.g., local, remote panel, control room), and what instruments provide input to a process computer and/or have alarm and automatic actuation functions.
d. Figure 9.2.5-1 does not show what the normal valve positions are, what valves are locked in position, and what valves have automatic functions; and these design features are not described in Section 9.2.5.
e. Figure 9.2.5-1 shows the UHS bypass but flow rates are not provided for low load/low ambient temperature conditions to maintain essential service water (ESW) cold water temperature within established limits.
f. The UHS fan alarms are not discussed in the FSAR.
g. Figure 9.2.5-1 does not show the cooling tower basin instruments (level and temperature).

09.02.05-6

Final Safety Analysis Report (FSAR) Tier 2 Section 9.2.5 states that the ultimate heat sink (UHS) is sized to provide adequate cooling capacity to dissipate essential service water system (ESWS) heat loads, however, insufficient information is provided to confirm this capability. Table 9.2.5-2 provides some technical information for the dual cell forced draft ESW cooling towers, but no heat rejection rate is provided that would support confirmation of sufficient cooling capability. Standard Review Plan (SRP) 9.2.5 Section III, paragraph 2.B of “Evaluation Procedures" instructs the reviewer to verify whether “the UHS can dissipate the maximum possible total heat load including that of a loss of coolant accident (LOCA) under the worst combination of adverse environmental conditions.” Provide key assumptions and inputs for the design calculations that demonstrate sufficient capability and margin. Additional information that is needed in the FSAR includes (for example):

1. Key assumptions and inputs (including justification) for calculations that demonstrate sufficient heat rejection capability to meet maximum predicted heat loads and define the available margin with limited system temperatures and pressures. These assumptions should include sufficient margin to account for

uncertainties in the analysis, anticipated degradation in performance over time, and fluctuations in the frequency of electric current. These calculations should be made available for staff audit
2. Explanation of how the wet bulb correction of 1˚F was determined to be sufficient for potential tower interferences; (FSAR Tier 2 Table 9.2.5-2).
3. Performance curves that show the minimum required tower heat rejection capability verses time (including spent fuel pool cooling) for post LOCA cooldown, and cooldown to cold shutdown conditions following a reactor trip with and without offsite power available.
4. Explanation of the monitoring of UHS heat rejection capability for ensuring adequate performance over time.

09.02.05-7

General Design Criteria (GDC) 44 requires that "A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided." The staff noted the proper understanding of the function and operation of the ESWS ultimate heat sink (UHS) cooling tower fans is necessary for compliance with GDC 44 since these components support the overall system safety functions including accident mitigation.

Final Safety Analysis Report (FSAR) Tier 2 Section 9.2.5.4 states that the cooling tower fans have multi-speed drives that have the capability of operating in the reverse directions for short periods in cold weather for deicing purposes. The staff identified the following questions relative to these important components:

1. Describe the seismic class and electrical class (1E) of the fans and fan motors in Section 9.2.5.
2. Provide a description in Section 9.2.5 of fan mechanical properties (e.g. capacity, speeds etc).
3. Describe in the FSAR if the associated ESWS train is considered inoperable when the fans are operated in the reverse direction for deicing purposes.
4. Since the fans receive an automatic signal in response to an accident, describe in the FSAR the results if an accident occurred during reverse fan operation.
5. Provide in either FSAR Section 9.2.1 or 9.2.5 a description of UHS/ESW cooling tower fan automatic start in response to an accident.
6. Describe in the FSAR how proper fan speed is selected during normal/ accident conditions (automatic process or a manual operator action).
7. Describe in the FSAR the speed at which fans on a standby train will be started in response to an accident signal and what is normal speed for a fan that was previously in operation.
8. Describe in the FSAR the indications and controls for the fans provided to the operator in the main control room (MCR).
9. With respect to the non safety related (NSR) dedicated train; describe the emergency power source for the division four cooling tower fans (used by the dedicated train) during severe accidents. Similarly, describe the emergency power source for the dedicated train filter and motor operated valves. This should be identified in the FSAR.

09.02.05-8

General Design Criteria (GDC) 44 requires that "A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided." This function must also be met in the event of a loss of off-site power and a single failure. The staff noted that assurance of separation between safety and non-safety portions of the system is therefore necessary for compliance with GDC 44.

Final Safety Analysis Report (FSAR) Tier 1 Figure 2.7.11-1 and Tier 2 Figure 9.2.1-1 show a safety/ non-safety-related interface at the outlet of safety-related cooling tower blowdown motor operated isolation valve 30PEB10/20/30/40 AA016 (typical) and emergency blowdown motor operated isolation valve 30PEB10/20/30/40 AA003. Further, no mention of automatic isolation of the normal blowdown path was located by the staff in either FSAR Tier 1 Section 2.7.11 or Tier 2, Section 9.2.5 of the ultimate heat sink (UHS). This question also relates to Regulatory Position C.1 of RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants."

The staff noted that it was likely that the normal cooling tower basin blowdown path will be open on more than one train during plant operation. Describe the prevention of the continued loss of basin water volume through this line in case of an accident when basin makeup may be unavailable for the first 72 hours. Describe in the FSAR if the blowdown valve automatically closes or is manually closed.

09.02.05-9

In order to satisfy system flow requirements, the ultimate heat sink (UHS) design must assure that the minimum net positive suction head (NPSH) for the essential service water system (ESWS) pumps will be met for all postulated conditions, including consideration of vortex formation. Standard Review Plan (SRP) 9.2.5 Section III, paragraph 3.C specifies confirmation that the maximum design cooling water temperature is not exceeded under the worst combination of adverse environmental conditions, in conjunction with a design basis accident. Final Safety Analysis Report (FSAR) Tier 2 Table 9.2.5-1 indicates the maximum required ESWS design basis accident (DBA) temperature is 35˚C (95˚F) and FSAR Tier 2 Section 16 Technical Specification Surveillance Requirement (SR) 3.7.8.2 requires UHS basin temperature during plant operation to be maintained less than or equal to 32.2˚C (90˚F). This indicates that the maximum basin temperature increase during worst case design basis conditions is 2.8˚C (5˚F). However, there is no explanation of the relationship between these temperatures or the calculation basis used to determine the 2.8˚C (5˚F) temperature increase in FSAR Section 9.2.5. As such, the following questions need to be addressed in the FSAR:

1. Provide key assumptions and inputs in FSAR Section 9.2.5 for calculations that establish the basis and define design margin for the minimum basin water level, maximum basin volume loss and maximum temperature increase during the first 72 hours when basin water makeup is assumed to be lost and after the minimum makeup water flow (300 gpm) is established; include consideration of vortex formation. These calculations should be made available for staff audit
2. Provide the heat load associated with ESWS pump mechanical work and ESWS pump room cooler in this analysis. The heat loads/flows should be listed in FSAR Tier 2 Table 9.2.5-1.

3. Provide an explanation in FSAR Tier 2 Section 9.2.5 for (1) the relationship between 32.2˚C (90˚F) and 35˚C (95˚F) and (2) the analysis used to determine the accident temperature increase and why it is conservative.
4. Provide the maximum temperature for the cooling tower water volume in FSAR Tier 1 Section 2.7.11 .

09.02.05-10

General Design Criteria (GDC) 44 requires that "A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided." The staff noted the protection of the essential service water system (ESWS) pump suction supports compliance with GDC 44 since these components are essential for the overall system function.

Describe in the FSAR the protection of the ESWS pump suction from potential debris intrusion (e.g. tower fill degradation, etc.). The staff noted that some plants have found this type of protection to be necessary (e.g. screens) due to damage to the fill from failed cooling tower spay nozzles. Also provide in the FSAR a description of the cooling tower spray and fill design arrangements related to failure modes.

09.02.05-11

General Design Criteria (GDC) 44 requires systems to transfer heat from structures, systems, and components important to safety to a ultimate heat sink under accident conditions. Fermi 2, as part of their design bases, has a nitrogen brake system to prevent overspeed from the design basis tornado. During a design basis tornado, the brake will engage and disengage a number of times. Since two groups of fan are provided for each safety related cooling tower and each cooling tower is divisionally separated, justify that a safety related fan braking system is not needed for the design basis tornado.

09.02.05-12

General Design Criteria (GDC) 45 requires the ultimate heat sink (UHS) to be designed so that periodic inspections of piping and components can be performed to assure that the integrity and capability of the system will be maintained over time. The staff finds the design to be acceptable if the Final Safety Analysis Report (FSAR) describes inspection program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2 FSAR Section 9.2.5.6 indicates that periodic inspections will be performed, the extent and nature of these inspections and procedural controls that will be implemented to assure that the UHS is adequately maintained over time were not described. Furthermore, the accessibility and periodic inspection safety related buried piping and the cooling tower spray header system and tower fill is of particular interest. Consequently, additional information needs to be provided in the FSAR to describe the extent and nature of inspections that will be performed and procedural controls that will be implemented commensurate with this requirement.

09.02.05-13

General Design Criteria (GDC) 46 requires the ultimate heat sink (UHS) to be designed so that periodic pressure and functional testing of components can be performed to assure the structural and leak tight integrity of system components, the operability and performance of active components, and the operability of the system as a whole and performance of the full operational sequences that are necessary for accomplishing the UHS safety functions. The staff finds the design to be acceptable if the Final Safety Analysis Report (FSAR) describes pressure and functional test program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2 FSAR Section 9.2.5.6 indicates that periodic testing will be performed, the extent and nature of these tests and procedural controls that will be implemented to assure continued UHS structural and leak tight integrity and system operability over time were not described. Consequently, additional information needs to be provided in the FSAR to describe the extent and nature of testing that will be performed and procedural controls that will be implemented commensurate with this requirement.

09.02.05-14

Means must be provided for monitoring effluent discharge paths and the plant environs for radioactivity that may be released in accordance with General Design Criteria (GDC) 64 requirements. Also, 10 CFR 52.79(a)(45) and 10 CFR 20.1406 require combined operating license (COL) applicants to describe how facility design and procedures for operation will minimize contamination of the facility and the environment. The staff's review criteria (standard review plan (SRP) Section 9.2.1, Paragraph III.3.D) specify that provisions should be provided to detect and control leakage of radioactive contamination into and out of the essential service water system (ESWS) which is part of the ultimate heat sink (UHS). The design is considered to be acceptable by the staff if the UHS/essential service water system (ESWS) piping and instrumentation diagram (P&IDs) show that radiation monitors at components that are susceptible to leakage, and if the components that are susceptible to leakage can be isolated. However, the staff noted that Tier 2 Final Safety Analysis Report (FSAR) Section 9.2.5 and the UHS/ESWS P&ID do not include radiation monitors in the system design and the NRC regulations in this regard have not been addressed. Therefore, additional information needs to be included in Tier 2 FSAR Section 9.2.5 to address the NRC requirements referred to above.

09.02.05-15

General Design Criteria (GDC) 46 requires the ultimate heat sink (UHS) to be designed so that periodic pressure and functional testing of components can be performed. The staff determined that the cooling tower fans are noted in Section 3.7.8.4; however, there was no required test for the various speeds and direction.

1. Revise Final Safety Analysis Report (FSAR) Tier 2 Chapter 16 Technical Specification (TS) Surveillance Test, item 3.7.8.4 to clarify that the cooling tower fans are required to be tested in "each speed setting and direction, including reverse."

2. TS Bases 3.7.8 sheet 2, last paragraph states “An essential service water (ESW) train is considered OPERABLE when two cooling tower fans, pump, associated piping, valves, and instrumentation and controls required to perform the safety related function are OPERABLE...”
    a. Address the single failure of one of the two essential service water system (ESWS) cooling tower fans and discuss if failure of one fan results is an automatic train swapover.

09.02.05-16

General Design Criteria (GDC) 44 requires that “A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided.” The staff noted in GDC 44 that adequate emergency makeup is also necessary.

Final Safety Analysis Report (FSAR) Tier 2, Table 9.2.5-2 identifies a maximum essential service water system (ESWS) cooling tower evaporation rate of 2.16 m^3/min (571 gpm). However, Technical Specification Surveillance (TS) 3.7.8.7 requires periodic confirmation that safety-related ESW basin makeup is greater than or equal to 1.14 m^3/min (300 gpm). Regulatory Position C.1 of Regulatory Guide (RG) 1.27 states that, “A cooling supply of less than 30 days may be acceptable if it can be demonstrated that replenishment or use of an alternative water supply can be effected to assure the continued ability of the sink to perform its safety functions…”

a. Explain the basis in FSAR 9.2.5 for why the basin makeup to be less than the maximum evaporation rate.
b. Describe in the FSAR Section 9.2.5 the basis for the Technical Specification minimum 1.14 m^3/min (300 gpm).

09.02.05-17

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 requires confirmation of the overall arrangement of the ultimate heat sink (UHS). The staff reviewed the descriptive information, arrangement, design features, environmental qualification, performance requirements, and interface information provided in Tier 1 Final Safety Analysis Report (FSAR) Section 2.7.11 to confirm completeness and consistency with the plant design basis as described in Tier 2 Section 9.2.5. The staff found that the Tier 1 information is incomplete, inconsistent, inaccurate, or that clarification is needed in the FSAR with respect to the following considerations:

a. Although the Introduction Section in Chapter 1 of the Tier 1 FSAR states that the information in the Tier 1 portion of the FSAR is extracted from the detailed information contained in Tier 2, the staff found that much of the information provided in FSAR Tier 1 is not described in Tier 2 FSAR Section 9.2.5 (e.g., equipment locations, valve functional requirements, indication and control information, priority actuation and control system description and functions, automatic actuation and interlock details, valve failure modes, and harsh environment considerations). This Tier 1 information needs to be added to Tier 2.

b. FSAR Tier 1 does not stipulate that the ultimate heat sink (UHS) is accessible for performing periodic inspections as required by General Design Criteria (GDC) 45.
c. FSAR Tier 1 does not stipulate that the UHS design provide for flow testing of makeup water for accident and emergency conditions.
d. FSAR Tier 1 does not stipulate that the essential service water system (ESWS) pumps are protected from debris from the cooling towers.
e. FSAR Tier 1 does not stipulate that the safety related UHS outdoor piping is adequately protected from the elements and postulated hazards.
f. Tier 1, Figure 2.7.11-1, "Essential Service Water System Functional Arrangement," does not show nominal pipe sizes for the UHS, which are necessary for design certification. This table does not show design information for the UHS fans.
g. Tier 1, Table 2.7.11-2, "Essential Service Water System Equipment I&C and Electrical Design," does not include information pertaining to the UHS fans and corresponding power supplies.
h. The point of Note 2 for Tier 1, Table 2.7.11-2 is not clear since it does not appear to pertain to anything on the table. However, this appears to be due to an oversight whereby dedicated ESWS components are not listed in the table.
i. The discussion under Item 6 Tier 1 of Table 2.7.11-2 related to environmental qualification is inconsistent with the information provided in Table 2.7.11-2 in that no equipment is listed in the table for harsh environment considerations.

09.02.05-18

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 specifies confirmation of the overall arrangement of the ultimate heat sink (UHS). The staff reviewed the information provided in Tier 1, Table 2.7.11-3, "Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," to confirm that the proposed ITAAC are adequate for EPR design certification. However, the staff found that the proposed ITAAC are incomplete, inconsistent, inaccurate, or that clarification is needed in the FSAR as follows:

a. Item 2.1 only refers to functional arrangement, but it should refer to functional arrangement and design details since nominal pipe size is an important consideration that needs to be verified, as it pertains to the ultimate heat sink (UHS).
b. Item 2.3 is incomplete in that it does not address physical separation criteria for outdoor piping and components such as for the UHS fans.
c. Provide an ITAAC for the UHS/ESW fans are (proper accident response, operating capability in various speeds including reverse).
d. Need to include under several existing item, such as 7.1, the performance of the UHS fans since neither the UHS fans are listed under Tables 2.7.11-2 or 2.7.11-3. Quantitative acceptance criteria need to be established for all ITAAC as applicable (flow rates, heat transfer rates, completion times, etc.).

09.02.05-19

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 specifies confirmation of the overall arrangement of the ultimate heat sink (UHS). The staff noted that Tier 1 Final Safety Analysis Report (FSAR) Section 4.7, "Buried Piping and Pipe Ducts for Service Water," states that interface requirements for buried ESWS pipe and ducts are provided in Tier 1 FSAR Section 2.7.11. However, the interface information that is referred to is

not provided in Section 2.7.11. Also, the interface information is not listed in Tier 2 FSAR Table 1.8-1, “Summary of U.S. EPR Plant Interfaces with Remainder of Plant,” and there is no discussion of the interface requirements for buried safety related ultimate heat sink UHS pipe and ducts in Tier 2 Section 9.2.5. Therefore, additional information is needed in the FSAR to provide the missing interface requirements for buried UHS and essential service water system (ESWS) pipe and ducts.

09.02.05-20

10 CFR 52.47(a)25 relates to requirements for site specific items to be identified by the design certification (DC) applicant that must be addressed by the combined operating license (COL) applicant.

1. Final Safety Analysis Report (FSAR) Tier 2 paragraph 9.2.5.3.2 indicates that system materials are selected that are suitable to the site location, UHS fluid properties and site installation. The staff noted that for some site locations the selection of service water system materials in combination with chemical treatment and ongoing inspection programs have proven to be essential for continued assurance of system integrity. Accordingly, the staff recommends that a new COL information item be added to FSAR Tier 2 Table 1.8-2, “U.S. EPR Combined License Information Items,” that states “A COL applicant that references the U.S. EPR Design Certification will identify the site specific materials selected for UHS piping and components, including the bases for the selections.”

2. FSAR Tier 2, Section 9.2.5.2, “System Description,” contains several COL information items including UHS makeup water, blowdown and chemical treatment for the control of bidfouling. In accordance with 10 CFR52.47, part 24 a conceptual design of makeup water and blowdown is needed in order to aid the staff it is review and to determine the adequacy of the interface requirements.

3. COL Information Item 2.3-10 states “A COL applicant that references the U.S. EPR design certification will describe the means for providing UHS makeup sufficient to meet the maximum evaporative and drift water loss after 72 hours through the remainder of the 30 day period consistent with RG 1.27.” This COL information item may need clarification due to Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plant”, Rev 2, Jan 1976, Section C3, which states in part the UHS should consist of at least two highly reliable water sources.