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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10256

Subject: MHI's Responses to US-APWR DCD RAI No. 585-4464 Revision 0

Reference: [1] "Request for Additional Information No. 585-4464 Revision 0, SRP Section: 09.02.01 – Station Service Water System - Design Certification and New License Applicants, Application Section: 9.2.1," dated May 10, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 585-4464 Revision 0".

Enclosure 1 contains the responses to 28 questions in Reference [1].

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Atsushi Kumaki for

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Responses to Request for Additional Information No. 585-4464 Revision 0

D081
NRO

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-10256
Docket No. 52-021

Responses to Request for Additional Information No. 585-4464 Revision 0

September 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-32

Paragraph 10 CFR 52.47(a)(24) requires "a representative conceptual design for those portions of the plant for which the application does not seek certification, to aid the NRC in its review of the FSAR and to permit assessment of the adequacy of the interface requirements." Nuclear Regulatory Commission (NRC) staff has been reviewing Revision 2 of the Design Control Document (DCD) for the US-Advanced Pressurized Water Reactor (US-APWR). The staff reviewed the Tier 1 and Tier 2, DCD ESWS description and related figures and tables. The staff found instances of incomplete or unclear descriptive information as to distinguish conceptual design information (CDI) from standard plant design information (SPDI). The portions that are plant specific still require a conceptual design as required by 10 CFR 52.47(a)(24) and should also be clearly differentiated from the SPDI within the application as follows:

a. SPDI needs to be differentiated from CDI in the text, tables, and figures of the DCD so the staff can properly review the certified design portions against the Standard Review Plan (SRP) and adequately assess to what extent interface requirements need to be established based on the CDI that is provided.

b. Interface requirements should be established for those parts of the description that are CDI as appropriate. Note that interface requirements must be sufficiently detailed to allow completion of the FSAR by COL applicants.

c. The extent that the DCD needs to be revised to satisfy (a) and (b) above could be rather extensive and the DCD should be reviewed in its entirety to ensure that SPDI is properly differentiated from CDI and that the description of this information in the DCD is accurate and consistent throughout.

d. For example, Section 1.2.1.6 indicates that the site-specific details of a USAPWR site plan is to be presented in the combined license application and refers to Figure 1.2-1 for a "typical site plan." This section also states that the area within the perimeter fence of a US-APWR installation includes a site-specific portion of the facility. Contrary to this, Section 1.8 indicates that the standard scope of design for the US-APWR includes the entire nuclear island and all safety-related systems that would be required for constructing the plant at a site. Section 1.8 goes on to state that the standard site plan for US-APWR design certification is shown in Figure 1.2-1. However, it is not clear from Figure 1.2-1 what parts of the site plan are plant-specific (conceptual design) vs. what parts are within the scope of the certified design. Sections 1.2.1.6 and 1.8, and Figure 1.2-1 need to clearly distinguish what is within the scope of the standard plant design and what is not.

e. For example, Table 1.8-1 indicates that portions of the ESWS outside the USAPWR buildings are outside the scope of the standard plant design. Based on this description, the ESW pumps, piping, pipe tunnel, valves, and instrumentation up to the point where the ESWS enters and exits the reactor and power source buildings are outside the scope of the US-APWR standard plant design. Because there is no way to distinguish CDI from SPDI, the descriptive information provided for the ESWS in Section 9.2.1 and shown on Figure 9.2.1-1 does not distinguish CDI from SPDI. This makes it difficult for the NRC staff and COL applicants to recognize what parts of the description are actually CDI that will need to be replaced by plant-specific information. This lack of clarity also makes it more difficult to properly identify interface requirements and COL information items that should be established. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

f. For example, Table 3.2-2 specifies classification information for all parts of the ESWS. However, for those parts of the ESWS that are not included within scope for the standard plant design, it's not clear to what extent and on what basis this information applies to the COL applicants. Furthermore, additional confusion is added by COL Information Items 3.2(4) and (5) which indicate that the COL applicant is to identify the classifications for site-specific SSCs without identifying specifically which SSCs are site-specific. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

g. For example, Table 3.2-4 specifies the seismic classification for the ESWS pipe tunnel. However, because the ESWS pipe tunnel is not included within the scope of the standard plant design, it's not clear to what extent and on what basis this information applies to the COL applicants. Furthermore, additional confusion is added by COL Information Items 3.2(4) and (5) which indicate that the COL applicant is to identify the classifications for site-specific SSCs without identifying specifically which SSCs are site-specific. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

Understand that in the RAIs that follow, the staff may be asking questions on parts of the DCD description that are not SPDI and are not really relevant. In the absence of clarity, the staff assumed that the descriptive information provided in Revision 2 of the DCD was SPDI unless clearly and consistently distinguished as CDI.

ANSWER:

Question: a) SPDI needs to be differentiated from CDI in the text, tables, and figures of the DCD so the staff can properly review the certified design portions against the Standard Review Plan (SRP) and adequately assess to what extent interface requirements need to be established based on the CDI that is provided.

Answer: a)
DCD Section 9.2.1 has been revised in its entirety to distinguish SPDI from CDI which are enclosed in brackets. Please refer to Attachment 1 for changes to DCD Section 9.2.1. Other related sections have also been revised as applicable and can be found in the responses to subsequent questions of this RAI.

DCD Chapter 1 identifies the locations of large plant structures such as buildings that are SPDI. DCD Section 9.2.1, on the other hand, mainly describes the ESWS functional requirements regardless of location since some structures (e.g. ESWPT and UHSRS) where some of the ESWS components are located are site specific. The functional requirements for the following components installed in the UHSRS and those that are described in Table 3.2-4, DCD Chapter 7 main text, DCD Section 9.2.1 main text, Table 9.2.1-1 and Figure 9.2.1-1 are essentially part of the standard design:

- ESW pump with the following standard parameters to maintain the ESW temperature below 95° F for the removal of the CCW HX and essential chiller unit heat loads with single active failure and coincident online maintenance:
  - Existence of four 50% capacity pumps
  - Power supply from Class 1E source
  - Vertical, centrifugal, mixed flow pump type
  - Design flow rate of 13,000 gpm
  - Design pressure of 150 psig
  - Design temperature of 140° F
  - Stainless steel construction
  - Equipment Class 3
  - Interlocks for ECCS actuation signal, LOOP signal, remote manual actuation signal
- ESW pump discharge strainer with automatic vent valves to prevent degradation of CCW heat exchanger due to debris clogging leading to the loss of its heat transfer function from CCWS to ESWS has the following standard parameters:
  - Existence of eight strainers, two strainers for each ESWS train
  - Power supply from Class 1E source
  - Design flow rate of 13,000 gpm
  - Design pressure of 150 psig
  - Design temperature of 140° F
  - Equipment Class 3
  - Interlocks for actuation at high strainer differential pressure, stoppage at low strainer differential pressure or pump stoppage signal (See Question 09.02.01-52.)
- ESW pump discharge strainer discharge/backwash line and associated isolation valves with the following functions for supporting the strainer functions above and prevention of water hammer due to drain down:
  - Existence of an isolation valve as an integral component to the strainer—actuated by a high strainer differential pressure signal and isolated by a low strainer differential pressure or pump stoppage signal
  - Existence of an isolation valve downstream of the strainer and isolated by a pump stoppage signal
  - Power supply from Class 1E source
  - Design flow rate of 13,000 gpm
  - Design pressure of 150 psig
  - Design temperature of 140° F
  - Equipment Class 3
- ESW pump discharge motor operated valve with the following required functions to mitigate water hammer by gradually transporting essential service water through the ESWS and UHS at pump actuation and by keeping the ESWS and UHS water filled during pump stoppage:
  - Existence of four valves, one for each train
  - Power supply from Class 1E source
  - Design flow rate of 13,000 gpm
  - Design pressure of 150 psig
  - Design temperature of 140° F
  - Equipment Class 3
  - Interlock for valve opening at pump start signal and remote manual signal
  - Interlock for valve closure at pump stop signal and remote manual signal
- ESW pump discharge check valve with the following required functions to prevent water hammer by keeping the ESWS and UHS water tight during pump stoppage.
  - Existence of four check valves, one for each train
  - Design flow rate of 13,000 gpm
  - Design pressure of 150 psig

- Design temperature of 140° F
- Equipment Class 3

The information above will be summarized in Tier 2 DCD Table 9.2.1-1.

- Vacuum breaker installed upstream of the check valve to mitigate water hammer effect This is further described in the response to RAI 09.02.01-36 (a).
- Instrumentation requirements:
  - ESW pump discharge pressure gauge with local indications for confirmation of pump performance
  - ESW pump discharge pressure gauge with local and MCR indication and low pressure annunciation to the MCR for providing ESWS post accident monitoring variables and providing component controls at safe shutdown
  - ESW pump discharge strainer differential pressure gauge with local and MCR indication, high and low strainer differential pressure annunciation for automatic strainer control
  - ESW flow for providing ESWS post accident monitoring (PAM) variables
- Equipment class for the above components, associated valves, piping and instrumentation should be as shown in Table 3.2-4, Figure 9.2.1-1 and DCD Chapter 7 main text.
- The layout and functional installation of the above components, associated isolation valves and piping is as shown in Figure 9.2.1-1.

The ESW pump head is dependent of the site specific physical layout of the components, associated isolation valves, and piping of both the ESWS and UHS as identified in COL item 9.2(6).

CDI described in DCD Section 9.2.1 are those parts of the design that are dependent on the type of UHS used such as the blowdown line to the CWS blowdown main header for water chemistry control of cooling tower basin.

DCD Section 9.2.1 has been revised to distinguish SPDI from CDI which are enclosed in brackets. Please refer to Attachment-1 for changes to DCD Section 9.2.1.

Question: b) Interface requirements should be established for those parts of the description that are CDI as appropriate. Note that interface requirements must be sufficiently detailed to allow completion of the FSAR by COL applicants.

Answer: b)
Tier 1 DCD Sections 2.7.3.1.1 and 3.2.1 have been revised to clarify interface requirements of the ESWS with the UHS. See response to Questions 09.02.01-36 and 39.

Additional COL interface items have been added in various subsections of Tier 2 DCD Section 9.2.1. Please find these in the responses to the questions that follow.

Question: c) The extent that the DCD needs to be revised to satisfy (a) and (b) above could be rather extensive and the DCD should be reviewed in its entirety to ensure that SPDI is properly differentiated from CDI and that the description of this information in the DCD is accurate and consistent throughout.

Answer: c)
DCD Section 9.2.1 has been revised in its entirety to distinguish SPDI from CDI which are enclosed in brackets. Please refer to Attachment 1 for changes to DCD Section 9.2.1. Other related sections have also been revised as applicable and can be found in the responses to subsequent questions of this RAI.

Question: d) For example, Section 1.2.1.6 indicates that the site-specific details of a USAPWR site plan is to be presented in the combined license application and refers to Figure 1.2-1 for a "typical site plan." This section also states that the area within the perimeter fence of a US-APWR installation includes a site-specific portion of the facility. Contrary to this, Section 1.8 indicates that the standard scope of design for the US-APWR includes the entire nuclear island and all safety-related systems that would be required for constructing the plant at a site. Section 1.8 goes on to state that the standard site plan for US-APWR design certification is shown in Figure 1.2-1. However, it is not clear from Figure 1.2-1 what parts of the site plan are plant-specific (conceptual design) vs. what parts are within the scope of the certified design. Sections 1.2.1.6 and 1.8, and Figure 1.2-1 need to clearly distinguish what is within the scope of the standard plant design and what is not.

Answer: d)
The last two sentences in the 3rd paragraph of Tier 2 DCD Section 1.8 have been revised to correct the inconsistency between Section 1.8 and the statement in Section 1.2.1.6 as follows:

"Thi~~s~~**e** standard scope of design includes the entire nuclear island and all safety systems **except the UHS and associated HVAC system** that would be required for construction of the US-APWR at a nuclear power plant site. **However, the cooling water intake and discharge structures and the ESWPT towards the intake and discharge structures are site specific.** **A** ~~The standard~~ **typical** site plan for the US-APWR design included in this application for design certification is shown in Figure 1.2-1."

See also response to Question 09.02.01-32(e) below.

Question: e) For example, Table 1.8-1 indicates that portions of the ESWS outside the USAPWR buildings are outside the scope of the standard plant design. Based on this description, the ESW pumps, piping, pipe tunnel, valves, and instrumentation up to the point where the ESWS enters and exits the reactor and power source buildings are outside the scope of the US-APWR standard plant design. Because there is no way to distinguish CDI from SPDI, the descriptive information provided for the ESWS in Section 9.2.1 and shown on Figure 9.2.1-1 does not distinguish CDI from SPDI. This makes it difficult for the NRC staff and COL applicants to recognize what parts of the description are actually CDI that will need to be replaced by plant-specific information. This lack of clarity also makes it more difficult to properly identify interface requirements and COL information items that should be established. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

Answer: e)
See above response (d).

The standard design portion of the ESWS are those components and piping within the R/B and PS/B and the components in the ultimate heat sink related structures (UHSRS) such as the ESW pump and pump discharge strainers, piping and valves. The design and physical layout of the essential service water pipe tunnel (ESWPT) piping is site specific and depends on the design of the UHS but whose existence is a standard design requirement. See also responses to Questions 09.02.01-33(f), 09.02.01-33(m), 09.02.01-33(n), 09.02.01-37, 09.02.01-38, and 09.02.01-39.

Tier 2 DCD Section 9.2.1 has been revised for clarity and to distinguish SPDI from CDI which are enclosed in brackets.

Tier 2 DCD Figure 9.2.1-1 has been revised to include CDI.

Question: f)
For example, Table 3.2-2 specifies classification information for all parts of the ESWS. However, for those parts of the ESWS that are not included within scope for the standard plant design, it's not clear to what extent and on what basis this information applies to the COL applicants. Furthermore, additional confusion is added by COL Information Items 3.2(4) and (5) which indicate that the COL applicant is to identify the classifications for site-specific SSCs without

identifying specifically which SSCs are site-specific. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

Answer: f)
DCD Table 3.2-2 identifies those SSCs that are part of the standard design. Site-specific SSCs are COL Applicant items to be identified in the FSAR COLA. For the ESWS, interface requirements with the UHS for site-specific SSCs have been clarified in Tier 1 DCD Subsection 2.7.3.1.1 as explained in the response to Question 09.02.01-39 and are identified in appropriate DCD sections. Site specific information and CDI for the ESWS are appropriately described in DCD Section 9.2.1.

Table 3.2-2 has been revised to remove the deleted CCW heat exchanger inlet strainer line and ESWP motor cooling line. The strainer backwash and vent line piping and valves are also added in the table.

Site specific components and piping of the ESWS are addressed in FSAR COLA and will not be included in DCD Table 3.2-2.

Question: g) For example, Table 3.2-4 specifies the seismic classification for the ESWS pipe tunnel. However, because the ESWS pipe tunnel is not included within the scope of the standard plant design, it's not clear to what extent and on what basis this information applies to the COL applicants. Furthermore, additional confusion is added by COL Information Items 3.2(4) and (5) which indicate that the COL applicant is to identify the classifications for site-specific SSCs without identifying specifically which SSCs are site-specific. Therefore, the DCD needs to be revised to eliminate this confusion by providing a way to clearly distinguish CDI from SPDI.

Answer: g)

Tier 2 DCD Section 3.2.1.3 discusses the classification of the US-APWR buildings and their locations.

The existence of the ESWPT is a standard design requirement whereby ESW is being transported between the ESWS and UHS to remove heat loads from ESW cooled components. The final configuration of the ESWPT is determined by the type of UHS that will be used for each US-APWR plant; however, the seismic and dynamic qualification shall be as specified in Table 3.2-4. Specifying the seismic and dynamic qualification of the ESWPT to Class 3 and Seismic Category I ensures that the ESWS safety-related functions are maintained regardless of plant specific requirements. Tier 2 DCD Section 3.2.1.3 and Table 3.2-4 will be revised to add a footnote on the ESWPT as follows:

"**5. The ESWPT is a site specific structure but the existence and functions of which are required by the plant standard design. The specific features of the ESWPT are site dependent and will depend on the type of UHS.**"

Tier 2 DCD Section 3.2.1.3 is revised by adding the following after the third sentence:
"**The turbine building (T/B) is part of the standard design but outside the Nuclear Island.**"

Site specific information and CDI for the ESWS are appropriately described in DCD Section 9.2.1.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Section 9.2.1, Attachment 2 for changes to Tier 2 DCD Section 1.8, Attachment 3 for changes to Tier 2 DCD Table 3.2-2, and Attachment 8 for changes to Tier 2 DCD Table 3.2-4. Tier 1 is also changed as discussed in Answer (b) above.

Impact on COLA

See the responses to the questions that follow.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-33

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 NRC staff. The staff reviewed Revision 2 of the US-APWR DCD and found instances of incomplete or unclear descriptive information related to the ESWS as follows:

a. DCD Section 1.2.1.5.4.4 indicates that the ESWS discharges to the discharge pit. However, no "discharge pit" is shown on Figure 1.2-1.

b. Section 9.2.1.1.2 is supposed to describe the power generation design basis of the ESWS. However, no discussion of the ESWS power generation design basis is included in this section.

c. Section 9.2.1.1.2 indicates that the COL applicant is to address site-specific nonsafety related system isolation (intake basin blow down system, intake basin make up system) as applicable. However, these systems are not part of the ESWS and are not pertinent to the description that is provided in Section 9.2.1. Instead, these systems pertain to the ultimate heat sink (UHS) and should be discussed in Section 9.2.5. Furthermore, to the extent that these systems are not included within the scope of the standard plant, conceptual designs for these systems must be described in accordance with 10 CFR 52.47(a)(24).

d. Section 9.2.1.2.1 indicates that the ESWS is arranged into four independent trains. However, the descriptive information does not adequately explain how the design ensures that failures, events, or conditions that ultimately render one train inoperable won't adversely affect the other trains. A brief summary discussion is adequate provided complete evaluations of these considerations are provided in other parts of the DCD and referred to for completeness. However, for those parts of the ESWS that are not included within the scope of the standard plant design, it's not clear to what extent and on what basis this information pertains to COL applicants.

e. Section 9.2.1.2.1 indicates that the COL applicant is to provide the piping, valves, and other design related to the site specific UHS. This does not pertain to the ESWS and should be discussed in Section 9.2.5.

f. Section 9.2.1.2.2.5 indicates that underground piping is epoxy lined carbon steel and placed in trenches. The following considerations need to be addressed:
· Figure 1.2-1 shows that an ESWS pipe tunnel is used, not trenches.
· Applicable design specifications and potential failure modes'
· The buried piping and pipe tunnel are not within scope for the standard plant, and it's not clear to what extent and on what basis this information applies to the COL applicants.

g. Section 9.2.1.2.2.6 indicates that valves are provided for back-flushing the CCW heat exchangers. It isn't clear why this design feature is provided since an in-line self cleaning strainer is provided and this needs to be better explained.

h. Section 9.2.1.2.3.1 does not include a description of ESWS operation for satisfying shutdown cooling considerations.

i. Section 9.2.1.3 indicates that the UHS has sufficient water volume to perform required cooling to mitigate the consequences of an accident. The UHS is described in Section 9.2.5 and this discussion should be relocated to that section accordingly.

j. Section 9.2.1.3 (page 9.2-9) indicates that the COL applicant is to provide the UHS water volume, maximum operating water temperature and the lowest water level for the ESWPs. This item pertains to the UHS and should be discussed in Section 9.2.5.

k. Section 9.2.1.3 indicates that the COL applicant is to provide the safety evaluation for the ESWS design related to the site specific conditions. This item is much too broad and needs to identify what design features and site specific conditions are being referred to for action by the COL applicant.

l. Section 9.2.1.3 indicates that the COL applicant is to provide the protection against adverse environmental, operating, and accident conditions that can occur such as freezing and thermal overpressurization; and that the COL applicant is to provide the preventive measures for protection against adverse environmental conditions. This is much too broad and needs to be more specific. Protection of structures, systems, and components (SSCs) against adverse environmental, operating and accident conditions should not be deferred to a COL applicant unless adequately justified by the plant-specific considerations that are involved. For example, freeze protection of piping systems is dependent on plant-specific temperature considerations and would have to be addressed by the COL applicant. However, protection of piping that is included within the scope of the standard plant from environmental effects due to an accident should be addressed by the standard plant design. The applicant needs to address this.

m. Section 9.2.10, COL 9.2(6) indicates that the COL applicant is to provide ESWP design details – required total dynamic head, NPSH available, etc. NPSH available is a function of the water level in the pump basin and the design detail of interest that needs to be addressed is the minimum NPSH that is required.

n. Section 9.2.10, COL 9.2(7) indicates that the COL applicant is to provide piping and valves, including those at the boundary between safety-related and nonsafety-related portions related to site-specific conditions. It isn't clear what this item is referring to and to what extent it applies to that part of the ESWS that is within scope for the standard plant design, such as vents and drains.

o. Table 9.2.1-4 shows for Trains A & B that 50 gpm are required for cooling the ESW pump motor to support safe shutdown. This appears to be in error since only one ESW pump is needed which requires a flow rate of 25 gpm for motor cooling. Also, because this aspect of the ESWS design is not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants.

p. Table 9.2.7-1 shows that the cooling water inlet temperature is 100 degrees F. However, the maximum allowed supply temperature for the ESWS is 95 degrees F and this apparent inconsistency needs to be explained.

ANSWER:

Question: a) DCD Section 1.2.1.5.4.4 indicates that the ESWS discharges to the discharge pit. However no "discharge pit" is shown on Figure 1.2-1.

Answer: a)
There is no discharge pit in the ESWS for the standard design. DCD Section 1.2.1.5.4.4 Rev. 2 has been changed to state that the circulated ESWS for cooling the CCW heat exchangers and essential chiller units is discharged back to the UHS.

Question: b) Section 9.2.1.1.2 is supposed to describe the power generation design basis of the ESWS. However, no discussion of the ESWS power generation design basis is included in this section.

Answer: b)
DCD Section 9.2.1.1.2 heading will be changed to Power Generation Design Bases and will be revised by replacing the current contents with the following:

"**The ESWS removes the heat loads from the CCWS through heat exchange with the CCWS heat exchangers and essential chiller units during normal plant operation, refueling, and normal shutdown.**"

The current Subsection 9.2.1.1.2 will be changed under a new subsection number 9.2.1.1.3 with the heading "Nonsafety-Related Design Bases" and the following revised content:

"The ESWS does not provide cooling water to any nonsafety-related components **during normal plant operations or design basis events such as a LOCA. The ESWS may be used as a backup source of water to the fire protection water supply system (FSS) in the event where the normal supply is unavailable due to design basis events such as an earthquake. The ESWS is normally isolated from the FSS. The ESWS is not required to supply water to the FSS during any design basis event other than the safe shutdown earthquake.** ~~However, some portions of the system are nonsafety-related, e. g., sections of pipe in heat exchanger drain piping after the isolation valves. These boundary isolation valves which provide separation between the safety-related and nonsafety-related portions are normally closed. During a design basis event, postulated simultaneous failure of all nonsafety-related piping would not impact operation of any ESW train and would not affect ESWS capability to perform its safety functions. The COL Applicant is to address site specific nonsafety-related system isolation (intake basin blowdown system, intake basin makeup water, FSS) as applicable.~~"

Isolation of the safety-related from the nonsafety-related portions of the ESWS is considered a safety function to ensure that the design flow is being supplied to the ESWS during all plant operations, as well as assure the UHS water inventory during accident and safe shutdown with LOOP conditions as described in Subsection 9.2.5.2.3.

The eleventh bullet of DCD Subsection 9.2.1.1.1 has been revised as follows:

"The ESWS is designed with the capability to isolate nonsafety-related portion**s from the safety-related portions of the system**."

DCD Subsection 9.2.1.3 is revised is by adding the following after the 14th paragraph:

"**Some portions of the system are nonsafety-related, e. g., sections of pipe in heat**

exchanger drain piping after the isolation valves. These boundary isolation valves which provide separation between the safety-related and nonsafety-related portions are normally closed. During a design basis event, postulated simultaneous failure of all nonsafety-related piping would not impact operation of any ESW train, thus will not affect the ESWS capability to perform its safety-related functions."

Question: c) Section 9.2.1.1.2 indicates that the COL applicant is to address site-specific nonsafety-related system isolation (intake basin blow down system, intake basin make up system) as applicable. However, these systems are not part of the ESWS and are not pertinent to the description that is provided in Section 9.2.1. Instead, these systems pertain to the ultimate heat sink (UHS) and should be discussed in Section 9.2.5. Furthermore, to the extent that these systems are not included within the scope of the standard plant, conceptual designs for these systems must be described in accordance with 10 CFR 52.47(a)(24).

Answer: c)

The blowdown system is a site-specific design of the ESWS that depends on the type of UHS used, specifically cooling towers. This portion of the ESWS is installed to maintain the water chemistry of the cooling tower basin by blowing down a fraction of the basin water and introducing fresh makeup water to achieve the required cycles of concentration. The blowdown system will be renamed as "ESWS blowdown system" or "ESWS blowdown," whichever is applicable, instead of intake basin blowdown or UHS blowdown. DCD Section 9.2.1 is revised in its entirety for consistency of terminology.

Please see responses to (b) above for the isolation of the blowdown system and other nonsafety-related portions of the ESWS. The intake basin makeup system does not exist; instead there is a UHS [basin] makeup system, however, it does not have any physical connections to the ESWS hence it will be deleted.

CDI is provided after the 10th paragraph of DCD Section 9.2.1.2.1 as follows:

"**[As part of the water chemistry management program of a plant that utilizes cooling towers and basins as the ESWS water source, an ESWS blowdown line is installed at the ESWP discharge piping. Part of the pumped ESW is blown down to remove a portion of the accumulated chemical salts and dissolved solids per site environmental chemistry requirements while the UHS makeup system is in operation. Details are given for blowdown and UHS basin water makeup in Section 9.2.5.]**"

The first paragraph of the proposed Tier 2 DCD Section 9.2.5.2.2 markup from RAI 286-2145 Rev. 1 (MHI Letter # UAP-HF-10191 dated July 7, 2010) has been revised as follows:

"[Each ESWP takes suction from its ESW intake basin located beneath the pump house as described in Subsection 9.2.5.2.1. The water flows through the CCW heat exchangers and essential chiller units and then is cooled by the cooling tower before being returned to the basin. A portion of the water is discharged as blowdown water to maintain water chemistry **via the ESWS when the makeup water is available. The blowdown rate is determined using a conductivity cell located at ESW pump discharge and is based on the total dissolved solids in the water and the makeup water source.** The blowdown operation is terminated during accident mitigation or loss of make-up water]."

The CDI provided in DCD Section 9.2.5 for Table 9.2.5-4, Failure Modes and Effects Analysis for the Ultimate Heat Sink, which was submitted as part of the response to RAI 286- 2145 Rev. 1 is revised by deleting item (5) from the table and adding it to Table 9.2.1-2, Essential Service Water System Failure Modes and Effects Analysis as CDI:

(Table 9.2.5-4)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
~~5~~	~~UHS Basin Blowdown Control Valve (EWS-HCV-010, 011, 012, 013), fail close air operated valve~~	~~Closes to isolate blowdown~~	~~All~~	~~Fails to close upon command~~	~~Position indication in MCR~~	~~None. Blowdown can be isolated by closing the manual valves (VLV-541A,B,C,D, VLV-543A,B,C,D)~~ ~~Effect of uncontrolled blowdown for 30 minutes on basin inventory is insignificant.~~	

(Table 9.2.1-2)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
[5	**ESWS Basin Blowdown Control Valve (EWS-HCV-010, 011, 012, 013), fail close air operated valve**	**Closes to isolate blowdown**	**All**	**Fails to close upon command**	**Position indication in MCR**	**None. Blowdown can be isolated by closing the manual valves (VLV-541A,B,C,D, VLV-543A,B,C,D)** **Effect of uncontrolled blowdown for 30 minutes on basin inventory is insignificant.]**	

Question: d) Section 9.2.1.2.1 indicates that the ESWS is arranged into four independent trains. However, the descriptive information does not adequately explain how the design ensures that failures, events, or conditions that ultimately render one train inoperable won't adversely affect the other trains. A brief summary discussion is adequate provided complete evaluations of these considerations are provided in other parts of the DCD and referred to for completeness. However, for those parts of the ESWS that are not included within the scope of the standard plant design, it's not clear to what extent and on what basis this information pertains to COL applicants.

Answer: d)
The four independent train arrangement of the ESWS assures that failures and postulated events in one train do not affect the safety-related functions of the other trains. During normal ESWS operation, at least two trains out of four are required to be operable to meet the design requirements. During accidents and other design basis events, such as during a LOCA or safe shutdown conditions, a postulated single active component failure in one train coincident with on-line maintenance in another train does not prevent the ESWS from performing its safety-related functions with the two remaining operable trains. Instrumentation is also provided independently and not shared among the trains. DCD 3.8.4.1.1 R/B states that "Non-radioactive safety systems such as the ESWS, CCWS and electrical system, etc., are located in the plant southern area of the R/B. This area is also separated into four divisions by a physical barrier to assure that the functions of the safety-related systems are maintained in the event of postulated incidents such as fires, floods, and high energy line break events."

The second paragraph of DCD Subection 9.2.1.2.1 has been revised by adding the following at the end:

"**This arrangement assures that failures and postulated events in one train do not affect the safety-related functions of the other trains. During normal ESWS operation, at least two trains out of four are required to be operable to meet the safety-related design requirements. During accidents and other design basis events, such as a LOCA or safe shutdown with a LOOP, a postulated single active component failure in one train coincident with on-line maintenance in another train do not prevent the ESWS from performing its safety-related functions with the two remaining operable trains. Instrumentation is also provided independently and not shared among the trains.**"

For the site specific portions of the ESWS such as the ESWPT and discharge and intake structures, the four independent train arrangement also applies. DCD Subsection 9.2.1.1.1 "Safety Design Bases" is revised by adding the following after the last bullet:

"**The ESWS is composed of four redundant trains completely separated from each other, and whose components and piping are not shared with the other trains and other plant units. There are no interconnections among the trains so that the failure of one train will not affect another per GDC 5.**"

Question: e) Section 9.2.1.2.1 indicates that the COL applicant is to provide the piping, valves, and other design related to the site specific UHS. This does not pertain to the ESWS and should be discussed in Section 9.2.5.

Answer: e)
The statement in question has been deleted from DCD Section 9.2.1.2.1, relocated to Section 9.2.5, and added as COL 9.2 (28) in DCD Section 9.2.10 as given in the response to RAI 286-2145 Revision 0 (MHI Letter # UAP-HF-10191 dated July 7, 2010).

Question: f) Section 9.2.1.2.2.5 indicates that underground piping is epoxy lined carbon steel and placed in trenches. The following considerations need to be addressed:
· Figure 1.2-1 shows that an ESWS pipe tunnel is used, not trenches.
· Applicable design specifications and potential failure modes'

· The buried piping and pipe tunnel are not within scope for the standard plant, and it's not clear to what extent and on what basis this information applies to the COL applicants.

Answer: f)

The essential service water pipe tunnel (ESWPT) is site specific but the existence and function of which are required in the standard plant design. The ESWS supply and return pipes (feeding components in the R/B and PS/B) are located in this tunnel. The COL Applicant is to design the pipes entering and exiting this tunnel based on the location of the Ultimate Heat Sink Related Structure (UHSRS). As noted in DCD Section 9.2.1.2.2.5, means are provided for periodic inspection of this piping. The pipe lining material will no longer be specified. The COL Applicant will be given the option to choose the material most suitable for the site. The site specific ESW piping will be chosen by the COL Applicant based on ESWS water chemistry. The rest of the ESWS piping will be carbon steel or internally lined carbon steel depending on ESWS water chemistry requirements. All piping will be inspected in accordance with the established ISI program. ASME B&PV Code, Section XI, Article IWA 5244 provides alternate in service inspection rules for those sections of buried components that are not accessible. No specific failure of the underground ESWS piping is anticipated. Cathodic protection will be provided for any buried piping. All safety-related ESWS are designed to ASME B&PV Code, Section III, Class 3 requirements.

Tier 2 DCD 9.2.1.2.2.5 is revised as follows:

"Carbon steel piping designed, fabricated, installed and tested in accordance with ASME Section III, Class 3 requirements, is used for the safety-related portion of the ESWS. Piping is arranged to permit access for inspection. ~~Underground piping is epoxy lined carbon steel and placed in trenches. Manholes are provided for periodic piping inspection.~~ **The essential service water pipe tunnel (EWPT), including the ESW piping from this tunnel to the ESW pump intake and discharge structures and the UHS, is site specific but the existence and function of which are required in the standard design. The COL applicant is to locate the pipes entering and exiting the pipe tunnel based on the location of the UHSRS, as required. [The piping located in trenches will be externally lined carbon steel and the lining material specification will vary according to the site soil chemistry. The rest of the ESWS piping will be carbon steel or internally lined carbon steel depending on ESWS water chemistry requirements. Cathodic protection will be provided for buried piping. Access manholes will be provided as required for periodic inspection.] The piping will be inspected per ASME Section XI, article IWA 5244 requirements.**"

COL 9.2 (7) is revised as follows:

"*COL 9.2 (7)* *The COL Applicant is to ~~provide~~ **address** the piping, valves, lining **material specifications for piping, valves, and fittings as applicable,** including those at the boundary between the safety-related and nonsafety-related portions, and other design of the ESWS related to the site specific conditions~~, including the safety evaluation~~. **The COL Applicant is also to design the pipes entering and exiting the pipe tunnel based on the location of the UHSRS.**"*

A new subsection outlining the ESWS interface requirements in Tier 1 (Subsection 3.2.3) will be added to include the following:

"**a. The ESWS piping in the ESWPT that connects to the cooling water intake and discharge structures is designed, constructed and inspected in accordance with ASME Code Section III and Section XI.**"

Question: g) Section 9.2.1.2.2.6 indicates that valves are provided for back-flushing the CCW heat exchangers. It isn't clear why this design feature is provided since an in-line self cleaning strainer is provided and this needs to be better explained.

Answer: g)
The CCW heat exchanger inlet strainers have been removed from the design and, along with the ESWP discharge basket strainers, have been replaced by automatic self-cleaning strainers at the ESWP discharge. See responses to Questions 09.02.01-34 and 09.02.01-52 for details.

The CCW plate heat exchangers have flow passages approximately between 3 mm ~ 6 mm in width. The ESW pump discharge strainer mesh size of 3 mm effectively removes debris materials over 3 mm in size. Smaller size debris of less than 3 mm could accumulate in the heat exchanger and cause a rise in the HX differential pressure. If ever the differential pressure increases, backflushing the CCW heat exchangers relieves this rise in pressure and effectively removes the accumulated debris materials.

Tier 2DCD Subsection 9.2.1.2.2.3 is revised by adding the following after the first paragraph:
"**A backflushing line is provided for each CCW HX to enable backflushing of the heat exchanger following a high differential pressure alarm that may likely be caused by accumulation of debris materials inside the heat exchanger plate flow channels.**"

Question: h) Section 9.2.1.2.3.1 does not include a description of ESWS operation for satisfying shutdown cooling considerations.

Answer: h)
The first paragraph of DCD Subsection 9.2.1.2.3.1 is revised as follows:
"The ESWS consists of four independent trains. During normal plant operation, two trains are operating and at least one other train is on standby. Each train is designed to provide 50% of cooling capacity required for design basis accident and for safe shutdown with LOOP. The ESWS is designed to perform its safety function of **removing heat from the CCW heat exchangers and essential chiller units for** accident mitigation **and during safe shutdown** ~~assuming that~~ with one train assumed ~~is~~ out of service **due to** ~~for~~ maintenance coincident with ~~the loss of offsite power~~ **a LOOP** and a single failure in another train. A maximum ESW operating temperature of 95° F, based on the bounding meteorological and water source conditions from representative locations in the United States, has been evaluated to adequately remove CCW HX heat load at all operating conditions. This temperature is deemed conservative **and supports safely bringing the reactor coolant temperature from 350° F to 200° F 36 hours after reactor shutdown via four operating ESWS and CCWS trains. Failure of one ESWS train will not prevent the plant from achieving cold shutdown conditions**."

The second paragraph of DCD Subsection 9.2.1.2.3.1 is revised by adding the following:

"Table 9.2.1-3 and Table 9.2.1-4, respectively, provide heat loads and water flow balance for various operating modes. **The ESWS design heat loads are based on the maximum safe shutdown heat loads with only two ESWS trains operable while one train is assumed to have failed due to a single active component failure and another train is undergoing online maintenance. The ESW flow rate of 13,000 gpm and maximum supply temperature of 95° F are maintained even under these conditions.**"

Question: i) Section 9.2.1.3 indicates that the UHS has sufficient water volume to perform required cooling to mitigate the consequences of an accident. The UHS is described in Section 9.2.5 and this discussion should be relocated to that section accordingly.

Answer: i)
The statement in question was misplaced and has been deleted. Markups to DCD Section 9.2.5 on this subject are provided as a follow up response to RAI 286-2145 Rev. 1 (MHI Letter # UAP-HF-10191 dated July 7, 2010).

Question: j) Section 9.2.1.3 (page 9.2-9) indicates that the COL applicant is to provide the UHS water volume, maximum operating water temperature and the lowest water level for the ESWPs. This item pertains to the UHS and should be discussed in Section 9.2.5.

Answer: j)
The UHS water volume and maximum supply temperature are equally important to the ESWP design so as to ensure that the ESWPs have available NPSH and the ESWS can perform its safety functions during the worst design basis events such as during a LOCA or safe shutdown. Nevertheless, ample description and interfaces have been added to Tier 2 DCD Section 9.2.5 as a response to RAI 286-2145 Rev. 1 (MHI Letter # UAP-HF-10191 dated July 7, 2010), thus the description in DCD Section 9.2.1.3 is deleted.

Question: k) Section 9.2.1.3 indicates that the COL applicant is to provide the safety evaluation for the ESWS design related to the site specific conditions. This item is much too broad and needs to identify what design features and site specific conditions are being referred to for action by the COL applicant.

Answer: k)
This COL applicant requirement in DCD 9.2.1.3, 14th paragraph, has been changed to specify the design features and site specific conditions for evaluation as follows:

"The COL Applicant is to provide the safety evaluation **of the capability of the ESWS to: (1) isolate its site-specific, nonsafety-related portions [such as the ESWS blowdown line and FSS supply line when applicable]; and (2) provide measures to prevent long-term corrosion and organic fouling that may degrade its performance, per Generic Letter (GL) 89-13**~~for the ESWS design related to the site specific conditions~~."

Consequently, the above COL applicant requirement will be added to Section 9.2.10 as COL 9.2(29) below:

"***COL 9.2(29)*** ***The COL applicant is to provide the safety evaluation of the capability of the ESWS to: (1) isolate its site-specific, nonsafety-related portions; and (2) provide measures to prevent long-term corrosion and organic fouling that may degrade its performance, per Generic Letter (GL) 89-13.***"

Also, response to item (f), clarified SPDI and CDI portions of the ESWS. The COL applicant is to provide safety evaluation for the CDI portions of the system.

Question: l) Section 9.2.1.3 indicates that the COL applicant is to provide the protection against adverse environmental, operating, and accident conditions that can occur such as freezing and thermal overpressurization; and that the COL applicant is to provide the preventive measures for protection against adverse environmental conditions. This is much too broad and needs to be more specific. Protection of structures, systems, and components (SSCs) against adverse environmental, operating and accident conditions should not be deferred to a COL applicant unless adequately justified by the plant-specific considerations that are involved. For example, freeze protection of piping systems is dependent on plant-specific temperature considerations and would have to be addressed by the COL applicant. However, protection of piping that is included within the scope of the standard plant from environmental effects due to an accident should be addressed by the standard plant design. The applicant needs to address this.

Answer: l)
See response to Question 09.02.01-55.

The COL applicant requirement is intended to provide protection of the site-specific portions of the ESWS; 13th paragraph of DCD Subsection 9.2.1.3 has been revised as follows:

"The COL applicant is to provide ~~the~~ protection **of the site-specific portions of the ESWS [such as the ESWS blowdown line, FSS supply line, ESWPT piping towards the intake and discharge structures, i.e. piping running between the nuclear island and UHSRS, and any ESWS piping in the UHSRS]** against adverse environmental, operating, and accident conditions that can occur such as freezing, **low temperature operation,** and thermal overpressurization."

COL item 9.2(2) has been revised as follows:

"*COL 9.2(2)* *The COL Applicant is to provide ~~the~~ protection* ***of the site-specific portions of the ESWS*** *against adverse environmental, operating, and accident conditions that can occur, such as freezing,* ***low temperature operation, and*** *thermal overpressurization. ~~The COL Applicant is to provide the preventive measures for protection against adverse environmental conditions.~~*"

Question: m) Section 9.2.10, COL 9.2(6) indicates that the COL applicant is to provide ESWP design details – required total dynamic head, NPSH available, etc. NPSH available is a function of the water level in the pump basin and the design detail of interest that needs to be addressed is the minimum NPSH that is required.

Answer: m)
The minimum required NPSH is a function of pump design and determined by the pump manufacturer and is dependent on a number of pump design parameters, e.g., speed, impeller inlet flow angle, and number of impeller vanes. The minimum available NPSH, which is dependent on the pump intake basin level (at the end of 30 days into the design basis accident as described in DCD Section 9.2.5 based on the response to RAI 286-2145 Rev.1 (MHI Letter # UAP-HF-10191 dated July 7, 2010)), shall be determined by the COL Applicant. In other words, the minimum required NPSH can only be provided by the pump manufacturer during the detailed design phase, hence, COL 9.2(6) is retained.

See also response to Question 09.02.01-37.

Question: n) Section 9.2.10, COL 9.2(7) indicates that the COL applicant is to provide piping and valves, including those at the boundary between safety-related and nonsafety-related portions related to site-specific conditions. It isn't clear what this item is referring to and to what extent it applies to that part of the ESWS that is within scope for the standard plant design, such as vents and drains.

Answer: n)
Vents and drains up to the isolation valves are within the scope of the standard plant design. Piping downstream of these valves is nonsafety-related. For the site specific piping mentioned in the response to Question 09.02.01-32 (a), the COL applicant is to determine the location of the vents or drains and the boundaries in accordance with COL 9.2(7). Site specific conditions identified in this COL item refers to the systems like blowdown piping (tapped from pump discharge), which is shown in the revised Figure 9.2.1-1 as CDI of using cooling tower for UHS as stated in the response to RAI 286-2145 R1, or ESWS acting as a back-up water source to the fire service system in certain areas. These site specific details including interface requirements are to be addressed by the COL Applicant.

Tier 2 DCD Subsection 9.2.1.2.2.5 has been revised as described in the response to Question (f) above.

Question: o) Table 9.2.1-4 shows for Trains A & B that 50 gpm are required for cooling the ESW pump motor to support safe shutdown. This appears to be in error since only one ESW pump is needed which requires a flow rate of 25 gpm for motor cooling. Also, because this aspect of the ESWS design is not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants.

Answer: o)
The ESWP motor cooling line was deleted in DCD Section 9.2.1 and in Table 9.2.1-4 as a response to RAI 3968 (CP RAI #109), Question 09.02.01-4 (ML100560572). Instead of specifying the mode of cooling of the ESWP, this was changed to a site-specific item to be determined by the COL Applicant. The DCD markups were provided in an MHI letter to the NRC, UAP-HF-09533 dated November 20, 2009.

Question: p)
Table 9.2.7-1 shows that the cooling water inlet temperature is 100 degrees F. However, the maximum allowed supply temperature for the ESWS is 95 degrees F and this apparent inconsistency needs to be explained.

Answer: p)
This is a typographical error. The cooling water inlet temperature of the essential chiller unit in Table 9.2.7-1 should be 95° F. It follows that the cooling water outlet temperature should be 111° F. Appropriate corrections are made to the table. See related markups.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Sections 9.2.1, 9.2.1.1.1, 9.2.1.1.2, 9.2.1.1.3, 9.2.1.2.1, 9.2.1.2.2, 9.2.1.2.2.5, 9.2.1.2.3.1, 9.2.1.3, 9.2.10 and DCD Tables 9.2.7-1 and 9.2.5-4, Attachment 2 for changes to Tier 2 DCD Section 1.2.1.5.4.4, and Attachment 5 for Tier 1 DCD Subsection 3.2.3.

Impact on COLA

Corresponding changes will be made to the R-COLA in the next revision.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-34

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 NRC staff. The ESWS descriptive information provided in Tier 2 of the DCD, Revision 2, Section 9.2.1.2.2.2 was reviewed to confirm that the ESWS is capable of performing its heat removal function. The staff found that the use of strainers (both ESWS and CCW self-cleaning) was not adequately described and justified in this regard. For example, items that need to be addressed include:

a. Applicable design and quality specifications that apply.

b. Maximum allowed differential pressure and basis; and maximum design differential pressure.

c. Mesh size and basis.

d. Failure modes.

e. Figure 9.2-1 shows that the self-cleaning strainer discharges water through a flow path that includes a flow orifice. This is a potential choke point for debris accumulation that can ultimately cause diminished flow and plugging of this flow path, and no flow indication is provided for monitoring this condition. Furthermore, the debris that is flushed out through this flow path could cause a problem for the UHS if mechanical draft cooling towers are used because the debris could cause the spray nozzles to become obstructed. These aspects of the design need to be addressed and justified.

f. For ESWS strainers: a clear distinction between what actions are automatic vs. what actions require operator action along with justification as appropriate.

g. For ESWS strainers: for worst case scenario with strainers at/near maximum allowable differential pressure, an explanation is needed for how the safety function is assured. Manual operator actions need to be identified and justified.

h. The ESWS strainers are not within the scope of the standard plant, and it's not clear to what extent and on what basis the information in the DCD applies to COL applicants.

ANSWER:

Note: The CCW HX inlet strainers and ESWP discharge basket type strainers have been deleted from the design as explained in the response to Question 09.02.01-52. Thus the responses below apply only to the automatic self-cleaning ESWP discharge strainers that are proposed to replace the ESWP discharge basket strainers and CCW HX inlet passive self-cleaning strainers.

Question: a) Applicable design and quality specifications that apply.

Answer: a) Table 9.2.1-1 describes the ASME Code classification of the strainers along with the other major components of the ESWS.

The ESWP discharge strainers are designed per ASME Boiler and Pressure Vessel Code Section III, Division I, Subsection ND - Class 3 Components and ASME NQA-1 - Quality Assurance Requirements for Nuclear Facility Applications. DCD Subsection 9.2.1.2.2.2 has been revised to include this information.

Question: b) Maximum allowed differential pressure and basis; and maximum design differential pressure.

Answer: b)
The maximum allowed differential pressure is 7 psi at the design rate of 13,000 gpm—a design requirement and a necessary parameter in the pump design head calculations. The maximum design differential pressure shall be greater than the maximum allowed differential pressure and subject to other design parameters according to manufacturer specifications to assure component structural integrity. Table 9.2.1-1 is revised to add the maximum allowed differential pressure.

Question: c) Mesh size and basis.

Answer: c)
The strainer mesh size of 3 mm is selected in relation to the CCW plate heat exchanger flow channels approximately 3 mm ~ 6 mm wide. The essential chiller unit flow passages are greater than 8mm—the basis of the 8 mm mesh size of the formerly proposed bucket type strainer. The strainer mesh size ensures that solids larger than 3 mm do not enter the heat exchangers, essential chiller units, and the cooling tower nozzles (when cooling towers are used) thus protect them from clogging. Tier 2 DCD 9.2.1.2.2.2 has been revised to add this information as described in the response to Question 09.02.01-52.

Question: d) Failure modes.

Answer: d)
Strainer failure modes are tabulated in the revised Tier 2 DCD Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis as follows:

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 3 of 5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
3	ESWP Discharge Strainer (SST-001A, B, C, D and SST-002A, B, C, D)	Starts and opens to provide flow path to backwash flow before strainer clogging to maintain ESW supply to CCW HX	A, Accident, Safe shutdown, cooldown – loss of offsite power	A, Fails to start and fails to open on remote manual demand	A, Position indication in MCR	A, None Remaining three 50% capacity trains are available. Minimum of two trains are required for safety function.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two ESWS trains are required.
		Stops and isolates backwash flow to prevent drain down which leads water hammer at pump restart	A, Startup, normal shutdown, normal operation, refueling, cooldown B, Accident, safe shutdown, – loss of offsite power	A, Fails to closed position at pump stop signal B, Fails to closed position at pump stop signal	A, Position indication in MCR B, Position indication in MCR	A, None Backwash flow can be isolated by closing ESWP Discharge Strainer Backwash Isolation Valve at pump stop signal B, None Same as A.	

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 4 of 5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
4	ESWP Discharge Strainer Backwash Isolation Valve to Normal Drain Path (EWS-MOV-573A, B, C, D and EWS-MOV-574A, B, C, D)	Starts and opens to provide flow path to backwash flow before strainer starts to clog to maintain ESW supply to CCW HX	A, Accident, safe shutdown, – loss of offsite power	A, Fails to open on remote manual demand	A, Position indication in MCR	A, None Remaining three 50% capacity trains are available. Minimum of two trains are required for safety function.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two ESWS trains are required.
		Stops and isolates backwash flow to prevent drain down which leads water hammer at pump restart	A, Startup, normal shutdown, normal operation, refueling, cooldown B, Accident, safe shutdown, – loss of offsite power	A, Fails to closed position at pump stop signal B, Fails to closed position at pump stop signal	A, Position indication in MCR B, Position indication in MCR	A, None Backwash flow can be isolated by closing ESWP Discharge Strainer Backwash Isolation Valve at pump stop signal B, None Same as A.	

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 5 of 5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
[5	ESWS Blowdown Control Valve (EWS-HCV-010, 011, 012, 013), fail close air operated valve	Closes to isolate blowdown	All	Fails to close upon command	Position indication in MCR	None. Blowdown can be isolated by closing the manual valves (VLV-541A,B,C,D, VLV-543A,B,C,D) Effect of uncontrolled blowdown for 30 minutes on basin inventory is insignificant.]	

Question: e) Figure 9.2-1 shows that the self-cleaning strainer discharges water through a flow path that includes a flow orifice. This is a potential choke point for debris accumulation that can ultimately cause diminished flow and plugging of this flow path, and no flow indication is provided for monitoring this condition. Furthermore, the debris that is flushed out through this flow path could cause a problem for the UHS if mechanical draft cooling towers are used because the debris could cause the spray nozzles to become obstructed. These aspects of the design need to be addressed and justified.

Answer: e)
See response to Question 09.02.01-52.

The ESWS piping at the strainer inlet and backwash piping are chosen so that the ESW velocity is maximized to produce sufficient driving force to expel small size debris out of the backwash piping. A backwash line orifice shall be chosen to have a differential pressure drop that prevents choking or plugging of the orifice. In the former layout with the CCW HX self-cleaning strainers, the orifice in the discharge line downstream of the CCW HX where the strainer backwash line converged was expected to have a diameter much larger than the orifice in the backwash line 6 inches in diameter. Thus, the probability of debris choking the flow path in the 24 inch-ESWS pipe would be rather small.

In the present design, the normal strainer backwash flow from the automatic strainers does not converge with the ESWS discharge piping, hence no debris material of diameters larger than 3 mm can pass through the cooling tower nozzles. The cooling tower spray nozzle size, nonetheless, shall be chosen to prevent plugging by small size debris materials.

Tier 2 DCD Subsection 9.2.1.3 has been revised to include the following COL applicant interface as the end of the subsection:

"**The COL applicant is to specify appropriate sizes of piping and pipe fittings such as restriction orifices to prevent potential plugging due to debris buildup, and develop maintenance and test procedures to monitor debris build up and flush out debris.**"

COL 9.2(26) is revised as follows to ensure that no plugging in narrow piping anywhere within the ESWS occurs:

COL 9.2(26) *The COL applicant is to* ***specify appropriate sizes of piping and pipe fittings such as restriction orifices to prevent potential plugging due to debris buildup,*** ~~*to*~~ ***and*** *develop maintenance and test procedures to monitor debris build up and flush out debris.*

Question: f) For ESWS strainers: a clear distinction between what actions are automatic vs. what actions require operator action along with justification as appropriate.

Answer: f)

The parallel basket strainers at the ESWP discharge, along with the CCW heat exchanger inlet passive self-cleaning strainer, are replaced with parallel automatic self-cleaning strainers. A high differential pressure alarm from the operating strainer will initiate automatic backwashing of debris materials. The manual actions involving these new strainers would be the remote manual actuation of the strainer backwash control valves during all plant conditions.

See also response to Question 09.02.01-52. The above description has been added to Tier 2 DCD Subsection 9.2.1.2.2.2 as part of the response to Question 09.02.01-52.

Question: g) For ESWP discharge strainers: for worst case scenario with strainers at/near maximum allowable differential pressure, an explanation is needed for how the safety function is assured. Manual operator actions need to be identified and justified.

Answer: g)
During normal power operation, automatic backwashing shall start before the strainer differential pressure reaches the maximum allowable differential pressure of 7 psi. Failure of any of the backwash valves to open automatically will require the operator to remotely actuate the valve to start the strainer backwash operation. During accident conditions, if backwashing fails due to faulty instrumentation or mechanical failure, that whole ESWS train can be isolated without impact since one other train is operable while another is assumed to be out of service due to maintenance. Technical Specifications 3.7.8 ensure that at least three trains are operable by restoring one required yet unavailable train to operable status within 72 hours.

See also response to Question 09.02.01-52.

Question: h) The ESWP discharge strainers are not within the scope of the standard plant, and it's not clear to what extent and on what basis the information in the DCD applies to COL applicants.

Answer: h)
The ESWP discharge strainers and all required parameters such as type, design flow rate, and maximum allowable differential pressure are within the scope of the standard plant. Tier 2 DCD Table 9.2.1-1 provides the standard design details of the ESWS. The design details of the strainer backwash line and vent line and their discharge locations are site specific.

Tier 2 DCD Subsection 9.2.1.2.2.2 is revised to include the COL applicant interface requirement at the end of the subsection as follows (see also response to Question 09.02.01-52.):

"**<u>The COL Applicant is to provide the design details of the strainer backwash line, vent line, and their discharge locations.</u>**"

Tier 2 DCD Subsection 9.2.10 is also revised by adding the new COL Applicant item below:

"***<u>COL 9.2(33)</u>*** ***<u>The COL Applicant is to provide the design details of the strainer backwash line, vent line, and their discharge locations.</u>***"

Tier 2 DCD Table 9.2.1-1 is also revised to add the power supply classification of the active ESWS components.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Table 9.2.1-1 Essential Service Water System Component Design Data, Table 9.2.1-2 FMEA Table and DCD Subsections 9.2.1.2.2.2, 9.2.1.3, and 9.2.10. See also response to Question 09.02.01-52.

Impact on COLA

Changes to R-COLA will be reflected appropriately in the next revision. All other changes are incorporated by reference.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-35

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) Chapter 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 ESWS descriptive information provided in Tier 2 of the DCD, Revision 2, Section 9.2.1 was reviewed to confirm that the ESWS is capable of performing its heat removal function. The staff found that the minimum system design temperature and low temperature operation were not adequately described and addressed in this regard. Current operating plants have found it necessary to throttle CCWS and ESWS flow rates to accommodate reduced temperature operating conditions and it isn't clear why this will not be necessary for the US-APWR design during both normal operating and shutdown conditions. The impact of reduced temperature on accident mitigation capability and the need for operator action in this regard also needs to be addressed.

ANSWER:

See also response to Question 09.02.01-55.

There are three main areas where the minimum system design temperature and low temperature operation are a consideration:

1. ESWS internal fluid freezing because the required service water flow to the CCW heat exchanger is not achieved.

The COL Applicant is required to comply with the requirements in COL 9.2(2) on the preventive measures and protection of the ESWS against adverse environmental conditions, such as freezing, in order to deliver the required service water flow to the essential chiller units and CCW heat exchangers. The ESWS is designed to operate at a minimum ESW temperature of 32° F in the liquid phase. More severe conditions can be expected for the standby trains, however, the HVAC system maintains the ESW pump, the CCW heat exchanger and essential chiller unit room temperatures between 50° F ~ 105° F (DCD Table 9.4-1) so that there will be no instance of the temperature ever dropping to freezing temperatures at any operating conditions. ESW piping outside the nuclear island buildings is required to have protection provided by the COL Applicant from adverse environmental effects, thus freezing of the ESW running through the pipes is not a concern. Stagnant and exposed portions of the standard design will be protected from the environment as delineated in COL 9.2(2). The COL applicant is to provide specific details as required by the location. See Tier 2 DCD Section 9.4 for HVAC system details.

2. Safety analysis such as performance capability studies of the emergency core cooling system (ECCS) and external pressure analysis for containment integrity
   - Two safety analyses have been performed:
     (a) The containment vessel external pressure analysis which assures the integrity of the PCCV at a maximum outside to inside differential pressure caused by inadvertent actuation of the containment spray system with inside PCCV air depressurization. This analysis assumes a spray temperature of 32° F. Tier 2 DCD Subsection 6.2.1.1.3.5 states this assumption.
     (b) The minimum containment pressure analysis for performance capability studies of the ECCS which also assumes a conservative spray temperature of 32° F without freezing. Tier 2 DCD Subsection 6.2.1.5 states this assumption.

     The spray water is cooled by the CCWS through the containment spray heat exchanger, and the intermediate CCWS is cooled by the ESWS. However, this assumption does not imply that the CCWS and ESWS minimum temperatures are below freezing to maintain a spray temperature of 32° F but that assuming this temperature is conservative. The above analyses thus show that low temperature operations are not detrimental to any of the systems concerned.

3. Component integrity, e.g. of the ESWS piping, the CCW heat exchanger, the ESW pump
   - The ESWS piping, ESW pumps, CCW heat exchangers, and essential chiller units are designed to operate with water temperatures as low as 32° F during all modes of plant operation. The structural materials of these components are not affected by extreme reductions in the ESWS coolant temperature except freezing.

     The essential chiller units are installed with low temperature alarms and will trip when the coolant temperature reaches a predetermined setpoint to prevent damage to the chillers. The bypass line found downstream of the chiller is used to prevent tripping of the chillers during low temperature conditions. See DCD Section 9.2.7 for more details. The location of ESW piping in tunnels or trenches and heat tracing of those exposed to the atmosphere ensures that water filling the ESWS pipes from any type of UHS is always above the minimum temperature of 32° F.

As discussed above, it is not found necessary to throttle the ESW flow rate to the user components during low temperature conditions. Further, the following rationale also supports why the ESW design flow rate should be maintained at any condition: (1) at accident conditions, the heat loads from the CCWS to the ESWS are high so the potential for the ESW to drop near freezing temperatures is extremely low; (2) heat transfer rates through the CCW heat exchanger are increased at reduced ESW temperatures; and (3) reduced ESW rates through the pipes outside the reactor building may cool the ESW more rapidly and increase the potential for ice formation.

Tier 2 DCD Subsection 9.2.1.2.1 is revised by adding the following at the end of the 3rd paragraph:

"**<u>The ESW flow of 13,000 gpm is maintained at all operating conditions, including accident conditions and safe shutdown with a LOOP. The ESWS is designed to operate at temperatures as low as 32° F. For the ESWS piping and components in the R/B and PS/B, freezing of the ESW in the standby trains is precluded by the HVAC system operating</u>**

between 50° F and 105° F. [Piping running through tunnels and trenches are below grade so that freezing of the ESW is not a concern. Stagnant and exposed portions of the system are heat traced to ensure that the ESW inside these structures is maintained above 32° F.] "

Tier 2 DCD Subsection 9.2.1.3 is revised by adding the following at the beginning of the 13th paragraph:

"**The ESWS is designed for operation at low water temperature of 32° F during all modes of plant operation.**"

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsections 9.2.1.2.1 and 9.2.1.3.
See also response to Question 09.02.01-55.

Impact on COLA

The R-COLA will be revised to reflect the above changes to the DCD.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-36

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. This guidance includes consideration of water hammer effects. Sections 9.2.1.2.1 and 9.2.1.2.3.1 of the DCD indicate that voiding may occur following a loss of offsite power. In order to minimize the potential for water hammer, the pump discharge valve is interlocked to close when the pump is not running or is tripped. Upon pump restart, after a predetermined time delay, the discharge valve gradually opens to preclude water hammer. The following considerations need to be better addressed:

a) While the description indicates that water downstream of the high point in the CCW discharge pipe will void, this part of the system is apparently CDI and this may not occur for the plant specific design; especially if a cooling tower is on the downstream side.

b) While the pump discharge check valve is supposed to prevent voiding on the upstream side of the ESW pump, no justification in terms of a valve leak rate criterion and recognition of this in the IST program was provided. Likewise for the pump discharge motor operated butterfly valve.

c) The pump is being started in a voided condition with no flow through the pump and no cooling for the motor for a "predetermined" period of time. This mode of operation with no minimum-flow recirculation included in the design needs to be better described and justified.

d) The pump discharge valve is a butterfly valve which may not be capable of providing the flow control that is needed for "precluding" water hammer. Note that the extent of voiding that can occur based on the considerations involved needs to be established during the initial test program and acceptable performance needs to be demonstrated.

e) The description indicates that a pump is tripped if its discharge valve doesn't open and based on the description in Section 9.2.1.2.3.1, this is apparently a manual operator action. Note that manual operator actions are typically not allowed in this regard and must be justified.

f) Upon restart, the ESW pump is supposed to sweep out air in the system through high-point vents. However, there is no discussion about where these high point vents are and how they function to remove air without operator action involved.

g) Due to the uncertainties involved the initial test program needs to include testing to demonstrate that water hammer is not a problem for the design.

Much of the information pertains to parts of the ESWS that are not included within the scope of the standard plant, and it's not clear to what extent and on what basis this information applies to COL applicants.

ANSWER:

Answer to a)
There are two cases where voiding can occur in the system including the CCW discharge pipe:

(1) Formation of steam pockets in raised piping due to reduction of pressure below the saturation pressure when the ESWS pump stops caused by the difference in elevation with the part open to the atmosphere in the UHS including both suction and discharge side.

(2) Water drainage to the UHS during pump stop due to difference in elevation with the part open to the atmosphere in the UHS that leads to formation of air voids in the piping.

Countermeasure to case (1):
To maintain the discharge portions of the ESWS and UHS above saturation pressure during pump operation and stoppage, especially downstream of the pump discharge check valve, the highest portion in the raised piping of the ESWS/UHS with respect to the part open to the atmosphere in the UHS should not be higher than the height necessary to maintain the ESWS and UHS discharges above saturation pressure, approximately equal to the static head. During pump operation, the dynamic head adds to the static head which keeps the system above the saturation pressure therefore, the requirements during pump stoppage above will also satisfy the requirements during pump operation.

At the pump discharge upstream of the pump discharge check valve, the difference in elevation between the pump suction water level and the horizontal piping with the check valve may not be lower than the required height for keeping the saturation pressure which is dependent on the UHS type such as a cooling tower with basin whose volume could decrease during an accident condition. For other UHS types such as a once-through type UHS (e.g. sea water, rive, or pond), the suction water level may also reduce due to environmental conditions such as droughts, therefore, vacuum breakers will be added upstream of the check valve as a standard design feature for various UHS types. Commitment to add a vacuum breaker to the system will be added to DCD Subsection 9.2.1.2.3.1 as shown in the "Impact on DCD" below.

Countermeasure to case (2):
For a UHS utilizing cooling towers, the cooling tower spray header may partially drain down during pump stoppage and create air voids in the ESWS discharge piping. At pump restart, abrupt filling of the empty portion of the discharge piping could cause a high pressure spike or water hammer, therefore, an ESWP-discharge MOV interlock is installed so that the discharge MOV gradually opens to slowly fill the downstream piping towards the spray header and prevent pressure surge. This interlock applies to other UHS types, therefore, the discharge MOV interlock is included in standard design.

To establish the COL applicant requirement for item (1) including site specific information has already been described in DCD Subsection 9.2.1.2.1, therefore a new COL item 9.2(31) is added to DCD Subsection 9.2.10 as follows:

"COL 9.2(31)   The COL applicant is to verify the system layout of the ESWS and UHS and is to develop operating procedures to assure that the ESWS and UHS are above saturation conditions for all operating modes."

The 3rd to the last paragraph of Tier 2 DCD Subsection 9.2.1.2.1 is revised as follows:

"The COL Applicant is to ~~develop operating procedures to~~ verify system layout ~~and performance~~ **of the ESWS and UHS and is to develop operating procedures** to assure that the ESW**S and UHS are** ~~is~~ above saturation conditions **for all operating modes** ~~throughout the system~~."

An interface requirement is also added to Tier 1 DCD Section 3.2.3 as follows:

"**b. Operating procedures are developed and system layout of the ESWS and UHS is verified to assure that the ESWS and UHS are above saturation conditions during all operating modes."**

CDI in brackets are added to DCD Section 9.2.1.2.1 in order to demonstrate water hammer prevention through countermeasures to case (1).

Tier 1 DCD Subsections 2.7.3.1.1 and 3.2.1 have also been revised to clarify interface requirements of the ESWS with the UHS. Tier 1 DCD Section 2.7.3.1.1 will be revised as shown in the response to RAI 09.02.01-39. The UHS interface requirements in Tier 1 Section 3.2.1 will be revised to add the following:

"**Countermeasures for water hammer prevention is applied to the UHS and ESWS.**"

This addition to Tier 1 includes the reflection of the answer to RAI 09.02.01-49 (a) regarding the detection of water hammer condition.

Answer to b)
As noted in the DCD the ESWP discharge check valve and the motor operated valve (MOV) prevent water flowing back through the pump into the intake structure when the pump is tripped and prevent voiding.

The allowable leak rate for the discharge MOV and the pump discharge check valve should be less than 10 ml/hr/NPS in inches when the differential pressure is equal to the design pressure in accordance with the MSS SP-61-1999, Pressure Testing of Steel Valves. This is specified in the valve procurement specification. When the ESW pump stops the differential pressure across these valves is just equal to the hydrostatic head downstream of the valves and whose value is smaller than the design pressure. The actual leakage rate should be less than that which is measured at their design pressure. Furthermore, the pressure downstream of the MOV is the static system pressure, hence the leakage from the check valve installed upstream of the MOV should be fairly small. The differential pressure in leakage testing is equal to the design pressure. Actual differential pressure of MOV is equal to the static pressure which is lower than the pressure at testing with the pump in standby. Actual differential pressure of check valve installed upstream of the MOV is low because the system pressure tends to work against the MOV and especially since the assumed leakage is minimal and can be considered negligible to challenge valve performance against voiding.

The MOV and the check valve are identified in DCD Table 3.9-14 with their safety function in "maintain closed" position. The IST program with detailed criteria including valve leak rates shall be prepared by the COL applicant in accordance with COL 3.9(8).

Answer to c)
Because there is no pre-determined time delay for the pump discharge MOV opening, the valve is to open simultaneously with the pump start, the pump is prevented from operating against shut-off head. The DCD will be revised to incorporate this statement.

Answer to d)
The ESWP discharge MOV is not used for flow control but only used to fully open and fully close at pump start and pump stop, respectively for water hammer prevention.

As mentioned in the response to item a) of this question, to preclude the water hammer caused by draining of water from the cooling tower spray header (which may be unavoidable in cooling towers) may be precluded by gradually filling the discharge piping running towards the spray header. Gradually opening the discharge MOV from fully closed to fully open position within 30 seconds provides adequate water hammer prevention.

The COL applicant is to address water hammer issues. Water hammer analysis will be performed in the ITAAC stage of the piping analysis. This analysis will confirm the required opening time for the discharge MOV and then the time may be modified to reflect the results of the analysis.

Tier 2 DCD 14.2.12.1.34 Essential Service Water System (ESWS) will be revised to include testing for confirmation that water hammer does not occur in the system. Please note that the test can be included in DCD Subsection 14.2.12.1.45 Class 1E Bus Load Sequence Preoperational Test. The COL applicant will determine detailed test specifications in accordance with COL 14.2(7).

Answer to e)
Under accident condition, all the ESWPs including standby pump will be actuated by ECCS sequence signal or LOOP sequence signal. If one of the MOV discharge valves fails to open, which is categorized as a single failure criterion, the failure will lead to losing only one ESWS train. For plant safety, two ESWS trains are required to operate during an accident, therefore, the loss of one train is acceptable with another train undergoing on-line maintenance. DCD Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis, item 2 evaluates the above. From the above, no operator action will be necessary under accident condition.

In terms of train switching during normal power operation, the operator can identify which valve has failed from the parameters indicated in the main control board such as the pump discharge pressure or the ESWS flow rate; from then, the operator will stop the pump. The operator action shown above is acceptable under normal power operation.

Answer to f)
Automatic vent valves are to be installed in the strainer because of the following reasons:

- It is preferable to trap air within the strainer and not expel it through other portions of the system—the vent being nearest to the pump ensures this.
- Air voids formed within the pump can be easily introduced to the strainers through the vacuum breakers installed between the pump and the strainer for water hammer prevention. The ESWP discharge strainer structure allows trapped air to accumulate in the upper region hence venting through the strainers can be effectively accomplished.

Commitment to add automatic vent valves to the system will be added to DCD Subsection 9.2.1.2.3.1 as shown in the "Impact on DCD" below.

Answer to g)
Tier 2 DCD 14.2.12.1.34 Essential Service Water System (ESWS) will be revised to include testing for confirmation that impacts due to water hammer are within acceptable limits. Please note that the test can be included into 14.2.12.1.45 Class 1E Bus Load Sequence Preoperational Test. The COL applicant will determine detailed test specifications in accordance with COL 14.2(7).

Impact on DCD

DCD subsection 9.2.1.2.1, 5th paragraph is replaced with the following:

"**The COL applicant is to determine the piping layout of the UHS to maintain the ESWS/UHS pressure above saturation pressure for all operating modes. [The piping layout of the UHS maintains the ESWS/UHS system pressure downstream of the pump discharge check valve above their saturation pressure at 140° F design temperature by ensuring that no piping high points are above the cooling tower spray header. This prevents potential void formation during pump stoppage. During pump operation, due to the addition of the dynamic head to the static head, the ESWS/UHS system pressure will be above saturation pressure.]**
~~The ESWPs are sized to provide positive pressure at the highest point in the system. The system is designed for 140° F.~~ The system layout and the design assure that the fluid pressure remains above saturation conditions at all locations during all modes of operation."

DCD subsection 9.2.1.2.1, 6th paragraph will be revised as shown below:

"~~The ESWS layout ensures that the fluid pressure in the system is above saturation conditions at all locations.~~ The ESWS layout, in combination with the motor-operated valves **(MOVs)** at the discharge of each ESWP, minimizes the potential for transient water hammer. The starting logic of the ESWP interlocks the operation of the motor operated valve with the pump operation. [Voiding in any train **due to potential ESW drain down through the cooling tower spray nozzles** may occur ~~on~~ during loss of offsite power and subsequent pump trip.] To preclude water hammer on pump re-start, the MOV at each pump discharge is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed **except during emergency situations such as an accident or LOOP events**. ~~After a predetermined time delay after the pump starts,~~ **Upon receiving the pump actuation signal such as ECCS actuation or LOOP sequence signal,** the MOV starts to gradually open to preclude water hammer. **The ESWP and ESWP discharge MOV interlock is overridden by either the ECCS actuation or LOOP sequence signal.** If the valve fails to open, **the train may be placed out of service since the loss of one train will not affect any plant safety functions as shown Table 9.2.1.2.**~~pump is tripped~~ **If the valve fails to open during pump switching at normal power operation,** and alarm~~ed~~ is sent to ~~in~~ the MCR. The short time duration during which the pump is dead headed is not detrimental for ~~long term~~ pump performance **and the pump can be manually tripped."**

DCD subsection 9.2.1.2.3.1, 6th paragraph will be revised as shown below:

"Voiding **upstream of the pump discharge check valve** in any train may occur ~~on~~ **during** loss of offsite power and subsequent pump trip**, particularly at a low UHS water level**. **To maintain the pressure at this portion above the saturation pressure to preclude steam void formation which leads to water hammer, vacuum breakers shall be installed between the pump discharge and its check valve. Air entering the piping cushions any abrupt water flow filling the voids and water hammer will not take place at pump actuation. The entering air then discharges through the automatic vent valve installed in the strainer.** The motor-operated pump discharge valve, being powered by a DC power source, is unaffected by the loss of offsite power and will close when the pump stops. [Water **in the cooling tower spray header** ~~downstream of the high point in the CCW heat exchanger discharge pipe~~ will drain to the UHS.] The check valve located in the pump discharge pipe will prevent water flowing back through the pump into the intake structure. In order to preclude water hammer on pump restart, the motor operated valve at the discharge of each pump is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed. When the emergency electrical power becomes available from the gas turbine generators (GTGs), the ESW pump is restarted in accordance with **the LOOP sequence (or** blackout**)** sequence signal and the discharge MOV opens. Since most of the ESWS remains filled with water, the

ESW pump restart will sweep out the trapped air via high point vents **attached at the ESWP discharge strainers**. Therefore, any potential water hammer forces, if present, will have minimum impact on the ESWS operation."

DCD subsection 9.2.1.2.3.1, 7th paragraph will be revised as shown below:

Draining of ESW in an inactive or tripped ESWS train is prevented by double isolation valves downstream of the ESWP, i.e. check valve and MOV. **The differential pressure measured during leakage testing of these valves is established in accordance with the MSS SP-61-1999, Pressure Testing of Steel Valves, is equal to the design pressure. Actual differential pressure of the MOV is equal to the static pressure which is lower than the pressure at testing with the pump in standby or tripped. Actual differential pressure across the check valve installed upstream of the MOV is low because the system pressure tends to works against the MOV, therefore, almost no leakage can be anticipated.**
The MOV and the check valve are identified in DCD Table 3.9-14 with their safety function in "maintain closed" position. The IST program with detailed criteria including valve leak rates shall be prepared by the COL applicant in accordance with COL 3.9(8). ~~Potential voids caused by insufficient venting may be formed in the ESWS lines.~~ Inservice testing **of the ESWS**, as described in Tier 2 DCD Subsection 3.9.6.1, includes ~~periodic testing of the high points in the ESWS and~~ discharging~~e~~ **of** any voids into the UHS basin **and filling of the system to**~~. These tests~~ **ensure that voids,** ~~and unacceptable dynamic effects like~~ **which are the primary cause of** water hammer, are minimized.

The following will be added to Tier 2 DCD 14.2.12.1.34 Essential Service Water System (ESWS), C. Test Method (See Attachment 7 for markups.):

"**4. Verify the absence of indications of water hammer effects by re-activating the ESW pump after a simulated LOOP as specified in Section 14.2.12.1.45, Class 1E Bus Load Sequence Preoperational Test.**"

Impact on COLA

The COL applicant is to address the new COL item 9.2(31).

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-37

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. This guidance includes consideration of flow rate and net positive suction head considerations' as well as material specifications. Section 9.2.1.2.2.1 of the DCD indicates that each ESW pump is designed to provide 13,000 gpm at the required total dynamic head. The total dynamic head requirement is unknown because much of the system is CDI. This is inconsistent with the information provided in Table 9.2.1-1 which indicates that the pumps are designed for 150 psig. Also, the pump material is listed as stainless steel, which may be inappropriate. The material should be suitable for the UHS and water conditions that exist at the site. All of this needs to be properly addressed in COL information items.

a) For that part of the design that is included within scope, the total dynamic head requirement and basis should be specified. The applicant would have to add this to the total dynamic head required for the plant-specific parts of the design and select a pump that satisfies the total dynamic head requirement for the plant while providing 13,000 gpm flow.

b) Because the ESWS pumps are not included within the scope of the standard plant design, it's not clear to what extent and on what basis this information pertains to COL applicants.

ANSWER:

a. The ESW system provides cooling water to the CCW heat exchangers and essential chiller units. These components are installed in the R/B and PS/B, respectively and are part of the standard plant design as described in DCD Section 1.8. The ESW pump discharge strainer is also part of the standard design. The ESW flow requirements to this equipment are part of the standard design. Thus, the pump design flow is defined by the standard design. Except for the ultimate heat sink and piping from the ESW intake structure to the nuclear island and the return piping from the nuclear island to the UHS particularly those outside the boundaries of the R/B, PS/B, and T/B, the ESW system piping is part of the standard design. See also responses to Questions 09.02.01-33(f) and (n). Thus, a major part of the system pressure drop is determined by the standard design. The required pressure drop across the standard plant components is approximately 100 feet. The COL applicant is to determine the total dynamic head of the pump by adding the pressure drop across the plant specific components to this pressure drop and the maximum static lift.

b. The standard plant design scope and the site specific portions of the ESW system are clarified in item a) above. The pump parameters provided in the Table 9.2.1-1 are part of the standard design. The COL applicant will assure that the selection and location of the site specific components and structures (ultimate heat sink, pump intake and discharge structures) will be within these parameters. Stainless steel is compatible with most water conditions. The COL applicant design assures that the maximum system design pressure does not exceed the ESWS design pressure of 150 psig as required by the standard design.

Tier 2 DCD Subsection 9.2.1.2.2.1, 3rd paragraph, will be revised as follows:

"Each pump is designed to provide 13,000 gpm flow at the required total dynamic head. **The required pressure drop across the ESWS components and piping (within standard plant design scope) is approximately 100 feet. The COL applicant is to determine the required ESWP TDH by adding pressure drop across the site specific components and piping and maximum static lift to this pressure drop.** The COL Applicant is to provide the site specific data for the ESWPs and assure that the selected ESWP will require less NPSH than the minimum available NPSH under all operating conditions."

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsection 9.2.1.2.2.1.

Impact on COLA

The COL applicant is to compute pump TDH and system design pressure per DCD Subsection 9.2.1.2.2.1.and COL 9.2(6).

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-38

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. This guidance includes consideration of net positive suction head (NPSH) requirements for the ESW pumps. Section 9.2.1.3 of the DCD indicates that the COL applicant is to provide the evaluation of ESWP at the lowest probable water level of the UHS. This is inadequate. This evaluation should be performed based on the lowest possible water level that may be reached in the UHS during the 30 day period following an accident, and should address both NPSH and vortex considerations based on the most limiting assumptions that apply (e.g., temperature, flow rate, operation of other pumps). The initial test program in conjunction with appropriate analysis should include confirmation that NPSH and vortex formation considerations are satisfied by the design and operating limitations that have been established.

ANSWER:

The ESW pumps are located in the ESW pump intake structure. Design of this structure is site specific based on the type of ultimate heat sink (UHS). The COL applicant is to design the intake structure to locate each ESW pump in a separate bay. The intake structure design and pump location will be based on Hydraulic Institute standards The ESWP pump design and impeller location will be based on the lowest probable water level in the UHS at the end of 30 day period following a design basis accident. This level will be based on design basis heat loads, pump operation at design flow rate, operation of any other pump(s) in the same bay and the maximum cooling tower water temperature of 95° F. The pump design will assure sufficient submergence is available with this level to prevent surface vortex formation. The NPSH available is calculated using these parameters. The selected pump will assure adequate margin over the required NPSH.

During the design phase, detailed hydraulic analysis of the intake bay will be performed using design basis operating conditions. The analysis will include the potential for vortex formation. If required, vortex suppressors will be provided. This will reduce the probabilities of vortices, excessive variations in velocity and swirl and entrained gas bubbles. Preoperational testing of the ESW pump performance at the minimum UHS level coincident with the end of the 30-day period will be performed by the COL Applicant. Pump performance preoperational testing includes verification that the available NPSH is greater than the required NPSH and verification of the absence of vortex formation.

Tier 2 DCD Subsection 9.2.1.2.2.1 will be revised as follows by adding the following after the last sentence in the 3rd paragraph:

"**The UHS level is based on the 30-day emergency cooling at design basis accident heat loads, pump(s) operating at design flow rates with maximum cooling water temperature of 95° F. The potential for vortex formation is evaluated and the available NPSH computed using these parameters. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply (e.g., temperature, flow rate, operation of other pumps for vortex evaluation).**"

COL Applicant item 9.2(26) in DCD Section 9.2.10 and Table 1.8-2 will be revised as follows:

"COL 9.2(6) *The COL Applicant is to provide ESWP design details – required total dynamic head with adequate margin, NPSH available****, and the mode of cooling of the ESWP motor.****~~etc.~~* ***The COL Applicant is to assure that the sum of the shut-off head of the selected ESW pumps and the static head will not result in system pressure that exceeds the ESWS design pressure at any location within the system. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply****.*"

Tier 1 DCD Section 3.2.1 item (e) is revised as follows to include the evaluation of potential vortex formation as a COL applicant interface requirement:

"a. The UHS ~~keeps the~~ water level is maintained such that available ~~at a~~**available** net positive suction head (NPSH) is greater than the **ESW** pump's required NPSH **during normal operation, AOOs and accident conditions. The ESW pump operation does not cause vortex formation.**"

Impact on DCD

See Attachment 2 for changes to Tier 2 DCD Table 1.8-2, Attachment 1 for changes to Tier 2 DCD Sections 9.2.1.2.2.1 and 9.2.10, and Attachment 5 for Tier 1 DCD Subsection 3.2.3.

Impact on COLA

The COL applicant is to evaluate ESWP per DCD Subsection 9.2.1.3.

The FSAR R-COLA 14.2.12.1.113, Item C(2) envelopes the ESWP NPSH and vortex formation issues, hence no further resolution is required.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: **5/10/2010**

QUESTION NO.: 09.02.01-39

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. This guidance includes consideration of ESWS pump performance considerations. Shutoff head of the ESW pumps is not addressed in the DCD because these pumps are CDI. Consequently, a Tier 1 interface item is needed to specify the maximum allowed ESW pump shutoff head to ensure that ESWS design pressure will not be exceeded. This also needs to be described in Tier 2 Section 9.2.1.

ANSWER:

As noted in the response to RAI 09.02.01-37, the ESW pump design flow is determined by the standard plant design, while the TDH is site specific parameter that depends on UHS system design. The response to Question 09.02.01-37 includes guidance to the COL applicant in computing TDH. The ESW system design pressure as determined by the standard design is 150 psig (approximately 347 feet). Maintaining as-built system pressure below the design pressure depends on the shut-off head of the pump and the static head. Thus the sum of the pump shut-off head and the static head should not exceed this pressure at any location.
The COL Applicant is to assure that the selected ESW pump shutoff head plus the system static head will not exceed 330 feet, allowing for uncertainties as part of (COL 9.2(6)). The interface requirements in Tier 1 Subsection 3.2.1 will be revised to specifically address pump shutoff head with respect to ESW system design pressure. Tier 1 Subsection 2.7.3.1.1 is being revised to cross-reference Tier 1 Subsection 3.2.1 instead of duplicating the interface requirements listed in Subsection 3.2.1.

The ESWS interface requirements in Tier 1 Subsection 2.7.3.1.1 will be revised as follows:

"Interface Requirements

UHS is a safety-related system and is not within the scope of the certified design. ~~The maximum supply water temperature is 95 °F under the peak heat loads condition to provide sufficient cooling capacity to ESWS.~~

~~The UHS keeps the water level at a net positive suction head (NPSH) greater than the pump's required NPSH.~~

Combined License applicants referencing the certified design are responsible to assure that the site-specific design meets the interface requirement**s of Subsection 3.2.1** and verify ~~the~~ conformance **via** ~~in~~ the ITAAC process ~~that are similar to those provided in the certified design~~."

The new subsection outlining the ESWS interface requirements ESWS in Tier 1 Subsection 3.2.3 will be revised to add the following:

"**c. The sum of the ESW pump shutoff head and static head is such that the ESW system design pressure is not exceeded.**"

Tier 2 DCD Subsection 9.2.1.2.2.1, the 3rd Paragraph will be revised by adding the following at the end:

"**The COL Applicant is to assure that the sum of the shut-off head of the selected ESW pumps and the static head will not result in system pressure exceeding the ESWS design pressure.**"

COL 9.2(6) is revised as follows:

"COL 9.2(6) *The COL Applicant is to provide ESWP design details – required total dynamic head with adequate margin, NPSH available,* ***and the mode of cooling of the ESWP motor****.* ***The COL Applicant is to assure that the sum of the shut-off head of the selected ESW pumps and the static head will not result in system pressure that exceeds the ESWS design pressure at any location within the system. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply.****"*

Impact on DCD

See Attachment 1 for changes to DCD Section 9.2.1, Attachment 4 for changes to Tier 1 DCD Subsection 2.7.3.1.1, and Attachment 5 for changes to Tier 1 DCD Subsections 3.2.1 and 3.2.3.

Impact on COLA

The COL applicant is to determine and specify the maximum allowed ESW pump shutoff head to ensure that ESWS design pressure will not be exceeded per DCD COL 9.2(6). COLA Part 10 is to address the DCD interface requirement in Tier 1 Subsection 3.2.1 via ITAAC.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-40

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. This guidance includes consideration of ESWS instrumentation that is necessary for operating the ESWS. The instrumentation and controls (I&C) for the ESWS need to be specified in sufficient detail to ensure that plant operators can properly monitor ESWS status and performance. Section 9.2.1.2.3.1 of the DCD indicates that when low ESW header pressure is annunciated, the standby CCW pump of the same subsystem and corresponding ESW pump are placed in service. The following considerations need to be addressed:

a) The description needs to distinguish between manual and automatic actions, and justification needs to be provided as appropriate.

b) The description needs to explain what is meant by the "subsystem" designation, what makes one subsystem different from another, what the consequences are if the CCW or ESW pump of the same subsystem is not available, and how this "subsystem" designation impacts the independence that is credited between trains.

c) Because the ESW pumps and header pressure instrumentation are not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants.

ANSWER:

Question: a) The description needs to distinguish between manual and automatic actions, and justification needs to be provided as appropriate.

Answer: a)
The description in DCD Section 9.2.1.2.3.1 on the alternate or backup operations of the ESWPs does not involve manual actions. The 3rd paragraph of DCD Section 9.2.1.2.3.1 is revised as follows:

"**The ESWP operation, ESW header pressure signals, and component cooling water pump (CCWP) operation are interlocked to enable automatic start and stop functions of the ESWPs and CCWPs.** A low ~~signal of~~ ESW header pressure **signal** due to **failure or** tripping of **an** operating ESWP is alarmed in the ~~main control room (~~MCR~~)~~. When the low ESW header pressure alarm is annunciated, the standby **ESWP and the** standby ~~component cooling water pump (~~CCWP~~)~~ **of** the same **train designation start automatically, ensuring continuous heat removal.** ~~and the corresponding ESWP are placed in service to resume the cooling process."~~ **In the same manner, a low CCW supply header pressure signal accompanied by a start signal from the CCWP in the same train will automatically start the corresponding ESWP. This indicates that an operating CCWP has failed and requires the alternate (or standby) ESWP and CCWP in another train to start for backup. The EWSP, however, does not start if the pump discharge MOV is not in a fully closed position as a means to prevent water hammer previously discussed in Subsection 9.2.1.2.1. Only emergency core cooling system (ECCS) actuation and LOOP sequence (also termed as blackout sequence) signals can override the permissive discharge MOV interlock in order to prioritize the ESWS cooling function during an accident or a LOOP.** DCD_09.02.01-40

~~Stoppage of the operating ESWP automatically activates the alternate standby pump via interlocks between the ESWS and CCWS.~~

All valves except the pump discharge valves in the flow path are locked open. The **discharge** MOV ~~discharge valve~~ position is monitored in the control room. **At pump swapping operation, i.e. alternately operating the standby pump in lieu of the operating pump during normal power operation, f**~~F~~ailure of the valve to open on pump start is alarmed in the control room."

Question: b) The description needs to explain what is meant by the "subsystem" designation, what makes one subsystem different from another, what the consequences are if the CCW or ESW pump of the same subsystem is not available, and how this "subsystem" designation impacts the independence that is credited between trains.

Answer: b)
The term "subsystem" is incorrect. There are no subsystems within the ESWS. Please refer to the appropriate corrections made in response (a) above.

Question: c) Because the ESW pumps and header pressure instrumentation are not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants.

Answer: c)
Please refer to the response to Question 09.02.01-37 for portions of the ESW system within the scope of the standard design.

The ESW header pressure instrumentation and the ESWP flow requirement are part of the standard design. The ESW header pressure instrumentation are labeled in DCD Figure 9.2.1-1 as PIA-015, PIA-016, PIA-017, and PIA-018. DCD Section 9.2.1.5.2 also provides a description of the ESW header pressure. All components, including piping and valves, shown in that drawing, unless otherwise stated, are part of the standard design. Components, including piping and valves, found in the DCD Figure 9.2.1-1 are part of the standard design unless otherwise noted.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsection 9.2.1.2.3.1.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-41

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. This guidance includes consideration of ESWS instrumentation that is necessary for operating the ESWS. The instrumentation and controls (I&C) for the ESWS need to be specified in sufficient detail to ensure that plant operators can properly monitor ESWS status and performance. Section 9.2.1.5 of the DCD provides a description of ESWS instrumentation. The following items require additional consideration and explanation:

a) The ESWP discharge pressure is only provided locally and is not available in the control room. This does not appear to be appropriate since the ESW pumps are started with their respective discharge isolation valves closed and pressure indication is important for confirming proper functioning of the pump/valve interlock when a pump is starting. Therefore, ESWP discharge pressure should be indicated locally and in the control room.

b) The ESWP discharge pressure is reflective of ESW line pressure and a separate indication in the control room for line pressure is not necessary. Low ESWP discharge pressure can be annunciated in the control room to alert operators to a low pressure condition. By taking this approach, the line pressure indicator can be used for local indication but need not be indicated in the control room.

c) The description of those indications that are available in the control room should also state that the indication is available locally for completeness.

d) In order to ensure that ESWS temperature limits are not exceeded during plant cool down and post-accident conditions, the ESWS outlet temperature from the CCW heat exchangers should be indicated and annunciated in the control room.

e) In order for the operators to adequately monitor the status of ESWS cooling for CCW and to ensure that design limitations are not exceeded, the differential pressure for the CCW heat exchanger inlet strainer should be indicated and annunciated in the control room.

f) In order for the operators to adequately monitor ESWS status, alignment of the ESWS strainers, the flow path being used for the essential chiller units (bypass or mainline), and the open/closed position of the blowdown valve for the ESWS/CCW in-line strainer should be indicated in the control room.

g) Some of the ESWS instrumentation is outside the scope of the standard plant, and it's not clear to what extent and on what basis this information applies to COL applicants for those instruments.

ANSWER:

Question: a) The ESWP discharge pressure is only provided locally and is not available in the control room. This does not appear to be appropriate since the ESW pumps are started with their respective discharge isolation valves closed and pressure indication is important for confirming proper functioning of the pump/valve interlock when a pump is starting. Therefore, ESWP discharge pressure should be indicated locally and in the control room.

Answer: a)
The local ESWP discharge pressure indicator (PIA-010, 011, 012, 013) is installed for pump performance monitoring and checks during maintenance operations, inservice tests and inspections. Confirmation of proper pump/valve function is monitored from the MCR through the ESW line pressure instrumentation, thus it is not necessary to have MCR indications of the ESWP discharge pressure. Moreover, the discharge valve position is monitored in the MCR by the ESW line pressure and will provide confirmation of the proper functioning of the pump/valve interlock.

Question: b) The ESWP discharge pressure is reflective of ESW line pressure and a separate indication in the control room for line pressure is not necessary. Low ESWP discharge pressure can be annunciated in the control room to alert operators to a low pressure condition. By taking this approach, the line pressure indicator can be used for local indication but need not be indicated in the control room.

Answer: b)
As discussed in the response to (a) above, the ESW line pressure indications and alarms are taken from the pressure instrumentation downstream of the ESWP discharge MOV. Taking the ESW line pressure from the indications and alarms of the ESWP discharge pressure could lead to confusion because a low pressure alarm could only indicate pump failure but not the failure of the ESWP discharge MOV. If the ESW line pressure is taken downstream of the ESWP discharge MOV, either pump failure or ESWP discharge MOV failure can be verified by the low pressure alarm along with other indications. This arrangement is preferred and the pump discharge pressure and ESW line pressure instrumentation will thus be kept as is.

Question: c) The description of those indications that are available in the control room should also state that the indication is available locally for completeness.

Answer: c)
All instrumentation available in the main control room are also provided locally. DCD Figure 9.2.1-1 has been appropriately revised.

Question: d) In order to ensure that ESWS temperature limits are not exceeded during plant cool down and post-accident conditions, the ESWS outlet temperature from the CCW heat exchangers should be indicated and annunciated in the control room.

Answer: d)
The MCR temperature indications of the CCWS heat exchangers on the CCWS side and the MCR temperature indications at the UHS are sufficient indicators of the CCW heat exchanger and ESW system performance (bulk of the ESW heat load is from the CCW HX). Refer to Tier 2 DCD Subsection 9.2.5.5 for the UHS instrumentation requirements. The UHS water initial temperature is prescribed by site-specific Technical Specifications to ensure that the maximum ESW supply temperature of $\leq 95^{o}$ F is not exceeded. Installing a temperature indicator downstream of the CCW heat exchanger for monitoring the ESWS outlet temperature is not considered to serve any purpose on the context of ensuring that the ESWS temperature is within the prescribed limits for heat removal.

Question: e) In order for the operators to adequately monitor the status of ESWS cooling for CCW and to ensure that design limitations are not exceeded, the differential pressure for the CCW heat exchanger inlet strainer should be indicated and annunciated in the control room.

Answer: e)
The CCW heat exchanger inlet strainers, along with the ESWP discharge basket strainers, have been removed from the design and replaced with parallel automatic self-cleaning strainers at the discharge side of the ESWP. The automatic strainers are equipped with local and MCR differential pressure indications and alarms. Please also refer to the responses to Questions 09.02.05-34 and 09.02.01-52 for further details.

Question: f) In order for the operators to adequately monitor ESWS status, alignment of the ESWS strainers, the flow path being used for the essential chiller units (bypass or mainline), and the open/closed position of the backwash valve for the ESWS/CCW in-line strainer should be indicated in the control room.

Answer: f)
Isolation valve positions of the ESWP discharge strainers and essential chiller unit line discharge are indicated in the MCR for monitoring the ESWS status. Strainer backwash valve positions are also indicated and alarmed in the MCR. The isolation valves in these lines are administratively controlled by chain locking to prevent inadvertent alteration of the valves positions.

The valves in the ESWP discharge strainers and chiller units (return) lines, main or bypass, are administratively controlled and thus positions are monitored. The valves in the chiller unit main and bypass lines are chain locked to prevent inadvertent alteration of the valve positions. Technical Specifications Surveillance Requirements 3.7.8.1 also ensure that the positions of valves that are not locked, sealed or otherwise secure in position are frequently being checked so that they are in their required positions at all times.

Question: g) Some of the ESWS instrumentation is outside the scope of the standard plant, and it's not clear to what extent and on what basis this information applies to COL applicants for those instruments.

Answer: g)
The ESWS instrumentation described in the DCD is part of the standard design. DCD Section 9.2.1 has been revised due to the changes discussed in the above responses. None of them is site-specific.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Figure 9.2.1-1.

Impact on COLA

Comanche Peak Units 3 and 4 FSAR Table 9.2.1-1R, Essential Service Water System Component Design Data will be revised according to the changes made in DCD Figure 9.2.1-1. All other changes are incorporated by reference.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-42

This is a follow-up to RAI 326-2279, Question 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. SRP 9.2.1, Section III, 2.A requires that ESWS portions to be identified correctly and can be isolated from nonessential portions. Nuclear Regulatory Commission (NRC) staff has been reviewing Revision 2 of the Design Control Document (DCD) for the US-Advanced Pressurized Water Reactor (US-APWR). As previously noted by RAI 09.02.01-4 Item 2, the staff requested the applicant to identify piping and/or components that are identified as non-safety and/or any related isolation design features and class breaks. In addition, the RAI requested the applicant, in Section 9.2.1 of the DCD, to provide a description of (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, (b) how periodic testing will be performed to ensure the specified requirements will be met, and (c) 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.

In its response to RAI 09.02.01-4, the applicant indicated that the ESWS does not provide cooling for any non-safety related systems. However, some piping sections are non-safety related. These piping sections are drains that are connected to the ESWS and are normally isolated by closed valves. The applicant proposed a revision to Tier 2 DCD Subsection 9.2.1.2.2, renaming this subsection to "Nonsafety-Related Design Basis" and to clarify the distinction of safety related and non-safety related piping. The applicant also proposed to alter COL information item 9.2(7) in DCD Chapter 1, Table 1.8-2 and Subsection 9.2.10, "Combined License Information," to specify that the nonsafety-related design is a COL responsibility and that the COL applicant is to provide the piping and valves that form the boundary between the safety related and nonsafety-related portions of the ESWS system. The staff reviewed the response and found that it was inadequate. The following items need to be addressed in this regard:

a) In the response to RAI 09.02.01-4 the applicant used the term "ditto piping." The staff is uncertain as to what this means and the DCD needs to be revised to use more conventional terminology.

b) The applicant proposed a revision to Tier 2 DCD Subsection 9.2.1.2.2, renaming this subsection to "Nonsafety-Related Design Basis" and to clarify the distinction of safety related and non-safety related piping. Section 9.2.1.1.2 of the DCD is supposed to describe the power generation design basis of the ESWS. However, no discussion of the ESWS power generation design basis is included in this section. The staff does not agree that the title for Section 9.2.1.2.2 should be changed as proposed in the RAI response. However, a discussion of the ESWS power generation design basis needs to be provided.

The applicant proposed a revision to COL information item 9.2 (7) for the COL applicant to provide piping and valves, including those at the boundary between safety-related and nonsafety-related portions related to site-specific conditions. It isn't clear what this item is referring to and to what extent it applies to that part of the ESWS that is within scope for the standard plant design, such as vents and drains and this needs to be better explained.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

a. In the response to RAI 326-2279 (MHI Letter UAP-HF-09326), Question 09.02.001-4, the term "ditto" piping referred to the nonsafety-related ESWS piping, namely, drains piping downstream of the isolation valve. This piping is classified into the nonsafety, nonseismic piping category but no equipment classification will be provided in the DCD.

   The revised description in DCD 9.2.1.1.2 as proposed in the response to RAI 326-2279 does not use the word "ditto", hence will not be further revised. This term had been deleted in other parts of this section and appropriately replaced with more conventional terms.

b. See response to Question 09.02.01-33 (b).

The response to this question is the same as the response to Question 09.02.01-33 (f) and 09.02.01-33 (n).

The proposed COL 9.2 (7) in the response to RAI 326-2279, Question 09.02.001-4 refers to the site-specific portions and interfaces of the ESWS, such as the ESWS blowdown line and FSS supply line. The piping and valve specifications, as well as proper isolation, shall be the responsibility of the COL Applicant. The ESWS vents and drains of standard components are within the scope of the standard design. Vents and drains of the portions outside the standard design shall be the responsibility of the COL Applicant per COL item 9.2(7).

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsections 9.2.1.1.2, 9.2.1.1.3, and 9.2 (10) according to the responses to Questions 09.02.01-33(b) and 09.02.01-33(n).

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-43

This is a follow-up to RAI 326-2279, Question 09.02.01-6:

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. Nuclear Regulatory Commission (NRC) staff has been reviewing Revision 2 of the Design Control Document (DCD) for the US-Advanced Pressurized Water Reactor (US-APWR). The staff reviewed the Tier 2, DCD ESWS description and related drawings; Tier 1, DCD Figure 2.7.3.1-1 and Tier 2, DCD Figure 9.2.1-1. The staff found instances of incomplete descriptive information and missing equipment on the Tier 1 and Tier 2 referenced drawings and diagrams. In RAI 09.02.01- 6, the staff requested the applicant to address numerous instances of incomplete and/or missing information related to those drawings in the DCD.

In its response to RAI 09.02.01-6, the applicant responded to the staff's request to provide the missing or incomplete information on the drawings. The staff found that several of the items in the RAI were not adequately addressed and the following items need to be addressed:

a) The applicant described the operational procedures that help prevent water hammer, and proposed changes to the Tier 2 DCD, Subsection 9.2.1.2.1 to highlight system design and operational procedures that prevent water hammer. The applicant also stated that the CCW heat exchanges and essential chilled water chillers are located at a much lower elevation than the ESWS pumps and ultimate heat sink. On this basis the applicant concluded that the ESWS is always at a positive pressure and there is no need for vacuum breakers. However, the staff noted that the ESWS pumps and UHS are currently classified as CDI, and no provisions were established to ensure that COL applicants will place the ESWS pumps and UHS at grade elevation. Consequently, credit cannot be taken for configuration of these items as a basis for addressing water hammer considerations. Therefore, this item will remain open pending satisfactory resolution of this item by the applicant. Note that this issue also applies to RAI 09.02.01-12 and RAI 09.02.01-13.

b) The staff noted that Tier 1 of the DCD Figure 2.7.3.2-1 did not show many of the important system components, such as the radiation monitors, the strainers and piping for flushing the CCW strainers. A level of detail needs to be provided in the Tier 1 drawings of the DCD in order to meet inspections, tests, analyses, and acceptance criteria (ITAAC) commitments for verifying system configuration. The applicant stated that a revised figure will be included containing the same level of detail. However, upon review of revision 2 of the DCD, the level of detail of Tier 1 drawings still appear to be inadequate, and Tier 1 Figure 2.7.3.2-1 appears to be an incorrect figure number. Therefore, this item will remain open pending a satisfactory response to this RAI issue by the applicant.

c) 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. The applicant's response indicated that ESWS piping is described in Tier 2 Section 9.2.1.2.5. The staff was unable to find this section in Revision 2 of the DCD, and evidently the correct reference is Section 9.2.1.2.2.5. However, it is still not clear to the staff what sections of ESWS pipe are buried in trenches. While Section 9.2.1.2.2.5 (page 9.2-5) indicates that underground piping is epoxy lined carbon steel and placed in trenches, Tier 2 Figure 1.2-1 shows that an ESWS pipe tunnel is used. Furthermore, because buried ESWS pipe and pipe tunnel are not within scope for the standard plant, it's not clear to what extent and on what basis this information applies to the COL applicants. Therefore, this item will remain open pending a satisfactory response to the RAI issue by the applicant

d) It was identified in Tier 2 of the DCD Section 9.2.1.2.1, that the typographical error (typo) 'doses not' should be 'does not.' There are many other typos in Section 9.2.1. In its RAI response, the applicant stated that the DCD will be revised to correct typographical errors, however Tier 2 Section 9.2.1 of DCD Rev 2 still contains typos and additional effort is needed by the applicant to identify and correct editorial errors.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Answer: a)
As mentioned in the response to 09.02.01-36 a), the COL applicant requirement on water hammer prevention which depends on the system layout will be added as a new COL item, COL 9.2(31). COL 9.2(31) requires that the elevation differential between the UHS water level and the highest point in ESWS maintains the system pressure above saturation, therefore, the elevation of the UHS is addressed for water hammer prevention. Tier 2 DCD Section 9.2.1.2.1 is revised by deleting the 7th paragraph as follows:

"~~The CCW HXs and the essential chiller units are located at floor elevation (-26' 4") in the reactor building. The ESWPs and ultimate heat sink which is site dependent will be located at grade elevation. This arrangement assures that all points in the system remain above atmospheric pressure.~~"

Answer: b)
As explained in the response to Question 09.02.01-58, the radiation monitors do not have a safety function in the ESWS but are installed for conservatism even though radiation contamination is not a concern in the ESWS. This justifies why the radiation monitors are not included in the Tier 1 figure and related tables. The ESW radiation monitors, however, are described in Tier 1 Table 2.7.6.6-1.

The ESWS automatic strainers with their backwash line, however, should be included in the Tier 1 Figure 2.7.3.1-1. Related Tier 1 Tables 2.7.3.1-1 through 2.7.3.1-4 have been revised to include the strainer information, including piping and valves. See following pages for the proposed markups to these tables.

Tier 1 DCD Table 2.7.3.1-5 ITAAC has been revised to include the essential service water strainers and their backwash isolation valves. See following pages for the proposed markups to this table.

The CCW heat exchanger inlet strainers have been removed from the design as mentioned in the response to Questions 09.02.01-34 and 09.02.01-52 so there is no need to include them in Figure 2.7.3.1-1.

Tier 2 DCD Table 3.9-14 has been revised to add the ESWP discharge strainer backwash isolation valves in the Valve Inservice Test Program. See Attachment 6.

Answer: c)

Please see response to RAI 09.02.01-33 item (f).

Answer: d)
The typographical error in Subsection9.2.1.2.1 has been corrected. Other errors have been corrected in Tier 2 DCD Section 9.2.1 such as the following:

- Subsection 9.2.1.2.1, 8th paragraph

"doses" → "does"
"selection and design of the UHS supplies" → "selection and design of the UHS **deliver the design** water **flow**"
"95 F" → "95° F"

- Subsection 9.2.1.2.1, 10th paragraph

"Biofouling and chemistry control of the ESWS **is** site specific and depend**s**" → "Biofouling and chemistry control of the ESWS **are** site specific and **depend**"

- Subsection 9.2.1.2..2.3, 1st paragraph

"A detailed description of the HXs is **discussed**" → "A detailed description of the HXs is **given**"

- Subsection 9.2.1.2.3.1, 5th paragraph

"The system design and layout provide**s** adequate resistance to prevent pump run_out" → "The system design and layout **provide** adequate resistance to prevent pump **runout**"

- Subsection 9.2.1.3, 2nd paragraph, 1st to 4th bullets

Deletion of unnecessary semicolons after the bullets

- Subsection Section 9.2.10

COL 9.2(1): "The COL **Application**" → "The COL **Applicant**"

COL 9.2(8), 1st and 2nd bullets: Enlarged font

COL 9.2(23): "These is to include" → "These include"

- Table 9.2.1-2, Item 1and 2, 4th column

"B, Accident, Safe shutdown, Cooldown – loss of offsite power" → "B, Accident, safe shutdown, cooldown – loss of offsite power"

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Section 9.2.1. See also response to RAI 09.02.01-33 item (f).

See Attachment 4 for changes to Tier 1 DCD Tables 2.7.3.1-1 through 2.7.3.1-5 and Attachment 6 for changes to Tier 2 DCD Table 3.9.6-14.

Impact on COLA

Please see response to RAI 09.02.01-33 item (f).

Impact on PRA

There is no impact on PRA.

Table 2.7.3.1-1 Essential Service Water System Location of Equipment and Piping

System and Components	Location
Essential service water pumps	Ultimate heat sink related structures
Essential service water supply header piping and valves	Ultimate heat sink related structures and essential service water pipe tunnel
Essential service water return header piping and valves	Ultimate heat sink related structures and essential service water pipe tunnel
Essential service water header piping and valves to essential service water pump discharge strainers	**Ultimate heat sink related structures**
Essential service water header piping and valves from essential service water pump discharge strainers	**Ultimate heat sink related structures**
Essential service water supply line piping and valves to component cooling water heat exchangers	Reactor Building and essential service water pipe tunnel
Essential service water return line piping and valves from component cooling water heat exchangers	Reactor Building and essential service water pipe tunnel
Essential service water supply line piping and valves to essential chiller units	Power Source Building and essential service water pipe tunnel
Essential service water return line piping and valves from essential chiller units	Power Source Building and essential service water pipe tunnel

DCD_09.02.01-43

Table 2.7.3.1-2 Essential Service Water System Equipment Characteristics (Sheet 1 of 2)

Equipment Name	Tag No.	ASME Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Essential service water pumps	EWS-MPP-001 A, B, C, D	3	Yes	-	Yes/No	ECCS Actuation	Start	-
						LOOP sequence	Start	
						Remote Manual	Start	
Essential service water pump discharge valves	EWS-MOV-503 A, B, C, D	3	Yes	Yes	Yes/No	ESW pump start	Transfer Open	As Is
						<u>ESW pump stop</u>	**<u>Transfer close</u>**	
Component Cooling Water Heat Exchanger Essential Service Water Flow	EWS-FT-034, 035, 036, 037	-	Yes	-	Yes/ No	-	-	-
Essential Service Water Header Pressure	EWS-PT-015, 016, 017, 018	-	Yes	-	Yes/ No	-	-	-
Essential Service Water Pump Discharge Check Valves	EWS-VLV-502A, 502B, 502C, 502D	3	Yes	-	-/-	-	Transfer Open/ Transfer Close	-
<u>Essential service water pump discharge strainers</u>	**<u>EWS-SST-001A, B, C, D EWS-SST-002A, B, C, D</u>**	**<u>3</u>**	**<u>Yes</u>**	**<u>-</u>**	**<u>Yes/No</u>**	**<u>ESW pump stop</u>**	**<u>Stop</u>**	**<u>-</u>**
						<u>Remote manual</u>	**<u>Start/Stop</u>**	

NOTE:
Dash (-) indicates not applicable

DCD_09.02.01-43

Table 2.7.3.1-2 Essential Service Water System Equipment Characteristics (Sheet 2 of 2)

Equipment Name	Tag No.	ASME Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Essential service water pump discharge strainer backwash line isolation valves	EWS-MOV-573A, B, C, D EWS-MOV-574A, B, C, D	-	Yes	Yes	Yes/No	ESW pump stop	Transfer Close	As is
						Remote manual	Transfer Open/ Transfer Close	

NOTE:
Dash (-) indicates not applicable

Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 6 of 6)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13.a Controls exist in the MCR to start and stop the active strainer functions identified in Table 2.7.3.1-4.	13.a Tests will be performed on the as-built strainers listed in Table 2.7.3.1-4 using controls in the as-built MCR.	13.a Controls exist in the as-built MCR to start and stop the active functions of the as-built strainers listed in Table 2.7.3.1-4.
13.b The strainers identified in Table 2.7.3.1-2 as having PSMS control perform an active safety function after receiving a signal from PSMS.	13.b Tests will be performed on the as-built strainers listed in Table 2.7.3.1-2 using simulated signals.	13.b The as-built strainers identified in Table 2.7.3.1-2 as having PSMS control perform the active safety function identified in the table after receiving a simulated signal.
14. Upon the receipt of an ESWP stop signal, the essential service water pump discharge strainer backwash isolation valves close automatically. The valve starts to open after the respective pump starts.	14. A test of each as-built interlock for the essential service water system pump discharge strainer backwash isolation valve will be performed using a simulated test signal.	14. The ESWP discharge strainer backwash isolation valve closes when its respective pump is not running. Upon the receipt of a simulated ESWP stop signal, the as-built discharge valve for the respective pump starts to close automatically after the pump stops. The valve closes when the pump is tripped.

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Table 2.7.3.1-3 Essential Service Water System Piping Characteristics

Pipe Line Name	ASME Code Section III Class	Seismic Category I
Essential service water supply header piping and valves	3	Yes
Essential service water return header piping and valves	3	Yes
Essential service water header piping and valves to essential service water pump discharge strainers	**3**	**Yes**
Essential service water header piping and valves from essential service water pump discharge strainers	**3**	**Yes**
Essential service water supply line piping and valves to component cooling water heat exchangers	3	Yes
Essential service water return line piping and valves from component cooling water heat exchangers	3	Yes
Essential service water supply line piping and valves to essential chiller units	3	Yes
Essential service water return line piping and valves from essential chiller units	3	Yes

Table 2.7.3.1-4 Essential Service Water System Equipment Alarms, Displays, and Control Functions

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Essential service water pumps EWS-MPP-001A, B, C, D	No	Yes	Yes	Yes
Essential service water pump discharge valves EWS-MOV-503A, B, C, D	No	Yes	Yes	Yes
Essential service water header pressure EWS-PIA-015, 016, 017, 018	Yes	Yes	No	Yes
Component cooling water heat exchanger essential service water flow EWS-FIA-034, 035, 036, 037	Yes	Yes	No	Yes
Essential service water pump discharge strainers EWS-SST-001A, B, C, D EWS-SST-002A, B, C, D	**Yes**	**Yes**	**Yes**	**Yes**
Essential service water pump discharge strainers backwash line isolation valves EWS-MOV-573A, B, C, D EWS-MOV-574A, B, C, D	**Yes**	**Yes**	**Yes**	**Yes**

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-44

This is a follow-up to RAI 326-2279, Question 09.02.01-7:

Original question
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.

New question
In its response to RAI 09.02.01-7, the applicant provided the following information:
"Each CCW pump & CCWHX room has a leak-detecting floor drain box with electrode type level switch to provide alarm in the main control room for the detection of a leaking train from ESWS or CCWS. A common alarm in the main control room provides audible indication of a leak or flooding.

A method of identifying a leaking train by an operator who recognizes leakage of the ESWS in either side of R/B through the above alarm from the CCW pump &CCW HX room will be the indications from the inlet pressure and outlet flow of the CCW HX and essential chiller units. The leaking ESWS train is then isolated by shutting down the corresponding ESWS pump and CCWS pump, and activating the standby and intact ESWS and CCWS trains."

The staff does not agree that use of a common alarm is adequate for operators to be able to diagnose leaks from CCW and ESWS trains. Therefore, additional explanation and justification for this approach needs to be provided, including a description of the safety classification of the leak detection instrumentation. This item will remain open pending a satisfactory response for the RAI issue by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

A nonsafety grade electrode type level switch, which is used as a level detector, is provided in the leak-detecting floor drain box in the CCW pump & CCW HX room of each train. If ESWS leakage occurs within any CCW pump & CCW HX room, the level switch of the leaking train sends signals to the alarm visual display unit (VDU) in the main control room to enable the operator to immediately identify the leaking train. The CCW and ESW trains supplying the heat exchanger in that room are isolated by shutting down the corresponding ESWS pump and CCWS pump, and activating the standby and intact ESWS and CCWS trains, regardless of whether the leak is from the CCW train or ESW train. Which side the leak or component/pipe failure that can cause flooding in any of the CCW pump and CCW HX is from is not being specified because either way, leakage or component/pipe failure will bring about the same result. The only difference is the amount of water that can flood each room, i.e. more water from the ESWS than from the CCWS due to its infinite volume. As specified in DCD Subsection 19.1.5.3.1, there is a need to isolate the ESWS within 15 minutes to mitigate flooding effects and prevent it from propagating to other system trains of the same designation. From this, it is immaterial to first distinguish where the leak is coming from before isolation is performed thus, a common alarm for each room is adequate. A nonsafety grade electrode type level switch is also provided in the leak-detection floor drain box in each essential chiller room located in the power source building (PS/B). If ESWS leakage occurs in any essential chiller room, the level switch of the leaking train sends signals to the alarm VDU in the main control room to enable the operator to immediately identify the leaking train. Leaks can also be detected by low flow indications through the CCW heat exchanger and low ESWS header pressure indications.

If, however, the leak detector fails to alarm, or the operator fails to recognize the flooding signals, the physical separations, which include water tight doors, on the east side and west side of the ESWS as described in the US-APWR DCD Rev.2, Section 19.1.5.3, "Internal Flooding Risk Evaluation," item 19.1.5.3.1(n) will prevent the effects of flooding from propagating. The east side contains ESWS trains A and B, and the west side contains ESWS trains C and D. The physical separations prevent leakage or flooding in one area from affecting the safety-related functions of the other area.

Tier 2 DCD 9.2.1.3 will be revised as follows:

"**Leakage in the ESWS due to piping or component failure that could cause flooding of surrounding SSCs has been evaluated for the CCW pump and CCW HX room. Flooding mitigation in the ESWS is achieved by installation of a nonsafety grade electrode type level switch or detector in the leak-detecting floor drain box in the CCWP and CCW HX room of each train. Pre-determined water level due to leakage in any CCWP and CCW HX room is alarmed in the MCR. A nonsafety grade electrode type level switch is also provided in the leak-detection floor drain box in each essential chiller unit room located in the power source building (PS/B). Pre-determined water level due to leakage in any essential chiller room is alarmed in the MCR. The leaking train can also be identified by low outlet flow from each CCW HX or decrease in the ESWS header pressure.** ~~Flooding and flooding effects in the ESWS are mitigated due to the physical separations in the reactor building such as watertight doors. These doors are monitored and controlled during plant operation and maintenance. Each CCW pump & CCW HX room has a leak-detecting floor drain box with electrode type level switch to provide alarm in the MCR for the detection of a leaking train from the ESWS or CCWS. A common alarm in the MCR provides audible indication of a leak or~~

~~flooding. A method of identifying a leaking ESWS train by an operator who recognizes leakage of the ESWS in either side of R/B through the above alarm from the CCW pump & CCW HX room will be the indications from the inlet pressure and outlet flow of the CCW HX and essential chiller units.~~ The leaking ESWS **and CCWS** trains **are** then isolated by shutting down the corresponding ESWS pump and CCWS pump, and activating the standby and intact ESWS and CCWS trains. **If, however, the leak detector fails to alarm, or the operator fails to recognize the flooding signals, the physical separations, which include water tight doors, between the east side of the ESWS enclosing ESWS trains A and B and the west side of the ESWS enclosing ESWS trains C and D will serve to isolate flooding and prevent it from propagating to other trains."**

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsection 9.2.1.3.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-45

This is a follow-up to RAI 326-2279, Question 09.02.01-8:

Original question
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.

New question
In its response to RAI 09.02.01-8, the applicant provided information to address the staff's question. The staff found that proposed Table 9.2.1-4, "Essential Service Water System Flow Balance (in gpm)" appears to contain an error. In the "Safe Shutdown" column for "Trains A&B" the ESW pump motor flow rate is listed as 50, but this flow rate appears to be inconsistent with the rest of the table and appears to be incorrect. This item remains open pending satisfactory resolution of this inconsistency by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

The ESWP motor cooling rate is only 50 gpm, however, since the mode of ESWP motor cooling has been changed to a site-specific design as part of COL applicant item COL 9.2(6), this value in Tier 2 DCD Table 9.2.1-4 no longer applies.

Impact on DCD

Tier 2 DCD Table 9.2.1-4 has been changed according to the response in RAI 3968 (CP RAI #109), Question 09.02.01-4 (ML093280698). The specific DCD change to revise COL 9.2(6) to include ESWP cooling as a site specific design is provided in MHI letter UAP-HF-09521 dated November 17, 2009 (ML093240138).

Impact on COLA

Related Comanche Peak Units 3 and 4 FSAR Section 9.2.1.5.4 has been deleted according to the response to RAI 3968 (CP RAI #109), Question 09.02.01-4 (ML093280698).

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-46

This is a follow-up to RAI 326-2279, Question 09.02.01-9:

Original question

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.

New question

In its response to RAI 09.02.01-9, the applicant described how the required pump head is calculated. The applicant states that margin is provided since the maximum allowable pressure loss will not simultaneously occur in the pump strainer and the associated heat exchangers. The staff does not agree with this assumption since is nonconservative and has not been adequately explained and justified. The staff found that the applicant has not defined allowable system degradations nor has the applicant defined the available system margins as requested in RAI 09.02.01-9. Therefore, this item will remain open pending a satisfactory response from the applicant to address this issue.

Also, because the ESWS pumps are CDI, it's not clear to what extent and on what basis this information is applicable to COL applicants.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

As noted in the (original) RAI 09.02.01-9 response and the DCD Subsection 9.2.1.2.2.1, each ESW pump is designed to provide 13,000 gpm flow at the required total dynamic head, and requires approximately 12,043 gpm flow rate for all modes of plant operation, as indicated in the DCD Table 9.2.1-4. This provides approximately 7.7 percent margin for flow. As noted in the response to the original RAI and RAI 09.02.01-37, pump TDH is a site specific parameter and the COL applicant is to provide adequate margin in this computation. In this computation, maximum pressure drops across the pump discharge strainer and the CCW heat exchanger are used. All these pressure drops are monitored and high differential pressure is alarmed. The components are cleaned as required. Moreover, in this computation maximum static lift (water level at the end of 30 days) is used.

The pump performance is monitored by In-Service Test program. The acceptance criteria for monitored parameters are established per this program and corrective action taken as required. This will assure that the pump will deliver the required flow for accident mitigation.

Also, per DCD COL 9.2(8), the COL Applicant is to specify the ESW chemistry requirements to assure that system degradation by fouling and biological film formation will be within the allowable limits based on the site-specific water conditions and industry practice.

The CCW heat exchanger and the essential chiller unit performance are monitored per heat exchanger test program developed per GL 89-13. The acceptance criteria developed will keep the heat exchanger performance within acceptable range for accident mitigation. The CCW heat exchanger design margin is discussed in Tier 2 DCD Section 9.2.2 based on its response to RAI 571-4365 (MHI Letter # UAP-HF-10160) Question 09.02.02-52. The essential chiller unit design margin is discussed in Tier 2 DCD Section 9.2.7 based on its response to RAI 584-468 (MHI Letter #UAP-HF-10167) Question 09.02.02-72. The component manufacturers will be required to incorporate adequate margins to ensure that degradations due to fouling and other factors do not interfere with the required ESWS heat removal capability.

See Tier 2 DCD markup in response to RAI 09.02.01-37. The following has been added after the first sentence in Subsection 9.2.1.2.2.1:

"**Approximately 12,043 gpm ESWP flow is required for all modes of plant operation as indicated in the DCD Table 9.2.1-4. This provides approximately 7.7 percent margin to the design ESWP flow rate of 13,000 gpm. The margin allows for pump and heat transfer degradation by fouling, leakages, excessive pressure drop across system components or, fluctuations due to supplied electrical frequency.**"

Tier 2 DCD Subsection 9.2.1.4, third and fourth paragraphs will be revised as follows:

"Inservice testing of active pumps and valves is performed to assure operational readiness, as described in Subsection 3.9.6. **Acceptance criteria for the monitored parameters are established to allow for pump degradation and to maintain acceptable pump performance for all modes of plant operation.**

Periodic performance verification of the ESWS components, including the heat exchanger**(s)**

~~which is~~ cooled by the ESW, is performed to detect performance degradation due to fouling. **<u>The heat exchangers are monitored per test program developed in accordance with the requirements of GL 89-13. Acceptance criteria for performance verification are established to allow for degradation and maintain acceptable heat exchanger performance for all modes of plant operation.</u>**"

COL Applicant Item 9.2(6) has been revised as shown in the response to Question 09.02.01-38.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsections 9.2.1.2.2.1, 9.2.1.4, and 9.2.10.

Impact on COLA

See RAI 09.02.01-37 response. The COL applicant is to establish acceptance criteria for the pump and heat exchangers performance as described in the DCD markup.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-47

This is a follow-up to RAI 326-2279, Question 09.02.01-12:

Original question
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. In RAI 09.02.01-12, the applicant was requested to describe in the design control document (DCD) those 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.

New question
In its response to RAI 09.02.01-12, the applicant stated that the UHS is located at grade elevation, and this assures that the ESWS water is always above the saturation pressure. In response to RAI 09.02.01-30 the applicant identified a new COL information item 9.2 (25) requiring the COL applicant to develop operating and maintenance procedures to address water hammer issues in the ESWS in accordance NUREG-0927. However, the staff noted that the ESWS pumps and UHS are currently classified as CDI, and no provisions were established to ensure that COL applicants will place the ESWS pumps and UHS at grade elevation. Consequently, credit cannot

be taken for configuration of these items as a basis for addressing water hammer considerations. Therefore, this item will remain open pending satisfactory resolution of this item by the applicant. Note that this issue also applies to RAI 09.02.01-6 and RAI 09.02.01-13.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Refer response to RAI 09.02.01-43.

Impact on DCD

See response to RAI 09.02.01-43.

Impact on COLA

See response to RAI 09.02.01-43.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-48

This is a follow-up to RAI 326-2279, Question 09.02.01-13:

Original question

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. In RAI 09.02.01-13, the staff requested the applicant to 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.

New question

In its response to RAI 09.02.01-13, the applicant stated that the UHS is located at grade elevation, and this assures that the ESWS water is always above the saturation pressure. In response to RAI 09.02.01-30 the applicant also identified a new COL information item 9.2. (25) requiring the COL applicant to develop operating and maintenance procedures to address water hammer issues in the ESWS. However, the staff noted that the ESWS pumps and UHS are currently classified as CDI, and no provisions were established to ensure that COL applicants will place the ESWS pumps and UHS at grade elevation. Consequently, credit cannot be taken for configuration of these items as a basis for addressing water hammer considerations. Therefore, this item will remain open pending satisfactory resolution of this item by the applicant. Note that this issue also applies to RAI 09.02.01-6 and RAI 09.02.01-12.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Refer response to RAI 09.02.01-43.

Impact on DCD

See response to RAI 09.02.01-43.

Impact on COLA

See response to RAI 09.02.01-43.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-49

This is a follow-up to RAI 326-2279, Question 09.02.01-14:

Original question
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.

This includes a description of 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 essential service water (ESWS) trains, 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. In RAI 09.02.01-14 the applicant was requested to provide in the DCD the information to address the inadequacies as described related to water hammer.

New question
In its response to RAI 09.02.01-14, the applicant provided information to address the staff's question. However, the staff found that further clarification/resolution by the applicant is needed for the following items:

a) The applicant referenced the responses to RAI 09.02.01-12 and 09.02.01-13 to explain how an inadvertent water hammer is avoided. The applicant referenced Tier 2 DCD Section 3.9.6.2 where the response stated that periodic inservice testing of the high points in the ESWS results in discharge of any voids into the UHS. The staff's review of DCD Rev 2 Section 3.9.6.2 did not reveal any such procedures. Therefore, this item will remain open pending a satisfactory response by the applicant to describe in the DCD how the potential for voiding an ESWS train is prevented by the design and operating procedures, including a description of periodic inservice tests that are credited.

b) With respect to COL Item 9.2(25), DCD Rev 2 Section 9.2.1.2.1 "General Description," states: "The COL Applicant is to develop procedures for filling and venting the system, analyze inadvertent water hammer events, design the piping system to withstand the potential water hammer forces, and develop procedures to minimize the impact of these forces." However, COL item 9.2(25) in Table 1.8-2 in Rev 2 of the DCD dealing with water hammer does not include this same level of detail. Therefore, this item will remain open pending satisfactory resolution of this discrepancy by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Answer to a)

For the standby trains, maintaining the ESWS and associated UHS filled is necessary. The following are effective in maintaining the system filled as described in the responses to other related questions in this RAI:

- Operating and maintenance procedures in accordance with NUREG-0927 will be provided by the COL applicant as given in COL 9.2 (25). This procedure should address proper filling and venting of water-filled lines and components and eliminates air voids in the system at system startup.
- Isolation by the discharge check valve followed by the MOV to keep the system filled. The allowable leak rate for each valve is conservativeand confirmed by IST as mentioned in the response to 09.02.01-36 b).
- The standby trains will be placed in service per operating procedures identified in DCD Subsection 13.5 which is under the responsibility of the COL applicant. The system will be filled periodically.

The following is added at the end of the 6th paragraph in Tier 2 DCD Section 9.2.1.2.3.1:

"**The COL applicant is to provide a void detection system with alarms to detect system voiding.**"

Furthermore, a new COL item will be added in DCD Subsection 9.2.10 to ensure that the system is kept filled as shown below:

COL 9.2(32) ***The COL applicant is to provide a void detection system with alarms to detect system voiding.***

Answer to b)

The description in DCD Section 9.2.1.2.1 will be revised to remove "analyze inadvertent water hammer events" since this is included as one of the dynamic loads in the piping analysis to be performed in the ITAAC (see Tier 1 DCD Table 2.7.3.1-5).

"The COL Applicant is to develop ~~procedures for~~ system filling, ~~and~~ venting**, keeping** the system **full, and operational procedures to minimize the potential for water hammer; to analyze the system for water hammer impacts;** ~~analyze inadvertent water hammer events,~~**;** **to** design the piping system to withstand the potential water hammer forces; **and to** analyze inadvertent water hammer events**, in accordance with NUREG-0927.**~~and develop procedures to minimize the impact of these forces.~~

COL 9.2.(25) will be revised as follows for consistency with the description given in DCD Subsection 9.2.1.2.1 regarding water hammer mitigation:

COL 9.2(25) *The COL applicantwill is to develop operating and maintenance procedures for system **filing, venting, keeping the system full, and operational procedures to minimize the potential for water hammer; to analyze the system for water hammer impacts; to design the piping system to withstand potential water hammer forces; and to analyze inadvertent water hammer events** to address water hammer issues in accordance with NUREG-0927.*

COL item 9.2(25) in Table 1.8-2 and the description in Subsection 9.2.9.10 Combined License Information will be revised accordingly.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD 9.2.1.

Impact on COLA

Appropriate changes will be made to FSAR COLA 9.2.1.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-50

This is a follow-up to RAI 326-2279, Question 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.

In the response to RAI 09.02.01-15, a proposed DCD markup was provided that stated, "Since most of the ESW system remains filled with water, the ESW pump restart will sweep out the trapped air via high point vents..." However, it's not clear how air will be evacuated from high point vents and this aspect of the system design was not adequately explained. Therefore, this item will remain open pending a satisfactory response explaining how air is vented from these high point vents following a loss of power. Also, because much of the ESWS piping is CDI, the description needs to explain to what extent and on what basis this information pertains to COL applicants.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

See responses to Question 09.02.01-49.

Impact on DCD

See responses to Question 09.02.01-49.

Impact on COLA

See responses to Question 09.02.01-49.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-51

This is a follow-up to RAI 326-2279, Question 09.02.01-16:

Original question
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. In RAI 09.02.01-16, the staff requested the applicant to 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.

New question
In its response to RAI 09.02.01-16, the applicant stated that biological fouling is a concern of the COL applicant. MHI indicated that this issue is addressed by COL information item 9.2(23) which requires that the COL applicant address this issue. However, COL Information Item 9.2(23) pertains to the UHS and not the ESWS. Furthermore, this COL information item does not adequately address the periodic maintenance, inspection, and testing provisions that are specified by GL 89-13. Consequently, this item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

All ESWS piping and components are protected from fouling, namely, corrosion, erosion and biological fouling, through the ESW chemistry control required of the COL Applicant per DCD COL 9.2(8). The COL applicant is to develop inspection program and test procedures to address GL 89-13 and GL 89-13 Supplement 1 requirements. This shall include periodic monitoring, maintenance, performance testing and verification of the ESWS components and piping, inspection including visual for corrosion, erosion and biofouling. A test program shall be developed to verify performance of all safety related heat exchangers including CCW heat exchangers and essential chiller units in the ESW and UHS systems. A new COL Applicant requirement for periodic inspection, monitoring, maintenance, performance testing and verification of the ESWS components pursuant to GL 89-13 has been added as follows:

"***COL 9.2 (30)*** ***The COL Applicant shall conduct periodic inspection, monitoring, maintenance, performance and functional testing of the ESWS and UHS piping and components, including the heat transfer capability of the CCW heat exchangers and essential chiller units, consistent with GL 89-13 and GL 89-13 Supplement 1. The COL Applicant is to develop operating procedures to periodically alternate the operation of the trains to ensure performance of all trains is regularly monitored.***"

The above COL applicant item has been added to DCD Subsection 9.2.1.4.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsections 9.2.1.4 and 9.2.10.

Impact on COLA

The COL applicant is to develop inspection and test program per COL 9.2 (30).

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-52

This is a follow-up to RAI 326-2279, Question 09.02.01-18:

Original question
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. In RAI 09.02.01-18 the applicant was requested to 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, the applicant was requested to 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.

New question
In its response to RAI 09.02.01-18, the applicant stated that the strainers are replaced when they reach the specified differential pressure setpoint, and they are not the backwash type of strainer. The response implies that the replacement is done while the system is in operation as follows: *"... the standby strainer is placed in service by manually opening the strainer inlet and outlet valves. The clogged strainer is isolated manually by closing corresponding inlet and discharge valves."* The applicant proposed a revision to Tier 2 DCD Subsection 9.2.1.2.2.2, 1st paragraph. In the

revisions it is clearly stated that the ESWS is shut down first, the clogged strainer is isolated, and then the standby strainer is valved into service. The two descriptions provided by the applicant disagree. Consequently, the staff concerns remain unresolved and this item will remain open pending clarification of the information that was provided.

Additionally, relying upon operator actions to identify and address clogged strainer problems is of concern. Depending on what is used as the UHS, strainer clogging could be a common cause failure problem during plant accident conditions. Operator actions are typically not allowed for this condition and need to be justified. Also, the strainers are not included within the scope of the standard plant and it's not clear to what extent and on what basis this information applies to COL applicants. Consequently, staff concerns regarding strainer functionality have not been adequately addressed and this item will remain open pending satisfactory resolution of this RAI.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

The EWSP discharge non-backwash basket type strainer was originally installed in each ESWS train with a parallel strainer for backup. The 8 mm mesh size of the strainer element was intended to remove debris materials larger than 8 mm in order to prevent clogging of the shell and tube type essential chiller unit with flow passages greater than 8 mm. The passive self-cleaning strainer with 3 mm mesh size was also originally installed to prevent the introduction of debris materials with sizes over 3 mm to 8 mm to prevent these materials from accumulating inside the CCW plate heat exchangers with flow passages approximately 3~6 mm wide.

The description in DCD Section 9.2.1 has been revised to reflect the changes in the type and number of strainers used for each train. The serial strainer arrangement in each ESWS train, i.e. the ESWP discharge basket type (with parallel backup basket strainer) followed by a passive, self-cleaning type strainer is replaced by a single automatic self-cleaning (3 mm mesh size) strainer at the ESWP discharge. A parallel strainer is also installed for backup to ensure continuous debris removal and cooling by the ESWS. The fully automatic backwash function significantly reduces operator actions especially during normal plant operations including refueling operations. A differential pressure gauge across the strainers with local and MCR indication and alarm is installed. A high differential pressure alarm initiates backwash for discharge of the accumulated debris inside the strainer. Backwash operation is started before the maximum allowable differential pressure is reached to prevent strainer clogging. During normal operations, the automatic strainers are not expected to fail due to clogging since backwashing is performed at an alarm setpoint that is much lower than the maximum allowable differential pressure. The operator, however, may be required to remotely start backwashing when automatic actuation fails. At abnormal conditions such as during an accident or LOOP, the nonsafety-related differential pressure indications and alarms are not credited so that the operator might need to remotely start the backwash operation. The safety-related flow indication at the CCW HX outlet and alarm will aid the operator to identify the need for strainer backwashing.

During normal operations, the operator may also periodically swap the strainers to operate the standby or parallel strainer in lieu of the normally operating strainer in the same operating train. No common cause failures are expected due to operator errors at manual swapping of the strainers since the isolation valves are administratively locked on each side of the strainers.

The strainer backwash line is installed with a normally open isolation valve. The COL applicant is to determine the backwash line discharge. This normally open isolation valve in the backwash line and the strainer integral solenoid valve are interlocked to close at a pump stop signal to prevent water drainage that could potentially lead to water hammer effects. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers installed for prevention of water hammer.

DCD Section 9.2.1.2.2.2 is revised to as follows:

Two 100% capacity **parallel** strainers are located in each ESWP discharge line. **The strainers are automatic self-cleaning type**. **One strainer per train is operated at a time; the other strainer is installed as backup.** The differential pressure across the operating strainer is monitored. When the predetermined high differential set pressure across the strainer is reached an alarm is sent **locally and** to the MCR**.**~~; the clogged strainer is isolated by first shutting off the ESWP and them closing the strainer isolation valves. The standby strainer is then placed in service by manually opening the strainer isolation valves. The clogged strainer cartridge will be manually replaced.~~ **A high differential pressure alarm initiates backwashing for discharge of the accumulated debris inside the strainer. Backwash operation is started before the maximum allowable differential pressure is reached to prevent strainer clogging. The automatic strainers are not expected to fail due to clogging since backwashing is performed at an alarm setpoint that is much lower than the maximum allowable differential pressure. The operator also may remotely start backwash operation when automatic actuation fails. At abnormal conditions such as during an accident or LOOP, however, the nonsafety-related differential pressure indications and alarms are not credited so that the operator may have to remotely start strainer backwashing. The safety-related flow indication and alarm categorized as PAM variables will aid the operator to identify the need for strainer backwashing. In principle, the backup strainer is installed only for cases when the operating strainer is clogged at an unanticipated degree, although this is rather unlikely. Failure of any active component in the backwash line or the strainer itself, which could lead to failure of the associated train can be dealt with in one of two ways: i.e. either to shut down that train or operate the standby strainer. Failure of one train does not challenge the performance of the entire ESWS as mentioned previously. See the failure modes effects and analysis in Table 9.2.1-2.**

During normal operations, the operator may also periodically swap the strainers to operate the standby or parallel strainer in lieu of the normally operating strainer in the same operating train. No common cause failures are expected due to operator errors at manual swapping of the strainers since the isolation valves are administratively locked on each side of the strainers.

The strainer backwash line is installed with a normally open isolation valve. The COL applicant is to determine the backwash line discharge location in accordance with the type of the UHS used. This normally open isolation valve in the backwash line and the strainer integral backwash control valve are interlocked to close at a pump stop signal to prevent water drainage that could potentially lead to water hammer. The isolation valve is also provided with remote manual control from the MCR to enable remote manual isolation during accidents. The backwash line valves are powered by a Class 1E DC source so that they close upon loss of offsite power. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers installed for prevention of water hammer.

~~These strainers filter out most of the debris and thus provide adequate protection for ESWS components.~~

~~One 100% capacity self-cleaning type strainer is located upstream of each CCW HX. The strainer is continuously blown down at a rate of 500 gpm to prevent buildup of impurities and clogging of the CCW HXs. The blowdown water is discharged downstream of the CCW HXs.~~ **The automatic strainers have a 3 mm mesh which is considered to effectively remove debris from the system that could clog the CCW plate heat exchangers with flow passages approximately 3~6 mm in diameter. Since the essential chiller units, being shell and tube type heat exchangers, have a much larger flow path than the CCW heat exchangers,** ~~N~~**n**o strainer ~~is provided~~ for ~~essential chller unit coolers since filtration is provided by the ESWP discharge pipe strainers and~~ additional filtering is ~~not~~ deemed necessary. **[The 3 mm mesh of**

the strainer element also assures that potential clogging of the cooling tower nozzles is avoided.]"

A new subsection outlining the ESWS interface requirements in Tier 1 (Subsection 3.2.3) will be added and will include the following:

"**d. The discharge location of the ESWP discharge strainer backwash piping is determined according to the type of UHS used.**"

Impact on DCD

See Attachment 1 for changes to DCD Subsection 9.2.1.2.2.2 and Attachment 5 for Tier 1 DCD Subsection 3.2.3.

Impact on COLA

The R-COLA will be revised appropriately in the next revision. All other changes are incorporated by reference.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-53

This is a follow-up to RAI 326-2279, Question 09.02.01-19:

Original question
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 design control document, 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.

New question
In its response to RAI 09.02.01-19, the applicant stated that "additional filtering is not deemed necessary" for the essential chiller units. A more complete explanation in the DCD is needed for why a self-cleaning strainer is necessary for the CCW heat exchangers and not for the chillers.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

See also response to Question 09.02.01-52.

The essential chiller units are of the shell and tube type with flow passages much larger than that of the CCW plate heat exchangers. Since the debris size passing through the ESWP discharge strainers is less than 3 mm, placing another strainer at the essential chiller inlet is unnecessary.

DCD Subsection 9.2.1.2.2.2 has been revised to reflect the above as given in the response to Question 09.02.01-52.

Impact on DCD

See response to Question 09.02.01-52.

Impact on COLA

See response to Question 09.02.01-52.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-54

This is a follow-up to RAI 326-2279, Question 09.02.01-20:

Original question
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. In RAI 09.02.01-20, the applicant was requested to 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.

New question
In its response to RAI 09.02.01-20, the applicant stated that the ESWS side of the essential chiller heat exchangers will be cleaned while the system is offline per an established maintenance program. The applicant further stated that the essential chiller operation will be monitored via a site specific program as prescribed in COL information item 9.2(23). Staff review of COL information item 9.2(23) finds that this item only concerns fouling of the UHS system and does not specifically mention the ESWS. Consequently, this item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Refer to Question 09.02.01-51 response.

Similar to the response in Question 09.02.01-51, all ESWS piping and components shall be protected from fouling through the chemistry control program required of the COL Applicant in DCD COL 9.2(8). Regular performance testing and verification of the heat transfer capability of the essential chiller units that are commensurate with GL 89-13 requirements shall be required. A new COL Applicant requirement for regular performance testing and verification of the ESWS components pursuant to GL 89-13 has been added as COL 9.2 (30) as shown in the response to Question 09.02.01-51.

Impact on DCD

See response to Question 09.02.01-51.

Impact on COLA

See response to Question 09.02.01-51.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-55

This is a follow-up to RAI 326-2279, Question 09.02.01-21:

Original question
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.

New question
In its response to RAI 09.02.01-21, the applicant indicated that excessive wall thinning is not anticipated due to throttled butterfly valves following ESWS flow balancing. However, no provisions are established to ensure that excessive throttling of butterfly valves will not occur as a consequence of flow balancing operations. Also, the ESWS pump discharge butterfly valves are throttled every time the ESW pump is started and this needs to be recognized and addressed. It is also likely that butterfly valves will be throttled during low temperature operating conditions and this consideration also needs to be addressed. Finally, because the ESWS pump discharge butterfly valves are not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants and the applicant needs to address this as well. Consequently, this item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

All butterfly valves shown in DCD Figure 9.2.1-1 are part of standard design. The ESWS serves two components: Component Cooling Water Heat Exchangers and Essential Chiller Units. The ESW flow to all components remains the same for all modes of plant operation. All butterfly valves in the flow path are sized so that they will be close to full open position during operation and, no significant throttling for flow balancing is expected for all modes of plant operation. Considerations, however, are taken to provide valve opening margins to ensure that the design flow is met during all operating conditions. As already noted in response to (original) Question No. 09.02.01-21, the butterfly valves utilized in the ESWS are not intended to be used for throttling purposes. At least two butterfly control valves (EWS-VLV-511 and EWS-VLV-520) and one orifice downstream of the CCW HXs are available for adequate flow and resistance balancing, thus preventing unnecessary throttling operations. The ESW pump discharge butterfly valve goes from full closed to full open position in a short time period and should have insignificant impact on downstream piping. The pump start-stop operation will be infrequent. Low temperature operating conditions are site specific and also depend on the type of UHS. The standard plant design does not require throttling based on operating conditions.

Tier 2 DCD Subsection 9.2.1.2.2.6, last paragraph will be revised as follows:

"To avoid concerns with potential downstream pipe wall thinning, butterfly valves provided in the ESWS piping are not used for excessive throttling of the water flow. **The valves are sized such that they are near the full open position during the various modes of plant operation. Valve opening margins are included to ensure that the design flow is met during all plant operating modes. Restriction orifices are provided downstream of the heat exchangers as required for flow balancing.**"

COL 9.2(2) in Tier 2 DCD Table 1.8-2 and Subsection 9.2.10 will be revised as shown in the response to Question 09.02.01-33(I).

See also responses to Questions 09.02.01-33(I) and 09.02.01-35.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsections 9.2.1.2.2.6, 9.2.10, and Attachment 2 for changes to Tier 2 DCD Table 1.8-2.

Impact on COLA

The COL applicant is to address the system operation at low water temperature conditions per COL 9.2(2) and as described in DCD Subsection 9.2.1.2.2.6.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-56

This is a follow-up to RAI 326-2279, Question 09.02.01-23:

Original question
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. In RAI 09.02.01-23, the applicant was requested to address in the DCD 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.

New question
In response to RAI 09.02.01-23, the applicant indicated that piping will be inspected periodically per an established in-service inspection program. However, the staff is concerned with the ability to inspect piping systems buried in trenches since these are not generally accessible. The response provided by the applicant does not address this issue. Also, because the ESWS buried piping is not included within the scope of the standard plant, it's not clear to what extent and on what basis this information applies to COL applicants and the applicant needs to address this as well. Consequently, this item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

As noted in response to RAI 09.02.01-33 item (f), all ESWS piping will be inspected in accordance with the COL Applicant's ISI program. ASME B&PV Code, Section XI, Article IWA 5244 provides alternate in-service inspection rules for those sections of buried components, if any, that are not accessible. Cathodic protection will be provided, if required, for the buried piping.

Impact on DCD

See mark up in response to RAI 09.02.01-33, item (f) response.

Impact on COLA

See mark up in response to RAI 09.02.01-33, item (f) response.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: **5/10/2010**

QUESTION NO.: 09.02.01-57

This is a follow-up to RAI 326-2279, Question 09.02.01-24:

Original question
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, in RAI 09.02.01-24, the applicant was requested 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 this requirement.

New question
In its response to RAI 09.02.01-24, the applicant indicated that two trains are in operation under the normal power generation mode. This allows for monitoring the system temperature, pressure and flows. Periodic in-service inspections will provide further indication of proper operation. The applicant further stated that the operation of the various trains will be alternated to allow observation of the standby trains. However, a COL information item was not established to ensure proper implementation of this provision by COL applicants. Consequently, this item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

A COL Applicant item will be added to ensure that the ESWS system parameters and performance monitoring as stated in the RAI 326-2279, Question 09.02.01-24 (MHI Letter UAP-HF-09326) response are implemented. See also responses to Questions 09.02.01-51 and 09.02.01-59. See the COL item 9.2(30) in the response to Question 09.02.01-51.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Section 9.2.10.

Impact on COLA

The COL Applicant is to conduct periodic inspection, monitoring and performance and functional testing of the ESWS and UHS piping and components per GL 89-13, as well as develop operating procedures to periodically alternate the ESWS and UHS train operation.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

9/24/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-58

This is a follow-up to RAI 326-2279, Question 09.02.01-25:

Original question
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 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. The applicant was requested, in RAI 09.02.01-25, to describe 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.

New question
In its response to RAI 09.02.01-25, the applicant indicated that radiation monitors are located downstream of the CCWS heat exchangers and that they alarm in the MCR when the radiation level exceeds the setpoint. Upon receipt of an alarm the operators will isolate the contaminated ESWS train and the corresponding CCWS train. The response goes on and discusses a "ditto" train. The following items remain to be addressed:

a. While radiation monitors are shown on Figure 9.2-1, automatic isolation valves are apparently not provided and this needs to be explained and justified. Furthermore, failure to provide automatic isolation as specified by SRP Section 9.2.1, Paragraph III(3)(D) is an exception to the SRP that needs to be acknowledged and justified in accordance with 10 CFR 52.47(a)(9).

b. Plate-type heat exchangers are much more prone to leakage than shell and tube heat exchangers. Consequently, it is more likely that the use of these heat exchangers for cooling the CCW system will result in the spread of radioactive contamination to the ESWS, UHS, and environment over time unless suitable design and monitoring provisions are established to address 10 CFR 20.1406 considerations and to satisfy the requirements specified by GDC 60 and GDC 64. This is especially true for those situations where the level of contamination in the CCW and ESW systems is below the threshold of detection by the installed radiation monitors. Therefore, additional information is needed to describe design and monitoring provisions that will be implemented to ensure that the spread of contamination over time will be minimized.

c. Section 9.2.1.2.3.1 states, that the "ditto train is ultimately placed out of service..." The use of the term "ditto" in this context is unusual and confusing. The description needs to be rewritten using more conventional terminology. This item will remain open pending satisfactory resolution of this RAI by the applicant.

Reference: MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

a. The ESWS essentially does not contain nor transport radioactive materials from its source to its recipient components. Any leaks from the CCW heat exchanger does not allow mixing of the potentially radioactive CCW and the nonradioactive ESW unless holes are developed in the titanium plates which are very unlikely. Any leakage through the gaskets is toward the outside of the heat exchangers hence radioactive contamination to the ESWS is of no concern. The probability of the potentially radioactive CCW propagating to the environment through the ESWS is, therefore, very low and explains why an automatic isolation valve is not needed as required in SRP 9.2.1.

The first paragraph of Tier 2 DCD Subsection 9.2.1.2.1 is revised as follows (See also revised response to RAI 285-2145 Rev.1 (MHI Letter # UAP-HF-10191 dated July 7, 2010):

"Figure 9.2.1-1 shows the piping and instrumentation diagram of the ESWS. The ESWS draws water from the intake basin and returns the **effluent** water to the UHS after passing through the CCW HXs and the essential chiller units. The UHS is the source of water to the intake basin. The essential chiller units do not include **any** ~~the~~ radioactive fluid~~,~~**.** ~~and~~ **The** CCWS is the intermediate loop between the reactor auxiliaries and the ESWS. This arrangement minimizes direct leakage of radioactive fluid from the ESWS to the environment. **Nevertheless, the CCW plate heat exchangers are constructed to prevent intermixing of the fluids from both sides so that any leakage will go to the outside of the heat exchanger except when a hole is developed in the plates—a rare event with titanium plates. Gasket failure directs leakage towards the outside of the CCW heat exchanger, hence radioactive contamination of the ESWS propagating to the UHS and ultimately to the environment is not considered credible. Any leakage from the CCW heat exchangers is collected into the nonradioactive floor drains thus ensuring that no ESWS water is released directly to the environment. For conservatism, however,** ~~In addition~~, radiation monitors are provided in each discharge line of **the** CCW HX essential service water (ESW) side. **See also the description of these monitors in DCD Subsection 11.5.2.5.2. Radiation alarms are provided to** alert the operator if **radioactive**~~the~~ leakage~~ing~~ **from the** CCW **side has entered the ESW side.** ~~contains radioactivity so that~~ ~~t~~The operator ~~can~~ **then** isolate**s** the leaking train **to prevent uncontrolled radiation contamination of the ESWS and UHS. Prior to any radiation leakage being**

detected in the ESWS, however, radiation alarms in the CCWS side would have already alerted the operators of contamination in the CCWS. The affected CCWS train is immediately isolated followed by the isolation of the aligned ESWS to prevent possible contamination of the UHS and the environment."

The beginning of the ninth paragraph of Tier 2 DCD Subsection 9.2.1.2.1 is revised as follows:

"~~The ESWS system design assures that the CCW HX operating pressure on the ESW side is not higher than the CCWS operating pressure.~~ The~~us,~~ construction of the CCW plate heat exchangers prevents any leakage ~~is~~ from **either** the CCW **side or** ~~to~~ the ESW~~S~~ **side** from contaminating each other. Therefore, the raw service water do~~s~~es not contaminate the demineralized CCW **nor does the potentially radioactive CCW contaminate the ESW**. The ESWS interfaces with the UHS system are further described in Section 9.2.5. "

b. As explained in response to (a) above, the CCW plate type heat exchangers are constructed to prevent intermixing of the CCW and ESW in case of a leakage through gasket failure. The gasketing ensures that leakage on either side goes to the outside of the heat exchanger thereby preventing one fluid from contaminating the other. The titanium construction of the plates also precludes a hole from developing in the plates so that radioactive contamination through the intermixing of the CCW and ESW is not credited. If, by any means (e.g. through pinholes in the plates although rather unlikely), radioactive contamination of the ESW from the CCW does occur, a local grab sampling line is installed downstream of the CCW heat exchanger to provide grab sampling capability. Periodic sampling of the ESW stream will be performed to determine any trace amounts of radioactivity prior to release to the UHS. For discharge to cooling towers, the ESW is sampled prior to blowdown releases.

The first paragraph of Tier 2 DCD Subsection 9.2.1.2.1 is revised by adding the following at the end:

"**A local grab sampling line is installed downstream of the CCW heat exchanger to determine any trace amounts of radioactivity prior to release to the UHS. ESW discharge sampling is performed periodically. [For discharge to cooling towers, the ESW is sampled prior to blowdown releases.]**"

Tier 2 Table 9.3.2.6 is also revised as follows:

Sample Point No.	Sample Point Name	Analysis	Pressure$^{(b)}$ (psig)	Temperature$^{(b)}$ (°F)
37	Steam Generator blowdown demineralizers inlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
38	**A-, B-, C-, D- Component Cooling Water Heat Exchanger Essential Service Water Side Discharge**	**Radioactivity**	**150**	**140**
Yard Area				
1	External Water Makeup	pH, conductivity	Atmospheric	Ambient

c. The term “ditto” has been deleted from Section 9.2.1 and replaced by more conventional terminology.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsection 9.2.1.2.1 and Table 9.3.2.6.

Impact on COLA

Table 9.3.2.6 will be added to FSAR R-COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 585-4464 REVISION 0**

SRP SECTION: **9.2.1 – Station Service Water System**

QUESTION FOR BALANCE OF PLANT BRANCH 2 (SBPB)

DATE OF RAI ISSUE: 5/10/2010

QUESTION NO.: 09.02.01-59

This is a follow-up to RAI 326-2279, Question 09.02.01-29:

Original question
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, RAI 09.02.01-29, requested the applicant to address in the Tier 1, Section 2.7.3 and Table 2.7.3.1-5 revisions to address issues listed below.

(1) 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.

(2) 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.

(3) Item 7; clarify how the ITAAC will account for the degradation in heat removal capability at the maximum allowable supply water temperature of 35 °C (95 °F). Clarify how the as-built provides adequate cooling water. (4) 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.

(5) Quantitative acceptance criteria need to be established for all ITAAC as applicable (flow rates, heat transfer rates, completion times, etc.).

(6) 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.

(7) The DCD does not stipulate that the ESWS is accessible for performing periodic inspections as required by GDC 45.

(8) 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.

(9) The DCD needs an item for the inspection of Class 1E divisional separation.

(10) The DCD needs a test item for the testing of the ESW pump discharge strainer differential pressure alarms and monitors.

(11) The DCD needs a test item for the testing of the CCW heat exchanger inlet strainer differential pressure alarms and monitors.

(12) The DCD needs a test item for the testing of the CCW discharge radiation monitor alarms and monitors.

(13) The DCD needs a test item for the testing of essential chiller unit alarms and malfunctions on the ESWS side.

(14) The DCD needs a test item for the testing of ESWS check valves.

(15) The DCD needs an inspection item for supports per the requirements of ASME.

(16) The DCD needs an inspection item for lined underground piping which is placed in trenches.

<u>New question</u>
In its response to RAI 09.02.01-29, the applicant addressed the items referred to above. The staff found that the following items were not adequately addressed and additional clarification is needed by the applicant.

- For part (2), the applicant proposes changes to Tier 1 Table 2.7.3.1-5 that clarifies that piping in the ESWS pipe tunnel is the only exception where separation between divisions is not maintained. This exception needs to be described and justified in Tier 2 of the DCD. Consequently, this item will remain open pending satisfactory resolution of this RAI issue by the applicant.
- For part (3), the applicant stated that this ITAAC item has been expanded in response to RAI 192(-1847) question 14.03.04-15. The applicant further stated that the IST includes periodic pump testing to assure continued operation in the proposed degraded condition. Finally the applicant implies that a new COL applicant program to monitor heat exchange performance is put into place in response to RAI question 09.02.01-30. The staff could not find this new monitoring program within the RAI response 09.02.01-30. In addition, the program should address all of the provisions contained in Generic Letter 89-13. Consequently, this item will remain open pending satisfactory resolution of this RAI issue by the applicant.
- For part (10), the applicant refers the staff to the response to RAI 09.02.01-22. It is implied that the differential pressure alarm is included in Tier 1 DCD Table 2.7.3.1-4. The NRC staff could not find this alarm listed in this table, nor was a modified table provided in response to RAI 09.02.01-22. Consequently, this item will remain open pending satisfactory resolution of this RAI issue by the applicant.
- For part (11), the applicant refers the staff to the response to RAI 09.02.01-22. It is implied that the CCW heat exchanger inlet strainer is addressed in that response. The NRC staff

could not find this component addressed in that response. Consequently, this item will remain open pending satisfactory resolution of this RAI issue by the applicant.

- For part (16), the applicant referred to the response provided to RAI 09.02.01-23. The staff's review of the response to RAI 09.02.01-23 found that piping buried in trenches is not addressed. This item remains open pending satisfactory resolution of this RAI issue by the applicant.

References:
MHI's Responses to US-APWR DCD RAI No. 192-1847; MHI Ref: UAP-HF-09167; Dated April 10, 2009; ML091040326.
MHI's Responses to US-APWR DCD RAI No. 326-2279; MHI Ref: UAP-HF-09326; Dated June 19, 2009; ML091870782.

ANSWER:

Answer (1):

As described in the second paragraph of Tier 2 DCD Subsection 9.2.1.2.1, all components and piping of the ESWS are physically separated into independent divisions without exceptions. The exception in item 1(b) of ITAAC Table 2.7.3.1-5 in Tier 1 for the ESWS pipe tunnel piping was written based on site specific layout considerations. See response to Question 09.02.01-33(f). Item 1(b) will be revised to remove the exception as follows:

1.b Each mechanical division of the ESWS (Division A, B, C & D) ~~except for piping~~ is physically separated from the other divisions ~~with the exception of the components in the ESWS piping tunnel~~.	1.b Inspections of the as-built ESWS will be performed.	1.b Each mechanical division of the as-built ESWS (Division A, B, C & D) ~~except for piping~~ is physically separated from the other divisions of the system by structural barriers~~ divisions with the exception of the components in the ESWS piping tunnel~~.

Answer (2):
The heat exchanger integrity in terms of fouling protection and blockage is expected to be upheld by the maintenance and test programs stated in COL 9.2 (8) and COL 9.2 (26). A new COL Applicant requirement for regular performance testing and verification of the ESWS, including the heat transfer capability of the CCWS heat exchangers, pursuant to GL 89-13 has been added as shown in the response to Questions 09.02.01-51.

Answer (3):
The ESWP discharge strainer differential pressure alarms and indications are nonsafety-related and will not be added to Tier 1 Table 2.7.3.1-4. For the US-APWR components and instrumentation, only those that have safety-related functions or having PSMS controls and functions are included in the Tier 1 tables and figures unless otherwise noted or required.

Answer (4):
The CCWS heat exchanger inlet strainer, along with the ESWP discharge basket strainers, has been removed and replaced with parallel automatic self-cleaning strainers at the ESWP discharge. See responses to Questions 09.02.05-34 and 09.02.01-52.

Answer (5):
As noted in the response to Question 09.02.01-33 (f) the ESWS buried piping is not part of the standard plant. The COL Applicant is to design site specific piping from the ESW intake structure to the nuclear island and the return piping from the nuclear island to the UHS. As noted in the DCD Section 9.2.1.2.2.5, means are provided for periodic inspection of this piping. All piping will be inspected in accordance with the established ISI program. ASME B&PV Code, Section XI, Article IWA 5244 provides alternate in service inspection rules for those sections of buried components, if any, that are not accessible. No specific failure of the underground ESWS piping is anticipated. Cathodic protection will be provided for the buried piping, if required based on site specific soil conditions. All ESWS piping is safety-related and designed to ASME B&PV Code, Section III, Class 3 requirements. If required, the COL applicant will develop inspection and maintenance program per GL 89-13 recommendations. This will ensure integrity of underground piping to perform its safety function.

Impact on DCD

See response to Question 09.02.01-33 (f).
See Attachment 4 for the changes to Tier 2 DCD Table 1.8-2 which reflects all the new COL items due to the responses to this RAI.

Impact on COLA

If required, the COL Applicant is to establish inspection and maintenance program to monitor integrity of underground piping.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

9.2 Water systems

9.2.1 Essential Service Water System

The essential service water system (ESWS) provides cooling water to remove the heat from the component cooling water (CCW) heat exchangers (HXs) and the essential chiller units. The ESWS transfers the heat from these components to the ultimate heat sink (UHS). The UHS is described in Subsection 9.2.5.

The following subsections contain conceptual design information enclosed in brackets and are outside the scope of the standard design, thus shall not be incorporated by reference in the COLA.

RAI 585-4464

9.2.1.1 Design Bases

The ESWS operates during all modes of plant operation and performs safety-related as well as non-safety related functions. The ESWS is designed to meet the relevant requirements of GDC 2, GDC 4, GDC 5, GDC 44, GDC 45, and GDC 46 (Ref. 9.2.11-1).

9.2.1.1.1 Safety Design Bases

The ESWS is designed to the requirements of the overall US-APWR plant design criteria. Specific safety design bases for the ESWS are as follows:

- The system is capable of transferring heat loads from safety-related SSCs to the UHS during normal operating and accident conditions, including LOCA, pursuant to the requirements of GDC 44.
- The system, in conjunction with the plant UHS, is designed to remove heat from the plant auxiliaries required to mitigate the consequences of a design basis event and for safe shutdown, assuming a single failure and one train unavailable due to maintenance coincident with a loss of offsite power pursuant to the requirements of GDC 44.
- ESWS is designed to equipment Class 3 and seismic category requirements, and as such it is designed to remain functional during and following an SSE per RG 1.29.
- The system is designed considering the protection against adverse environmental, operating, and accident conditions that can occur, such as freezing, thermal overpressurization, and water_hammer per RG 1.206.
- The system is designed to detect and preclude uncontrolled release of radioactive contaminants to the environment. Radioactive contaminants may enter the ESWS from the component cooling water system (CCWS).
- Measures to prevent long-term corrosion and organic fouling in the ESWS are considered pursuant to the requirements in SRP 9.2.1 and RG 1.206.

- Protection against natural phenomena for the safety-related portions are provided such as protection from wind and tornado effects, as described in Section 3.3; flood protection as described in Section 3.4; internal missile protection as described in Section 3.5; protection against dynamic effects associated with the postulated rupture of piping as described in Section 3.6. Environmental qualification of Class 1E equipment is described in Section 3.11; seismic design is described in Section 3.7,; and fire protection is described in Section 9.5.
- The ESWS is constructed in accordance with ASME Section III, Class 3 requirements.
- The ESWS is designed to permit periodic inservice testing and inspection of components to assure system integrity and capability in accordance with GDC 45 and ASME Code Section XI.
- The ESWS is designed to permit appropriate pressure and functional testing to assure the structural and leaktight integrity of components, operability and the performance of the active components of the system, and system operability during reactor shutdown, loss-of-coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources per GDC 46.
- The ESWS is designed with the capability to isolate nonsafety-related portions from the safety-related portions of the system. DCD 09.02.01-33 (b)
- The essential service water pumps (ESWPs) are designed to have sufficient available net positive suction head (NPSH) to assure that they can perform their safety function at the lowest probable water level of the UHS.
- The ESWS is composed of four redundant trains completely separated from each other, and whose components and piping are not shared with the other trains and other plant units. There are no interconnections among the trains so that the failure of one train will not affect another per GDC 5. DCD 09.02.01-33 (d)

9.2.1.1.2 Power Generation Design Bases

DCD 09.02.01-33 (b)

The ESWS removes the heat loads from the CCWS through heat exchange with the CCWS heat exchangers and essential chiller units during normal plant operation, refueling, and normal shutdown.

9.2.1.1.3 Nonsafety-Related Design Bases

DCD 09.02.01-42; DCD 09.02.01-33 (b)

The ESWS does not provide cooling water to any nonsafety-related components during normal plant operations or design basis events such as a LOCA. The ESWS may be used as a backup source of water to the fire protection water supply system (FSS) in the event where the normal supply is unavailable due to design basis events such as an earthquake. The ESWS is normally isolated from the FSS. The ESWS is not required to supply water to the FSS during any design basis event other than the safe shutdown

RCOL 09.02.01-5

DCD 09.02.01-33(c)

earthquake. . However, sSome portions of the system are nonsafety-related, e. g., sections of pipe in heat exchanger drain piping after the isolation valves. These boundary isolation valves which provide separation between the safety-related and nonsafety-related portions are normally closed. During a design basis event, postulated simultaneous failure of all nonsafety-related piping would not impact operation of any ESW train and would not affect ESWS capability to perform its safety functions. The COL Applicant is to address site specific nonsafety-related system isolation (intake basin blow down system, intake basin make up water system, FSS) as applicable.

9.2.1.2 System Description

9.2.1.2.1 General Description

Figure 9.2.1-1 shows the piping and instrumentation diagram of the ESWS. The ESWS draws water from the intake basin and returns the effluent water to the UHS after passing through the CCW HXs and the essential chiller units. The UHS is the source of water to the intake basin. The essential chiller units do not include anythe radioactive fluid,. andThe CCWS is the intermediate loop between the reactor auxiliaries and the ESWS. This arrangement minimizes direct leakage of the radioactive fluid, from the ESWS to the environment. Nevertheless, the CCW plate heat exchangers are constructed to prevent intermixing of the fluids from both sides so that any leakage will go to the outside of the heat exchanger except when a hole is developed in the plates—a rare event with titanium plates. Gasket failure directs leakage towards the outside of the CCW heat exchanger, hence radioactive contamination of the ESWS propagating to the UHS and ultimately to the environment is not considered credible. Any leakage from the CCW heat exchangers is collected into the nonradioactive floor drains thus ensuring that no ESWS water is released directly to the environment. For conservatism, however, In addition, radiation monitors are provided in each discharge line of the CCW HX essential service water (ESW) side. See also the description of these monitors in DCD Subsection 11.5.2.5.2. Radiation alarms are provided to The monitors to alert the operator if radioactive the leakageing from the CCW side has entered the ESW side. contains radioactivity so that tThe operator then can isolates the leaking train to prevent uncontrolled radiation contamination of the ESWS and UHS. Prior to any radiation leakage being detected in the ESWS, however, radiation alarms in the CCWS side would have already alerted the operators of contamination in the CCWS. The affected CCWS train is immediately isolated followed by the isolation of the aligned ESWS to prevent possible contamination of the UHS and the environment. A local grab sampling line is installed downstream of the CCW heat exchanger to determine any trace amounts of radioactivity prior to release to the UHS. ESW discharge sampling is performed periodically. [For discharge to cooling towers, the ESW is sampled prior to blowdown releases.]

DCD 09.02.05-8

DCD 09.02.01-58

DCD 09.02.05-8;
DCD 09.02.01-58 (b)

The ESWS is arranged into four independent trains (A, B, C, and D). Each train consists of one ESWP, two 100% strainers in the pump discharge line, one 100% strainer upstream of the CCW HX, one CCW HX, one essential chiller unit, and associated piping, valves, instrumentation and controls. This arrangement assures that failures and postulated events in one train do not affect the safety-related functions of the other trains. During normal ESWS operation, at least two trains out of four are required to be

DCD 09.02.01-34;
DCD 09.02.01-52;
DCD 09.02.01-33(d)

operable to meet the safety-related design requirements. During accidents and other design basis events, such as a LOCA or safe shutdown with a LOOP, a postulated single active component failure in one train coincident with on-line maintenance in another train do not prevent the ESWS from performing its safety-related functions with the two remaining operable trains. Instrumentation is also provided independently and not shared among the trains.

Each supply line after the strainer is tapped to supply cooling water to each component. Each CCW HX is provided with piping and isolation valves around the heat exchanger, which facilitates back-flushing of the CCW HX of the ESW side when required. Heat from the reactor auxiliaries is removed from the CCW HX and the heated service water flows to the UHS via independent lines. The ESW flow of 13,000 gpm is maintained at all operating conditions, including accident conditions and safe shutdown with a LOOP. The ESWS is designed to operate at temperatures as low as 32° F. For the ESWS piping and components in the R/B and PS/B, freezing of the ESW in the standby trains is precluded by the HVAC system operating between 50° F and 105° F. [Piping running through tunnels and trenches are below grade so that freezing of the ESW is not a concern. Stagnant and exposed portions of the system are heat traced to ensure that the ESW inside these structures is maintained above 32° F.]

DCD 09.02.0 1-35

DCD 09.02.0 1-55

The ESW piping from the pump discharge after passing through the discharge strainers drops underground and runs to the reactor building. The ESW tunnels near the building are located at -26' 4" elevation. After serving the CCW HXs and the essential chiller units ESW piping runs to the UHS.

The COL applicant is to determine the piping layout of the UHS to maintain the ESWS/UHS pressure above saturation pressure for all operating modes. [The piping layout of the UHS maintains the ESWS/UHS system pressure downstream of the pump discharge check valve above their saturation pressure at 140° F design temperature by ensuring that no piping high points are above the cooling tower spray header. This prevents potential void formation during pump stoppage. During pump operation, due to the addition of the dynamic head to the static head, the ESWS/UHS system pressure will be above saturation pressure.] The ESWPs are sized to provide positive pressure at the highest point in the system. The system is designed for 140° F. The system layout and the design assure that the fluid pressure remains above saturation conditions at all locations during all modes of operation.

DCD 09.02.0 1-36

The ESWS layout ensures that the fluid pressure in the system is above saturation conditions at all locations. The ESWS layout, in combination with the motor-operated valves (MOVs) at the discharge of each ESWP, minimizes the potential for transient water hammer. The starting logic of the ESWP interlocks the operation of the motor operated valve with the pump operation. [The vVoiding in any train due to potential ESW drain down through the cooling tower spray nozzles may occur on during loss of offsite power and subsequent pump trip.] To preclude water hammer on pump re-start, the MOV at each pump discharge is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed

DCD 09.02.0 1-36

DCD 09.02.0 1-43(a)

except during emergency situations such as an accident or LOOP events. Upon receiving the pump actuation signal such as an ECCS actuation or LOOP sequence signalAfter a predetermined time delay after the pump starts, the MOV starts to gradually open to preclude water hammer. The ESWP and ESWP discharge MOV interlock is overridden by either the ECCS actuation or LOOP sequence signal. If the valve fails to open, the train may be placed out of service since the loss of one train will not affect any plant safety functions as shown Table 9.2.1.2. the pump is tripped If the valve fails to open during pump switching at normal power operation, and alarmed is sent to in the MCR. The short time duration during which the pump is dead headed is not detrimental for long term pump performance and the pump can be manually tripped.

The CCWHXs and the essential chiller units are located at floor elevation (- 26' 4") in the reactor building. The ESWPs and ultimate heat sink which is site dependent will be located at grade elevation. This arrangement assures that all points in the system remain above atmospheric pressure.

The COL Applicant is to develop procedures forsystem filling, and venting, keeping the system full, and operational procedures to minimize the potential for water hammer;, to analyze the system for inadvertent water hammer eventsimpacts,; to design the piping system to withstand the potential water hammer forces,; and to analyze inadvertent water hammer events, in accordance with NUREG-0927develop procedures to minimize the impact of these forces.

The ESWS system design assures that the CCW HX operating pressure on the ESW side is not higher than the CCWS operating pressure. Theus, construction of the CCW plate heat exchangers prevents any leakage is from either the CCW side or to the ESWS side from contaminating each other. Therefore, the raw service water doses not contaminate the demineralized CCW nor does the potentially radioactive CCW contaminate the ESW. The ESWS interfaces with the UHS system which isare further described in Section 9.2.5. Type and location of the UHS is are site specific. The COL Applicant's is to assure that selection and design of the UHS to deliver the design supplies water flow rate to the ESWS does not exceed the at a maximum design temperature of 95° F under all operating conditions to assure sufficient cooling capacity. The UHS design also assures the cooling water inventory for a minimum of 30 days without make-up to mitigate the consequences of a design basis event. The COL Applicant is to design the ESW intake structure or UHS [basin] such that the minimum water level (after a 30--day emergency operation) will provide adequate NPSH to the ESWPs under accident conditions. DCD_09.02.01-58 DCD_09.02.01-43(c)

Bio-fouling and chemistry control of the ESWS is are site specific and depends upon the type of UHS. The COL Applicant is to specify the following ESW chemistry requirements.

- A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation
- The type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor and silt dispersant based on the site conditions

[As part of the water chemistry management program of a plant that utilizes cooling towers and basins as the ESWS water source, an ESWS blowdown line is installed at the DCD_09.02.01-33(c)

ESWP discharge piping. Part of the pumped ESW is blown down to remove a portion of the accumulated chemical salts and dissolved solids per site environmental chemistry requirements while the UHS makeup system is in operation. Details are given for blowdown and UHS basin water makeup in Section 9.2.5.-]

The COL Applicant is ~~to develop operating procedures~~ to verify system layout ~~and performance~~ of the ESWS and UHS and is to develop operating procedures to assure that the ESWS and UHS ~~is~~are above saturation conditions ~~throughout the system~~for all operating modes.

The COL applicant is to develop maintenance and test procedures to monitor debris build-up and flush out debris.

~~The COL Applicant is to provide the piping, valves and other design related to the site specific UHS.~~ DCD 09.02.01-33(e)

9.2.1.2.2 Component Description

Table 9.2.1-1 shows the design parameters of the major components in the system.

9.2.1.2.2.1 ESWPs

Four 50% capacity ESWPs, one per train, supply cooling water to remove heat from the recipient components, and then discharge the heated water to the UHS. Approximately 12,043 gpm ESWP flow is required for all modes of plant operation as indicated in the DCD Table 9.2.1-4. This provides approximately 7.7 percent margin to the design ESWP flow rate of 13,000 gpm. The margin allows for pump and heat transfer degradation by fouling, leakages, excessive pressure drop across system components or, fluctuations due to supplied electrical frequency. RCOL 09.02.01-46

The pumps are powered from the Class 1E ~~normal~~ ac power system. On loss of offsite power, the pumps are automatically powered from their respective emergency power source.

Each pump is designed to provide 13,000 gpm flow at the required total dynamic head. The required pressure drop across the ESWS components and piping (within standard plant design scope) is approximately 100 feet. The COL applicant is to determine the required ESWP TDH by adding pressure drop across the site specific components and piping and maximum static lift to this pressure drop. The COL Applicant is to provide the site specific data for the ESWPs and assure that the selected ESWP will require less NPSH than the minimum available NPSH under all operating conditions. The COL Applicant is to assure that the sum of the shut-off head of the selected ESW pumps and the static head will not result in exceeding the ESWS design pressure. The UHS level is based on the 30-day emergency cooling at design basis accident heat loads, pump(s) operating at design flow rates with maximum cooling water temperature of 95° F. The potential for vortex formation is evaluated and the available NPSH computed using these parameters. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply (e.g., temperature, flow rate, operation of other pumps for vortex evaluation). RCOL 09.02.01-37 RCOL 09.02.01-39 RCOL 09.02.01-38

The ESWP motors are water cooled mode of cooling of the ESWP motors is site-specific and shall be determined by the COL Applicant. RCOL 09.02.01-4

9.2.1.2.2.2 Strainers

Two 100% capacity parallel strainers are located in each ESWP discharge line. The strainers are automatic self-cleaning type. One strainer per train is operated at a time; the other strainer is installed as backup. The differential pressure across the operating strainer is monitored. When the predetermined high differential set pressure across the strainer is reached an alarm is sent locally and to the MCR.; the clogged strainer is isolated by first shutting off the ESWP and them closing the strainer isolation valves. The standby strainer is then placed in service by manually opening the strainer isolation valves. The clogged strainer cartridge will be manually replaced. A high differential pressure alarm initiates backwashing for discharge of the accumulated debris inside the strainer. Backwash operation is started before the maximum allowable differential pressure is reached to prevent strainer clogging. The automatic strainers are not expected to fail due to clogging since backwashing is performed at an alarm setpoint that is much lower than the maximum allowable differential pressure. The operator also may remotely start backwash operation when automatic actuation fails. At abnormal conditions such as during an accident or LOOP, however, the nonsafety-related differential pressure indications and alarms are not credited so that the operator may have to remotely start strainer backwashing. The safety-related flow indication and alarm categorized as PAM variables will aid the operator to identify the need for strainer backwashing. In principle, the backup strainer is installed only for cases when the operating strainer is clogged at an unanticipated degree, although this is rather unlikely. Failure of any active component in the backwash line or the strainer itself, which could lead to failure of the associated train, can be dealt with in one of two ways: i.e. either to shut down that train or operate the standby strainer. Failure of one train does not challenge the performance of the entire ESWS as mentioned previously. See the failure modes effects and analysis in Table 9.2.1-2

DCD 09.02.01-34; 09.02.01-52

09.02.01-52

During normal operations, the operator may also periodically swap the strainers to operate the standby or parallel strainer in lieu of the normally operating strainer in the same operating train. No common cause failures are expected due to operator errors at manual swapping of the strainers since the isolation valves are administratively locked on each side of the strainers.

The strainer backwash line is installed with a normally open isolation valve. The COL applicant is to determine the backwash line discharge location in accordance with the type of the UHS used. This normally open isolation valve in the backwash line and the strainer integral backwash control valve are interlocked to close at a pump stop signal to prevent water drainage that could potentially lead to water hammer. The isolation valve is also provided with remote manual control from the MCR to enable remote manual isolation during accidents. The backwash line valves are powered by a Class 1E DC source so that they close upon loss of offsite power. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers installed for prevention of water hammer. 09.02.01-52

~~These strainers filter out most of the debris and thus provide adequate protection for ESWS components.~~

~~One 100% capacity self-cleaning type strainer is located upstream of each CCW HX. The strainer is continuously blown down at a rate of 500 gpm to prevent buildup of impurities and clogging of the CCW HXs. The blowdown water is discharged downstream of the CCW HXs.~~ The automatic strainers have a 3 mm mesh which is considered to effectively remove debris from the system that could clog the CCW plate heat exchangers with flow passages approximately 3~6 mm in diameter. Since the essential chiller units, being shell and tube type heat exchangers, have a much larger flow path than the CCW heat exchangers, ~~N~~no strainer ~~is provided~~ for ~~essential chller unit coolers since filtration is provided by the ESWP discharge pipe strainers and~~ additional filtering is ~~not~~ deemed necessary. [The 3 mm mesh of the strainer element also assures that potential clogging of the cooling tower nozzles is avoided.]

DCD 09.02.01-34; 09.02.01-52

DCD 09.02.01-34; 09.02.01-52

The ESWP discharge strainers are designed per ASME Boiler and Pressure Vessel Code Section III, Division I, Subsection ND - Class 3 Components and ASME NQA-1 - Quality Assurance Requirements for Nuclear Facility Applications.

DCD 09.02.01-34(a)

The COL Applicant is to provide the design details of the strainer backwash line, vent line, and their discharge locations.

DCD 09.02.01-34(h)

9.2.1.2.2.3 CCW HX

Four 50% capacity plate type HXs, one per train, are provided. A detailed description of the HXs is given~~discussed~~ in Subsection 9.2.2.

A backflushing line is provided for each CCW HX to enable backflushing of the heat exchanger following a high differential pressure alarm that may likely be caused by accumulation of debris materials inside the heat exchanger plate flow channels.

DCD 09.02.01-33(g)

9.2.1.2.2.4 Essential Chiller Units

Four 50% capacity chiller units, one per train, are provided. A detailed description of the essential chiller units is given in Subsection 9.2.7.

9.2.1.2.2.5 Piping

Carbon steel piping designed, fabricated, installed and tested in accordance with ASME Section III, ~~c~~Class 3 requirements, is used for the safety-related portion of the ESWS. Piping is arranged to permit access for inspection. ~~Underground piping is epoxy lined carbon steel and placed in trenches. Manholes are provided for periodic piping inspection.~~ The essential service water pipe tunnel (ESWPT), including the ESW piping from this tunnel to the ESW pump intake and discharge structures and the UHS, is site specific but the existence and function of which are required in the standard design. The COL applicant is to locate the pipes entering and exiting the pipe tunnel based on the location of the UHSRS, as required. [The piping located in trenches will be externally lined carbon steel and the lining material specification will vary according to the site soil chemistry. The rest of the ESWS piping will be carbon steel or internally lined carbon

DCD 09.02.01-33(f)

DCD 09.02.01-34;

DCD 09.02.01-33(f)

DCD 09.02.01-33 (n)

steel depending on ESWS water chemistry requirements. Cathodic protection will be provided for buried piping. Access manholes will be provided as required for periodic inspection.] The piping will be inspected per ASME Section XI, article IWA 5244 requirements.

9.2.1.2.2.6 Valves

The water in the ESWS does not normally contain radioactivity and, therefore, special provisions against the leakage to the atmosphere are not necessary. Isolation valves are provided upstream and downstream of each component to facilitate its removal from service.

The A motor operated valve is provided at the discharge of each pump. The starting logic of the ESWP interlocks the motor operated valve with the pump operation. The closed discharge valve opens after starting the ESWP. This feature minimizes transient effects that may occur as the water sweeps out air that may be present in the system. If the motive power of the valve is lost, the valve maintains its open current position.

Each CCW HX is provided with two separate locked closed isolation valves and piping around the heat exchanger for back flushing. One valve is located in the piping running from the inlet of the heat exchanger inlet isolation valve to the inlet of the heat exchanger discharge isolation valve, and the second valve is located in the piping running from the outlet of the heat exchanger inlet isolation valve to the outlet of the heat exchanger discharge isolation valve. To initiate back–flush operation, both bypass valves are opened and the heat exchanger isolation valves are closed. Cooling water flows from the discharge side into the heat exchanger and is discharged from the heat exchanger inlet side to the ESW discharge line.

To avoid concerns with potential downstream pipe wall thinning, butterfly valves provided in the ESWS piping are not used for excessive throttling of the water flow. The valves are sized such that they are near the full open position during the various modes of plant operation. Valve opening margins are included to ensure that the design flow is met during all plant operating modes. Restriction orifices are provided downstream of the heat exchangers as required for flow balancing. Orifices having adequate differential pressures are installed downstream of the heat exchangers to prevent excess throttling of the butterfly flow control valves.

DCD_09.02.01-55

9.2.1.2.2.7 Deleted

9.2.1.2.3 System Operation

9.2.1.2.3.1 Normal Operation

The ESWS consists of four independent trains. During normal plant operation, two trains are operating and at least one other train is on standby. Each train is designed to provide 50% of cooling capacity required for design basis accident and for safe shutdown with LOOP. The ESWS is designed to perform its safety function of removing heat from the CCW heat exchangers and essential chiller units for accident mitigation and during safe shutdown -assuming that with one train assumed is out of service fordue to maintenance coincident with the loss of offsite powerwith a LOOP and a single failure in another train. A maximum ESW operating temperature of 95° F, based on the bounding meteorological and water source conditions from representative locations in the United States, has been evaluated to adequately remove CCW HX heat load at all operating conditions. This temperature is deemed conservative and supports safely bringing the reactor coolant temperature from 350° F to 200° F 36 hours after reactor shutdown via four operating ESWS and CCWS trains. Failure of one train will not prevent the ESWS from achieving cold shutdown conditions. DCD_09.02.01-33(h)

Table 9.2.1-3 and Table 9.2.1-4, respectively, provide heat loads and water flow balance for various operating modes. The ESWS design heat loads are based on the maximum safe shutdown heat loads with only two ESWS trains operable while one train is assumed to have failed due to a single active component failure and another train is undergoing online maintenance. The ESW flow rate of 13,000 gpm and maximum supply temperature of 95° F are maintained even under these conditions. DCD_09.02.01-33(h)

The ESWP operation, ESW header pressure signals, and component cooling water pump (CCWP) operation are interlocked to enable automatic start and stop functions of the ESWPs and CCWPs. A low signal of ESW header pressure signal due to failure or tripping of the an operating ESWP is alarmed in the main control room (MCR). When the low ESW- header pressure alarm is annunciated, the stand-by ESWP and the standby component cooling water pump (CCWP) ofof the same train designation start subsystem automatically, ensuring continuous heat removal. and the corresponding ESWP are placed in service to In the same manner, a low CCW supply header pressure signal accompanied by a start signal from the CCWP in the same train will automatically start the corresponding ESWP. resume the cooling process. This indicates that an operating CCWP has failed and requires the alternate (or standby) ESWP and CCWP in another train to start for backup. The EWSP, however, does not start if the pump discharge MOV is not in a fully closed position as a means to prevent water hammer previously discussed in Subsection 9.2.1.2.1. Only emergency core cooling system (ECCS) actuation and LOOP sequence (also termed as blackout sequence) signals can override the permissive discharge MOV interlock in order to prioritize the ESWS cooling function during an accident or a LOOP. DCD_09.02.01-40

Stoppage of the operating ESWP automatically activates the alternate standby pump via interlocks between the ESWS and CCWS.

All valves except the pump discharge valves in the flow path are locked open. The discharge MOV discharge valve position is monitored in the control room. At pump swapping operation, i.e. alternately operating the standby pump in lieu of the operating pump during normal power operation, Ffailure of the valve to open on— pump restart is alarmed in the control room. The operator will stop the pump and restart the standby pump. The pump discharge pressure is monitored and low pressure is— alarmed. The system design and layout provides adequate resistance to prevent pump— run-out. DCD_09.02.01-40

Voiding upstream of the pump discharge check valve in any train may occur on during loss of offsite power and subsequent pump trip, particularly at a low UHS water level. To maintain the pressure at this portion above the saturation pressure to preclude steam void formation which leads to water hammer, vacuum breakers shall be installed between the pump discharge and its check valve. Air entering the piping cushions any abrupt water flow filling the voids and water hammer will not take place at pump actuation. The entering air then discharges through the automatic vent valve installed in the strainer. The motor-operated pump discharge valve, being powered by a DC power source, is unaffected by the loss of offsite power and will close when the pump stops. [Water in the cooling tower spray header downstream of the high point in the CCW heat exchanger discharge pipe will drain to the UHS.] The check valve located in the pump discharge pipe will prevent water flowing back through the pump into the intake structure. In order to preclude water hammer on pump restart, the motor operated valve at the discharge of each pump is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed. When the emergency electrical power becomes available from the gas turbine generators (GTGs), the ESW pump is restarted in accordance with the LOOP sequence (or blackout sequence) signal and the discharge MOV opens. Since most of the ESWS remains filled with water, the ESW pump restart will sweep out the trapped air via high point vents attached at the ESWP discharge strainers. Therefore, any potential water hammer forces, if present, will have minimum impact on the ESWS operation. The COL applicant is to provide a void detection system with alarms to detect system voiding.

DCD_09.02.0 1-36

DCD_09.02.0 1-49(a)

Draining of ESW in an inactive or tripped ESWS train is prevented by double isolation valves downstream of the ESWP, i.e. check valve and MOV. The differential pressure measured during leakage testing of these valves is established in accordance with the MSS SP-61-1999, Pressure Testing of Steel Valves, is equal to the design pressure. Actual differential pressure of the MOV is equal to the static pressure which is lower than the pressure at testing with the pump in standby or tripped. Actual differential pressure across the check valve installed upstream of the MOV is low because the system pressure tends to work against the MOV, therefore, almost no leakage can be anticipated. The MOV and the check valve are identified in DCD Table 3.9-14 with their safety function in "maintain closed" position. The IST program with detailed criteria including valve leak rates shall be prepared by the COL applicant in accordance with COL 3.9(8). Potential voids caused by insufficient venting may be formed in the ESWS lines. Inservice testing of the ESWS, as described in Tier 2 DCD Subsection 3.9.6.21, includes periodic testing of the high points in the ESWS and discharginge of any voids into the UHS [basin] and filling of the system to. These tests ensure that voids, and unacceptable dynamic effects like which are the primary cause of water hammer, are minimized.

DCD_09.02.0 1-36(b)

The effect of long-term corrosion of the piping is mitigated by adding a corrosion inhibitor. The ESW is periodically sampled and chemicals are added, as required, during normal operation.

Radioactivity leakages from the CCWS to the ESWS can be detected by the radiation monitors located downstream of the CCW heat exchangers. Predetermined high radiation level is alarmed in the MCR. The operator manually isolates the contaminated

ESWS train and corresponding CCW train by stopping the ESWS and CCW pumps, and thus taking the contaminated CCW heat exchanger out of service. Standby CCWS and ESWS trains are placed in service. The manual isolation valves placed on each side of the CCW heat exchanger will also be closed to ensure that the radioactive leakage is not circulated in the ESW and eventually in the UHS. A second valve, which acts as a control valve, downstream of the CCW downstream isolation valve can also be closed to further isolate the train. ~~However, since the leaking train is taken out of service, there is no need to further isolate the CCW heat exchanger~~

Nevertheless, the CCWS, which is intermediate between the ESWS and reactor auxiliaries, has been designed so that no radioactive contamination to the environment occurs through direct leakage into the ESWS. If, however, radioactive leakage does occur in the CCWS, radiation monitors will alarm in the MCR to enable immediate stoppage of the CCW pump and isolation of the leaking train. The ~~ditto~~ leaking train is ultimately placed out of service to treat this problem. Therefore, prior to occurrence of radioactive leakage into the ESWS, isolation of the affected CCWS train should have taken place first.

DCD_09.02.0 1-42(a)

9.2.1.2.3.2 Emergency Operation

Loss of Coolant Accident (LOCA)

All ESWPs are automatically started by the ECCS actuation signal, and supply cooling water to their respective CCW HXs and essential chiller units. When offsite power is not available, ESWPs are automatically powered by onsite Class 1E power supplies.

During LOCA conditions, a minimum of two trains of the ESWS are required.

Loss of Offsite Power

On loss of offsite power, onsite Class 1E gas turbine generators (GTGs) are automatically started to restore power to the Class 1E 6.9 KV power buses that service safety-related active components such as ESWS pumps and discharge MOVs. GTG operation, including automatic starting and sequencing logic, is further described in Subsection 8.3.1. During this condition, a minimum of two trains of ESWS are required.

9.2.1.3 Safety Evaluation

~~The UHS has sufficient water volume to perform required cooling to mitigate the consequences of an accident. Subsection 9.2.5 discusses conformance with Regulatory Guide 1.27 (Ref. 9.2.11-2).~~

DCD_09.02.0 1-33(i);

The safety-related portion of the ESWS is designed and constructed to seismic category I requirements. The safety-related portions of the ESWS are protected against natural phenomena and missiles. The following sections address natural phenomena and missiles protection.

- Section 3.3, Wind and tornado loadings~~;~~

- Section 3.4, Water Level (Flood) Protection;
- Section 3.5, Missile Protection;
- Section 3.7, Seismic Design;

Pipe rupture protection is addressed in Section 3.6, Protection against Dynamic Effects Associated with Postulated Rupture of Piping.

The ESWS continues to perform its safety function in the event of a fire. Subsection 9.5.1 addresses fire protection.

Leakage in the ESWS due to piping or component failure that could cause flooding of surrounding SSCs has been evaluated for the CCW pump and CCW HX room. Flooding mitigation in the ESWS is achieved by installation of a nonsafety grade electrode type level switch or detector in the leak-detecting floor drain box in the CCWP and CCW HX room of each train. Pre-determined water level due to leakage in any CCWP and CCW HX room is alarmed in the MCR. A nonsafety grade electrode type level switch is also provided in the leak-detection floor drain box in each essential chiller unit room located in the power source building (PS/B). Pre-determined water level due to leakage in any essential chiller room is alarmed in the MCR. The leaking train can also be identified by low outlet flow from each CCW HX or decrease in the ESWS header pressure. Flooding and flooding effects in the ESWS are mitigated due to the physical separations in the reactor building such as watertight doors. These doors are monitored and controlled during plant operation and maintenance. Each CCW pump & CCW HX room has a leak-detecting floor drain box with electrode type level switch to provide alarm in the MCR for the detection of a leaking train from the ESWS or CCWS. A common alarm in the MCR provides audible indication of a leak or flooding. A method of identifying a leaking ESWS train by an operator who recognizes leakage of the ESWS in either side of R/B through the above alarm from the CCW pump & CCW HX room will be the indications from the inlet pressure and outlet flow of the CCW HX and essential chiller units. The leaking ESWS and CCWS trains is are then isolated by shutting down the corresponding ESWS pump and CCWS pump, and activating the standby and intact ESWS and CCWS trains. If, however, the leak detector fails to alarm, or the operator fails to recognize the flooding signals, the physical separations, which include water tight doors, between the east side of the ESWS enclosing ESWS trains A and B and the west side of the ESWS enclosing ESWS trains C and D will serve to isolate flooding and prevent it from propagating to other trains.

DCD_09.02.0 1-44

DCD_09.02.0 1-44

The ESWS equipment and piping are located either underground or in the pump house and the R/B. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7, 3.8 and 9.5 describe the bases of the structural design and protection from natural events.

Radioactive contamination of the ESWS is unlikely but can occur if the CCWS system is contaminated and then leaks into ESWS via the CCW HX. Subsection 9.2.1.2.1 describes prevention of this leakage to the environment.

Four independent, redundant trains, each powered from an independent Class 1E power supplies, are provided. The system is designed to provide the required cooling to mitigate the consequences of an accident with a single failure and one train unavailable due to maintenance coincident with a loss of offsite power.

The ESWS and its components are initially tested in accordance with the program given in Section 14.2. Periodic in-service functional testing is performed as described in Subsection 9.2.1.4. Section 6.6 lists appropriate ASME Section XI requirements for the safety-related portion of the system.

Failure mode and effects analysis (FMEA) Table 9.2.1-2 concludes that no single failure, coincident with one train being unavailable due to maintenance and a loss of offsite power compromises the safety functions of ESWS.

The ESWS is not shared with multi-units.

The COL Applicant is to provide the evaluation of the ESWP at the lowest probable water level of the UHS. The COL applicant is to develop recovery procedure in the event of approaching low water level of UHS.

The ESWS is designed for operation at low water temperature of 32° F during all modes of plant operation. **The COL Applicant is to provide** ~~the~~ **protection** of the site specific portions of the ESWS [such as the ESWS blowdown line, FSS supply line, ESWPT piping towards the intake and discharge structures, i.e. piping running between the nuclear island and UHSRS, and any ESWS piping in the UHSRS] **against adverse environmental, operating, and accident conditions that can occur such as freezing**, low temperature operation, **and thermal overpressurization.** ~~The COL Aplicant is to provide the preventive measures for protection against adverse environmental conditions.~~

DCD_09.02.01-35; DCD_09.02.01-33(l); DCD_09.02.01-55

The COL Applicant is to provide the safety evaluation of the capability of the ESWS to: (1) isolate its site-specific, nonsafety-related portions [such as the ESWS blowdown line and FSS supply line when applicable]; and (2) provide measures to prevent long-term corrosion and organic fouling that may degrade its performance, per Generic Letter (GL) 89-13~~for the ESWS design related to the site specific conditions~~.

DCD_09.02.01-33(k)

Some portions of the system are nonsafety-related, e. g., sections of pipe in heat exchanger drain piping after the isolation valves. These boundary isolation valves which provide separation between the safety-related and nonsafety-related portions are normally closed. During a design basis event, postulated simultaneous failure of all nonsafety-related piping would not impact operation of any ESWS train, thus will not affect the ESWS capability to perform its safety related functions.

~~RCOL~~DCD_09.02.01-33(b)~~5~~

The COL applicant is to specify appropriate sizes of piping and pipe fittings such as restriction orifices to prevent potential plugging due to debris buildup, and develop maintenance and test procedures to monitor debris build up and flush out debris.~~The COL Applicant is to provide the UHS water volume, maximum operating water temperature and the lowest water level for ESWPs~~

RCOL_09.02.01-5; 1-32(i); DCD_09.02.01-34(e)

9.2.1.4 Inspection and Testing Requirements

The ESWS is hydrostatically tested prior to initial startup. Preoperational testing is described in Section 14.2. System performance during normal operation is verified by monitoring system pressures, temperatures and flows.

Inservice inspection and testing of piping is performed in accordance with the requirements of ASME Section XI, as discussed in section 6.6.

Inservice testing of active pumps and valves is performed to assure operational readiness, as described in subsection 3.9.6. Acceptance criteria for the monitored parameters are established to allow for pump degradation and to maintain acceptable pump performance for all modes of plant operation. DCD_09.02.01-46

~~The p~~Periodic performance verification of the ESWS components, including the heat exchanger(s) ~~which is~~ cooled by the ESW, is performed to detect performance degradation due to fouling. The heat exchangers are monitored per test program developed in accordance with the requirements of GL 89-13. Acceptance criteria for performance verification are established to allow for degradation and maintain acceptable heat exchanger performance for all modes of plant operation. DCD_09.02.01-46

The COL Applicant shall conduct periodic inspection, monitoring, maintenance, performance and functional testing and verification of the ESWS and UHS piping and components, including the heat transfer capability of the CCW heat exchangers and essential chiller units, consistent with GL 89-13 and GL 89-13 supplement 1. The COL Applicant is to develop operating procedures to periodically alternate the operation of the trains thus performance of all trains will be regularly monitored. DCD_09.02.01-51

9.2.1.5 Instrumentation Requirements

The operator has functional control and monitoring capability of the ESWS in the MCR and also at the remote shutdown room (RSR). All functions described below that are available in the MCR are also available at the RSR.

9.2.1.5.1 ESWS discharge pressure

The ESWP discharge pressure is locally indicated, and pressure readings are used for ESWP performance testing.

9.2.1.5.2 ESW header line pressure

ESW header pressure is indicated both locally and in the MCR. When the pressure decreases due to ~~the~~ failure or inadvertent shutdown of the operating pump or valve misalignment, a low pressure alarm is transmitted both locally and to the MCR. The ESW header line pressure is categorized as a PAM variable to assist the MCR personnel in evaluating the safety status of the plant. DCD_09.02.01-41

The ESW header line pressure signal is also used for backup activation of the alternate ESWS train as discusses in Subsection 9.2.1.2.3.1.

9.2.1.5.3 CCW HX essential service water flow

The ESW flow rate to the CCW HX heat exchanger is indicated locally and in the MCR. A low flow alarm is transmitted both locally and to the MCR. The CCW HX ESW flow is also categorized as a PAM variable.

9.2.1.5.4 Essential chiller unit service water flow

The ESW flow rate to the essential chiller units is indicated locally.DeletedESWP motor essential service water flow

9.2.1.5.4The flow rate is indicated in the MCR. A low flow alarm is transmitted to the MCR.

9.2.1.5.5 Differential pressure of strainer

Differential pressure of strainers located in each ESWP discharge line is indicated locally and in the MCR. High differential pressure alarm is transmitted locally and to the MCR. The differential pressure signals activate the start and stop functions of the ESWP discharge strainers.Differential pressure of CCW HX inlet strainer is locally indicated. DCD_09.02.01-41 DCD_09.02.01-41

9.2.1.5.6 Radiation monitor

9.2.1.5.7Radiation monitors are located downstream of the CCW HX and the signal is indicated locally and in the MCR. When the radiation level exceeds the setpoint, an alarm is transmitted both locally and to the MCR.

9.2.1.5.7 Other instrumentation

As shown in the piping and instrumentation diagram of the ESWS, the other instrumentation and thermowells for temperature detection are provided where required to support testing and maintenance.

In addition, remotely operated pump discharge valves are provided with position indication instrumentation. The valve positions are monitored in the MCR. Valve operation is interlocked with the pumps as noted in Subsection 9.2.1.2.3.1. The ESW pump control and status indication are provided in the MCR. The ESWS is interlocked with the CCWS such that at either a low ESW supply header pressure or at low CCW header pressure, alternate standby pumps are being automatically activated. There are no interlocks between the ESWS and the essential chilled water system.

9.2.2 Component Cooling Water System

9.2.2.1 Design Bases

The component cooling water system (CCWS) provides cooling water required for various components during all plant operating conditions, including normal plant intake basin is deeper than the UHS basin. This is to assure adequate NPSH to the ESW pump.]

[The UHS design concept described herein is depicted in Figure 9.2.5-1. The UHS design and process parameters are provided in Table 9.2.5-3.]

9.2.5.2.2 System Operation

[Each ESWP takes suction from its ESW intake basin located beneath the pump house as described in Subsection 9.2.5.2.1. The water flows through the CCW heat exchangers and essential chiller units and then is cooled by the cooling tower before being returned to the basin. A portion of the water is discharged as blowdown water to maintain water chemistry **via the ESWS when the makeup water is available**. **The blowdown rate is determined using a conductivity cell located at ESW pump discharge and is based on the total dissolved solids in the water and the makeup water source.** The blowdown operation is terminated during accident mitigation or loss of make-up water]. RAI 585-4464 DCD 09.02.01-33(c)

[Heat rejection to the environment is effected by direct contact with the cooling tower forced airflow, which provides evaporative cooling of the ESW return flow. During normal operation, evaporation, drift and blowdown losses are replaced with the makeup water. Water level controllers provided in each basin automatically open and close the makeup control valves.] Low and high water level are annunciated in the main control room (MCR).

The maintained water level in each UHS [basin] assures adequate NPSH for the ESWP under all operating modes. Assuming one train is out of service for maintenance and the source of makeup water is unavailable for a period of thirty days after the accident, the combined inventory [of three basins] provides a thirty-day cooling water supply.

The ESWS together with the UHS are designed, arranged and operated to minimize the effects of water hammer forces. The system layout assures water pressure remains above saturation conditions throughout the system. High point vents and low point drains are provided. [The ESW pump is designed to provide positive pressure at the spray nozzle headers. This, together with the high point vents, minimizes system drain down in the idle trains or upon loss of offsite power and subsequent pump trip.]

[The following features preclude or minimize water hammer forces:

- On loss of off-site power (LOOP), the discharge MOV of the operating train is closed by DC power. This, together with the pump discharge check valve, prevents draindown to the basin.
- The ESW pump start logic interlocks the discharge MOV operation with the pump operation. The re-start of the tripped pump or start of the stand-by pump opens the discharge valve slowly, sweeping out voids from the discharge piping and CT riser and distribution piping.

The performance, structural, and leak-tight integrity of system components is demonstrated by operation of the system. Preoperational testing is described in Chapter 14.

9.2.9.5 Instrumentation Requirements

Parameters important to system operation are monitored in the MCR.

Pressure indication and pressure transmitters with low pressure alarms are provided for the non-ESW pump discharge header. A low pressure signal is alarmed and the standby non-ESW pump is automatically started. Flow indicators with low flow alarms are provided in each TCS heat exchanger outlet line.

Temperature indication is provided for the service water supply to and discharge from each TCS heat exchanger to determine the temperature differential across the heat exchanger. The temperature differential is used for monitoring heat exchanger performance.

Differential pressure measurement across the strainer is provided and a high differential pressure is alarmed. The operator places the standby strainer in service, isolates the clogged strainer, and initiates a manual backwash.

9.2.10 Combined License Information

Information for following items is required to be provided in support of the Combined License Application:

COL 9.2(1) *The COL Applicant is to provide the evaluation of the ESWP at the lowest probable water level of the UHS. The COL Applicantion is to develop recovery procedures in the event of approaching low water level of UHS.*

COL 9.2(2) *The COL Applicant is to provide the protection of the site-specific portions of the ESWS against adverse environmental, operating, and accident conditions that can occur, such as freezing, low temperature operation, and thermal overpressurization. The COL Applicant it to provide the preventive measures for protection against adverse environmental conditions.*

DCD 09.02.01-33(I)

DCD 09.02.01-55

COL 9.2(3) *The COL Applicant is to determine source and location of the UHS.*

COL 9.2(4) *The COL Applicant is to determine location and design of the ESW intake structure.*

COL 9.2(5) *The COL Applicant is to determine location and design of the ESW discharge structure.*

COL 9.2(6) *The COL Applicant is to provide ESWP design details – required total dynamic head with adequate margin, NPSH available, and the mode of cooling of the ESWP motor. etc. The COL Applicant is to assure that the*

RCOL 09.02.01-4];

DCD 09.02.01-39;

DCD 09.02.01-38

sum of the shut-off head of the selected ESW pumps and the static head will not result in system pressure that exceeds the ESWS design pressure at any location within the system. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply.

COL 9.2(7) The COL Applicant is to ~~provide~~ address the piping, valves, lining material specifications for piping and fittings as applicable, including those at the boundary between the safety-related and nonsafety-related portions, and other design of the ESWS related to the site specific conditions~~, including the safety evaluation~~. The COL Applicant is also to design the pipes entering and exiting the pipe tunnel based on the location of the UHSRS.

DCD 09.02.01-33(f)

COL 9.2(8) The COL Applicant is to specify the following ESW chemistry requirements:

- A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation.
- Type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor and silt dispersant based on the site conditions.

COL 9.2(9) COL Applicant is to confirm the storage capacity and usage of the potable water.

COL 9.2(10) COL Applicant is to confirm that all State and Local Department of Health and Environmental Protection Standards are applied and followed.

COL 9.2(11) The COL Applicant is to confirm the source of potable water to the site and the necessary required treatment.

COL 9.2(12) COL Applicant is to confirm that the sanitary waste is sent to the onsite plant treatment area or they will use the city sewage system.

COL 9.2(13) COL Applicant is to identify the potable water supply and describe the system operation.

COL 9.2(14) COL Applicant is to confirm Table 9.2.4-1 for required components and their values.

COL 9.2(15) The COL Applicant is to determine the total number of people at the site and identify the usage capacity. Based on these numbers the COL Applicant is to size the potable water tank and associated pumps.

COL 9.2(16) The COL Applicant is to provide values to the component Table 9.2.4-1 based on system and component descriptions from Section 9.2.4.2.1 and 9.2.4.2.2 respectively.

COL 9.2(17) The COL Applicant is to determine the total number of sanitary lift stations and is to size the appropriate interfaces.

COL 9.2(18) *The COL Applicant is to determine the type of the UHS based on specific site conditions and meteorological data.*

COL 9.2(19) *The COL Applicant is to design the UHS to receive its electrical power supply, if required by the UHS design, from safety busses so that the safety functions are maintained during LOOP. The UHS also receives its standby electrical power from the onsite emergency power supplies during a LOOP.*

COL 9.2(20) *The COL Applicant is to provide a detailed description and drawings of the UHS, including water inventory, temperature limits, heat rejection capabilities, instrumentation, and alarms.*

COL 9.2(21) *The COL Applicant is to determine the source of makeup water to the UHS inventory and the blowdown discharge location based on specific site conditions.*

COL 9.2(22) *The COL Applicant is to provide results of UHS capability and safety evaluation of the UHS based on specific site conditions and meteorological data. The COL Applicant is to use ~~at least 30 years~~ site specific meteorological data and heat loads data for UHS performance analysis per Regulatory Guide 1.27.*

COL 9.2(23) *The COL Applicant is to provide test and inspection requirements of the UHS. These ~~is to~~ include inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity.*

COL 9.2(24) *The COL Applicant is to provide the required alarms, instrumentation and controls details based on the type of UHS to be provided.*

COL 9.2(25) *The COL applicant is to ~~will~~ develop ~~operating and maintenance procedures for~~ system filing, venting, keeping the system full, and operational procedures to minimize the potential for water hammer; to analyze the system for water hammer impacts; to design the piping system to withstand potential water hammer forces; and to analyze inadvertent water hammer events ~~the ESWS to address water hammer issues~~ in accordance with— NUREG-0927.*

DCD 09.02.01-49

DCD 09.02.01-34 (e)

COL 9.2(26) *The COL applicant is to specify appropriate sizes of piping and pipe fittings such as restriction orifices to prevent potential plugging due to debris buildup, ~~to~~and develop maintenance and test procedures to monitor debris build up and flush out debris.*

COL 9.2(27) *The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention.*

DCD 09.02.01-33 (e)

COL 9.2(28) The COL Applicant is to provide the piping, valves, materials specifications, and other design related to the site specific UHS.

COL 9.2(29) The COL applicant is to provide the safety evaluation of the capability of the ESWS to: (1) isolate its site-specific, nonsafety-related portions; and (2) provide measures to prevent long-term corrosion and organic fouling that may degrade its performance, per Generic Letter (GL) 89-13.

DCD 09.02.01-33 (k)

COL 9.2(30) The COL Applicant shall conduct periodic inspection, monitoring, maintenance, performance and functional testing of the ESWS and UHS piping and components, including the heat transfer capability of the CCW heat exchangers and essential chiller units, consistent with GL 89-13 and GL 89-13 Supplement 1. The COL Applicant is to develop operating procedures to periodically alternate the operation of the trains to ensure performance of all trains is regularly monitored.

DCD 09.02.01-51; DCD 09.02.01-57; DCD 09.02-01-59

COL 9.2(31) The COL applicant is to verify the system layout of the ESWS and UHS and is to develop operating procedures to assure that the ESWS and UHS are above saturation conditions for all operating modes.

DCD 09.02.01-36;

COL 9.2(32) The COL applicant is to provide a void detection system with alarms to detect system voiding.

DCD 09.02.01-49

COL 9.2(33) The COL Applicant is to provide the design details of the strainer backwash line, vent line, and their discharge locations.

DCD 09.02.01-34 (h)

9.2.11 References

9.2.11-1 General Design Criteria for Nuclear Power Plants, NRC Regulations Title 10, Code of Federal Regulations, 10CFR Part 50, Appendix A.

9.2.11-2 Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27 Revision 2, January 1976.

9.2.11-3 Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants, NRC Regulatory Guide 1.26 Revision 4, March 2007.

9.2.11-4 National Primary Drinking Water Standards, Environmental Protection Agency, Title 40, Code of Federal Regulations, 40CFRPart 141.

9.2.11-5 Occupational Safety and Health Standard, Occupational Safety and Health Administration, Department of Labor, Title 29, Code of Federal Regulations, 29CFRPart 1910.

9.2.11-6 American Nuclear Society Standards Committee Working Group, American National Standard for Decay Heat Power in Light Water Reactors, ANS 5.1, August 1979.

9.2.11-7 Electric Power Research Institute Palo Alto, California, Advanced Light Water Reactor Utility Requirements Document, Rev.8.

9.2.11-8 ANSI B31.1 Power Piping Code.

Table 9.2.1-1 Essential Service Water System Component Design Data

Essential Service Water Pump	
Quantity	4
Type	Vertical, centrifugal, mixed flow
Design flow rate	13,000 gpm
Design pressure	150 psig
Design temperature	140 F
Materials	Stainless steel
Equipment Class	3
Electric Power Supply Class	Class 1E power source
Essential Service Water Pump Outlet Strainer	
Quantity	8
Design flow rate	13,000 gpm
Design pressure	150 psig
Design temperature	140 F
Maximum allowed differential pressure	7 psi at 13,000 gpm
Strainer mesh size	3 mm
Equipment Class	3
Electric Power Supply Class	Class 1E power source
~~Component Cooling Water Heat Exchanger Inlet Strainer~~	
~~Quantity~~	~~4~~
~~Design flow rate~~	~~11,500 gpm~~
~~Design pressure~~	~~150 psig~~
~~Design temperature~~	~~140 F~~
~~Equipment Class~~	~~3~~
Essential Service Water Pump Discharge Valve	
Quantity	4
Design flow rate	13,000 gpm
Design pressure	150 psig
Design temperature	140 F
Equipment Class	3
Electric Power Supply Class	Class 1E power source

DCD 09.02.01-34(h)

DCD 09.02.01-34;

DCD 09.02.01-52

DCD 09.02.01-34(h)

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 1 of ~~2~~5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
1	ESWP (MPP-001A,B,C,D)	Supplies ESW to CCW HX and Essential Chiller Unit	A.~~,~~ Startup, normal shutdown, normal operation, refueling B, Accident, ~~S~~safe shutdown, ~~C~~cooldown – loss of offsite power	A1, Fails to start upon command A2, Trips for any reason B1, Fails to start upon command B2, Trips for any reason.	A1, Pump status light indication in MCR A2, Pump status light indication in MCR B1, Pump status light indication in MCR B2, Pump status light indication in MCR	A1, None Remaining three 50% capacity pumps are available. Minimum two pumps are required for safety function. A2, None Same as A1. B1, None Same as A1. B2, None Same as A1.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two pumps are required.

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 2 of ~~2~~5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
2	ESWP Discharge Valve (MOV-503A,B,C,D), fail as is, motor operated valve	Opens to provide flow path	A, Startup, normal shutdown, normal operation, refueling	A, ~~-~~ Fails in closed position	A, Position indication in MCR	A, None Remaining three 50% capacity pumps are available. Minimum two pumps are required for safety function.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two pumps are required.
			B, Accident, ~~S~~safe shutdown, ~~C~~cooldown – loss of offsite power	B, ~~-~~ Fails in closed position	B, Position indication in MCR	B, None Same as A.	

DCD 09.02.01-34

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 3 of 5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
3	ESWP Discharge Strainer (SST-001A, B, C, D and SST-002A, B, C, D)	Starts and opens to provide flow path to backwash flow before strainer clogging to maintain ESW supply to CCW HX	A. Accident, safe shutdown, cooldown – loss of offsite power	A. Fails to start and fails to open on remote manual demand	A. Position indication in MCR	A. None Remaining three 50% capacity trains are available. Minimum two trains are required for safety function.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two ESWS trains are required.
		Stops and isolates backwash flow to prevent drain down which leads water hammer at pump restart	A. Startup, normal shutdown, normal operation, refueling, cooldown B. Accident, safe shutdown, – loss of offsite power	A. Fails to closed position at pump stop signal B. Fails to closed position at pump stop signal	A. Position indication in MCR B. Position indication in MCR	A. None Backwash flow can be isolated by closing ESWP Discharge Strainer Backwash Isolation Valve at pump stop signal B. None Same as A.	

DCD 09.02.01-34

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 4 of 5)

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
4	ESWP Discharge Strainer Backwash Isolation Valve to Normal Drain Path (MOV-573A, B, C, D and MOV-574A, B, C, D)	Starts and opens to provide flow path to backwash flow before strainer starts to clog to maintain ESW supply to CCW HX	A. Accident, safe shutdown, – loss of offsite power	A. Fails to open on remote manual demand	A. Position indication in MCR	A. None Remaining three 50% capacity trains are available. Minimum of two trains are required for safety function.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two ESWS trains are required.
		Stops and isolates backwash flow to prevent drain down which leads water hammer at pump restart	A. Startup, normal shutdown, normal operation, refueling, cooldown B. Accident, safe shutdown, – loss of offsite power	A. Fails to closed position at pump stop signal B. Fails to closed position at pump stop signal	A. Position indication in MCR B. Position indication in MCR	A. None Backwash flow can be isolated by closing ESWP Discharge Strainer Backwash Isolation Valve at pump stop signal B. None Same as A.	

Table 9.2.1-2 Essential Service Water System Failure Modes and Effects Analysis (Sheet 5 of 5)

Item ~~Item~~	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
[5	ESWS Blowdown Control Valve (HCV-010, 011, 012, 013), fail close air operated valve	Closes to isolate blowdown	All	Fails to close upon command	Position indication in MCR	None. Blowdown can be isolated by closing the manual valves (VLV-541A,B,C,D, VLV-543A,B,C,D) Effect of uncontrolled blowdown for 30 minutes on basin inventory is insignificant.]	

Table 9.2.1-3 Essential Service Water System Heat Loads (in Btu/hr)

Train	Component	No. of components	Startup		Normal Power Operation		Cooldown by CS/RHRS		Accident (LOCA)		Safe Shutdown	
A & B	CCW Heat Exchanger	2	2	65.45 x 10^6	1	50.0 x 10^6	2	220.43 x 10^6	1	161.7 x 10^6	1	190.9 x 10^6
	Essential Chiller Unit	2	2	8.66 x 10^6	1	4.33 x 10^6	2	8.66 x 10^6	1	4.33 x 10^6	1	4.33 x 10^6
	~~ESW pump motor~~	~~2~~	~~2~~	~~0.10 x 10^6~~	~~1~~	~~0.05 x 10^6~~	~~2~~	~~0.10 x 10^6~~	~~1~~	~~0.05 x 10^6~~	~~1~~	~~0.05 x 10^6~~
	Total		2	74.16x10^6	1	54.383 x 10^6	2	2298.196x10^6	1	166.083x10^6	1	195.283x10^6
C & D	CCW Heat Exchanger	2	2	61.2 x 10^6	1	41.23 x 10^6	2	221.2 x 10^6	1	161.7 x 10^6	1	190.9 x 10^6
	Essential Chiller Unit	2	2	8.66 x 10^6	1	4.33 x 10^6	2	8.66 x 10^6	1	4.33 x 10^6	1	4.33 x 10^6
	~~ESW pump motor~~	~~2~~	~~2~~	~~0.10 x 10^6~~	~~1~~	~~0.05 x 10^6~~	~~2~~	~~0.10 x 10^6~~	~~1~~	~~0.05 x 10^6~~	~~1~~	~~0.05 x 10^6~~
	Total		2	69.986 x 10^6	1	45.5863x10^6	2	229.986 x 10^6	1	166.083 x 10^6	1	195.283 x 10^6

Table 9.2.1-4 Essential Service Water System Flow Balance (in gpm)

Train	Component	No. of components	Startup		Normal Power Operation		Cooldown by CS/RHRS		Accident (LOCA)		Safe Shutdown	
A & B	CCW Heat Exchanger	2	2	22000	1	11000	2	22000	1	11000	1	11000
	Essential Chiller Unit	2	2	1086	1	543	2	1086	1	543	1	543
	~~ESW pump motor~~	~~2~~	~~2~~	~~50~~	~~1~~	~~25~~	~~2~~	~~50~~	~~1~~	~~25~~	~~1~~	~~50~~
	~~Continuous~~ ~~s~~Strainer backwash flow~~lowdown~~	2	2	1000	1	500	2	1000	1	500	1	500
	Total		2	~~24136~~ 24086	1	~~12068~~ 12043	2	~~24136~~ 24086	1	~~12068~~ 12043	1	~~12068~~ 12043
C & D	CCW Heat Exchanger	2	2	22000	1	11000	2	22000	1	11000	1	11000
	Essential Chiller Unit	2	2	1086	1	543	2	1086	1	543	1	543
	~~ESW pump motor~~	~~2~~	~~2~~	~~50~~	~~1~~	~~25~~	~~2~~	~~50~~	~~1~~	~~25~~	~~1~~	~~25~~
	S~~Continuous~~ ~~s~~trainer	2	2	1000	1	500	2	1000	1	500	1	500

	backwashlowdown											
	Total		2	24086	1	12043	2	24086	1	12043	1	12043
	Total		2	24136 24086	1	12068 12043	2	24136 24086	1	12068 12043	1	1204312 068

Table 9.2.7-1 Essential Chilled Water System Component Design Data

Essential Chiller Unit	
Type	Centrifugal Type, Electric-drive
Quantity	4
Refrigeration Capacity	3,600,000 Btu/hr-unit
Chilled Water Inlet temperature	40° F
Chilled Water Outlet temperature	56° F
Chilled Water Flow Rate	440 gpm
Cooling water inlet temperature	~~100~~95° F
Cooling water outlet temperature	~~116~~111° F ;delta T= 16° F
Essential chilled water pump	
Type	Centrifugal type
Quantity	4
Flow rate	440 gpm
Head	165 feet

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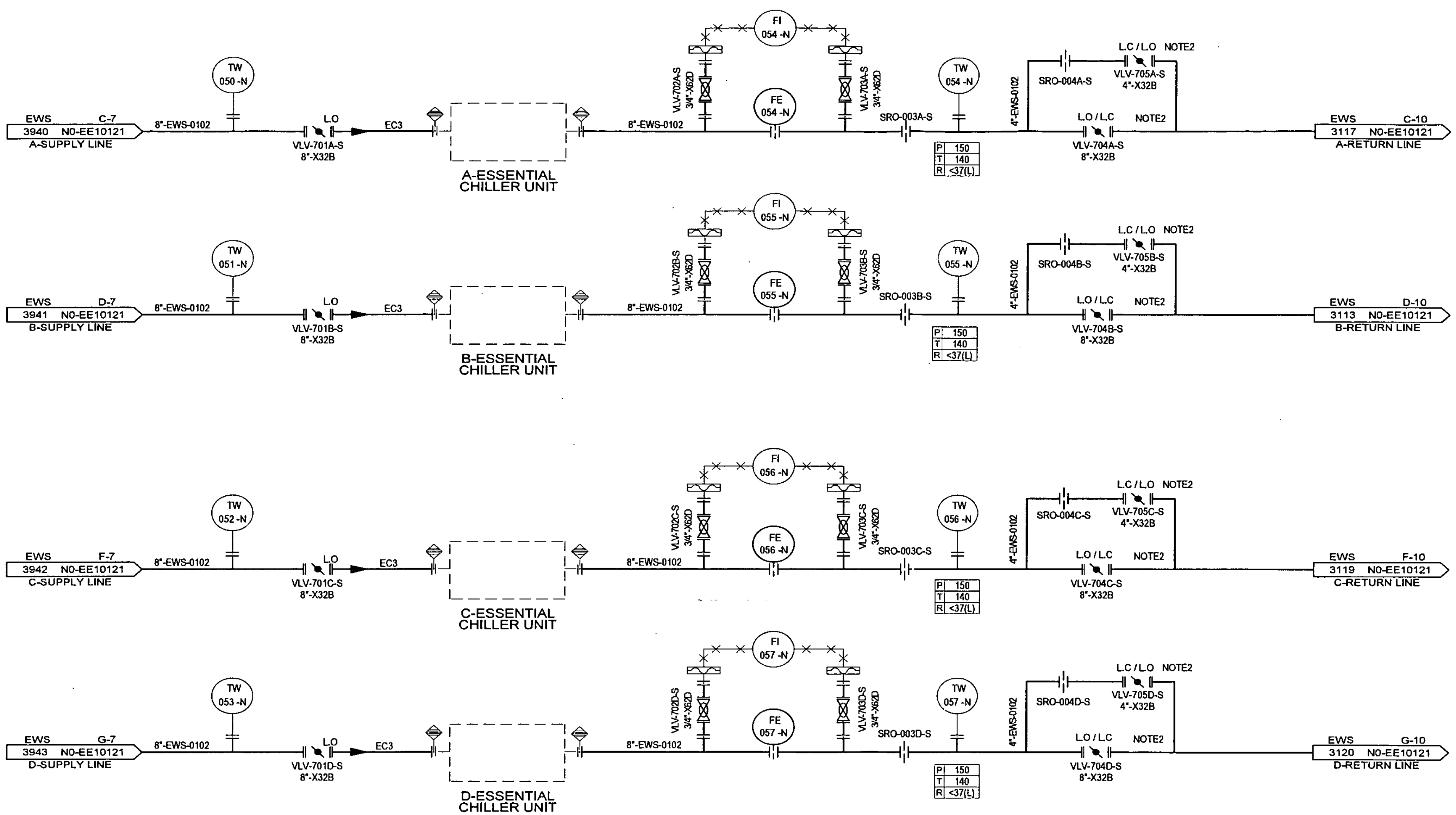
~~Figure 9.2.1-1 Essential Service Water System Piping and Instrumentation Diagram (Sheet 2 of 3)~~

Attachment 1



NOTES
1. LINE SPEC FOR INSTRUMENT IMPULSE LINE TO THE FIRST VALVE IS 3/4-EWS-0102.
2. OPENING THE VALVE AT THE MAIN LINE REQUIRES CLOSING THE VALVE AT THE BYPASS LINE AND VICE VERSA.

REMARK:
PLANT DESINATION, SYSTEM NAME OF EQUIPMENT AND VALVE NUMBERS ARE OMITTED IN THIS DRAWING.
~~STD-EWS-###-+++~~

Figure 9.2.1-1 Essential Service Water System Piping and Instrumentation Diagram (Sheet 32 of 32)

Table 9.3.2-6 Process Grab Sample Points [(a)] (Sheet 2 of 3)

Sample Point No.	Sample Point Name	Analysis	Pressure[(b)] (psig)	Temperature [(b)] (°F)
28	B-Component Cooling Water surge Tank Outlet	Conductivity, halogens, dissolved oxygen and N_2H_4	80	100
29	A,B-Spent Fuel Pit Filter Outlet	Boron, Halogens, radioactivity, pH and conductivity	100	120
30	A,B-Spent Fuel Pit Demineralizer Inlet	Boron, Halogens, radioactivity, pH and conductivity	100	120
31	Non-radeoactive Drain Sump Pump Discharge	Radioactivity	145	140
32	A-SG Blowdown Cation Bed Demineralizer Outlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
33	B-SG Blowdown Cation Bed Demineralizer Outlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
34	A-SG Blowdown Mix Bed Demineralizer Outlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
35	B-SG Blowdown Mix Bed Demineralizer Outlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
36	Steam Generator blowdown demineralizers inlet filters inlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
37	Steam Generator blowdown demineralizers inlet	Radioactivity, Specific conductivity, Cation conductivity, sodium ion, chloride ion,SO_4 and pH	145	113
38	A-, B-, C-, D-Component Cooling Water Heat Exchanger Essential Service Water Side Discharge	Radioactivity	150	140
Yard Area				
1	External Water Makeup	pH, conductivity	Atmospheric	Ambient
2	Waste Water Effluent (from sump)	pH, conductivity	Atmospheric	Ambient
3	Sewage and Industrial waste Effluent	pH, conductivity	Atmospheric	Ambient
4	Primary Makeup Water Tank outlet	Dissolved oxygen, radioactivity, halogens, conductivity, pH	155	Ambient
5	Refueling Water Storage Auxiliary Tank outlet	Boron, halogens	Atmospheric	Ambient
6	Auxiliary Boiler Feed water	pH(c), SiO_2, Specific Conductivity(c), Suspended solids, Cation Conductivity(c)	110	85
7	Auxiliary Boiler steam	Cation Conductivity	110	345
Radwaste				
1	C/V Reactor Coolant Drain Tank Outlet	Boron, halogens, pH, conductivity, O_2, H_2 and turbidity	155	120

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- The essential service water pumps can be powered from the safety buses so safety-related functions are maintained during a LOOP.
- The ESWS is designed to perform safety-related functions assuming a single failure in a one train, with another train out of service for maintenance.
- The ESWS is automatically initiated by a safety injection signal.

Each essential service water pump takes water from the UHS, pumps it through the component cooling water HXs and essential chiller units, and discharges it to the ~~discharge pit~~UHS. In an accident situation, the necessary safety functions can be performed by two of the four trains.

DCD 09.02.01-33 (a)

The system configuration for each operating mode is as follows:

- During normal operation, two trains are used to supply service water to two trains of the CCWS. In hot weather, if the outlet temperature of the component cooling water HXs increases to near 100°F, three service water trains are used.
- During plant cooldown by the SGs, a similar configuration is employed.
- During residual heat removal operation, after cooldown by the steam generators, all four CCWS trains and ESWS trains are operated.
- During refueling, the number of essential service water pumps and CCWS trains is determined by the decay heat to be removed.

Component Cooling Water System - The CCWS provides cooling water for the components of the primary systems during normal operation, plant shutdown, and after an accident. It also serves as an intermediate system between the reactor coolant and the ESWS to prevent leakage of radioactive material into the environment.

One subsystem consists of trains A & B, and the other subsystem consists of trains C & D, for a total of four trains. Each train has one CCW pump and one CCW heat exchanger and provides 50% of the cooling capacity required for the CCWS safety function. Electrical power to all trains is supplied by the safety-related buses, which are backed up by Class 1E power supplies. The CCWS provides cooling water for safety-related components such as the CS/RHR HXs, the spent fuel pit HXs, the safeguard pump coolers and other components used during normal operation, such as the CVCS coolers, the radwaste management system coolers, and the RCP coolers. The surge tanks accommodate the thermal expansion and contraction of the cooling water and potential leakage.

The CCWS satisfies the following design requirements:

- The design is based on the service water maximum design temperature (95°F).
- The system is designed to assure that leakage of radioactive fluid from the cooled components is held within the plant.

1.8 Interfaces for Standard Design

10 CFR 52.47, "Contents of applications: technical information", requires identification of the interface requirements to be met by those portions of the plant for which the application does not seek certification. As allowed by the regulations, conceptual designs for systems that are not part of the US-APWR standard design are included in the DCD for purposes of allowing the NRC to evaluate the overall acceptability of the design. However, the final details of these conceptual designs are subject to change due to site-specific conditions.

This section identifies the significant interfaces between the US-APWR standard plant design and the Combined License applicant.

The US-APWR standard plant design consists of several buildings as discussed in subsection 1.2.1.7, the equipment located in those buildings, and associated yard structures such as electrical equipment and tanks. Thise standard scope of design includes the entire nuclear island and all safety systems except the UHS and associated HVAC system that would be required for construction of the US-APWR at a nuclear power plant site. However, the cooling water intake and discharge structures and the ESWPT towards the intake and discharge structures are site specific. TheA standardtypical site plan for the US-APWR design included in this application for design certification is shown in Figure 1.2-1.

DCD 09.02.01-32(d)

Items in the "Description" column of Table 1.8-1 are site-specific and are outside the scope of the US-APWR standard plant design. The table includes a description of each interface and the DCD section in which it is discussed. Combined License applicants referencing the US-APWR certified design are to be required to demonstrate that interface requirements are satisfied. The interface items are divided into two types:

- System Interface – Portion of a system that must be added to the standard design package to complete the implementation of the US-APWR at a specific site. Generally, a system interface can be accomplished via and intertie between the standard and site-specific portions of a system, such as by piping or electrical cable.
- Site Feature Interface – Construction of a non-system feature that must be added to the standard design package to complete the implementation of the US-APWR at a specific site. Examples would include general site improvements, or a building that is not included in the standard design, such as the administrative building.

Per the language of 10CFR52, the tabulated items are significant interfaces, not a comprehensive inventory of all features outside the standard scope of supply. Additionally, the reader can refer to Table 1.8-2 for a master listing of all COL items in the DCD.

Table 1.8-2 Compilation of All Combined License Applicant Items for Chapters 1-19 (sheet 2427 of 44)

COL ITEM NO.	COL ITEM
COL 9.1(9)	*The COL applicant is to create a procedure that will instruct operators to perform formal inspection of the integrity of the spent fuel racks.*
COL 9.2(1)	*The COL Applicant is to provide the evaluation of the ESWP at the lowest probable water level of the UHS. The COL Application is to develop recovery procedures in the event of approaching low water level of UHS.*
COL 9.2(2)	*The COL Applicant is to provide ~~the~~ protection of the site-specific portions of the ESWS against adverse environmental, operating, and accident conditions that can occur, such as freezing, low temperature operation, and thermal overpressurization. ~~The COL Applicant is to provide the preventive measures for protection against adverse environmental conditions.~~*
COL 9.2(3)	*The COL Applicant is to determine source and location of the UHS.*
COL 9.2(4)	*The COL Applicant is to determine location and design of the ESW intake structure.*
COL 9.2(5)	*The COL Applicant is to determine location and design of the ESW discharge structure.*
COL 9.2(6)	*The COL Applicant is to provide ESWP design details – required total dynamic head with adequate margin, NPSH available ~~etc~~, and the mode of cooling of the ESWP motor. The COL Applicant is to assure that the sum of the shut-off head of the selected ESW pumps and static head will not result in system pressure that exceeds the ESWS design pressure at any location within the system. The COL Applicant is to evaluate the potential for vortex formation based on the most limiting assumptions that apply.*
COL 9.2(7)	*The COL Applicant is to ~~provide~~ address the piping, valves, lining material specifications for piping, valves, and fittings as applicable, including those at the boundary between the safety-related and nonsafety-related portions, and other design of the ESWS related to the site specific conditions, including the safety evaluation. The COL Applicant is also to design the pipes entering and exiting the pipe tunnel based on the location of the UHSRS.*

DCD_09.02.01-33(l)

DCD_09.02.01-55

DCD_09.02.01-4;

DCD_09.02.01-39

DCD_09.02.01-33(f)

Table 1.8-2 Compilation of All Combined License Applicant Items for Chapters 1-19 (sheet 2527 of 44)

COL ITEM NO.	COL ITEM
COL 9.2(8)	*The COL Applicant is to specify the following ESW chemistry requirements* · *A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation.* · *Type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor and silt dispersant based on the site conditions.*
COL 9.2(9)	*COL Applicant is to confirm the storage capacity and usage of the potable water.*
COL 9.2(10)	*COL Applicant is to confirm that all State and Local Department of Health and Environmental Protection Standards are applied and followed.*
COL 9.2(11)	*The COL Applicant is to confirm the source of potable water to the site and the necessary required treatment.*
COL 9.2(12)	*COL Applicant is to confirm that the sanitary waste is sent to the onsite plant treatment area or they will use the city sewage system.*
COL 9.2(13)	*COL Applicant is to identify the potable water supply and describe the system operation.*
COL 9.2(14)	*COL Applicant is to confirm Table 9.2.4-1 for required components and their values.*
COL 9.2(15)	*The COL Applicant is to determine the total number of people at the site and identify the usage capacity. Based on these numbers the COL Applicant is to size the potable water tank and associated pumps.*
COL 9.2(16)	*The COL Applicant is to provide values to the component Table 9.2.4-1 based on system and component descriptions from Section 9.2.4.2.1 and 9.2.4.2.2 respectively.*
COL 9.2(17)	*The COL Applicant is to determine the total number of sanitary lift stations and is to size the appropriate interfaces.*
COL 9.2(18)	*The COL Applicant is to determine the type of the UHS based on specific site conditions and meteorological data.*

Table 1.8-2 Compilation of All Combined License Applicant Items for Chapters 1-19 (sheet 2627 of 44)

COL ITEM NO.	COL ITEM
COL 9.2(19)	*The COL Applicant is to design the UHS to receive its electrical power supply, if required by the UHS design, from safety busses so that the safety functions are maintained during LOOP. The UHS also receives its standby electrical power from the onsite emergency power supplies during a LOOP.*
COL 9.2(20)	*The COL Applicant is to provide a detailed description and drawings of the UHS, including water inventory, temperature limits, heat rejection capabilities, instrumentation, and alarms.*
COL 9.2(21)	*The COL Applicant is to determine the source of makeup water to the UHS inventory and the blowdown discharge location based on specific site conditions.*
COL 9.2(22)	*The COL Applicant is to provide results of UHS capability and safety evaluation of the UHS based on specific site conditions and meteorological data. The COL Applicant is to use at least 30 years site specific meteorological data and heat loads data for UHS performance analysis per Regulatory Guide 1.27.*
COL 9.2(23)	*The COL Applicant is to provide test and inspection requirements of the UHS. These is to include inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity.*
COL 9.2(24)	*The COL Applicant is to provide the required alarms, instrumentation and controls details based on the type of UHS to be provided.*
COL 9.2(25)	*The COL applicant is to will develop operating and maintenance procedures system filing, venting, keeping the system full, and operational procedures to minimize the potential for water hammer; to analyze the system for water hammer impacts; to design the piping system to withstand potential water hammer forces; and to analyze inadvertent water hammer events for the ESWS to address water hammer issues in accordance with NUREG-0927.*
COL 9.2(26)	*The COL applicant is to specify appropriate sizes of piping and pipe fittings such as restriction orifices to prevent potential plugging due to debris buildup, toand develop maintenance and test procedures to monitor debris build up and flush out debris.*

DCD 09.02.01-49

DCD 09.02.01-34 (e)

Table 1.8-2 Compilation of All Combined License Applicant Items for Chapters 1-19 (sheet 2727 of 44)

COL ITEM NO.	COL ITEM
COL 9.2(27)	*The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention.*
COL 9.2(28)	*The COL Applicant is to provide the piping, valves, materials specifications, and other design related to the site specific UHS.*
COL 9.2(29)	*The COL applicant is to provide the safety evaluation of the capability of the ESWS to: (1) isolate its site-specific, nonsafety-related portions; and (2) provide measures to prevent long-term corrosion and organic fouling that may degrade its performance, per Generic Letter (GL) 89-13.*
COL 9.2(30)	*The COL Applicant shall conduct periodic inspection, monitoring, maintenance, performance and functional testing of the ESWS and UHS piping and components, including the heat transfer capability of the CCW heat exchangers and essential chiller units, consistent with GL 89-13 and GL.89-13 Supplement 1. The COL Applicant is to develop operating procedures to periodically alternate the operation of the trains thus performance of all trains will be regularly monitored.*
COL 9.2(31)	*The COL applicant is develop operating procedures to verify the system layout and performance of the ESWS and UHS to assure that the ESWS and UHS are above saturation conditions for all operating modes.*
COL 9.2(32)	*The COL applicant is to provide a void detection system with alarms to detect system voiding.*
COL 9.2(33)	*The COL Applicant is to provide the design details of the strainer blowdown line, vent line, and their discharge locations.*
COL 9.3(1)	*The COL Applicant is to provide the high pressure nitrogen gas, low pressure nitrogen gas, the hydrogen gas, carbon dioxide, and oxygen supply systems.*
COL 9.3(2)	*Deleted*
COL 9.3(3)	*Deleted*
COL 9.3(4)	*Deleted*
COL 9.3(5)	*Deleted*

DCD 09.02.01-33(e)

DCD 09.02.01-33 (k)

DCD 09.02.01-51;

DCD 09.02.01-57;

DCD 09.02-01-59

DCD 09.02.01-36;

DCD 09.02.01-49

DCD 09.02.01-34 (h)

Replace with "Essential service water system strainer blowdown piping and valves and vent piping and valves "

DCD 09.02.01-32(f)

Although meaning is the same, replace "outlet" with "discharge".

of Mechanical and Fluid Systems, Components, and Equipment (Sheet 32 of 57)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards(3)	Seismic Category(4)	Notes
Essential service water pump ~~outlet~~ strainers, including essential service water supply piping and valves	3	UHSRS ESWPT	C	YES	3	I	
~~Component cooling water heat exchanger inlet strainers, including essential service water supply piping and valves~~	3	R/B	C	YES	3	I	
Essential service water supply header piping and valves	3	UHSRS ESWPT	C	YES	3	I	
Essential service water return header piping and valves	3	UHSRS ESWPT	C	YES	3	I	
Essential service water supply line piping and valves to component cooling water heat exchangers, including component cooling water heat exchanger backwash piping	3	R/B ESWPT	C	YES	3	I	
Essential service water return line piping and valves from component cooling water heat exchangers	3	R/B ESWPT	C	YES	3	I	
Essential service water supply line piping and valves to essential chiller units	3	PS/B ESWPT	C	YES	3	I	
Essential service water return line piping and valves from essential chiller units	3	PS/B ESWPT	C	YES	3	I	
~~Essential service water pump motor cooling piping and valves~~	3	ESWPT	C	YES	3	I	
14. Gaseous Waste Management System (GWMS)							
Waste gas surge tanks	6	A/B	N/A	N/A	6	Note 1	

2.7.3 Cooling Water Systems

2.7.3.1 Essential Service Water System (ESWS)

2.7.3.1.1 Design Description

System Purpose and Functions

The essential service water system (ESWS), safety-related system provides cooling water to the component cooling water heat exchangers and the essential chiller units. The ESWS transfers the heat from these components to the ultimate heat sink (UHS).

Location and Functional Arrangement

Figure 2.7.3.1-1 shows the functional arrangement of the ESWS. Table 2.7.3.1-1 provides the location for the ESWS equipment and piping. Table 2.7.3.1-2 provides information on design characteristics of system equipment.

Key Design Features

The ESWS consists of four independent divisions with each division providing fifty percent (50%) of cooling capacity required for design basis accident and for safe shutdown. The ESWS performs its safety function assuming that one division is out of service for maintenance coincident with the loss of offsite power and any single failure. Each ESW pump discharge line is provided with two (2) 100% capacity automatic strainers. ~~A clogged strainer is taken out of service by placing the standby strainer in operation.~~

DCD_09.02.01-52

Each mechanical division of the essential service water system is physically separated from the other divisions by a structural barrier, which also serves as a fire barrier.

Seismic and ASME Code Classification

The seismic classifications for system components are identified in Table 2.7.3.1-2. The ASME Code Section III requirements for system components are also identified in Table 2.7.3.1-2. Table 2.7.3.1-3 provides this information for system piping.

System Operation

The ESWS provides cooling water required for the component cooling water heat exchangers and the essential chiller during all plant operating conditions, including normal plant operating, abnormal and accident conditions.

Alarms, Displays, and Controls

Table 2.7.3.1-4 identifies alarms, displays, and controls associated with the ESWS that are located in the main control room (MCR).

Logic

Upon the receipt of ECCS actuation signal, all essential service water pumps (ESWPs) automatically start or continue to operate.

Interlocks

Upon the receipt of an ESWP start signal, the essential service water discharge valve opens automatically. The motor operated valve at the discharge of each pump is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed. The valve starts to open after the respective pump starts.

Class 1E Electrical Power Sources and Divisions

The ESWS equipment identified in Table 2.7.3.1-2 as Class 1E is powered from their respective Class 1E divisions, and separation is provided between Class 1E divisions, and between Class 1E divisions and non-Class 1E cable.

Equipment to be Qualified for Harsh Environments

Not applicable

Interface Requirements

UHS is a safety-related system and is not within the scope of the certified design. The maximum supply water temperature is 95 °F under the peak heat loads condition to provide sufficient cooling capacity to ESWS. DCD_09.02.01-39

The UHS keeps the water level at a net positive suction head (NPSH) greater than the pump's required NPSH.

Combined License applicants referencing the certified design is are responsible to assure that the site-specific design meets the interface requirements of Subsection 3.2.1 and verify the conformance in via the ITAAC process that are similar to those provided in the certified design.

Numeric Performance Values

When necessary to demonstrate satisfaction of a design commitment, numeric performance values for selected components have been specified as ITAAC acceptance criteria in Table 2.7.3.1-5.

2.7.3.1.2 Inspections, Tests, Analysis, and Acceptance Criteria

Table 2.7.3.1-5 describes the ITAAC for the ESWS.

Table 2.7.3.1-1 Essential Service Water System Location of Equipment and Piping

System and Components	Location
Essential service water pumps	Ultimate heat sink related structures
Essential service water supply header piping and valves	Ultimate heat sink related structures and essential service water pipe tunnel
Essential service water return header piping and valves	Ultimate heat sink related structures and essential service water pipe tunnel
Essential service water header piping and valves to essential service water pump discharge strainers	Ultimate heat sink related structures
Essential service water header piping and valves from essential service water pump discharge strainers	Ultimate heat sink related structures
Essential service water supply line piping and valves to component cooling water heat exchangers	Reactor Building and essential service water pipe tunnel
Essential service water return line piping and valves from component cooling water heat exchangers	Reactor Building and essential service water pipe tunnel
Essential service water supply line piping and valves to essential chiller units	Power Source Building and essential service water pipe tunnel
Essential service water return line piping and valves from essential chiller units	Power Source Building and essential service water pipe tunnel
~~Essential service water pump motor cooling water piping and valves~~	~~Ultimate heat sink related structures~~

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Attachment 4

Table 2.7.3.1-2 Essential Service Water System Equipment Characteristics (Sheet 1 of 2)

Equipment Name	Tag No.	ASME Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Essential service water pumps	EWS-MPP-001 A, B, C, D	3	Yes	-	Yes/No	ECCS Actuation	Start	-
						LOOP sequence	Start	
						Remote Manual	Start	
Essential service water pump discharge valves	EWS-MOV-503 A, B, C, D	3	Yes	Yes	Yes/No	ESW pump start	Transfer Open	As Is
						ESW pump stop	Transfer close	
Component Cooling Water Heat Exchanger Essential Service Water Flow	EWS-FT-034, 035, 036, 037	-	Yes	-	Yes/ No	-	-	-
Essential Service Water Header Pressure	EWS-PT-015, 016, 017, 018	-	Yes	-	Yes/ No	-	-	-
Essential Service Water Pump Discharge Check Valves	EWS-VLV-502A, 502B, 502C, 502D	3	Yes	-	-/-	-	Transfer Open/ Transfer Closed	-
Essential service water pump discharge strainers	EWS-SST-001A, B, C, D EWS-SST-002A, B, C, D	3	Yes	-	Yes/No	ESW pump stop	Stop	-
						Remote manual	Start/Stop	
Essential Service Pump Motor Cooling Water	EWS-VLV-602A, 602B, 602C, 602D	3	Yes	-	-/-	-	Transfer Open/ Transfer Closed	-

~~Supply Line Check Valves~~								

NOTE:
Dash (-) indicates not applicable

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Table 2.7.3.1-2 Essential Service Water System Equipment Characteristics (Sheet 2 of 2)

Equipment Name	Tag No.	ASME Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Essential service water pump discharge strainer backwash line isolation valves	EWS-MOV-573A, B, C, D EWS-MOV-574A, B, C, D	3	Yes	Yes	Yes/No	ESW pump stop	Transfer Close	As is
						Remote manual	Transfer Open/ Transfer Close	

NOTE:
Dash (-) indicates not applicable

Table 2.7.3.1-3 Essential Service Water System Piping Characteristics

Pipe Line Name	ASME Code Section III Class	Seismic Category I
Essential service water supply header piping and valves	3	Yes
Essential service water return header piping and valves	3	Yes
Essential service water header piping and valves to essential service water pump discharge strainers	3	Yes
Essential service water header piping and valves from essential service water pump discharge strainers	3	Yes
Essential service water supply line piping and valves to component cooling water heat exchangers	3	Yes
Essential service water return line piping and valves from component cooling water heat exchangers	3	Yes
Essential service water supply line piping and valves to essential chiller units	3	Yes
Essential service water return line piping and valves from essential chiller units	3	Yes
~~Essential service water pump motor piping and valves~~	~~3~~	~~Yes~~

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Table 2.7.3.1-4 Essential Service Water System Equipment Alarms, Displays, and Control Functions

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Essential service water pumps EWS-MPP-001A, B, C, D	No	Yes	Yes	Yes
Essential service water pump discharge valves EWS-MOV-503A, B, C, D	No	Yes	Yes	Yes
Essential service water header pressure EWS-PIA~~T~~-015, 016, 017, 018	Yes	Yes	No	Yes
Component cooling water heat exchanger essential service water flow EWS-FIA~~T~~-034, 035, 036, 037	Yes	Yes	No	Yes
Essential service water pump discharge strainers EWS-SST-001A, B, C, D EWS-SST-002A, B, C, D	Yes	Yes	Yes	Yes
Essential service water pump discharge strainers backwash line isolation valves EWS-MOV-573A, B, C, D EWS-MOV-574A, B, C, D	Yes	Yes	Yes	Yes

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Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 56)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.a The functional arrangement of the ESWS is as described in the Design Description of Subsection 2.7.3.1 and as shown in Figure 2.7.3.1-1.	1.a An inspection of the as-built ESWS will be performed.	1.a The as-built ESWS conforms to the functional arrangement as described in the Design Description of Subsection 2.7.3.1 and as shown in Figure 2.7.3.1-1.
1.b Each mechanical division of the ESWS (Division A, B, C & D) ~~except for piping~~ is physically separated from the other divisions ~~with the exception of the components in the ESWS piping tunnel~~.	1.b Inspections of the as-built ESWS will be performed.	1.b Each mechanical division of the as-built ESWS (Division A, B, C & D) ~~except for piping~~ is physically separated from the other divisions of the system by structural barriers ~~divisions with the exception of the components in the ESWS piping tunnel~~.
2.a.i The ASME Code Section III components of the ESWS, identified in Table 2.7.3.1-2, are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.	2.a.i An inspection of the as-built ASME Code Section III components of the ESWS will be performed.	2.a.i The ASME Code Section III data report(s) (certified, when required by ASME Code) and inspection reports (including N-5 Data Reports where applicable) exist and conclude that the as-built ASME Code Section III components of the ESWS identified in Table 2.7.3.1-2 are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.
2.a.ii The ASME Code Section III components of the ESWS identified in Table 2.7.3.1-2 are reconciled with the design requirements.	2.a.ii A reconciliation analysis of the components using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.a.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the as-built ASME Code Section III components of the ESWS identified in Table 2.7.3.1-2 are reconciled with the design requirements. The report documents the results of the reconciliation analysis.

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Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 2 of 56)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2.b.i The ASME Code Section III piping of the ESWS, including supports, identified in Table 2.7.3.1-3, is fabricated, installed, and inspected in accordance with ASME Code Section III requirements.	2.b.i An inspection of the as-built ASME Code Section III piping of the ESWS, including supports, will be performed.	2.b.i The ASME Code Section III data report(s) (certified, when required by ASME Code) and inspection reports (including N-5 Data Reports where applicable) exist and conclude that the as-built ASME Code Section III piping of the ESWS, including supports, identified in Table 2.7.3.1-3 is fabricated, installed, and inspected in accordance with ASME Code Section III requirements.
2.b.ii The ASME Code Section III piping of the ESWS, including supports, identified in Table 2.7.3.1-3 is reconciled with the design requirements.	2.b.ii A reconciliation analysis of the piping of the ESWS, including supports, using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.b.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the as-built ASME Code Section III piping of the ESWS, including supports, identified in Table 2.7.3.1-3 is reconciled with the design requirements. The report documents the results of the reconciliation analysis.
3.a Pressure boundary welds in ASME Code Section III components, identified in Table 2.7.3.1-2, meet ASME Code Section III requirements for non-destructive examination of welds.	3.a Inspections of the as-built pressure boundary welds will be performed in accordance with the ASME Code Section III.	3.a The ASME Code Section III code reports exist and conclude that the ASME Code Section III requirements are met for non-destructive examination of the as-built pressure boundary welds.
3.b Pressure boundary welds in ASME Code Section III piping, identified in Table 2.7.3.1-3, meet ASME Code Section III requirements for non-destructive examination of welds.	3.b Inspections of the as-built pressure boundary welds will be performed in accordance with the ASME Code Section III.	3.b The ASME Code Section III code reports exist and conclude that the ASME Code Section III requirements are met for non-destructive examination of the as-built pressure boundary welds.
4.a The ASME Code Section III components, identified in Table 2.7.3.1-2, retain their pressure boundary integrity at their design pressure.	4.a A hydrostatic test will be performed on the as-built components required by the ASME Code Section III to be hydrostatically tested.	4.a The results of the hydrostatic test of the as-built components identified in Table 2.7.3.1-2 as ASME Code Section III conform to the requirements of the ASME Code Section III.

Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 56)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4.b The ASME Code Section III piping, identified in Table 2.7.3.1-3, retains its pressure boundary integrity at its design pressure.	4.b A hydrostatic test will be performed on the as-built piping required by the ASME Code Section III to be hydrostatically tested.	4.b The results of the hydrostatic test of the as-built piping identified in Table2.7.3.1-2 as ASME Code Section III conform to the requirements of the ASME Code Section III.
5.a The seismic Category I equipment identified in Table 2.7.3.1-2 is designed to withstand seismic design basis loads without loss of safety function.	5.a.i Inspections will be performed to verify that the seismic Category I as-built equipment identified in Table 2.7.3.1-2 is installed in the location identified in Table 2.7.3.1-1.	5.a.i The seismic Category I as-built equipment identified in Table 2.7.3.1-2 is installed in the location identified in Table 2.7.3.1-1.
	5.a.ii Type tests and/or analyses of the seismic Category I equipment will be performed.	5.a.ii The results of the type tests and/or analyses conclude that the seismic Category I equipment can withstand seismic design basis loads without loss of safety function.
	5.a.iii Inspections will be performed on the as-built equipment including anchorage.	5.a.iii The as-built equipment including anchorage is seismically bounded by the tested or analyzed conditions.
5.b Each of the seismic Category I piping, including supports, identified in Table 2.7.3.1-3 is designed to withstand combined normal and seismic design basis loads without a loss of its safety function.	5.b.i Inspections will be performed to verify that the as-built seismic Category I piping, including supports, identified in Table 2.7.3.1-3 are supported by a seismic Category I structure(s).	5.b.i Reports(s) document that each of the as-built seismic Category I piping, including supports, identified in Table 2.7.3.1-3 is supported by a seismic Category I structure(s).
	5.b.ii Inspections will be performed for the existence of a report verifying that the as-built seismic Category I piping, including supports, identified in Table 2.7.3.1-3 can withstand combined normal and seismic design basis loads without a loss of its safety function.	5.b.ii A report exists and concludes that each of the as-built seismic Category I piping, including supports, identified in Table 2.7.3.1-3 can withstand combined normal and seismic design basis loads without a loss of its safety function.
6.a The Class 1E equipment identified in Table 2.7.3.1-2 is powered from their respective Class 1E division.	6.a A test will be performed on each division of the as-built equipment by providing a simulated test signal only in the Class 1E division under test.	6.a The simulated test signal exists at the as-built Class 1E equipment identified in Table 2.7.3.1-2 under test.

Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 4 of ~~5~~6)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6.b Separation is provided between Class 1E divisions, and between Class 1E divisions and non-Class 1E cable.	6.b Inspections of the as-built Class 1E divisional cables will be performed.	6.b Physical separation or electrical isolation is provided between the as-built cables of Class 1E divisions and between Class 1E divisions and non-Class 1E cables.
7. The ESWS components identified in Table 2.7.3.1-2 provide adequate cooling water to the CCW heat exchangers and the essential chiller units of the ECWS during all plant operating conditions, including normal plant operating, abnormal and accident conditions.	7.i An inspection for the existence of a report that determines the capability of the as-built ESWS will be performed.	7.i A report exists and concludes that the as-built ESWS provides adequate cooling water to the CCW heat exchangers and the essential chiller units of the ECWS during all plant operating conditions, including normal plant operating, abnormal and accident conditions.
	7.ii Tests will be performed to confirm that the as-built ESWS pumps can provide flow to the CCW heat exchangers and the essential chiller units of the ECWS.	7.ii The as-built ESWS pumps identified in Table 2.7.3.1-2 are capable of achieving their design flow rate.
8. Controls exist in the MCR to open and close the remotely operated valves identified in Table 2.7.3.1-2.	8. Tests will be performed on the as-built remotely operated valves listed in Table 2.7.3.1-2 using controls in the as-built MCR.	8. Controls exist in the as-built MCR to open and close the as-built remotely operated valves listed in Table 2.7.3.1-2.
9.a The remotely operated and check valves, identified in Table 2.7.3.1-2, perform an active safety function to change position as indicated in the table.	9.a.i Tests or type tests of the remotely operated valves will be performed that demonstrate the capability of the valve to operate under its design conditions.	9.a.i Each remotely operated valve changes position as indicated in Table 2.7.3.1-2 under design conditions.
	9.a.ii Tests of the as-built remotely operated valves will be performed under pre-operational flow, differential pressure, and temperature conditions.	9.a.ii Each as-built remotely operated valve changes position as indicated in Table 2.7.3.1-2 under pre-operational test conditions.

Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 5 of 56)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	9.a.iii Tests of the as-built check valves will be performed under preoperational flow, differential pressure, and temperature conditions.	9.a.iii Each as-built check valve changes position as indicated in Table 2.7.3.1-2.
9.b Upon the receipt of an ESWP start signal, the essential service water discharge valve opens automatically. Each pump's discharge valve is interlocked to close when the pump is not running or is tripped. The valve starts to open after the respective pump starts.	9.b A test of each as-built interlock for the essential service water discharge valve will be performed using a simulated test signal.	9.b The ESW discharge valve closes when its respective pump is not running. Upon the receipt of a simulated ESWP start signal, the as-built discharge valve for the respective pump starts to open automatically after the pump starts. The valve closes when the pump is tripped.
9.c After loss of motive power, the remotely operated valves, identified in Table 2.7.3.1-2, assume the indicated loss of motive power position.	9.c Tests of the as-built valves will be performed under the conditions of loss of motive power.	9.c Upon loss of motive power, each as-built remotely operated valve identified in Table 2.7.3.1-2 assumes the indicated loss of motive power position.
10.a Controls exist in the MCR to start and stop the pumps identified in Table 2.7.3.1-4.	10.a Tests will be performed on the as-built pumps listed in Table 2.7.3.1-4 using controls in the as-built MCR.	10.a Controls exist in the as-built MCR to start and stop the as-built pumps listed in Table 2.7.3.1-4.
10.b The pumps identified in Table 2.7.3.1-2 as having PSMS control perform an active safety function after receiving a signal from PSMS.	10.b Tests will be performed on the as-built pumps listed in Table 2.7.3.1-2 using simulated signals.	10.b The as-built pumps identified in Table 2.7.3.1-2 as having PSMS control perform the active safety function identified in the table after receiving a simulated signal.
11. MCR alarms and displays of the parameters identified in Table 2.7.3.1-4 can be retrieved in the MCR.	11. Inspections will be performed for retrievability of the ESWS parameters in the as-built MCR.	11. The MCR alarms and displays identified in Table 2.7.3.1-4 can be retrieved in the as-built MCR.
12. RSC alarms, displays, and controls are identified in Table 2.7.3.1-4.	12. Inspections of the as-built RSC alarms, displays and controls will be performed.	12. Alarms, displays and controls exist on the as-built RSC as identified in Table 2.7.3.1-4.
13.a Controls exist in the MCR to start and stop the active strainer functions identified in Table 2.7.3.1-4.	13.a Tests will be performed on the as-built strainers listed in Table 2.7.3.1-4 using controls in the as-built MCR.	13.a Controls exist in the as-built MCR to start and stop the active functions of the as-built strainers listed in Table 2.7.3.1-4.
13.b The strainers identified in Table 2.7.3.1-2 as having PSMS control perform an active safety function after receiving a signal from PSMS.	13.b Tests will be performed on the as-built strainers listed in Table 2.7.3.1-2 using simulated signals.	13.b The as-built strainers identified in Table 2.7.3.1-2 as having PSMS control perform the active safety function identified in the table after receiving a simulated signal.

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Table 2.7.3.1-5 Essential Service Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 6 of 6)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
14. Upon the receipt of an ESWP stop signal, the essential service water pump discharge strainer backwash isolation valves close automatically. The valve starts to open after the respective pump starts.	14. A test of each as-built interlock for the essential service water pump discharge strainer backwash isolation valve will be performed using a simulated test signal.	14. The ESWP discharge strainer backwash isolation valve closes when its respective pump is not running. Upon the receipt of a simulated ESWP stop signal, the as-built discharge valve for the respective pump starts to close automatically after the pump stops. The valve closes when the pump is tripped.

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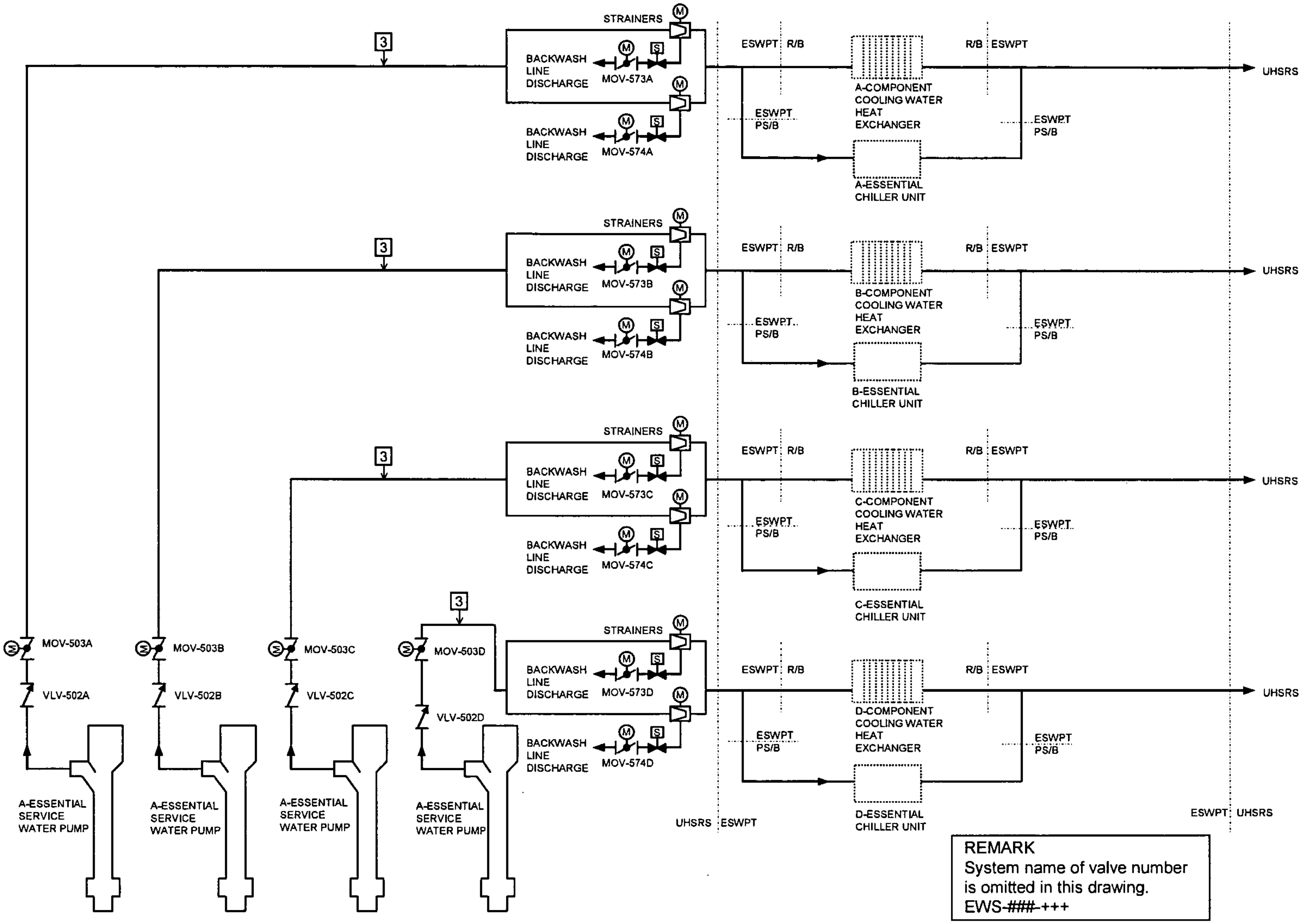

Figure 2.7.3.1-1 Essential Service Water System

3.0 INTERFACE REQUIREMENTS

3.1 Design Description

This section identifies the safety significant interfaces between the US-APWR standard plant design and the Combined License (COL) applicant.

The US-APWR standard plant design consists of several buildings (reactor building including the prestressed concrete containment vessel and containment internal structure, power source buildings, auxiliary building, turbine building and access building); the equipment located in those buildings, and structures (power source fuel storage vaults and essential service water pipe tunnel). As allowed by the regulations, conceptual designs for systems that are not part of the US-APWR standard design are included in the DCD for purposes of allowing the NRC to evaluate the overall acceptability of the design. However, the final details of these conceptual designs are subject to change due to site-specific conditions.

Although the system descriptions of the PSFSVs and ESWPT are within the scope of the US-APWR standard design, the structural design of the PSFSVs and ESWPT, including seismic and dynamic qualification as applicable, are to be finalized based on the site specific arrangement.

An interface requirement as specified in this section is the portion of a system that must be added to the standard design package to complete the design of the US-APWR at a specific site.

COL applicant referencing the certified design is responsible to assure that the site specific design meets the interface requirement and verify the conformance in the ITAAC process that is similar to those provided in the certified design.

3.2 Interface Requirements

3.2.1 Ultimate Heat Sink

Ultimate heat sink (UHS) is a safety-related system and is site-specific. The following are site specific interface requirements:

a. ~~. Each division of the~~The UHS system design is ~~separated from the other divisions~~ consistent with ESWS divisional separation and is capable of performing its safety function under design basis events and coincident single failure with or without offsite power available. DCD_09.02.05-1;

b. The safety related, pressure retaining components including supports, are designed, constructed and inspected in accordance with ASME Code Section III and XI. DCD_09.02.05-1;

c. The UHS is designed to withstand seismic, wind, tornado, missile, and flooding design basis loads without the loss of safety function.

d. The maximum supply water temperature is 95 °F under the peak heat loads condition to provide sufficient cooling capacity to ESWS.

e. The UHS keeps the water level is maintained such that at available net positive suction head (NPSH) is greater than the ESW pump's required NPSH during normal operation, AOOs and accident conditions. The ESW pump pump operation does not cause vortex formation. DCD_09.0 2.05-1; DCD_09.0 2.01-38

g.f. The UHS system has MCR and RSC alarms and displays for UHS water level and water temperature. DCD_09.0 2.05-1;

h.g. The UHS system has MCR and RSC controls for UHS components' active safety functions if applicable to the site-specific design.

i.h. UHS components that have PSMS control (e.g., blowdown isolationif applicable to the site-specific design) perform an active safety function after receiving a signal from PSMS. DCD_09.0 2.05-1;

i. The UHS is designed to cool the unit for a minimum of 30 days (36 days if the site-specific design uses a cooling pond) without make-up during a design basis event. DCD_09.0 2.05-1;

j. The UHS is designed for periodic inspection and testing.

k. Countermeasures for water hammer prevention is applied to the UHS and ESWS. DCD_09.0 2.01-36(a)

3.2.2 Fire Protection System

The seismic standpipe system can be supplied from a safety-related water source which capacity is at least 18,000 gallons.

3.2.3 Essential Service Water System

Some portions of the essential service water system (ESWS) are site specific due to its dependence on the site specific UHS. The following are the site specific interface requirements:

a. The ESWS piping in the ESWPT that connects to the cooling water intake and discharge structures is designed, constructed and inspected in accordance with ASME Code Section III and Section XI. DCD_09.0 2.01-33(f)

b. Operating procedures are developed and system layout of the ESWS and UHS is verified to assure that the ESWS and UHS are above saturation conditions during all operating modes. DCD_09.0 2.01-36

c. The sum of the ESW pump shutoff head and static head is such that the ESW system design pressure is not exceeded. DCD_09.0 2.01-39

d. The discharge location of the ESWP discharge strainer backwash piping is determined according to the type of UHS used. DCD_09.0 2.01-52

Table 3.9-14 Valve Inservice Test Requirements (Sheet 105 of 151)

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions(2)	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
EWS-MOV-503C	Essential service water pump discharge	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-503D	Essential service water pump discharge	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-VLV-602A	Essential service water pump cooling water check	Check	Maintain Open Transfer Open Transfer Close	Active	BC	Check Exercise/ Refueling Outage	3
EWS-VLV-602B	Essential service water pump cooling water check	Check	Maintain Open Transfer Open Transfer Close	Active	BC	Check Exercise/ Refueling Outage	3
EWS-VLV-602C	Essential service water pump cooling water check	Check	Maintain Open Transfer Open Transfer Close	Active	BC	Check Exercise/ Refueling Outage	3

Table 3.9-14 Valve Inservice Test Requirements (Sheet 106 of 151)

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions(2)	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
EWS-VLV-602D	Essential service water pump cooling water check	Check	Maintain Open Transfer Open Transfer Close	Active	BC	Check Exercise/ Refueling Outage	3
EWS-MOV-573A	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-573B	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-573C	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6

Table 3.9-14 Valve Inservice Test Requirements (Sheet 107 of 151)

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions(2)	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
EWS-MOV-573D	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-574A	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-574B	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6
EWS-MOV-574C	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6

Table 3.9-14 Valve Inservice Test Requirements (Sheet 108 of 151)

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions(2)	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
EWS-MOV-574D	Essential service water pump outlet strainer backwash isolation valve	Remote MO Butterfly	Maintain Close Maintain Open Transfer Open Transfer Close	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/ Cold Shutdown Operability Test	6

3. Test instrumentation is available and calibrated.
4. Required support systems are available.
5. The cooling tower fans are available.
6. The following systems are available:
   a. Instrument and service air systems.
   b. Makeup water pump system.
   c. Blowdown water system.
   d. Demineralized water system.

C. Test Method
1. Verify controls and functions of circulating water pump and cooling tower fans.
2. Verify strokes and functions of motor-operated valves and control valves.
3. Operate circulating water pumps and verify operating condition.
4. Verify indications and alarms.

D. Acceptance Criteria
1. The circulating water system performs as described in Subsection 10.4.5.
2. Indications and alarms operate as described in Subsection 10.4.5.

14.2.12.1.34 Essential Service Water System (ESWS) Preoperational Test

A. Objective
1. To demonstrate the operation of the ESWS.

B. Prerequisites
1. Required construction testing is completed.
2. Component testing and instrument calibration is completed.
3. Test instrumentation is available and calibrated.
4. Required support systems are available.

C. Test Method
1. Verify manual and automatic system controls.

2. Verify system flowrates and performance of ESWS pur

3. Verify alarms and status indications are functional.

Add as item 4. <u>**"4. Verify the absence of indications of water hammer by re-activating the ESW pump after a simulated LOOP as specified in Section 14.2.12.1.45, Class 1E Bus Load Sequence Preoperational Test."**</u>

D. Acceptance Criterion

1. The ESWS operates within design limits, as described in Subsection 9.2.1.

14.2.12.1.35 Main and Unit Auxiliary Transformers Preoperational Test

A. Objectives

1. To demonstrate operation of protective relaying, alarms, and control devices of the main and unit auxiliary transformers.

2. To demonstrate the energization of the unit auxiliary transformers.

B. Prerequisites

1. Required construction testing is completed.

2. Component testing and instrument calibration is completed.

3. Test instrumentation is available and calibrated.

4. Required support systems are available.

5. Related ac and dc power sources are available.

6. Actual service conditions of loads are simulated as closely as practical.

C. Test Method

1. Simulate fault conditions to verify alarms and operation of protective relaying circuits.

2. The unit auxiliary transformers are energized. Voltage and phase rotation are verified and recorded.

D. Acceptance Criterion

1. The performance of the main and unit auxiliary transformers is in accordance with the design criteria as described in Section 8.2.

14.2.12.1.36 Reserve Auxiliary Transformers Preoperational Test

A. Objectives

1. To demonstrate the operation of protective relaying, alarms, and control devices associated with the reserve auxiliary transformers.

withstand the effects of earthquakes without loss of capability to perform their safety function; and those site-specific, safety-related fluid systems or portions thereof; as well as the applicable industry codes and standards for pressure-retaining components.

The seismic category of safety-related and important to safety electrical, mechanical, and instrumentation and control (I&C) equipment is provided in Appendix 3D.

3.2.1.3 Classification of Building Structures

Table 3.2-4 provides the designated seismic category of building and structures (seismic category I, II, and NS). The US-APWR Nuclear Island consists of the R/B, PCCV, containment internal structure, A/B, access building (AC/B), and east and west power source buildings (PS/Bs). The US-APWR design includes the R/B, PCCV, containment internal structure, and PS/B (east and west). Unique non-standard buildings and structures in Table 3.2-4 include the UHSRS, ESWPT, PSFSV, NS T/G Pedestal, and NS Outside Buildings. Minor NS Buildings and all structures in the plant yard are generally not listed in Table 3.2-4. Design of all plant buildings and structures are addressed where appropriate in Chapter 3 and its appendices.

Add after the third sentence: "**The turbine building (T/B) is part of the standard design but outside the Nuclear Island.**"

3.2.2 System Quality Group C…

GDC 1 of 10 CFR 50, Appendix A… 3.2-12), as they relate to safety-related SSCs, requires that SSCs be designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed. RG 1.26 (Reference 3.2-13) is used to meet these requirements by classifying safety-related fluid systems and components and applying corresponding quality codes and standards to such systems and components.

Safety-related fluid systems may perform any of the following functions:

- Fission product containment
- Core cooling
- Reactor shutdown
- Reactivity control
- Post-accident containment heat removal
- Post-accident containment atmosphere cleanup
- Post-accident fission product removal
- Residual heat removal from the reactor and/or from the spent fuel storage pool
- Containment of radioactive materials

Portions of fluid systems which provide cooling or heating, sealing, lubrication, fuel, motive power, isolation, flood protection, or leakage detection necessary to support the accomplishment of any of the above functions are also considered safety-related.

10 CFR 50.55a (Reference 3.2-12) identifies those ASME Code, Section III, (Reference 3.2-14), Class 1, safety-related components that are part of the RCPB. These

Table 3.2-4 Seismic Classification of Buildings and Structures[1]

Structure	Acronym	Seismic Category[2]
Reactor Building[3]	R/B	I
Prestressed Concrete Containment Vessel[3]	PCCV	I
Containment Internal Structure[3]		I
Power Source Building[3]	PS/B	I
Power Source Fuel Storage Vault	PSFSV	I
Essential Service Water Pipe Tunnel (ESWPT) (from/to UHS)	ESWPT	I
UHS Related Structures[4]	UHSRS	I
A/B[3]	A/B	II
Turbine Building	T/B	II
AC/B[3]	AC/B	NS
Outside Building (e.g., maintenance facility, operations office)	O/B	NS
Turbine generator pedestal	T/G Pedestal	NS

Add superscript: "5"

Notes:

1. Other non-standard plant building structures, such as minor NS buildings and structures in the plant yard, are not listed in the above table and are not considered part of the US-APWR Nuclear Island.
2. Seismic category I (I)
   Seismic category II (II)
   Non-Seismic (NS)
3. US-APWR Nuclear Island
4. UHSRS include but are not limited to (1) dams, (2) ponds, or (3) cooling towers (including cooling tower enclosure, and pump house). The specific features of the UHSRS are site dependent and not part of the US-APWR standard plant. The UHSRS are seismic category I structures selected based on site-specific conditions and site-specific meteorological data.

Add as footnote: "**5. The ESWPT is a site specific structure but the existence and functions of which are required by the plant standard design. The specific features of the ESWPT are site dependent and will depend on the type of UHS.**"