REQUEST FOR ADDITIONAL INFORMATION 362-2278 REVISION 0

5/13/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 09.02.02 - Reactor Auxiliary Cooling Water Systems
Application Section: 9.2.2

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

09.02.02-22

Based on a review of the information provided in Tier 2 of the Design Control Document (DCD), Section 9.2.2, “Component Cooling Water System,” the staff found that the description of the component cooling water system (CCWS) is generally incomplete and does not adequately explain how design bases considerations are satisfied by the proposed design, what limiting assumptions apply, how much excess margin is available, what operating experience insights are relevant and how they were addressed, and so forth. Consequently, Tier 1 and Tier 2 of the DCD needs to be revised to include information that is sufficient to demonstrate that the CCWS 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 CCWS 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.

09.02.02-23

The component cooling water system (CCWS) must be able to withstand natural phenomena without the loss of function in accordance with 10 CFR 50, Appendix A, General Design Criterion (GDC) 2 requirements. There are several statements made in Tier 2 of the Design Control Document (DCD), Chapter 3, Table 3.2-2, sheet 23, item 11 (CCWS) that need to be clarified and corrected which includes:

- In several cases, the system and component description needs to be clarified and should be better described with “header names” such as header A, B, C, D, A-1, C-1, A-2 or C-2.
- Table 3.2-2, item 11, sheet 24; “Component cooling water supply, return lines piping and valves excluding the following; Component cooling water system containment isolation valves and piping between the valves Component cooling water supply, return lines piping and valves between and excluding the valves NCS-VLV-033A and 034A.” This statement is confusing. Clarify valves NCS-VLV-033A and 034A should be equipment class 3, quality group C.
- Table 3.2-2, item 11, sheet 24; “Component cooling water supply, return lines piping and valves excluding the following; Component cooling water system containment isolation valves and piping between the valves Component cooling water supply, return lines piping and valves between and excluding the valves

NCS-VLV-033B and 034B." This statement is confusing. Clarify valves NCS-VLV-033B and 034B should be equipment class 3, quality group C.

- Table 3.2-2, item 11, sheet 25;"Component cooling water supply, return lines piping and valves between and excluding the valves NCS-VLV-033A and 034A, excluding the following; Component cooling water system containment isolation valves and piping between the valves Component cooling water system piping and valves between and including the valve NCS-AOV-661A and NCS-VLV-671A Component cooling water system piping and valves between and including the valve NCS-AOV-601 and NCS-VLV-653." This statement is confusing. Clarify valves NCS-AOV-661A and NCS-VLV-671A should be equipment class 3, quality group C.
- Table 3.2-2, item 11, sheet 25, "Component cooling water supply, return lines piping and valves between and excluding the valves NCS-VLV-033B and 034B, excluding the following; Component cooling water system containment isolation valves and piping between the valves Component cooling water system piping and valves between and including the valve NCS-AOV-661B and NCS-VLV-671B. This statement is confusing. Clarify valves NCS-AOV-661B and NCS-VLV-671B should be equipment class 3, quality group C.
- Describe in Section 9.2.2 why filters are not necessary in the design of the component cooling water system since plate type heat exchangers are being utilized. If filters are determined to be required, the filter should also be described in Tier 1.

09.02.02-24

The component cooling water system (CCWS) must be able to withstand natural phenomena without the loss of function in accordance with General Design Criteria (GDC) 2 requirements. As specified in Standard Review Plan (SRP), Section 9.2.2, "Reactor Auxiliary Cooling Water Systems," staff acceptance is based upon compliance with GDC 2, "Design Basis for Protection Against Natural Phenomena." The staff considers the CCWS to be acceptable with respect to GDC 2 if it satisfies Position C1 and C.2 of Regulatory Guide 1.29, "Seismic Design Classification." Position C2 indicates that the design of non-safety-related SSCs is acceptable if failures of these non-safety-related SSCs do not adversely affect the control room occupants or safety-related SSCs to perform their safety related function.

The applicant is request to provide additional information in Tier 2, Section 9.2.2 of the Design Control Document (DCD) to address that failures of non-safety-related portions of the CCWS do not adversely affect any safety-related SSCs in performing their safety-related function, or adversely affect the control room occupants.

09.02.02-25

The component cooling water system (CCWS) 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 to ensure CCWS integrity and operability during seismic events and other natural phenomena. Consequently, the applicant needs to include the following information in Tier 2 Section 9.2.2 of the Design Control Document (DCD):

- Describe in the DCD how CCWS integrity and operability is assured by the safety-related boundary isolation valves so that common-cause simultaneous failure of all non-safety-related CCWS piping will not compromise the CCWS safety functions during seismic events.
- Describe in the DCD what the maximum allowed combined seat leakage is for the safety-related CCWS boundary isolation valves and periodic testing that will be performed to ensure that the specified limit will not be exceeded.
- Describe in the DCD any other performance assumptions that pertain to the boundary isolation valves or other parts of the system that is necessary to assure the capability of the CCWS to perform its safety functions during natural phenomena.

09.02.02-26

NRC Generic Letter (GL) 96-06 identifies concerns with hydrodynamic effects of water hammer during design events such as loss of coolant accidents. Describe how the design and operation of the US-APWR address the water hammer and two-phase flow concerns discussed in GL 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," and explain why these issues do not pose a problem for CCWS. Note that guidance for water hammer prevention and mitigation is provided in NUREG-0927, "Evaluation of Water Hammer Occurrence in Nuclear Power Plants."

09.02.02-27

Standard Review Plan (SRP) 9.2.2 Section III instructs the staff to confirm the overall arrangement of the component cooling system (CCWS). While the Design Control Document (DCD) Tier 1 flow diagrams, Figure 2.7.3.3-1, "Component Cooling Water System" and Tier 2 piping and instrumentation diagrams (P&IDs) in the Design Control Document (DCD), Figure 9.2.2-1, "Component Cooling Water System Piping and Instrumentation Diagram," show the component cooling water system (CCWS) components and identifies the boundaries between safety-related and non-safety-related parts of the system, some of the information is incomplete, inaccurate, or inconsistent. Revise the DCD, Tier 1 and Tier 2 figures to address the following considerations in this regard:

- Pipe sizes need to be shown on the flow diagrams (Tier 1, DCD Figure 2.7.3.3-1), and the system description does not explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).
- The system description in DCD, Tier 2 Section 9.2.2 needs to provide design details such as system operating temperatures, pressures, and flow rates for all operating modes and alignments.

- DCD, Tier 2 Figure 9.2.2-1 needs to show specific set point for alarms and relief valves. Also, the bases for these set points need to be explained in the system description.
- In DCD Tier 1, power supplies need to be listed for key electrical components such as motor operated valves, pumps, etc. For example, the 1E power supplies are not listed for various header isolation valves and for the non-safety-related (NSR) loads for header A-2 and C-2.
- In DCD Tier 1, Figure 2.7.3.3-1, sheet 2 of 2, the description has the equipment inside/outside containment reversed.
- In DCD Tier 1, Figure 2.7.3.3-1, safety-related support equipment is missing from the surge tank.
- In DCD Tier 2, Figure 9.2.2-1, sheet 4 of 9, the "C" and "D" CCWS pump return needs to show the correct return headers, headers "C" and "D". The figure incorrectly shows the return headers as "A" and "B".

09.02.02-28

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important-to-safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. In order for the staff to confirm that the CCWS has been adequately sized, the applicant needs to include additional information in Tier 2 of the Design Control Document (DCD), Section 9.2.2, to fully describe and explain what the minimum system heat transfer and flow requirements are for normal operating, refueling, and accident conditions, the bases for these requirements including limiting assumptions that apply (such as temperature considerations), how much excess margin is available and how this was determined, and what limiting system temperatures and pressures are assumed with supporting basis. In addition, the mechanism to control CCWS temperature to less than 37.8 °C (100 °F) in the system was not fully explained in the DCD in Section 9.2.2.

09.02.02-29

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criterion (GDC) 44 requirements. The Design Control Document (DCD) system description does not adequately explain the basis for sizing the CCWS pumps. Considerations that need to be addressed include head losses in the cooling water inlet piping based on full power flow conditions, fluctuations in the supplied electrical frequency, increased pipe roughness due to aging and fouling, fouled filters (if added), maximum pressure drop through the system heat exchangers, and the actual amount of excess margin that is provided by the CCWS pump design including the basis for this determination. In order for the staff to confirm that the CCWS pumps have been adequately sized, the applicant needs to include additional information in Tier 2, DCD Section 9.2.2 to address these considerations.

09.02.02-30

General Design Criterion (GDC) 44 provides requirements for the transfer of heat from systems, structures and components (SSCs) important to safety to a heat sink during both normal and accident conditions assuming a single failure. Both accident and normal component cooling water system (CCWS) heat exchanger (HX) heat loads are not provided in the Design Control Document (DCD). Additional information is needed with respect to component heat load and flow requirements (both safety and non-safety) that are assumed to be in service during these conditions. As specified in Standard Review Plan (SRP) Section 9.2.2, this information is needed in order for the staff to determine whether minimum system/equipment heat transfer and flow demands are specified and can be met. Therefore, the DCD needs to be revised, as appropriate, to address the following considerations:

- Provide in the DCD key assumptions and conclusions in DCD Section 9.2.2 for calculations related to component cooling water system (CCWS) flow and heat load calculations that demonstrate adequacy of the selected pump capacity (including normal degradation) to provide the minimum required flow plus margin to system users during various possible operating/accident alignments. The DCD should also include the necessary flow rates and heat loads for all safety-related and major components cooled by CCWS. These calculations should be made available for staff audit.
- Provide in the DCD key assumptions and conclusions in DCD Section 9.2.2 for calculations related to the CCW HX normal and accident heat loads. These calculations should be made available for staff audit.
- Explain in the DCD how the minimum required CCWS flow to the CCWS heat exchanger (HX) was determined for meeting the system required heat loads.
- Describe in the DCD the minimum flow that is needed for all important system loads. Examples of other important loads include (for example): (1) safety injection pumps, coolers and motors, (2) containment spray and residual heat exchangers (3) CCWS pump motor coolers, (4) charging pumps, coolers and motors, (5) spent fuel pit heat exchangers, and (6) reactor coolant pump (RCP) motor, thermal barrier, and bearing coolers.
- Describe the bases of the normally closed containment spray heat exchanger outlet valve which gets an automatic open signal on safety injection or CCWS pump start.

09.02.02-31

Standard Review Plan (SRP) 9.2.2 Section III, instructs the staff to confirm the overall arrangement of the component cooling system (CCWS). Tier 2, Design Control Document (DCD) Section 9.2.2.2.1.5 and Section 9.2.2.2.4 provided a description that the header isolation valves close on valve closure signals from emergency core cooling system (ECCS) actuation signal, with bus under voltage, containment spray signal, or low-low surge tank level signal. In order for the staff to complete its evaluation associated with the header isolation valve, the DCD needs to be revised as appropriate.

- Discuss in the DCD that if a closure signal is received and a safety train feeding the common header is lost, what design features are in place to permit the header isolation valves to be opened to provide cooling supply to the spent fuel pool heat exchanger and reactor coolant pumps thermal barriers. Describe available main control room (MCR) controls and permissives or interlocks that have to be bypassed for this function to be established. Describe if the cooling water supply to headers A-2 or C-2, which is cooling to non-safety components, can be isolated from the MCR before flow is re-established to the spent fuel pool heat exchanger and reactor coolant pumps seals.

- Discuss in the DCD the impact of a single failure of a header isolation valve to close on a demand signal.
- Discuss in the DCD the closure times for the header isolation valves.
- Discuss in the DCD the header isolation valve seat leakage for the isolation between safety-related CCWS trains.
- Discuss in the DCD if the header isolation valves remain open with the CCWS train in standby (normal operations).

09.02.02-32

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important-to-safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44, which includes single-failure criteria. The staff found that normally locked closed (LC) motor operated cross-tie valves (NCS-MOV-232A/B and NCS-MOV-233A/B) between common headers A-1 and C-1 are not described in the text of Tier 2, DCD Section 9.2.2. The bases for this piping design arrangement, main control room controls for the valves, or the conditions for when these cross tie valves would be opened is not described in the DCD. In addition, a failure modes and effects analysis is not described related to this cross tie arrangement. The DCD needs to be revised to include this information.

09.02.02-33

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. In order to satisfy system flow requirements, the CCWS design must assure that the minimum required net positive suction head (NPSH) for the CCWS pumps will be met for all postulated conditions, including consideration of vortex formation. The staff found that the minimum required NPSH for the CCWS pumps was not specified and Tier 2, Design Control Document (DCD) Section 9.2.2 did not describe how the CCWS design will assure that the minimum required NPSH for the CCWS pumps is satisfied (including consideration of vortex formation) and how much excess margin is provided by the CCWS design for the most limiting assumptions. Consequently, the DCD needs to be revised to address the following considerations:

- The minimum NPSH that is needed for CCWS operation needs to be specified and explained, including how this required minimum NPSH is satisfied by the system design when taking vortex formation into consideration and how much excess margin is available for the most limiting case. Sufficient information is needed to enable the staff to independently confirm that the design is adequate in this regard, including limiting assumptions that were used along with supporting justification. These calculations should be made available for staff audit.

- As discussed in Tier 2, DCD Section 9.2.2.3.2, “If the water level of the surge tank further decreases, the surge tank low-low water level signal is transmitted to the MCR and the header tie line isolation valves automatically close. Since the subsystem consists of two individual trains, the train with the leak can be isolated and the other train can be operated.” The bases for the surge tank setpoints water level needs to be explained in the DCD. Surge tank design details such as system internal volume, temperature extremes that are accommodated by the design, and the maximum leakage rate that is assumed including justification are some of the factors that need to be addressed. Provide in the DCD key assumptions and conclusion from the design calculations used for sizing the component cooling water system surge tanks. Since one tank services two safety related CCWS trains, internal surge tank separation plates, level instrument interactions, instrument logic, and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.

- As discussed in Tier 2, DCD Section 9.2.2.5.6, “The CCW surge tank pressure is locally indicated. The surge tank nitrogen cover gas supply valve and tank vent valve are controlled with open-closed control so that the tank pressures are maintained within a pre-set range. High and low surge tank pressures are alarmed in the MCR.” The bases for the surge tank setpoints needs to be explained in the DCD. Describe the relationship between the required minimum NPSH and the pressure which is to be maintained in the surge tanks. Describe if the control valves from the nitrogen system fails to open, the required actions that are needed to maintain the system operable to perform its intended safety function. Since one tank services two safety related CCWS trains, instrument interactions, instrument logic, and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.

- Tier 2, DCD Section 9.2.2.2.1.3 states that “...primary makeup water and refueling water may be used during an emergency. Refueling water storage pit is water source of seismic category I.” Additional details are needed related to this being a sufficient water source capacity to provide for seven days of makeup water. The basis for this conclusion (e.g. required makeup rate and volume) needs to be explained in the DCD. The source of water and flow path to the surge tanks should be safety-related, protected from internal and external hazards, and capable of performing its makeup function in the event of a single failure with and without off-site power available. Describe how the makeup volume is assured, indications and alarms that are available in the control room and at the remote shutdown panels, and actions that plant operators have to take to provide emergency makeup water to the surge tanks. This emergency water source (which is shown in Tier 2, DCD Figure 9.2.2-1) should be included on the system diagram in Tier 1, DCD Section 2.7.3.3 and appropriate Tier 1 requirements need to be established for the makeup function.

- Discuss the bases of the vacuum breakers in the DCD which are located on each surge tank (as shown in Tier 2, DCD Figure 9.2.2-1). Also, determine the safety classification of the vacuum breakers and add these components to Tier 1, DCD Section 2.7.3.3.

- Provide a discussion in Tier 2, DCD Section 9.2.2 related to the 'protection functions' statement in the Technical Specifications Basis, Section B3.7.7 which state the surge tanks in the system provide pump trip protection functions to ensure that sufficient net positive suction head is available.

09.02.02-34

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. The component cooling water system (CCWS) provides essential cooling to the reactor coolant pumps (RCP) thermal barrier. Potential thermal barrier leakage is a concern with such a large pressure differential between the reactor coolant system (RCS) and CCWS. Accordingly, Design Control Document (DCD) Tier 2, Section 9.2.2 should be revised to address the following concerns:

1. As stated in Tier 2, DCD Section 9.2.2.5.5, a high flow alarm, resulting from the in-leakage of reactor coolant to CCWS due to the reactor coolant pump thermal barrier HX tube leak, is transmitted to the MCR and the isolation valves located at cooling water return line are closed. Describe in detail any instrumentation and controls (I&C) logic/permissive and setpoints for automatic isolation of the thermal barrier CCWS coolant.

2. There is no specific Tier 2, DCD Section 9.2.2 discussion related to the potential RCS dilution from a thermal barrier tube rupture with the reactor coolant system at pressures below CCWS pressures.

3. There is no specific Tier 2, DCD Section 9.2.2 discussion related to the CCWS smaller bypass lines (4") around the main containment isolation (8") valves for the reactor coolant pumps (penetrations P234, P249, P232, P251). As stated in Table 6.2.4-3, the smaller 4" valves are opened post accident but these valves do not receive accident isolation signals. State the bases in Tier 2, DCD Section 9.2.2 for the smaller CCWS lines for coolant to the reactor coolant pumps.

09.02.02-35

Standard Review Plan (SRP) 9.2.2 Section II entitled, "Acceptance Criteria," requirement 4.G states as follows:

"Demonstration by testing that RCPs withstand a complete loss of cooling water for 20 minutes and instrumentation in accordance with Institute of Electrical and Electronics Engineers Standard (IEEE Std) 603, as endorsed by RG 1.153 with control room alarms detecting loss of cooling water so a period of 20 minutes is available for the operator to have sufficient time to initiate manual protection of the plant. Alternatively, if it is not demonstrated by the necessary pump testing that the RCPs will operate for 20 minutes without operator corrective action, then the following requirements apply:

- Instrumentation in accordance with IEEE Std 603, as endorsed by RG 1.153 consistent with the criteria for the protection system to initiate automatic protection of the plant upon loss of cooling water to a pump. For this case, the component cooling water supply to the seal and bearing of the pump may be designed to nonseismic Category I requirements and Quality Group D; or
- The component cooling water supply to each pump is designed to withstand a single, active failure or a moderate-energy line crack as defined in Branch Technical Position ASB 3-1 and to seismic Category I, Quality Group C, and American Society of Mechanical Engineers (ASME) Section III Class 3 requirements."

Revise Tier 2, DCD Section 9.2.2 to describe how the above item has been addressed by the US-APWR design.

09.02.02-36

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. The staff reviewed DCD, Tier 1 Table 2.7.3.3-4 and had noted twenty-seven (27) control functions related to the CCWS. In addition, Tier 2, DCD Section 9.2.2.5, "Instrumentation Requirements," includes discussions on the following: CCW supply header pressure, CCW radiation monitor, CCW supply header flow rate, CCW surge tank water level, RCP thermal barrier HX and RCP motor cooling water flow rate, CCW surge tank pressure, CCWP discharge and suction pressure, and CCW supply temperature.

Based on the staff's review of the Tier 1 and Tier 2 sections, the staff has concluded that additional detail is needed in the DCD. Items listed in DCD, Tier 1 Table 2.7.3.3-4, under the heading of "control functions," are not described in details in DCD, Tier 2 Section 9.2.2.5. Also, some items are identified in Tier 2 and not in Tier 1, such as radiation valve isolation. For example:

- For the component cooling water pumps, low system pressure starts the standby pump. Describe in the DCD which pumps are interlocked together for this function and describe the flow rate setpoints, power supplies and logic.
- In regards to CCWS header-tie line (suction and discharge) isolation, describe in the DCD which valves are interlocked together for this function and describe the setpoints, power supplies and logic.
- In regards to the CCWS containment spray heat exchanger, describe in the DCD which valves are interlocked together for this function and describe the setpoints, power supplies and logic.
- In regards to the reactor coolant pumps/motors, CCWS isolation valves, and containment isolation valves, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.

- In regards to the letdown and excess letdown, CCWS isolation valves, and containment isolation valves, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.
- For the CCWS isolation valves in the auxiliary building and turbine building, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.
- In regards to the reactor coolant pumps thermal barrier CCWS isolation valves, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.
- In regards to the CCWS surge tanks, level, and pressure, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.
- In regards to the CCWS radiation monitors, describe in the DCD which valves are interlocked together for this function and describe the power supplies, setpoints and logic.
- Describe in the DCD any time delays related to a CCWS pump automatic start signal (such as safety injection signals), containment spray heat exchanger discharge valve opening times, and sub-train header valve isolation timing.

09.02.02-37

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. System design features, operating procedures, and surveillance testing need to provide adequate assurance that the CCWS safety functions will not be compromised due to damaging water hammer events. Two of the four safety-related trains are normally in operation with the remaining two trains in standby. During a plant shutdown or refueling outage, three or four CCWS trains may be in operation at the same time as described in Tier 2, DCD Section 9.2.2.2.2. As stated in Tier 2, DCD Section 9.2.2.1.1, the “CCWS is protected against adverse environmental, operating, and accident conditions that can occur, such as flooding, high energy line break (HELB), thermal over-pressurization, and water hammer.” In addition, Section 9.2.2.3 states that the “CCWS is a closed system that is maintained in a water solid condition with a surge tank located at the highest point in the system thus preventing the potential for water hammer.” The CCWS description does not adequately consider and address water hammer vulnerabilities in the Design Control Document (DCD) and does not explain how system design features, operating procedures, and periodic surveillance tests provide adequate assurance that the CCWS safety functions will not be compromised by water hammer events. The DCD needs to be revised to provide additional information to address water hammer considerations.

09.02.02-38

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design

Criteria (GDC) 44 requirements. Also, 10 CFR 52.47(a)(22) requires that information demonstrating how operating experience insights have been incorporated into the plant design be included in the Design Control Document (DCD). During a recent review of industry operating experience (Information Notice 2007-06, *Potential Common Cause Vulnerabilities in Essential Service Water Systems*, dated February 9, 2007), the staff found that some licensees were experiencing significant wall thinning of pipe downstream of butterfly valves that were being used to throttle service water flow. In order to assure that this will not occur in the CCWS for the US-APWR design, the applicant needs to provide additional information in Tier 2, DCD Section 9.2.2 to describe to what extent butterfly valves will be used to throttle CCWS flow and design provisions that will be implemented to prevent consequential pipe wall thinning from occurring.

09.02.02-39

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. As described in Tier 2, DCD Section 9.2.2.5.4, "CCW Surge Tank Water Level", a "low-low water level signal isolates the components located in the non-seismic category I buildings." CCWS supplies two instrument air systems from header A-2 and header C-2 and also supplies miscellaneous equipment and other systems from header A-2 such as waste gas, waste dryers, chemical drain, auxiliary steam and boric acid evaporator which are designed as nonseismic and non-safety. For the required separation, two air-operated isolation valves are designed in series for the CCW supplies with a pair of check valves in series located on the return line for components located in the non-seismic Category I buildings (i.e. the turbine building (T/B) and auxiliary building (A/B)). Based on the staff's review of Tier 2, DCD Figure 9.2.2-1, the P&IDs identified other signals (such as safety injection signals) that generate a closure signal for this isolation function; however, this function or logic is not explicitly described in Tier 2, DCD Section 9.2.2.5. The DCD should be revised to describe all the actuation signals for seismic to non-seismic boundary interface, including the logic and power supplies available.

09.02.02-40

The component cooling water system (CCWS) must 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 in accordance with General Design Criteria (GDC) 45 requirements. The staff finds the design to be acceptable if the Design Control Document (DCD) describes inspection program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2, DCD Section 9.2.2.4.2 indicates that periodic inspections will be performed on the pumps and heat exchangers, the extent and nature of these inspections and procedural controls that will be implemented to assure that the CCWS is adequately maintained over time were not described. Consequently, the applicant needs to provide additional information in the DCD to describe the extent and nature of inspections that will be performed and procedural controls that will be implemented commensurate with GDC 45 requirements.

In addition, how valves which are shown in Figure 9.2.2-1 of the DCD as “lock-closed” will be inspected needs to be addressed.

09.02.02-41

The component cooling water system (CCWS) must be designed so that periodic pressure and functional testing of components can be performed in accordance with General Design Criteria (GDC) 46 requirements 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 CCWS safety functions. The staff finds the design to be acceptable if the Design Control Document (DCD) describes pressure and functional test programs that will be implemented are considered by the staff to be adequate for this purpose. While Tier 2, DCD Section 9.2.2.4.2 indicates that periodic testing will be performed, the extent and nature of these tests and procedural controls that will be implemented to assure continued CCWS structural and leak tight integrity and system operability over time were not described. Consequently, the applicant needs to provide additional information in the DCD to describe the extent and nature of testing that will be performed and procedural controls that will be implemented commensurate with GDC 46 requirements. In addition, how valves which are shown in Figure 9.2.2-1 of the DCD as “lock-closed” will be tested needs to be addressed.

09.02.02-42

Regulatory Guide (RG) 1.21 “Measuring, Evaluation and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquids and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants” indicates that monitoring should be included for anticipated operational occurrences. Standard Review Plan (SRP) Section 9.2.2, Areas for Review, Section I.10 specifies review of the means provided for detecting leakage of radioactivity from one system to another and for precluding its release to the environment. The staff noted that component cooling water system (CCWS) radiation monitors were discussed in Tier 2, DCD Section 9.2.2 which describes one radiation monitor for each of the two independent subsystems (A and B, C and D) with six radiation monitor sample points located in the A, B, C, D, A-1 and C-1 headers, downstream of the CCWS heat exchangers. The CCWS radiation monitors provide main control room indication and alarms and in the event the radiation setpoint is exceeded, the CCWS surge tank vent valve will automatically close. Based on the staff’s review of the CCWS radiation monitors, if radioactively from a higher pressure component leaks to the CCWS it should be detected; however, it was noted from the P&ID of the six monitoring points, only two sample points are normally open and four sample points are locked closed. Based on a review of the information that was provided, the applicant needs to revise the DCD to address the following:

- The CCWS radiation monitors are relied upon for satisfying 10 CFR 20.1406 and GDC 64 requirements and are considered to be important system design features. Therefore, these monitors should be identified in Tier 1, DCD and shown in Tier 1, Figure 2.7.3.3-1.
- As shown in Tier 2, DCD Figure 9.2.2-1, four of the root valves for CCWS radiation monitoring are shown as locked closed. In the event the A and B or C and D

headers become isolated (safety injection with bus under voltage, high containment pressure, low surge tank level) there will be no available system radiation monitoring since the root valves are lock closed. The bases for the lock closed valves radiation root valves need to be described in the DCD.

09.02.02-43

Standard Review Plan (SRP) Section 9.2.2, specifies in Section III confirmation of the overall arrangement of the component cooling system (CCWS). 10 CFR 52.47(a)(2), contents of applications, technical information states that, “The description shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations.” Technical Specification (TS) Bases (B3.7.7) under APPLICABLE SAFETY ANALYSES, only lists the following two design bases of the CCWS: (1) to remove the post loss of coolant accident heat loads from the refueling water storage pit, and (2) to cool the unit from RHR entry conditions to MODE 5, during normal and post accident operations. The staff considers this section of the TS Bases as incomplete and should describe other applicable analysis of the CCWS, for example, cooling for the containment sprays pumps, cooling for the safety injection pumps and reactor coolant pumps thermal barrier cooling.

09.02.02-44

10 CFR 52.47(b)(1) requires the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that the plant will be built in accordance with the certification. The staff found that the Tier 1 information is incomplete, inconsistent, inaccurate, and that clarification is needed to revise the Tier 1 information to address the following concerns:

- Although the Introduction Section in Chapter 1 of the Tier 1 DCD states that the information in the Tier 1 portion of the DCD is derived from the detailed information contained in Tier 2, the staff found that much of the information provided in DCD Tier 1 is not described in Tier 2, DCD Section 9.2.2 (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). Add the above information in Tier 2 of the DCD.
- The specifications need to stipulate that the CCWS is accessible for performing periodic inspections as required by GDC 45.
- The specification need to stipulate that the CCWS design provide for flow testing of the pumps during operation, in that it needs to specify provisions for flow testing all the individual component flow paths to verify flow balance requirements.
- System filters need to be described in Tier 2 or Tier 1 and should be shown on the Tier 1 drawings (if required).
- Specifications to assure that the relief valves satisfying design and performance requirements need to be provided.
- Figure 2.7.3.3-1, “Component Cooling Water System,” needs to show nominal pipe sizes, which are necessary for design certification.

- Figure 2.7.3.3-1 needs to show flow control valves for the individual flow paths of the components being cooled, and these components need to be listed in the applicable tables, which is necessary for design certification.
- In Table 2.7.3.3-1, “Component Cooling Water System Location of Equipment and Piping,” the statement “Component cooling water system containment isolation valves and piping between the valves,” is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor building. In general, this table is confusing and many of the components on this table need to be shown in Figure 2.7.3.3-1.
- In Table 2.7.3.3-3, “Component Cooling Water System Piping Characteristics,” the statement “Component cooling water system containment isolation valves and piping between the valves”, is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor building. In general, this table is confusing.
- The piping system association with the surge tank needs to be describes in various tables such as Table 2.7.3.3-1, Table 2.7.3.3-2 and Table 2.7.3.3-3. One example is NCS LCV-1200 and other safety-related piping systems at the surge tank should also be included in the Tier 1 tables.
- In Table 2.7.3.3-2, “Component Cooling Water System Equipment Characteristics,” ‘yes’ is misspelled as ‘yse’ on sheet 2 of 3. All items described in this table need to be shown in Figure 2.7.3.3-1, such as the instrumentation.
- The thermal barrier cross-tie needs to be described in Tier 1.
- The power supplies for the CCWS need to be shown in Tier 1. This is important for understanding how any cross-tie functions during a loss of power event.
- In Table 2.7.3.3-4, “Component Cooling Water System Equipment Alarms, Displays, and Control Functions,” radiation alarms need to be described and reactor coolant pump and thermal barrier flow need to be described. In addition, remote shutdown console controls (RSC) are not listed for the CCWS and should be described.
- Figure 2.7.3.3-1, “Component Cooling Water System,” is not drawn correctly as compared to the Tier 2 drawings. For example, the cross-connect between the A/B and C/D headers is out of place.

09.02.02-45

10 CFR 52.47(b)(1) requires the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that the plant will be built in accordance with the certification. The staff found that the Tier 1 information is incomplete, inconsistent, inaccurate, and that clarification is needed to revise the Tier 1 information to address the following concerns:

(1) Missing specific acceptance criteria for some ITAAC items in Table 2.7.3.3-5;

- Item 6 b, Components are verified to be powered from their respective Class 1E division; however, there needs to be a list of the equipment and their power supplies in Tier 1.
- Item 7 b; Component cooling water system (CCWS) provides adequate cooling water, but there needs to be a specific heat removal rate identified.
- Item 9 a; Remote operated components that perform an active safety function need to be verified to change positions. Clarify that testing of these components should include the logic that will cause these active components

to change positions. The logic and interlocks should be identified in Tier 1, Section 2.7.3 tables, and beside the listed component that performs an active function that should list the active position. Table 2.7.3.3-2 is confusing since many of the valves indicate an active safety function of “transfer open/transfer closed”; however, the active signal is for the valves to automatically close or open, not both.

- Table 2.7.3.3-5 needs to specify that CCWS pump testing to demonstrate adequate net positive suction head to be completed at the maximum CCWS flow rate conditions, with the inventory in the surge tank at the lowest allowable level (as corrected to account for actual temperature). The maximum CCWS flow rate and minimum allowable surge tank water level, along with the corresponding design basis water temperature needs to be listed to assure that test conditions are properly established. The acceptance criteria for an acceptable test need to be specified.
- Inspections should be specific to ASME III pipe supports.

(2) Missing ITAAC items that will assure required flow to some important users:

- Safety injection pumps and motors, containment spray pumps and motors, containment spray and residual heat removal heat exchangers.
- Component cooling water pump motor coolers.
- Reactor coolant pumps (RCP) and thermal barrier crosstie system functional capability.
- Spent fuel pit heat exchanger.
- Charging pumps.
- Emergency surge tank makeup capability.

(3) Missing ITAAC items that were not adequately addressed:

- ITAAC for verification of water hammer prevention design features such as adequate high point vents and or operational procedures for the avoidance of water hammer.
- ITAAC for American Society of Mechanical Engineers (ASME) III relief valve testing verification and set point verification for water-filled systems inside containment.
- ITAAC item to provide initial confirmation that all the CCWS radiation monitors are capable of performing their design functions and will provide required isolation of the surge tank.
- ITAAC item for verification of the all backup water supply to the CCWS surge tanks.
- Check valve functionality needs to be added to Table 2.7.3.3-5.
- Equipment locations need to be added to Table 2.7.3.3-5.
- Testing of remote shutdown console (RSC) control needs to be added to Table 2.7.3.3-5.
- Main control alarms need to be addressed in Table 2.7.3.3-5, such as those that are identified in Table 2.7.3.3-4.

(4) In some cases, the acceptance criteria for the inspections, tests, analyses, and acceptance criteria (ITAAC) that are included in Tier 1 of the DCD are non descriptive and do not provide numeric values. For example, Tier 1, DCD Table 2.7.3.3-5 item 7.b states, “The as-built CCWS provides adequate cooling water required for the various components during all plant operating conditions, including normal plant operating, abnormal and accident conditions.” The NRC review criteria that is provided in SRP

Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," calls for numeric performance values as ITAAC acceptance criteria when values consistent with the design commitments are possible. Therefore, the acceptance criteria that are specified for the Tier 1 ITAAC need to be revised to specify numeric performance values to the maximum extent possible, and the use of report documentation should be limited to those cases where the detailed supporting information in Tier 2 of the DCD does not lend itself to concise verification.