REQUEST FOR ADDITIONAL INFORMATION 326-2279 REVISION 0

4/8/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 09.02.01 - Station Service Water System
Application Section: 9.2.1

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

09.02.01-3

Standard Review Plan Section 9.2.1, "Station Service Water System," and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. During the review of the information in Tier 2 of the design control document (DCD), Section 9.2.1, "Essential Service Water System", the staff found the description of the essential service water system (ESWS) to be generally incomplete and does not adequately explain how design bases considerations are satisfied by the proposed design, the heat transfer requirements and capabilities, what limiting assumptions apply, how much excess margin is available, what operating conditions and experience insights are relevant and how they are addressed, and so forth. Consequently, information in Tier 1 and Tier 2 of the DCD needs to be revised to include information that is sufficient to demonstrate that the ESWS 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 will be maintained over the life of the plant.

09.02.01-4

Standard Review Plan Section 9.2.1, Station Service Water System, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. The staff noted that Tier 2, Design Control Document (DCD) Section 9.2.1.1 states that the essential service water system (ESWS) performs both safety-related as well as non-safety related functions and that the ESWS is designed with the capability to isolate non-safety related portions of the system. The staff was unable to find non-safety related components listed in Tier 2, DCD Table 3.2.2, "Classification of Mechanical and Fluid System, Components, and Equipment," or in either of the two system drawings or diagrams; Tier 1, Figure 2.7.3.1-1, "Essential Service Water System", and Tier 2, Figure 9.2.1-1, "Essential Service Water System Piping and Instrumentation Diagram", for the non-safety components of the ESWS. The DCD should discuss the following items related to GDC 2.

1. Provide clarification in Tier 1 Section 2.7.3 and Tier 2 Section 9.2.1 of the DCD related to the non-safety related function. Provide clarification related to the non-safety related function in all appropriate sections of the DCD.

2. Address (a) how ESWS integrity and operability is assured by the safety-related boundary with non-safety components so that common-cause simultaneous failure of all non-safety related ESWS piping will not compromise the ESWS safety functions during seismic events, and (b) a description of any other performance assumptions that pertain to the boundary isolation valves or other parts of the system that are necessary to assure the capability of the ESWS to perform its safety functions during natural phenomena. Describe the boundaries of the safety-related and non-safety related portions of the ESWS and how the system meets the GDC 2, ensuring the capability of the system to perform its safety-related functions during natural phenomena.

09.02.01-5

Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff. The review criteria of SRP 9.2.1, Station Service Water System, requires that essential system components are protected from the effects of high and moderate energy line breaks. Although essential service water system (ESWS) design pressure and temperature was provided in Tier 2, Design Control Document (DCD), Section 9.2.1, the staff found that information pertaining to the system’s operating pressure and temperature was not provided in Tier 2, DCD Section 9.2.1 to make a final determination of the proper designation as high or moderate energy. Describe the system operating data of pressure and temperatures in metric units to confirm the designation of moderate-energy.

09.02.01-6

The essential service water system (ESWS) 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, “Cooling Water,” requirements. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff. Provide a system description as well as piping and instrumentation diagrams (P&IDs) for the essential service water system (ESWS) showing all of the systems equipment used for normal and abnormal operations. The staff found instances of incomplete descriptive information and missing equipment in Tier 1, DCD Figure 2.7.3.1-1, “Essential Service Water System,” and in Tier 2, DCD Figure 9.2.1-1, “Essential Service Water System Piping and Instrumentation Diagram.” Include in the Design Control Document (DCD); 1) more information related to a complete description of the ESWS system and, 2) all system equipment is to be included on the Tier 1 and Tier 2 drawings, to include the following:

- Tier 2 of the DCD Section 9.2.1 provides a description of components used to prevent water hammer. In addition, describe how the ESWS is filled and vented.

These components should be shown on Tier 1 and Tier 2 system diagrams. Discuss the need for system vacuum breakers.

- Tier 2 of the DCD Section 9.2.1; for the two strainers in parallel downstream of the ESWS pumps (ESWSP), provide the piping connections used to back-flush an isolated, clogged strainer. Describe how the strainers are backwashed.
- Tier 1 and Tier 2 system drawing and diagrams of the DCD should indicate the building locations for ESWS components and indicating where the building transition occurs.
- Tier 2 of the DCD Section 9.2.1 does not provide design details such as system operating temperatures, pressures, and flow rates for all operating modes and alignments.
- Tier 2 of the DCD Figure 9.2.1-1 indicates a coolant line downstream of the two parallel strainers which provides coolant to the ESWS pump motor. The system description does not discuss this function or the required flow rates for this function.
- Tier 2 of the DCD Figure 9.2.1-1 does not show a separate strainer to the essential chiller units. This figure does not show any connections that would be used for backwash (cleaning) of the essential chiller units. Provide these on the figures and describe in Section 9.2.1 or provide the basis for why they are not needed.
- The system description does not provide an indication as to whether the ESWS backwash for the strainers utilizes a motor, and if so, how these are classified and powered (i.e. safety-related, Class1E).
- Tier 1of the DCD Figure 2.7.3.2-1 does not show all of the system components, for example the radiation monitors, the strainers and piping for backwashing strainers and heat exchangers. A similar level of detail needs to be provided in the Tier 1 and Tier 2 drawings of the DCD in order to meet inspections, tests, analyses, and acceptance criteria (ITAAC) commitments for verifying system configuration.
- Provide a discussion in Section 9.2.1 of the DCD on the ESWS pump discharge motor operated valve (MOV) logic for opening and closing, during any accident conditions. The Tier 2 Section 9.2.1 description does not provide a complete understanding of the logic of the MOVs. For example, describe any time or a signal delay on the opening of the MOVs after the ESWS pump start or stops. Also address and described in the DCD how long the ESWS pumps are dead-headed as the pump discharge valve opens and state that this time is acceptable for long term pump performance. Describe the results if the MOV does not open with the pump operating and resultant system alarms provided in the main control room.
- Tier 2 of the DCD Section 9.2.1 system description is not clear on how many ESWS trains are normally operating and how many system trains are in standby during various operating conditions.
- Tier 2 of the DCD Figure 9.2.1-1, sheet 2 of 3, describes the piping classification downstream of the ESWS pump motor.
- The system descriptions in Tier 2 of the DCD did not describe the essential service water piping tunnel for trains A, B, C and D. It is not clear that some of the ESWS piping is underground or in a tunnel, or both.
- Tier 2 of the DCD Section 9.2.1.2.1, typo ‘doses not’ should be ‘does not.’ There are many other typos in Section 9.2.1.
- Tier 2 of the DCD Section 9.2.1.2.2.5 states that the underground piping is lined; provide clarification of the materials.

- Tier 2 of the DCD Table 9.2.1-1, the CCWS heat exchange should be designed for total system flows for maximum flushing results.
- Tier 2 of the DCD Section 9.2.1, the design bases of the maximum ESW temperature is missing.

09.02.01-7

The essential service water system (ESWS) 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. Flooding isolation of the Essential Service Water System (ESWS) pumps is discussed in Tier 2 of the DCD, Section 19.1.5.3.1, "Description of the Internal Flooding Risk Evaluation," however, Tier 2 of Section 9.2.1 makes no mention of this important feature to mitigate a flood. From Tier 2 of the DCD 19.1.5.2.2.5, flooding of the ESWS can to be isolated within 15 minutes and flooding of the fire protection system can be isolated within 30 minutes. The four trains of the ESWS have physical separations and flooding in one train does not propagate to the other trains. Describe in the DCD, Section 9.2.1 the design features that are credited for mitigating the consequences of flooding from the ESWS and provide schematic diagrams showing all inputs (i.e., logic inputs, sensor inputs, all variables, actuation logic, binary limitation signals), with input types (i.e. hardwired, fiber, type of isolation used), ESWS circuit components, and all ESWS control signal outputs of the ESWS control system.

09.02.01-8

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

Describe for the essential service water system (ESWS), the minimum system heat transfer and flow requirements for normal plant operations, shutdown, and accident conditions. All heat loads should be specified for all operational conditions as well as ESWS pump flow and system heat transfer data, to confirm that the ESWS system can meet those heat transfer requirements. Provide in the design control document (DCD) the required data to address heat transfer and flow under all operating, shutdown, and accident conditions. In addition, describe in the DCD the mechanism of how water temperatures are controlled between the ESWS, ultimate heat sink (UHS), and other heat exchangers that the ESWS supplies since temperature control valves or throttled valves are not described for the ESWS.

09.02.01-9

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

Provide the design and operating information that identifies conditions that could lead to degradation of the essential service water system (ESWS) capability to meet minimum heat transfer requirements, quantify the allowable degradation from these sources, and provide system data to verify the margin available to successfully meet minimum heat transfer requirement during operating, shutdown, and accident conditions. Discuss in the Design Control Document (DCD), the excess flow and heat transfer margins provided by the ESWS pump and system design to accommodate heat transfer degradation by fouling, fluctuations due to supplied electrical frequency, pressure drop through the heat exchangers/chillers, pump leakage, excessive differential pressures due to strainer loading or other means and the bases for these margins.

09.02.01-10

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

For the essential service water system (ESWS), the requirements include specifying for other interfacing systems, such as the ultimate heat sink (UHS), the maximum water temperature, the minimum time (e.g. 30 days) that the UHS must be expected to be available, and so on. Tier 2 of the DCD Section 9.2.1 does not identify any interface requirements for the ESWS. Design Control Document (DCD) Tier 1, Section 2.7.3 and 3.2, specifies an interface requirement that the maximum UHS supply water temperature to the ESWS is 35 ^{o}C (95 ^{o}F) under peak load conditions to assure sufficient cooling capacity. The UHS is also to keep the water level at a net positive suction head (NPSH) greater than the pump's required NPSH. This interface requirement is not specified in Tier 2 of the DCD description of the ESWS in Section 9.2.1. Describe all ESWS interface requirements in the DCD.

09.02.01-11

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License

Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. Safety related active components that are required to operate during design basis accidents, with a loss of offsite power, are required to be powered by the Class IE on-site power source. Verify in the design control document, that all active essential service water system (ESWS) components, including the ESWS pumps and discharge motor operated valves are serviced by motor control centers powered from the Class IE gas turbine generators.

09.02.01-12

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

The system P&ID, Design Control Document (DCD) Figure 9.2.1-1, and description in Section 9.2.1 does not indicate vent lines or other means to provide for venting and filling the system. The system description also does not provide a description of operating procedures to fill and vent the ESWS or indicate this is a COL item. The system description in Tier 2 of the DCD Section 9.2.1 does not address the potential for water hammer, and system design to maintain functions following an inadvertent water hammer event. The Standard Review Plan (SRP) identifies NUREG-0927 "Evaluation of Water Hammer Occurrence in Nuclear Power Plants," that provides guidance for water hammer prevention and mitigation. Describe in the design control document (DCD) design features to maintain design functions after an occurrence of water hammer and address procedures and commitments for venting and filling of systems to address the potential for water hammer, to maintain operating procedures for avoiding a water hammer event, and a system design to maintain functions following an inadvertent water hammer event.

09.02.01-13

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

The design control document (DCD) states that the essential service water system (ESWS) layout ensures that the fluid pressure is above saturation conditions at all locations. Maintaining pressure above saturation, in combination with the control of the pump discharge valves, minimizes the potential for water hammer. From the staff's

review, additional information is required to verify that the system configuration (layout) is adequate to ensure that fluid pressures are above saturation conditions to preclude the potential for a water hammer event. The means to verify this design through operating procedures is also not addressed. Describe in the DCD in detail how the layout of the ESWS ensures that the water pressure is above the saturation pressure at all locations and during all operating conditions for the ESWS. A discussion of operating procedures and a commitment to those procedures that will verify this condition is met is also requested.

09.02.01-14

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Describe the procedures and commitments to address the potential for water hammer, to maintain operating procedures for avoiding a water hammer event, and a system design to maintain functions following an inadvertent water hammer event. The design control document for the essential service water system did not provide adequate information concerning how the operators are alerted to drainage of inventory in an essential service water (ESWS) train, and how “keep fill” requirements for the ESWS are met. The DCD description also lacked information as to how the operator has indication of abnormal pump or system conditions such as a dead-headed ESWS pump if the pump discharge MOV fails to open on restart of an ESWS pump or pump runout if required net positive suction head is not available and the discharge MOV is fully open. Provide in the DCD the information to address the inadequacies as described related to water hammer.

09.02.01-15

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Describe procedures and commitments to address the potential for water hammer, to maintain operating procedures for avoiding a water hammer event, and a system design to maintain functions following an inadvertent water hammer event. The staff determined that the DCD contained inadequate information to describe how drainage of the essential service water system (ESWS) is prevented during a loss of offsite power during the approximately 100 seconds that the ESWS pumps are without power and the discharge motor operated valves (MOV) remain open. Provide in the design control document (DCD), information as to how water hammer effects in the ESWS are

addressed given loss of offsite power during the time that the system would drain for 100 seconds until emergency electrical power is available from the gas turbine generators to start the ESWS pumps. Also given a loss of offsite power event, describe if the pump discharge MOV remains full open on an emergency power restart or if the discharge MOV goes full close.

09.02.01-16

The essential service water system (ESWS) 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. Standard Review Plan (SRP) Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. Section III of the SRP addresses acceptable provisions for addressing fouling of the service water system that are contained in generic letters (GL) 89-13, "Service Water System Problems Affecting Safety-Related Equipment," and 89-13 Supplement 1.

In Tier 2, DCD Table 1.8-2 "Compilation of All Combined License Applicant Items for Chapters 1- 19," contains COL 9.2(8) for the COL applicant to specify ESW chemistry requirements. Tier 2, Section 9.2.1.4 specifies that periodic performance verification of ESWS components, including the heat exchanger, will be performed to detect performance degradation due to fouling. The staff does not find this to be sufficient to address all issues associated with system fouling. SRP 9.2.1 specifies that the provisions of generic letter (GL) 89-13 and 89-13, Supplement 1 are to be evaluated in the DCD. In Tier 2 of the DCD Table 1.9.2-9, the provisions of GL 89-13 and GL 91-13 "Request for Info Related to the Resolution of GI 130, Essential Service Water System Failures at Multi-Unit Sites," were noted as it relates to SRP Section 9.2.1 which states the information will be considered acceptable if the provisions GL 89-13 and GL 91-13 are appropriately addressed.

The staff has determined that there is no discussion of GL 89-13 and GL 89-13, Supplement 1 in the DCD in terms of biofouling and the design provisions and testing/inspection activities that are specified. The GL specifies ongoing surveillance, control, and testing measures to prevent fouling of piping and heat exchangers from macroscopic biofouling such as could occur from asiatic clams. There is no discussion of the need to consider fouling effects in the design of the heat exchangers in the ESWS system. Discuss how GL 89-13 biofouling aspects are addressed in the design for the ESWS and/or how it is to be addressed by the COL applicant and provide information to consider how fouling considerations will be incorporated in the margin for the safety-related heat removal capacity of the heat exchangers in the ESWS system.

09.02.01-17

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service

Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff. Measures must be specified to protect the essential service water system (ESWS) from failures due to adverse environmental conditions.

The staff found that design control document description for the ESWS did not specify a design (such as screens or strainers) to prevent debris buildup and blockage of the ESWS pumps and the pumps suction source. The design and procedures to assure that failure of the ESWS pumps due to debris are not described. Describe specify design details and operating procedures/measures to prevent ESWS pumps from failing due to blockage by buildup of debris or identify a COL item that addresses this issue.

09.02.01-18

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Measures must be specified to protect the essential service water system (ESWS) from failures due to adverse environmental conditions. The staff found that the ESWS description in Tier 2 of the Design Control Document (DCD) Section 9.2.1, does not adequately describe the means to backwash the two parallel strainers downstream of the ESWS pump discharge and the associated system diagram, Tier 2, DCD Figure 9.2.1-1 does not show the piping connections used to back-flush an isolated, clogged strainer. The staff finds the diagram to be incomplete without this information. Additionally, the description does not clearly describe the process for backwashing these strainers, whether the flow is from system pressure or a separate motor/pump. Provide in the DCD an updated figure showing the required connections, components, safety related to non-safety related piping class breaks, and provides a more detailed description of the procedure and other required components to backwash the strainers. In addition, clarify if the ESWS pump is shutdown during this process since the description implies that all ESWS flow is stopped (the strainer is isolated and the standby strainer is placed into service) during this process.

09.02.01-19

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Measures must be specified to protect the essential service water system (ESWS) from failures due to adverse environmental conditions. Tier 2, Design Control Document (DCD) Figure 9.2.1-1 indicates a strainer downstream of the two parallel strainers at the inlet to each component cooling water (CCW) heat exchanger in each train of the ESWS. The ESWS also provides cooling water flow to the essential chiller units; however, there is no such additional strainer indicated for the piping to the essential chiller units in each train. The staff asks the applicant to address in the DCD, the need for an additional strainer for the essential chiller units served by the ESWS, either adding a necessary strainer or discussing the basis for why a strainer is not needed.

09.02.01-20

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Measures must be specified to protect the essential service water system (ESWS) from failures due to adverse environmental conditions. The staff did not find, for the ESWS on Tier 2, Design Control Document (DCD) Figure 9.2.1-1 connections for backwash cleaning of the essential chiller units on the ESWS side. There is also no discussion of the need to backwash or clean the ESWS side of the essential chiller units and how this is accomplished. Describe in the DCD, the need to backwash (clean) the ESWS side of the essential chiller units and provide indication of the connections and components on the Tier 2 Figure 9.2.1-1. In addition, clarify whether or not the associated ESWS train has to be removed from service for this operation.

09.02.01-21

The essential service water system (ESWS) must be capable of removing heat from structures, systems, 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff. 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, 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 ESWS for the US-APWR design, the applicant needs to provide additional information in Tier 2, DCD Section 9.2.1 to describe to what extent butterfly

valves will be used to throttle ESWS flow and design provisions that will be implemented to prevent consequential pipe wall thinning from occurring.

09.02.01-22

The essential service water system (ESWS) 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. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

The instrumentation and controls (I&C) for the essential service water system (ESWS) must be specified in adequate detail to confirm that monitoring, surveillance, and maintenance of the ESWS can be accomplished for normal operations and safe shutdown. The staff found several inadequacies and insufficient information in the applicant’s design control document (DCD) with respect to I&C for the ESWS. The staff requests the applicant provide additional information in the DCD to fully describe the I&C for the ESWS, the functions for I&C, and how the operating staff uses the provided information. The following are examples of inadequacies that must be addressed:

- Describe in the DCD industry standards and requirements that I&C for the ESWS is designed to meet, for example IEEE standards 603, 323, etc.
- DCD, Tier 1, inspections, tests, analyses, and acceptance criteria (ITAAC), item number 12, refers to ESWS displays in the remote shutdown console (RSC). Tier 2 of the DCD Section 9.2.1 does not indicate any I&C for monitoring or control in the RSC. Provide a full description of any ESWS I&C located in the RSC with their functions in Tier 2.
- Discuss all ESWS operator controls and instruments in Tier 2 of the DCD Section 9.2.1 that are available in the MCR and RSC. Tier 1 of the DCD Table 2.7.3.1-4 information should be included in Tier 2, Section 9.2.1.
- Verify that the I&C information that is described in Tier 2 of the DCD Section 9.2.1 is consistent with the I&C listed on ESWS system diagrams, Tier 1of the DCD Figure 2.7.3.1-1 and Tier 2 of the DCD Figure 9.2.1-1.
- Describe in the DCD any system logic connections (such as pump trips and automatic starts) between the ultimate heat sink (if fans are utilized in the conceptual design), component cooling water system and essential chilled water system or indicated these are all manual operations.

09.02.01-23

The essential service water system (ESWS) 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, “Inspection of Cooling Water System” requirements. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants

(LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

The staff finds the design to be acceptable if the DCD describes inspection program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2 of the DCD Section 9.2.1.4 indicates that periodic inspections will be performed, the accessibility and periodic inspection of ESWS piping in the piping tunnels and buried piping is of particular interest. Describe in the DCD to the extent and nature of inspections that will be performed in non-accessible areas, such as in piping systems that are buried or locations in piping tunnels.

09.02.01-24

The essential service water system (ESWS) must be designed so that periodic pressure and functional testing of components can be performed in accordance with General Design Criteria (GDC) 46, "Testing of Cooling Water System," 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 ESWS safety functions. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff.

The staff finds the design to be acceptable if the DCD describes pressure and functional test program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2 of the DCD Section 9.2.1.4 indicates that periodic testing will be performed, the extent and nature of these tests and procedural controls that will be implemented to assure continued ESWS structural and leak tight integrity and system operability over time were not described. Consequently, 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 this requirement.

09.02.01-25

Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, provide guidance on the specific information that should be included in the application for evaluation by the staff. Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. Section III.3.D of SRP Section 9.2.1 indicates that there should be provisions to detect and control leakage of radioactive contamination. SRP Section 9.2.1, Section III, also indicates that an acceptable design is the ability to isolate leaking components by one automatic and one manual valve in series.

The applicant's design control document (DCD) for the essential service water system (ESWS) shows a radiation monitor at the outlet of the component cooling water system

(CCWS) heat exchanger of the ESWS, however, there is no description in the DCD as to how leakage of radioactive contamination will be isolated in conformance with the SRP. The US-APWR application did not discuss valves and/or other means that would be utilized to isolate a train or component in the event of radioactive leakage from the CCWS to the ESWS or the procedure that would be used. The staff review did not identify automatic and manual isolation valves that could serve the purpose described in SRP Section 9.2.1 for isolating a contaminated ESWS train. Provide a detailed discussion of the design and procedure to be used to isolate an ESWS component or train in the event of radioactive contamination leakage from the CCWS to the ESWS.

09.02.01-26

Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff. Chapter 16 of the application is to provide the design technical specifications and bases.

Tier 2, Design Control Document (DCD) Chapter 16 technical specifications (TS) for the essential service water system (ESWS) are inaccurate in their identification of the cooling loads serviced by the ESWS. The basis section B.3.7.8 states that each ESWS train cools one component cooling water system (CCWS) heat exchanger and one gas turbine generator (GTG) cooler. This statement is inconsistent with Tier 2, Section 8.3.1.1.3.10 which states that the GTG does not require cooling water and Tier 2, Section 9.2.1 which does not identify GTG coolers as components cooled by the ESWS. Section 9.2.1 states that in addition to the CCW heat exchangers, essential chiller units are cooled by the ESWS. Section B.3.7.8 does not indicate the essential chiller units as being cooled by the ESWS. Provide an update to the Tier 2, Chapter 16 TS and Bases to clarify the safety-related cooling loads for the ESWS which includes the ESWS motor and specifically address the cooling bases to the essential chiller units and gas turbine generators (GTG) and revise the DCD, Sections 9.2.1, technical specification Bases 3.7.8, and Section 8.3.1.1.3.10 to correctly and consistently state the correct heat loads for the ESWS.

09.02.01-27

Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in the application for evaluation by the staff.

Tier 2 of the Design Control Document (DCD), Chapter 16, provides the design Technical Specifications (TS) and Bases. The staff’s review of Chapter 16, Section 3.7.8, determined that the TS and the Bases for the water level for the ESWS pumps and system maximum temperature requirements have not been properly addressed relative to ESWS considerations described in Tier 2 of the DCD Section 9.2.1. The staff determined that the surveillance requirement (SR) 3.7.8.2 in the TS does not adequately define the logic to be tested for the essential service water system discharge motor operated valves. Provide clarification in the TS SR 3.7.8.2 that all automatic features,

opening and closing, for the pump discharge MOVs must be tested. Also provide the specific basis for this SR in Tier 2, Chapter 16, Section B.3.7.8.

09.02.01-28

Standard Review Plan (SRP) Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. SRP Section 14.3, Appendix C, Item 1B.ix states that design control document (DCD), Tier 1 figures for safety-related system should include most of the valves on the DCD, Tier 2 drawings. The staff found that the Tier 1 and Tier 2 information is incomplete, inconsistent, inaccurate, or that clarification is needed and ask the applicant to revise the information in DCD, Tier 1 Section 2.7.3.1 and applicable Tier 2 Sections (as appropriate) to address the following considerations in this regard:

- Although the Introduction Section in Chapter 1 of the Tier 1 DCD states that "information contained in the Tier 1 document was derived from the Tier 2 document," the staff found that much of the information provided in DCD Tier 1 is not described in Tier 2 of the DCD Section 9.2.1. Conversely, some of the key information provided in Tier 2 section 9.2.1 is not provide in the Tier 1 system information, Section 2.7.3 (e.g., active safety function, loss of motive power position, harsh environment considerations, MCR alarm and display, control function, and RSC display).
- Tier 1 of the DCD, Figure 2.7.3.1-1 does not include many of the major components of the ESWS, such as strainers, radiation monitors, check valves, and pump motor self-cooling lines, nominal pipe sizes, testing connections, and so forth. This figure should contain all of the system level detail found in the Tier 2, Section 9.2.1, and Figure 9.2.1-1. The Tier 1 Figure 2.7.3.1-1 shows a '3' in a box in four locations which should be clarified. Revise Figure 2.7.3.1-1 to indicate all the major components of the ESWS to be confirmed by ITAAC, Item 1a.
- Tier 1 of the DCD, Table 2.7.3.1-2, "Essential Service Water System Equipment Characteristics," does not show power classification (IEEE class) for each applicable component.
- Tier 1 of the DCD, Table 2.7.3.1-2, "Essential Service Water System Equipment Characteristics," does not show system check valves which must change positions during normal and accident condition operations.

09.02.01-29

Standard Review Plan Section 9.2.1, Station Service Water System, Sections II and III, and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", provide guidance on the specific information that should be included in the application for evaluation by the staff. The applicant must address inspections, tests, analyses, and acceptance criteria (ITAAC) in the design control document (DCD). The staff found that the proposed ITAAC in Tier 1 of the DCD, Section 2.7.3, Table 2.7.3.1-5, for the essential service water system is incomplete, inconsistent, inaccurate, or that

clarification is needed. Consequently, the Tier 1, Section 2.7.3 and Table 2.7.3.1-5 information needs to be revised to address the following:

- Item 1a 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.
- Item 1b verifies physical separation of the as-built ESWS mechanical divisions. The acceptance criteria are that each division is physically separated from the other divisions by structural and/or fire barriers. The requirements for physical separation of the ESWS pumps, and associated valves and other components, located in the ESWS pump house and piping tunnels are not clear. The requirements for physical separation of ESWS components in the pump house need to be provided.
- Item 7; clarify how the ITAAC will account for the degradation in heat removal capability at the maximum allowable supply water temperature of 35 ^{o}C (95 ^{o}F). Clarify how the as-built provides adequate cooling water.
- The DCD needs a test item to specify that ESWS pump testing to demonstrate adequate net positive suction head will be completed at the lowest ultimate heat sink level. The acceptance criteria for an acceptable test need to be specified.
- Quantitative acceptance criteria need to be established for all ITAAC as applicable (flow rates, heat transfer rates, completion times, etc.).
- The DCD needs to stipulate that the ESWS design provides for flow testing of the pumps during operation is incomplete in that it does not specify provisions for flow testing the individual component flow paths to verify flow balance requirements are satisfied.
- The DCD does not stipulate that the ESWS is accessible for performing periodic inspections as required by GDC 45.
- The DCD needs a test item to demonstrate that water hammer will not occur in the as built system upon manual or automatic start of a previously idle train, and during loss-of-power scenarios.
- The DCD needs an item for the inspection of Class 1E divisional separation.
- The DCD needs a test item for the testing of the ESW pump discharge strainer differential pressure alarms and monitors.
- The DCD needs a test item for the testing of the CCW heat exchanger inlet strainer differential pressure alarms and monitors.
- The DCD needs a test item for the testing of the CCW discharge radiation monitor alarms and monitors.
- The DCD needs a test item for the testing of essential chiller unit alarms and malfunctions on the ESWS side.
- The DCD needs a test item for the testing of ESWS check valves.
- The DCD needs an inspection item for supports per the requirements of ASME.
- The DCD needs an inspection item for lined underground piping which is placed in trenches.

09.02.01-30

Standard Review Plan Section 9.2.1, "Station Service Water System," Sections II and III, and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”, provide guidance on the specific information that should be included in

the application for evaluation by the staff. The design control document (DCD) must specify Combined License (COL) items for future license applications against the DCD.

The staff found that an extensive amount of new information will be required by the applicant to address RAIs 9.2.1-1 through 9.2.1-28. The overall presentation of essential service water system information required to address the requirements of Standard Review Plan Section (SRP) 9.2.1, was found to be incomplete and inadequate for the staff's review. Due to the extensive amount of revisions and information that is requested in the RAIs in this section, the staff expects that the applicant will need to re-evaluate the set of COL action items, 9.2 (1) through 9.2 (8) in Tier 2 of the DCD Table 1.8-2. The resulting set of COL items for the essential service water system (ESWS) in the revised Tier 2 of the DCD Section 9.2.1, should be written to be more detailed in terms of what the COL applicant is requested to provide. In addition to the request to re-evaluate the existing COL items in DCD Revision 1, the following are some of the issues noted in the existing COL items.

- In item 9.2(1), the COL applicant was asked to evaluate the essential service water pump (ESWP) at the lowest probable water level of the UHS. The staff finds that more detail is required as to what the applicant is asking the COL applicant to provide in its evaluation. The staff also requests that the COL item address procedures for the ESWP in the event of low water levels in the UHS.
- In item 9.2(2), the COL applicant was asked to provide the protection against adverse environmental, operating, and accident conditions that can occur such as freezing, and thermal over pressurization. The staff finds that this item does not specifically address what the COL applicant is to provide. The staff finds that procedures for protection against the adverse conditions should also be specified
- In item 9.2(8) the COL applicant was asked to specify chemistry requirements for the ESWS. This item should be clear in asking for chemistry requirements that specify the corrosion inhibitors and other chemistry requirements necessary to address trains that are in normal operation as well as those that may be in standby for a period of time.
- The staff finds that an additional COL item may be necessary to provide a design configuration and evaluation for prevention of water hammer events in the ESWS.
- It is not clear how the maximum allowable UHS water supply temperature of 35 ^{o}C (95 ^{o}F) will be addressed. A COL item may be necessary for this item.
- The staff finds that an additional COL item may be necessary to provide drawings indicating the elevation of the ESWS pump impellers.
- Tier 2 of the DCD Section 9.2.1.2.3.1, describes placing the standby component cooling water pump (CCWP) of the same subsystem and the corresponding ESWP placed in service to resume the cooling process. "The previously activated CCWP is shut off after the switch in operating pump". The second sentence need to be clarified and this should be a COL information item to have procedures developed for this sequence in operating equipment.