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July 27, 2011

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-11235

Subject: **MHI's Revised Responses to US-APWR DCD RAI No. 585-4464 Revision 0 (SRP 09.02.01)**

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.
[2] MHI letter UAP-HF-10256 "MHI's Responses to US-APWR DCD RAI No. 585-4464 Revision 0," dated September 24, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Revised Responses to Request for Additional Information No. 585-4464 Revision 0". This transmittal amends the Reference 2 response for some questions. Reference 2 responses remain unchanged for other questions, as indicated in this transmittal.

Enclosure 1 contains the revised responses to 12 questions in Reference [2].

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,

Y. Ogata

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

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NRO

Enclosures:

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

CC: J. A. Ciocco
C. K. Paulson

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Enclosure 1

UAP-HF-11235
Docket No. 52-021

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

July 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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)
In DCD revision 3, DCD Section 9.2.1 has been revised in its entirety to distinguish SPDI from CDI which are enclosed in brackets or clouds for figures. Please refer to US-APWR DCD revision 3. Other related sections have also been revised as applicable and can be found in the DCD revision 3. For Tier 1 Figure 2.7.3.1-1, because this figure shows only SPDI portion, there is no need to show breaks where the figure goes from SPDI to CDI.

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 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 identified as functional requirements of standard plant design information. A short summary will be added at the beginning of DCD revision 3 Subsection 9.2.1 explaining that functional requirements are not dependent on site specific conditions for SSCs installed in the building as shown in Attachment-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).

Regarding the pump air cooling, DCD Subsection 9.4.5 describes the design detail of the ESW pump house ventilation system. DCD revision 3 Subsection 9.2.1.2.2.1 ESWPs will be revised to refer to the subsection 9.4.5. Also, DCD revision 3 Subsection 9.2.10 COL item 9.2(6) will be revised to delete the requirement for selecting the mode of cooling of the ESWP motor.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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 entire portion of Tier 2 DCD Section 1.8 has been adequately revised to clearly distinguish what is within the scope of the standard plant design and what is not in DCD revision 3. Also, in Section 1.2.1.6 and Figure 1.2-1, CDI portions are enclosed in brackets or clouds for figures to distinguish SPDI from CDI.

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)
CDI portions are enclosed in brackets or clouds for figures to distinguish SPDI from CDI in DCD revision 3 including Section 9.2.1 and Figure 9.2.1-1. The entire contents of Table 1.8-1 have also been revised to identify interface requirements and COL information items in DCD revision 3.

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)
Not changed from the response in Reference 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)
Not changed from the response in Reference 2.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- A short summary which describes that ESWS functional requirements are standard plant design regardless of location although some structures (e.g. ESWPT and UHSRS) where some of ESWS components are located are site specific will be added to the beginning of Subsection 9.2.1.
- Description regarding backwashing of the CCW heat exchanger will be added to Subsection 9.2.1.1.3 to clarify the heat exchanger backwashing is nonsafety-related design bases.

- Clarified that the non-safety design basis is only for conceptual design in Subsection 9.2.1.1.3.
- Also added the description regarding non-safety loads to Subsection 9.2.1.1.3.
- Subsection 9.2.1.2.2.1 will be revised to refer to Subsection 9.4.5 which describes the design detail of the ESW pump house ventilation.
- The description regarding backwash operating of the CCW heat exchanger including the case with out of service train is added to Subsection 9.2.1.2.3.1.
- Subsection 9.2.10, COL 9.2(6) will be revised to delete the requirement for selecting the mode of cooling of the ESWP motor.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)

Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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.

In DCD revision 3, Tier 2 DCD Subsection 9.2.1.2.2.3 has been revised to describe the CCW heat exchanger backwashing.

Also, the description regarding the backwashing will be added to the DCD revision 3 Subsection 9.2.1.1.3, Nonsafety-Related Design Bases.

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

Answer: h)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
In DCD revision 3, by adding supplemental description to DCD Subsection 9.2.1.3, it will become clear what the COL 9.2(7) is referring to and to what extent it applies to that part of the ESWS that is within scope for standard plant design.

Also in DCD revision 3 Subsection 9.2.10, COL 9.2(7) will be revised to clarify its requirement.

The CCW heat exchanger drain connections, including drainage points, are all SPDI and have been described in DCD Figure 9.2.1-1. The Safety and Non-safety boundaries have been clearly delineated by adding the class boundary symbol delineating the first normally closed valve drain connection as "EC3" in DCD revision 3.

With regard to vents and drains, local vent/drain lines cannot be determined until the detail design phase, therefore, the design of vent/drain is not within the standard plant design. Actually, in the DCD revision 3, the system drawing has been simplified and local vent/drain lines have been deleted from the system drawing or will not be added to the drawing to prevent having to make any minor changes to the DCD as local vent/drain lines.

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 has been deleted in DCD revision 3 Section 9.2.1 and the item of ESW pump motor has been deleted in Table 9.2.1-3 and 9.2.1-4 because the pump cooling method was changed to air cooling as standard design.

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)
Not changed from the response in Reference 2.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1.1.3 will be revised to add the description regarding the CCW heat exchanger backwashing operation.
- Subsection 9.2.1.3 and DCD Subsection 9.2.10 COL 9.2(7) will be revised to clarify what the COL 9.2(7) refers to and to what extent it applies to that part of the ESWS that is within scope for standard plant design.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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. Although which parts within SPDI that may be arranged in the outside standard design scope building could be stagnant will be identified in DCD revision 3 Subsection 9.2.1.3, the description which clarify that the SPDI building is maintained through ventilation and is therefore heat tracing is not required will also be added to DCD revision 3 Subsection 9.2.1.3. 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 outside of the standard design will be protected from the environment as delineated in COL 9.2(2). DCD revision 3 Subsection 9.2.10 COL 9.2(2) will also be revised to describe that the COL applicant will handle heat tracing measures as safety related. 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.

In DCD revision 3, Tier 2 DCD Subsection 9.2.1.2.1 and 9.2.1.3 have been revised to add the above contents as shown in Attachment-1.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1 will be revised to identify which parts within SPDI that may be arranged in the outside of standard design scope building could be stagnant.
- Subsection 9.2.10 COL 9.2(2) will be revised to describe that the COL applicant will handle heat tracing measures as safety related.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on the PRA.

This completes MHI's response to NRC's question.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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. In DCD revision 3, commitment to add a vacuum breaker to the system has been added to Subsection 9.2.1.2.3.1.

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) has been added to DCD revision 3 Subsection 9.2.10 as shown in Attachment-1.

Also, an interface requirement regarding water hammer prevention has been added to DCD revision 3 Tier 1 Section 3.2.1 and 3.2.3.
CDI in brackets has been added to DCD revision 3 Section 9.2.1.2.1 in order to demonstrate water hammer prevention through countermeasures to case (1).

Answer to b)
Not changed from the response in Reference 2.

Answer to c)
Not changed from the response in Reference 2.

Answer to d)
Not changed from the response in Reference 2.

Answer to e)
Not changed from the response in Reference 2.

Answer to f)
Not changed from the response in Reference 2.

Answer to g)
Not changed from the response in Reference 2.

Impact on DCD

There is no additional impact on DCD revision 3.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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 SPDI portions have been clarified at the beginning of DCD revision 3 Subsection 9.2.1 as answered as RAI 09.02.01-32 a). The CDI portions can be identified by brackets or clouds for figures which have been added in the DCD revision 3. 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 revision 3 Subsection 9.2.1.2.2.1 has been revised to the interface requirement to COL applicant regarding ESW pump design.

Impact on DCD

There is no additional impact on DCD revision 3.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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 revision 3 Subsection 9.2.1.2.2.1, Subsection 9.2.10 COL 9.2(6) and Table 1.8-2 will be revised to clarify testing requirement of the potential for vortex formation based on the most limiting assumptions for COL applicant.

Tier 1 DCD Section 3.2.1 item (d) was revised to include the evaluation of potential vortex formation as a COL applicant interface requirement for DCD revision 3."

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD revision 3 as follows.

- Subsection 9.2.1.2.2.1, Subsection 9.2.10 COL 9.2(6) and Table 1.8-2 will be revised to clarify testing requirement of the potential for vortex formation based on the most limiting assumptions for COL applicant.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's response to NRC's question.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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 has been revised in DCD revision 3 as Attachment-1.

The 4th paragraph of DCD revision 3 Subsection 9.2.1.2.3.1 will be revised to clarify that not only the standby pump will be started but also the discharge MOV will be opened when the operating pump discharge header pressure becomes low. Also, the definition of the word "standby" is added at the beginning of 9.2.1.2.3.1.

During refueling condition, the number of required operating train of CCWS and ESWS are three. At power operating condition, the number of required operating train of ESWS will be decreased to two trains when the heat load of SFP is decreased after refueling operation as shown in Table 9.2.1-3 because equal or more than half of the latest taken fuel assemblies to the SFP are returned back to the reactor vessel before starting power operation. During power operation, at least two trains are required to be in operation, however, three ESWS trains shall be operable for the Modes 1, 2, 3 and 4 as described in T-spec 3.7.8. Therefore, one ESWS train with the consideration of another one train under OLM or two trains without consideration of OLM will become in standby which means operable but not required to operate. When the train becomes in standby, the pump discharge MOV which has slow closure time of approx. 30 seconds will be closed gradually, and then, the pump will be stopped. The operation above can be done from MCR, however, it will be better to monitor the equipment stoppage by attending local operator. The contents above will be added in DCD revision 3 Subsection 9.2.1.2.3.1, as 2nd paragraph. Also Table 9.2.1-3 and 4 in DCD revision 3 will be revised to add the supplemental explanation for the detail of each operating modes.

The CCWS is used for supplying the cooling water to the components which are essential for normal power operation. The interlock between the ESWS and CCWS for inadvertent stoppage of one train of ESWS or CCWS is necessary for maintaining the water supplement to the components requiring rapid water re-supplement such as charging pump or RCP thermal barrier. The detail description of the interlock is added to 3rd paragraph of Subsection 9.2.1.2.3.1.
On the other hand, the ECWS is not required to restart rapidly at inadvertent stoppage of the components. Therefore, there are no interlocks between ESWS and ECWS. The contents above will be added to DCD revision 3 Subsection 9.2.1.5.7.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1.2.3.1 2nd paragraph, Table 9.2.1-3 and 4 will be revised to add the supplemental explanation for the detail of each operating modes.

- Subsection 9.2.1.2.3.1 3rd paragraph will be revised to add the detail description of the interlocks between the ESWS and CCWS.
- Subsection 9.2.1.2.3.1 4th paragraph will be revised to clarify that not only the standby pump will be started but also the discharge MOV will be opened when the operating pump discharge header pressure becomes low.
- Subsection 9.2.1.5.7 will be revised to add the supplemental information regarding the ESWS backup actuation interlock.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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 revision 3 Figure 9.2.1-1 has been appropriately revised to reflect that all instrumentation available in the MCR has local read out. The statement that all instrumentation available in MCR also has local read out will be added to DCD revision 3 Subsection 9.2.1.5.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

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)
Not changed from the response in Reference 2.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1.5 will be revised to clarify that all instrumentation available in MCR also has local read out.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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)
Not changed from the response in Reference 2.

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. Any leaks from the CCWS heat exchanger which is interface between CCWS and ESWS does not allow mixing of the potentially radioactive CCW and the nonradioactive ESW because the gaskets is toward the outside of the heat exchangers hence radioactive contamination to the ESWS is of no concern. The Table 12.3-8 in the DCD revision 3 Chapter 12 which shows RG 4.21 design objective and system features of the ESWS will be revised to identify this justification. 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, have been included in the Tier 1 DCD revision 3 Figure 2.7.3.1-1. Related Tier 1 DCD revision 3 Tables 2.7.3.1-1 through 2.7.3.1-4 have been revised to include the strainer information, including piping and valves.

Tier 1 DCD revision 3 Table 2.7.3.1-5 ITAAC has been revised to include the essential service water strainers and their backwash isolation valves.

In DCD revision 3, 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 revision 3 Table 3.9-14 has been revised to add the ESWP discharge strainer backwash isolation valves in the Valve Inservice Test Program.

Answer: c)

Not changed from the response in Reference 2.

Answer: d)

The typographical error in Subsection9.2.1.2.1 has been corrected in DCD revision 3. Other errors will be corrected in Tier 2 DCD revision 3 Section 9.2.1 such as those shown in the Attachement-1.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- The Table 12.3-8 in Chapter 12 will be revised to identify that any leak from the CCWS heat exchanger which is interface between CCWS and ESWS does not allow mixing of the potentially radioactive CCW and the nonradioactive ESW because of the CCW heat exchangers construction.
- The followings will be revised to correct typographical error:
  Subsection 9.2.1.1.3, Nonsafety-Related Design Bases, 1st paragraph,
  Subsection 9.2.1.2.2.2, Strainers, 2nd paragraph,
  Subsection 9.2.1.2.3.1 title,
  Subsection 9.2.1.2.3.1, Power Operation, 6th paragraph,
  Subsection 9.2.1.2.3.1, Power Operation, 8th paragraph,
  Subsection 9.2.1.4, Inspection and Testing Requirements, 1st paragraph

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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 non-safety 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.3, 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 Reactor Building Non-radiological Controlled Area (NRCA) is separated into the east and west areas by concrete walls and/or water-tight doors. The concrete walls are designed to prevent flood water migration from one safety train to another. This is accomplished by installing piping, electrical conduit, HVAC duct, cable trays and other potential connections with penetrations that are above the maximum flood level and/or by sealing the penetrations. The east side includes two trains (A and B) of the CCW heat exchanger and pump rooms. The west side includes two trains (C and D) of the CCW heat exchanger and pump room. Equipment rooms are isolated by concrete walls and the fireproof doors which are not water-tight. Therefore, flood water is assumed to run across the area.

Flood events are considered for earthquake, HELB/MELB and fire fighting operations. The worst case results are from a combination of earthquake and fire fighting operations. The maximum water levels are 0.45 ft above elevation -26 ft 4 in for east side and 0.60 ft above elevation -26 ft 4 in for west side. The pump foundations (top of concrete) height is 1.0 foot above floor elevation -26 ft 4 in. As such, the pumps are not flooded. The instrumentation of each pump is designed to be located at heights above the level of flood water. The results above are addressed in DCD revision 3 Subsection 3.4.1.5.2.2 and Table 3K-1.

Tier 2 DCD revision 3 Subsection 9.2.1.3 4th paragraph will be revised to refer to Subsection 3.4.1.5.2.2.

Also, for flooding barriers, Tier1 chapter 2.2, Table 2.2-4 item 1 has been revised to commit the physical separation in DCD revision 3.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1.3 will be revised to refer to Subsection 3.4.1.5.2.2 which describes detail of the flood protection.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on PRA.

This completes MHI's response to NRC's question.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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.

In DCD revision 3, the requirement to install the void detection system with alarm to detect system voiding has been added in Tier 2 DCD Section 9.2.1.2.3.1.Also associated COL item 9.2(32) has been added in DCD revision 3 Subsection 9.2.10.

Also, the CDI information which describes regarding the detail of the void detection system will be added to the end of the 6^{th} paragraph in DCD revision 3 Subsection 9.2.1.2.3.1.

Answer to b)
Not changed from the response in Reference 2.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as following.

- Subsection 9.2.1.2.3.1 5^{th} paragraph will be revised to add the CDI information which describes regarding the detail of the void detection system.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/27/2011

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**
APPLICATION SECTION:	**9.2.1**
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 revision 3 Section 9.2.1 has been revised to reflect the changes in the type 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. Two 100% capacity parallel strainers are located in each ESWP discharge line to prevent the CCW heat exchanger from clogging. Periodic inspection, monitoring, maintenance, performance and functional testing (including the heat transfer capability of the CCW heat exchangers consistent with GL 89-13) are performed to minimize the effect of potential CCW heat exchanger fouling. These activities will ensure that the actual fouling factor will not exceed the design fouling factor for at least the duration required for UHS capacity of 30 days or minimum of 36 days for a cooling pond. The strainers are the automatic self-cleaning type; each has a backwash line with an isolation valve of MOV-573 or MOV-574 as shown in Figure 9.2.1-1 with their valve ID marking. The backwash line discharge location in accordance with the type of the UHS used will be determined by COL applicant. The backwash line valves are powered by a Class 1E DC source so that they will be operable during Loss of Offsite Power. The strainers have exhaust valves which are part of the strainers, the valve symbol is shown but a unique valve ID is not identified in Figure 9.2.1-1. Also, the strainers have manual isolation valves, VLV-506 and 507, on ESW inlet piping and have manual isolation valves, VLV-508 and 509, on ESW outlet piping respectively as shown in Figure 9.2.1-1 with their valve ID marking. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers that are installed to prevent water hammer. Inside the strainer there is a cylilndrical screen with a rotating brush; the brush sweeps the inner surface of the cylindrical screen when the strainer receives start signal.

Strainers operating modes are Non-Backwash Operating, Backwash Operating or Out-of-Service. The strainer is available when in either Non-backwash Operating or Backwash Operating modes. The definition and details of each operating mode are clarified in Subsection 9.2.1.2.2.2 as shown in Attachment-1. Also, the detail procedure to make the strainer to the out-of-service mode for swapping the strainers is clarified in Subsection 9.2.1.2.2.2. Although the operator switches a out-of-service strainer to available locally when one strainer fails, as described in Table 9.2.1-2 Item 3, there are no issues in single failure criteria, and thus it is not a required operator action. Because the description is confusing, DCD revision 3 Section 9.2.1.2.2.2 1st paragraph will be revised to correct the contents.

The EPRI's technical report "Plant Support Engineering: Guidance for Replacing Heat Exchanger at Nuclear Power Plants with Plate Heat Exchangers," Section 3.1.3, "Disadvantages of the Plate Type Heat Exchangers" suggests particles should be less than 2mm to ensure proper operation of the heat exchanger over its useful lifetime however does not force the use of strainer with <2 mm mesh.
From the description in the report in Section 3.2, there are several gap size ranges for each plate type heat exchanger, and the strainer mesh size can be determined from the type of plate heat exchanger which will be applied for US-APWR with 3 to 6 mm flow passages.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Revision 3 as follows.

- Subsection 9.2.1.2.2.2 is revised to state that Figure 9.2.1-1 has the valve ID markings to match the DCD description to make it clear which valves are being referred.
- The definition and details of each operating mode of the strainer are clarified in Subsection 9.2.1.2.2.2.
- Clarified that the actual fouling factor will not exceed the design fouling factor for at least the duration required for UHS capacity of 30 days or minimum of 36 days for a cooling pond.
- Subsection 9.2.1.5.3 will be revised to clearly delineate that the differential pressure instrumentation of the strainer and/or alarm is credited post accident.
- Table 9.2.1-2 item 3 and 4 will be revised to add the plant operating mode of "startup, normal shutdown, normal operation, refueling, cooldown" to safety function of "starts and opens to provide flow path to backwash flow before strainer clogging to maintain ESW supply to CCW HX."
- Tier 1 Table 2.7.3.1-2 will be revised to match the new description added to Subsection 9.2.1.2.2.2.

Impact on R-COLA

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

Impact on S-COLA

Corresponding changes will be made to the S-COLA in the future revision.

Impact on PRA

There is no impact on PRA.

This completes MHI's response to NRC's question.

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.

DCD Subsection 1.8 identifies the significant interfaces between the US-APWR standard plant design and CDI for the SSCs outside the scope of the certified design. In Table 1.8-1, the ESWS is categorized as CDI interface type, DCD Section 9.2.1, on the other hand, mainly describes the ESWS functional requirements regardless of location although some structures (e.g. ESWPT and UHSRS) where some of the ESWS components are located are site specific. The requirements for the following SSCs installed in the UHSRS and those that are described in Table 3.2-4, DCD Chapter 7 main text, DCD Section 9.2.1 and Figure 9.2.1-1 are identified as functional requirements of standard plant design information.

- ESW pump
- ESW pump discharge strainer
- ESW pump discharge motor operated valve
- ESW pump discharge check valve
- Vacuum breaker installed upstream of the check valve
- Instrumentations such as the pump discharge pressure sensor for confirmation of pump performance, the ESW header line pressure sensor and the pump discharge strainer differential pressure sensor
- Associated isolation valves and piping

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 (specifically, the CCWS heat exchangers and essential chiller units) 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 in accordance with Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" (Ref. 9.2.11-9) 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). A discussion of the design objectives and operational programs to address these radiological aspects of the system is contained in DCD Section 12.3.1. System and component design features addressing RG 4.21 (Ref. 9.2.11-9) are summarized in Table 12.3-8.

- 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.
- 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.

9.2.1.1.2 Power Generation Design Bases

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

In the US-APWR standard plant design, the ESW pump The ESWS does not provide cooling water to any non_safety-related components. As discussed in Section 9.2.2, non safety-related heat loads are supported by the safety-related CCW heat exchangers during_ normal operation, but such loads are shed during accident condtions. The essential chiller unit supplies cooling water for only safety-related loads and components. [[As conceptual design, the ESWS is plant operations or design basis LOCA conditions. The ESWS may be used as a_ backup source of water to the fire protection water supply system (FSS) in the event the_ normal supply is unavailable due to 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.]]

Backwashing of the CCW heat exchangers on the essential service water side can be performed if the heat exchanger differential pressure of the essential water side is identified to be higher than the setpoint. Operator-initiated backwashing to prevent heat exchanger clogging is a safety-related function which is based on low ESW flow rate indication; the flow rate instrumentation is safety-related. Automatic actuation of backwashing by high strainer differential pressure is nonsafety function.

9.2.1.2 System Description

9.2.1.2.1 General Description

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.]]

The ESW piping from the pump discharge after passing through the discharge strainers runs to the PS/Bs and reactor building through the ESW tunnels. 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 system layout and the design assure that the fluid pressure remains above saturation conditions at all locations during all modes of operation.

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 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. Upon receiving the pump actuation signal such as an 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 in Table 9.2.1.2 an alarm is sent to the MCR. The short time duration during which the pump is dead headed is not detrimental for pump performance and the pump can be manually tripped.

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

The construction of the CCW plate heat exchangers prevents any leakage from either the CCW side or the ESW side from contaminating each other. Therefore, the raw service water does not contaminate the demineralized CCW nor does the potentially ratioactive CCW contaminate the ESW. The ESWS interfaces with the UHS system are further described in Section 9.2.5. Type and location of the UHS are site specific. The COL Applicant's selection and design of the UHS to deliver the design water flow rate to the ESWS does not exceed the maximum design temperature of 95° F under all operating conditions to assure sufficient cooling capacity. The UHS design also assures the cooling 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 responsible for the testing ofto 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).

The mode of cooling of the ESWP motors is air cooled. DCD Subsection 9.4.5 describes the design detail of the ESW pump area ventilation system requiring the heating, ventilatingsite-specific and air conditioning.will be determined by the COL Applicant.

9.2.1.2.2.2 Strainers

Two 100% capacity parallel strainers are located in each ESWP discharge line to prevent the CCW heat exchanger from clogging. Periodic inspection, monitoring, maintenance, performance and functional testing (including the heat transfer capability of the CCW heat exchangers consistent with GL 89-13) are performed to minimize the effect of potential CCW heat exchanger fouling. These activities will ensure that the actual fouling factor will not exceed the design fouling factor for at least the duration required for UHS capacity of 30 days or minimum of 36 days for a cooling pond. The strainers are the automatic self-cleaning type; each has a backwash line with an isolation valve of MOV-573 or MOV-574 as shown in Figure 9.2.1-1 with their valve ID marking. The COL Applicant is to determine the backwash line discharge location in accordance with the type of the UHS used. The backwash line valves are powered by a Class 1E DC source so that they will be operable during Loss of Offsite Power. The strainers have exhaust valves which are part of the strainers, the valve symbol is shown but a unique valve ID is not identified in Figure 9.2.1-1. Also, the strainers have manual isolation valves, VLV-506 and 507, on ESW inlet piping and have manual isolation valves, VLV-508 and 509, on ESW outlet piping respectively as shown in Figure 9.2.1-1 with their valve ID marking. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers that are installed to prevent water hammer. Inside the strainer there is a cylilndrical screen with a rotating brush; the brush sweeps the inner surface of the cylindrical screen when the strainer receives start signal. The strainers including their associated components such as exhaust valve or rotating brush motor are powered from class 1E source.

Strainers operating modes are Non-Backwash Operating, Backwash Operating or Out-of-Service. The strainer is available when in either Non-backwash Operating or Backwash Operating modes. The details of each operating mode is as follows:

Non-Backwash Operating:

- The associated inlet manual isolation valve of VLV-506 or VLV-507 is opened.

- The associated outlet manual isolation valve of VLV-508 or VLV-509 is opened.
- The full flow from ESW pump flows to CCW heat exchanger and essential chiller unit through the strainer.
- The exhaust valve is closed.
- The inner brush is not rotated by the drive unit.
- The associated backwash isolation valve of MOV-573 or MOV-574 is closed.

Backwash Operating:

- The associated inlet manual isolation valve of VLV-506 or VLV-507 is opened.
- The associated outlet manual isolation valve of VLV-508 or VLV-509 is opened.
- The partial flow below 500 gpm is discharged through backwashing line.
- The main flow over 11,543 gpm flows to CCW heat exchanger and essential chiller unit.
- The exhaust valve is opened.
- The inner brush is rotated by the drive unit. Debris trapped on the screen is dislodged by the brush and flushed through the exhaust valve by the differential pressure between the strainer internal pressure (provided by the ESW pump head) and discharge pressure.
- The associated backwash isolation valve of MOV-573 or MOV-574 is opened.

Out-of-Service:

- The associated inlet manual isolation valve of VLV-506 or VLV-507 is closed.
- The associated outlet manual isolation valve of VLV-508 or VLV-509 is closed.
- The exhaust valve is closed.
- The inner brush is not rotated by drive unit.
- The associated backwash isolation valve of MOV-573 or MOV-574 is closed.

The initiation and termination of the Backwash Operating is performed as follows:

Nonsafety-related Backwash Operating initiation and termination during starup, power operation, refueling and cooldown by CS/RHRS

- The differential pressure of the strainer is monitored; the strainer differential pressure is not safety-related.
- The predetermined high differential pressure signal provides a start signal for Backwash Operating to Non-backwash Operating strainer when ECCS actuation or LOOP signal is not provided and an alarm is sent locally and to the MCR. The high differential pressure setpoint is less than the maximum allowable differential pressure associated with strainer clogging. Thus, the automatic strainers are not expected to fail due to clogging since backwashing is performed at the lower setpoint.
- Upon the receipt of a start signal, the inner brush startes to rotate by the drive unit.
- Also, upon the receipt of a start signal, the exhaust valve and associated strainer backwash isolation valve, MOV-573 or MOV-574 will be opened simultaneously when ECCS actuation or LOOP signal is not provided.
- When the differential pressure of the strainer is below the setpoint, the inner brush

stops rotating and the exhaust valve and associated strainer backwash isolation valve will be closed simultaneously. Also, the alarms are stopped.

Safety-related Backwash Operating initiation and termination during accident or abnormal condition with ECCS actuation signal or LOOP signal

- Upon the receipt of an ECCS actuation or LOOP signal from the PSMS, Backwash Operating strainers will be terminated and their associated backwash isolation valves, MOV-573 or MOV-574 will maintain open position to establish discharge path for debris removal. For the Non-backwash Operating strainer, the associated strainer backwash isolation valve will open automatically as an active safety function to establish discharge path for debris removal upon the receipt of the ECCS actuation or LOOP signal.
- During abnormal conditions, such as during an accident or LOOP, the nonsafety-related differential pressure indications and alarms are not credited. Therefore, the operator performs the active safety function by remotely controlling strainer backwashing, if necessary, based on flow rate indication.
- The ESW flow rate to the CCW heat exchanger indication is safety-related and available in the MCR. This indication, EWS-FIA-034-S, 035-S, 036-S, 037-S which is shown in Figure 9.2.1-1, aids the operator in identifying the need for strainer backwashing. There is also a low flow rate alarm to indicate the reduction of the CCW heat exchanger performance due to the low flow rate compared to the design value of 11,000 gpm.
- The operator provides a start signal for the Non-backwash Operating strainer through the PSMS from the MCR by safety VDU switch if the low ESW flow rate to the CCW heat exchanger annunciates. Alarms and displays for EWS-FIA-034-S, 035-S, 036-S and 037-S and controls for the strainers and the backwash isolation valves are provided in the safety VDU and the RSC.
- When the ESW flow rate is restored to over 11,000 gpm, the operator can stop the strainer through the PSMS from the MCR by safety VDU switch. Also, the alarms are stopped.
- Start and stop signal for the strainer from the MCR by operator and the ECCS actuation or Loop signal override non safety-related Backwash Operating initiation and termination signal.

Safety-related Backwash Operating termination due to the ESW pump stoppage

- As an active safety function, when the strainer is under Backwash Operating, the associated backwash isolation valve, MOV-573 or MOV-574 and the strainer integral exhaust valve are interlocked to close at a pump stop signal from PSMS to prevent water drainage that could potentially lead to water hammer. The closure signal overrides all safety and non-safety Backwash Operating initiation signals.
- The isolation valve is also provided with remote manual control through the PSMS from the MCR by safety VDU to enable remote manual isolation as an active safety function during abnormal condition.
- Also, the exhaust valve will be closed manually when the strainer is stopped simultaneously through the PSMS from the MCR by safety VDU.

During power operations, the operator may also periodically swap the Backwash Operating or Non-backwash Operating strainer in the same train to Out-of-Service as follows:

- For the example case in which the strainer SST-001A-S is Non-backwash Operating and the strainer SST-002A-S is Out-of-Service.
- Open isolation valves of VLV-507A-S and VLV-509A-S for SST-002A-S locally then set the VDU switch for SST-002A-S to the auto position in MCR; this changes, the operating mode of SST-002A-S is from Out-of-Service to Non-backwash Operating.
- Turn the VDU switch for SST-001A-S in MCR to the pull lock position. Close isolation valves of VLV-506A-S and VLV-508A-S for SST-001A-S locally. If the strainer is backwash operating, stop the strainer from the MCR to make the strainer non-backwashing operating, and then turn the switch to the pull lock position. Therefore, the condition SST-001A-S is changed from Backwash Operating or Non-Backwash Operating to Out-of-Service.
- The strainer swapping operation is completed.
- The inlet and outlet isolation valves for the strainers shown on Figure 9.2.1-1 do not have remote valve operator symbol; the valves can be identified as local manual valves.

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.

~~Two 100% capacity parallel strainers are located in each ESWP discharge line. The strainers are automatic self-cleaning type. 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. 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.~~

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, no strainer for additional filtering is deemed necessary. [[The 3mm mesh of the strainer element also assures that potential clogging of the cooling tower nozzles is avoided.]]

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.

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

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 in Subsection 9.2.2.

CCW heat exchanger clogging will be prevented by the ESWP discharge strainer. Futher, a~~A~~ backflushing line is provided for each CCW HX to enable backflushing of the heat exchanger following a high differential pressure alarm that is ~~may likely be~~ caused by accumulation of debris materials inside the heat exchanger plate flow channels.

To prevent potential CCW heat exchanger fouling, periodic inspection, monitoring, maintenance, performance and functional testing (including the heat transfer capability of the CCW heat exchangers consistent with GL 89-13) will be provided as discussed in Subsections 9.2.1.3 and 9.2.1.4. Further, adequate fouling factor margins in accordance with the manufacturer's standards and the system water chemistry will be required in the design specifications. Periodic inspection, monitoring and maintenance will ensure that the actual fouling is within design fouling factor margins to accommodate heat transfer for a minimum of the UHS design of 30 days or 36 days for a cooling pond.

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.

9.2.1.2.2.7 Deleted

9.2.1.2.3 System Operation

9.2.1.2.3.1 PowerNormal 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. The term "standby" is used to indicate that a component is operable upon receipt of either an automatic or manual actuation signal, but is not required to operate. 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 with one train assumed out of service due to maintenance coincident with 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.

During refueling condition, the number of required operating train of CCWS and ESWS are three. At power operating condition, the number of required operating train of ESWS will be decreased to two trains when the heat load of SFP is decreased after refueling operation as shown in Table 9.2.1-3 because equal or more than half of the latest taken fuel assemblies to the SFP are returned back to the reactor vessel before starting power operation. During power operation, at least two trains are required to be in operation, however, three ESWS trains shall be operable for the Modes 1, 2, 3 and 4 as described in T-spec 3.7.8. Therefore, one ESWS train with the consideration of another train is under on-line maintenance or two trains without consideration of on-line maintenance will become in standby. When the train becomes in standby, the pump discharge MOV which has slow closure time of approx. 30 seconds will be closed gradually, and then, the pump will be stopped. The operation above can be done from MCR, however, it will be better to monitor the equipment stoppage by attending local operator.

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 on-line maintenance. The ESW flow rate of 13,000 gpm and maximum supply temperature of 95° F are maintained even under these conditions.

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 ESW header pressure signal due to failure or tripping of an operating ESWP is alarmed in the MCR. When the low ESW header pressure alarm is annunciated, the standby ESWP and the standby CCWP of the same train designation start automatically as follows, ensuring continuous heat removal:

Case (1), A and C trains of ESWS and CCWS are in operation:

With low A-ESWP discharge header pressure, B-ESWP and B-CCWP automatically start; however, if B train is out for on-line maintenance, train D must be manually started from the MCR.

With low C-ESWP discharge header pressure, D-ESWP and D-CCWP automatically start; however, if D train is out for on-line maintenance, train B must be manually started from theMCR.

Case (2), A and D trains of ESWS and CCWS are in operation:

With low A-ESWP discharge header pressure, B-ESWP and B-CCWP automatically start; however, if B train is out for on-line maintenance, train C must be manually started from the MCR.

With low D-ESWP discharge header pressure, C-ESWP and C-CCWP automatically start; however, if C train is out for on-line maintenance, train B must be manually started from the MCR.

Case (3), B and C trains of ESWS and CCWS are in operation:

With low B-ESWP discharge header pressure, A-ESWP and A-CCWP automatically start; however, if A train is out for on-line maintenance, train D must be manually started from the MCR.

With low C-ESWP discharge header pressure, D-ESWP and D-CCWP automatically start; however, if D train is out for on-line maintenance, train A must be manually started from the MCR.

Case (4), B and D trains of ESWS and CCWS are in operation:

With low B-ESWP discharge header pressure, A-ESWP and A-CCWP automatically start; however, if A train is out for on-line maintenance, train C must be manually started from the MCR.

With low D-ESWP discharge header pressure, C-ESWP and C-CCWP automatically start; however, if C train is out for on-line maintenance, train A must be manually started from the MCR.

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. When the ESWP is started, the respective pump discharge MOV will also open at the receipt of the pump start signal. This indicates that an operating CCWP has failed and requires the alternate (or standby) ESWP and CCWP in another train to start for backup. Subsection 9.2.2.5.1 also describes the backup actuation for CCWP. 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.

All valves except the pump discharge valves, the strainer discharge backwash isolation valves and the normally closed boundary valves in the exchanger drain piping in the flow path are locked open. The discharge MOV 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, failure of the valve to open on standby pump start is alarmed in the control room. The operator will stop the pump and restart the previously operatedstandby pump. The pump discharge pressure is monitored and low pressure is alarmed. The system design and layout provide adequate resistance to prevent pump runout.

Voiding upstream of the pump discharge check valve in any train may occur 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 safety 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 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. [[The void detection system is provided by the level transmitter located around the highest piping in the ESWS/UHS. When the water level in the ESWS/UHS decrease below the location of the level switch, the operator is annunciated and required to recover the water level by operating the standby ESWP to make the the water hammer effect minimum at the standby train which the water volume may be decreased by natural evaporation.]]

Draining of ESW in an inactive or non-operatingtripped 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 non-operationtripped. 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 will be prepared by the COL Applicant in accordance with COL 3.9(8). Inservice testing of the ESWS, as described in Tier 2 DCD Subsection 3.9.6.1, includes discharging of any voids into the UHS [[basin]] and filling of the system to ensure that voids which are the primary cause of water hammer are minimized.

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 power~~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.

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 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.

Clogging of the CCW heat exchanger is prevented by the ESWP discharge strainer. If the heat exchanger differential pressure on the essential water side is higher than setpoint, the alarm will be annunciated to the MCR. The operator can perform backwashing of the CCW heat exchanger locally. Because of the reverse flow through the CCW heat exchanger, there is a possibility that the CCW heat exchanger will not perform the design heat transfer from the CCWS to ESWS and the train is therefore considered inoperable. If the backwash operation will reduce the number of operable trains to fewer than three, the backwashing of the heat exchanger shall be finished and the train shall be restored within completion time of 72 hours in accordance with Technical Specification 3.7.8

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 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. 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 as follows:

The Reactor Building Non-radiological Controlled Area (NRCA) is separated into the east and west areas by concrete walls and/or water-tight doors. The concrete walls are designed to prevent flood water migration from one safety train to another. This is accomplished by installing piping, electrical conduit, HVAC duct, cable trays and other potential connections with penetrations that are above the maximum flood level and/or by sealing the penetrations. The east side includes two trains (A and B) of the CCW heat exchanger and pump rooms. The west side includes two trains (C and D) of the CCW heat exchanger and pump room. Equipment rooms are isolated by concrete walls and the fireproof doors which are not water-tight. Therefore, flood water is assumed to run across the area.

Flood events are evaluated with the following assumptions:

- Earthquake
  For flooding events caused by an earthquake, non-seismic category I piping and components are assumed to fail and release all of their contents.

- High-energy line break/Moderate-energy line break
  HELB event is not a concern, because there are no piping breaks, which are assumed to occur in the subject area.

- Fire fighting operations
  The flooding contribution from fire fighting operations is based on the full operation of two hose stations for 2 hours.

The worst case results are from a combination of earthquake and fire fighting operations, with a maximum water level of:

- East side: 0.45 ft above elevation -26 ft, 4 in.
- West side: 0.60 ft above elevation -26 ft, 4 in.

The pump foundations (top of concrete) height is 1.0 foot above floor elevation -26 ft, 4 in. As such, the pumps are not flooded. The instrumentation of each pump is located above the level of flood water.
Further discussion regarding flood protection is addressed in DCD Subsection 3.4.1.5.2.2.

The ESWS equipment and piping are located in the R/B, the UHSRS, the ESWPT, and the PS/Bs. 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 protection of the site specific safety related portions of the ESWS including [[[[such as the ESWS blowdown line, FSS supply line, ESWPT 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 countermeasures to freezing by safety-related heat tracing, low temperature operation, and thermal overpressurization. Temperature in the reactor building is maintained through ventilation and therefore heat tracing is not required. The SSCs outside the scope of the certified design building such as the branch piping to the pump discharge pressure sensor, [[to the conductivity cell]], to the pump ESWS header pressure sensor, to the pump discharge strainer differential pressure sensor, [[the UHS basin blowdown bypass lines]] and the standby strainer lines would become stagnant, therefore, the possibility for freezing depends on the location which is determined by the COL Applicant.

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 with clarification for their connecting locations and their boundaries 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.

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.

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.

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 powernormal 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.

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

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.

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 and have local read out.

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 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.

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

9.2.1.5.3 CCW HX essential service water flow

The ESWFSW 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 heat exchangerHX ESW flow indication for safe shutdown is safety-relatedalso categorized as shown in Table 7.4-2.. The CCW heat exchanger ESW flow is to be used for indicating the possibility of the clogging of the pump discharge strainer and used for initiating manual backwash remotely during accident conditiona 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.

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.

9.2.1.5.6 Radiation monitor

Radiation 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, 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 as described in 9.2.1.2.3.1. The CCWS is used for supplying the cooling water to the components which are essential for normal power operation. The interlock between the ESWS and CCWS for inadvertent stoppage of one train of ESWS or CCWS is necessary for maintaining the water supplement to the components that require rapid water re-supplement such as charging pump, letdown heat exchanger, instrument air compressor, seal water heat exchanger or RCP thermal barrier. There are no interlocks between the ESWS and the essential chilled water system because the ECWS is not required to restart rapidly at inadvertent stoppage of the components.

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 Applicant 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 protection of the site-specific portions of the ESWS against adverse environmental, operating, and accident conditions that can occur, such as countermeasure to freezing by safety-related heat tracing,, low temperature operation, and thermal overpressurization.*

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 and ,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 responsible for the testing ofto evaluate the potential for vortex formation based on the most limiting assumptions that apply.*

COL 9.2(7) *The COL Applicant is to 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 with clarifications for their connecting locations, and other design of the ESWS related to the site specific conditions. The COL Applicant is also to design the pipes entering and exiting the pipe tunnel based on the location of the UHSRS.*

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*

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 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 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.

COL9.2(25) The COL Applicant is to develop system fillingfiling, 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 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, 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.

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

COL9.2(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.

COL9.2(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.

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 (Note)	Class 1E power source
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

(Note) Including exhaust valve, rotating brush motor and other associated components

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

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of Failure~~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	A1, Fails to start upon command A2, Trips for any reason	A1, Pump status light indication in MCR A2, 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.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two pumps are required.
			B, Accident, safe shutdown, cooldown – loss of offsite power	B1, Fails to start upon command B2, Trips for any reason.	B1, Pump status light indication in MCR B2, Pump status light indication in MCR	B1, None Same as A1. B2, None Same as A1.	

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

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of Failure~~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, safe shutdown, cooldown – loss of offsite power	B, Fails in closed position	B, Position indication in MCR	B, None Same as A.	

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~~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, Startup, normal shutdown, normal operation, refueling, cooldown	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.
			B, Accident, Safe shutdown, cooldown – loss of offsite power	B, Fails to start and fails to open on remote manual demand	B, Position indication in MCR	B, None Same as A.	
		Stops and isolates backwash flow to prevent drain down which leads water hammer at pump restart	A, Startup, normal shutdown, normal operation, refueling, cooldown	A, Fails to closed position at pump stop signal	A, Position indication in MCR	A, None Backwash flow can be isolated by closing ESWP Discharge Strainer Backwash Isolation Valve at pump stop signal	
			B, Accident, safe shutdown, – loss of offsite power	B, ~~–~~Fails to closed position at pump stop signal	B, Position indication in MCR	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~~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)	Opens~~Starts and opens~~ to provide flow path to backwash flow before strainer starts to clog to maintain ESW supply to CCW HX	A, Startup, normal shutdown, normal operation, refueling, cooldown B, Accident, safe shutdown, – loss of offsite power	A, Fails to open on remote manual demand B, Fails to open on remote manual demand	A, Position indication in MCR B, Position indication in MCR	A, None Remaining three 50% capacity trains are available. Minimum of two trains are required for safety function. B, None Same as A.	One train unavailable due to maintenance does not affect the safety functions because only a minimum of two ESWS trains are required.
		Isolates~~Stops and isolates~~ backwash flow to prevent drain down which leads to 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~~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.]]	

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

Train	Component	No. of components	Startup (Note 1)		Power Operation (Note 2)		Refueling (Note 3)		Cooldown by CS/RHRS (Note 1)		Accident (LOCA) (Note 4)		Safe Shutdown (Note 4)	
A or B	CCW Heat Exchanger	2	2	65.5 x 10^6	1	50.0 x 10^6	2	62.7 x 10^6	2	220.3 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	2	8.66 x 10^6	1	4.33 x 10^6	1	4.33 x 10^6
	Total		2	74.16x10^6	1	54.33 x 10^6	2	71.36	2	228.96x10^6	1	166.03x10^6	1	195.23x10^6
C or D	CCW Heat Exchanger	2	2	61.2 x 10^6	1	41.3 x 10^6	1	41.9 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	1	4.33 x 10^6	2	8.66 x 10^6	1	4.33 x 10^6	1	4.33 x 10^6
	Total		2	69.86 x 10^6	1	45.63x10^6	1	46.13 x 10^6	2	229.86 x 10^6	1	166.03 x 10^6	1	195.23 x 10^6

(Note 1) All four trains are required to operate for these modes. Operating four trains bounds the LCO requirement by T-spec 3.7.8 which requires three operable trains in Modes 1, 2, 3 and 4.
(Note 2) At least three trains shall be operable as described in T-spec 3.7.8, however, two trains are required to operate for maintaining power operation.
(Note 3) At least three trains are required to operate for refueling (MODE 6). T-spec 3.7.8 does not apply to the refueling mode.
(Note 4) Three operable trains required by T-spec 3.7.8 provide two intact trains with the consideration of loss of one ESWS train by single failure.

Train	Component	No. of components	Startup		Normal Power Operation		Cooldown by CS/RHRS		Accident (LOCA)		Safe Shutdown	
A & B	CCW Heat Exchanger	2	2	65.5×10^6	1	50.0×10^6	2	220.3×10^6	1	161.7×10^6	1	190.9×10^6
	Essential Chiller Unit	2	2	8.66×10^6	1	4.33×10^6	2	8.66×10^6	1	4.33×10^6	1	4.33×10^6
Total			2	74.16×10^6	1	54.33×10^6	2	228.96×10^6	1	166.03×10^6	1	195.23×10^6
C & D	CCW Heat Exchanger	2	2	61.2×10^6	1	41.3×10^6	2	221.2×10^6	1	161.7×10^6	1	190.9×10^6
	Essential Chiller Unit	2	2	8.66×10^6	1	4.33×10^6	2	8.66×10^6	1	4.33×10^6	1	4.33×10^6
	Total		2	69.86×10^6	1	45.63×10^6	2	229.86×10^6	1	166.03×10^6	1	195.23×10^6

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

Train	Component	No. of components	Startup (Note 1)		Power Operation (Note 2)		Refueling (Note 3)		Cooldown by CS/RHRS (Note 1)		Accident (LOCA) (Note 4)		Safe Shutdown (Note 4)	
A or B	CCW Heat Exchanger	2	2	22000	1	11000	2	22000	2	22000	1	11000	1	11000
	Essential Chiller Unit	2	2	1086	1	543	2	1086	2	1086	1	543	1	543
	Strainer backwash flow	2	2	1000	1	500	2	1000	2	1000	1	500	1	500
	Total		2	24086	1	12043	2	24086	2	24086	1	12043	1	12043
C or D	CCW Heat Exchanger	2	2	22000	1	11000	1	11000	2	22000	1	11000	1	11000
	Essential Chiller Unit	2	2	1086	1	543	1	543	2	1086	1	543	1	543
	Strainer backwash flow	2	2	1000	1	500	1	500	2	1000	1	500	1	500
	Total		2	24086	1	12043	1	12043	2	24086	1	12043	1	12043

(Note 1) All four trains are required to operate for these modes. Operating four trains bounds the LCO requirement by T-spec 3.7.8 which requires three operable trains in Modes 1, 2, 3 and 4.
(Note 2) At least three trains shall be operable as described in T-spec 3.7.8, however, two trains are required to operate for maintaining power operation.
(Note 3) At least three trains are required to operate for refueling (MODE 6). T-spec 3.7.8 does not apply to the refueling mode.
(Note 4) Three operable trains required by T-spec 3.7.8 provide two intact trains with the consideration of loss of one ESWS train by single failure.

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
	Continuous Strainer backwash flow	2	2	1000	1	500	2	1000	1	500	1	500
	Total		2	24086	1	12043	2	24086	1	12043	1	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
	Strainer backwash flow	2	2	1000	1	500	2	1000	1	500	1	500
	Total		2	24086	1	12043	2	24086	1	12043	1	12043

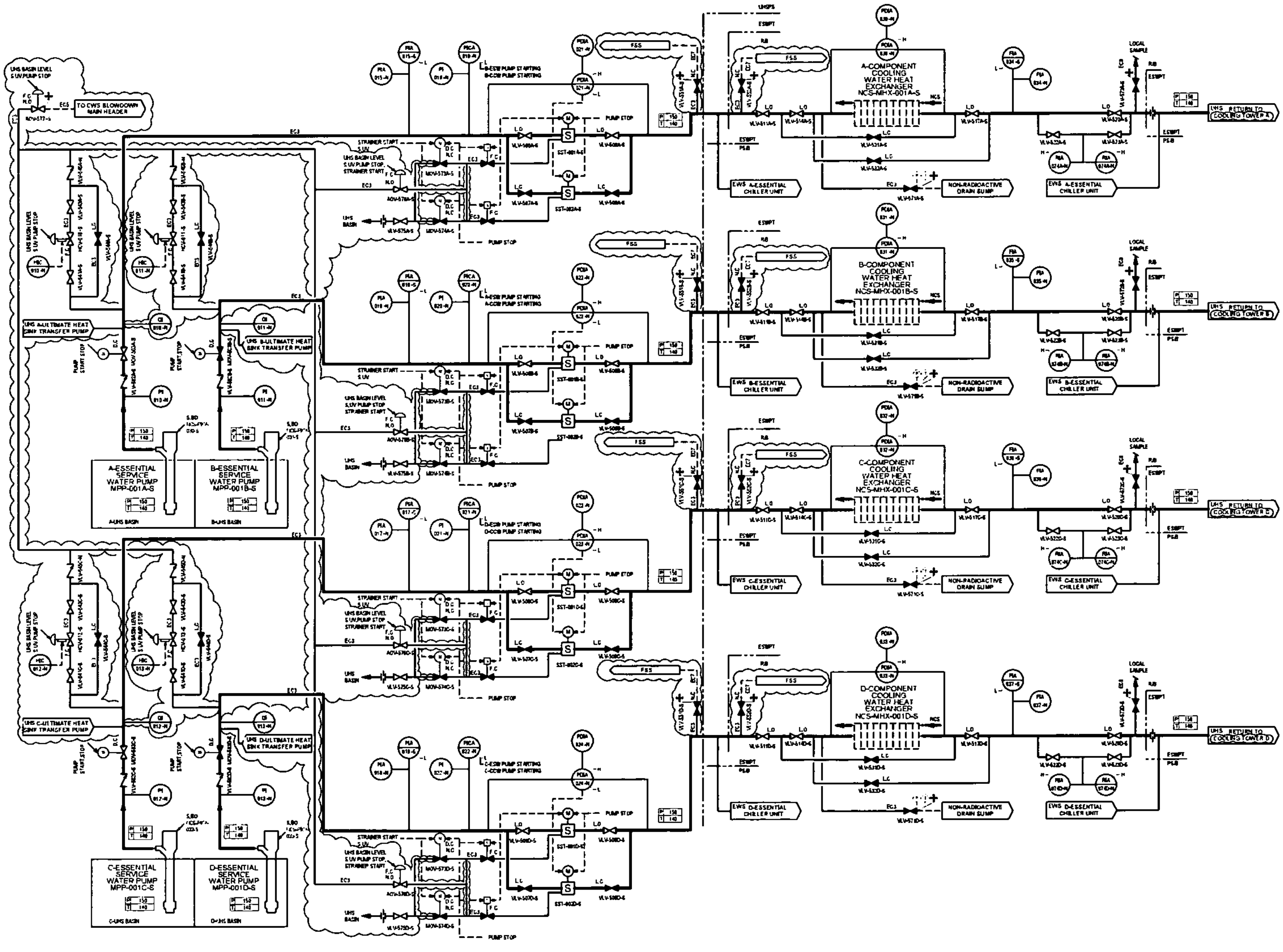

Figure 9.2.1-1 Essential Service Water System Piping and Instrumentation Diagram (Sheet 1 of 3)

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

Equipment Name	Tag No.	ASME Code 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 Closed	As Is
						Remote Manual	Transfer Open/ Transfer Closed	

NOTE:
Dash (-) indicates not applicable

ECCS actuation, undervoltage signal

Transfer Open