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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-11217

Subject: Amended MHI's Response to US-APWR DCD RAI No.584-4468 Revision 0 (SRP 09.02.02)

References: 1) "Request for Additional Information No. 584-4468 Revision 0, SRP Section: 09.02.02 – Reactor Auxiliary Cooling Water Systems Application Section: 9.2.7 Chilled Water System" dated May 10, 2010.

2) "MHI's Response to US-APWR DCD RAI No.584-4468 Revision 0" dated June 10, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Responses to Request for Additional Information No.584-4468 Revision 0". This amended response is submitted to reflect the discussion on clarification call.

Enclosed are the amended responses to 10 RAIs contained within Reference 1. The initial response was provided in Reference 2. MHI replaces the previous letters (Reference 2) with this amended response letter.

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.

D081
NRO

Enclosure:

1. Amended Responses to Request for Additional Information No. 584-4468, Revision 0

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

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Enclosure 1

UAP-HF-11217
Docket Number 52-021

Amended Responses to Request for Additional Information No. 584-4468, Revision 0

Jul, 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-70

This is a follow-up to RAI 343-2208, Question 09.02.02-5:

In response to RAI 09.02.02-5, the applicant stated that the ECWS and non-ECWS are both completely independent and separated systems. The RAI response also stated that the piping of the non-ECWS within an area containing safety-related equipment is designed as seismic Category II. Since Table 3.2-2 does not show any seismic Category II piping for the non-ECWS, it is not clear what non-ECWS seismic Category II piping is being referenced. Table 3.2-2 specifically defines non-ECWS "Piping and valves (except portion of the containment penetration)" as Seismic Category "NS".

Due to the apparent inconsistencies referred to above, the staff cannot conclude whether any of the non-ECWS piping should be seismic Category II and that non-ECWS failures will not adversely impact safety-related SSCs. The applicant is requested to:

1. Provide clarification and revise the DCD as necessary to address the above inconsistency with respect to seismic classification of non-ECWS piping and components.

2. Describe to what extent failures of non-ECWS piping and components can adversely impact safety-related SSCs, including the basis for this determination.

3. Parts of the non-ECWS which are non-safety related were designated as Equipment Class 4, Seismic Category NS, and Quality Group D. However, Rev 2 of the DCD changed this to Equipment Class 9, Seismic Category NS, and Quality Group N/A. The reason for this change in non-ECWS classification is unclear. In addition, more confusion is added by the designation of Equipment Class 5 that is assigned to the Auxiliary Building air handling unit (AHU) as shown in Tier 2 Table 9.4.3-1; which appears to be inconsistent with the equipment classification that was assigned for non-ECWS which provides the chilled water that is used for cooling this AHU. Therefore, additional explanation and justification is needed for the changes that were made to the non-ECWS classification designations that were made and the apparent inconsistencies that exist.

4. Tier 2 Table 3.2-2 (page 55 of 57) references "Valves VWS-MOV-425, -426" as Seismic Category I. However, Valve "-426" is not shown on non-ECWS Figure 9.2.7-2.

Explain this apparent discrepancy and revise the DCD as necessary to resolve this problem.

Reference:
MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

Question 1:
Provide clarification and revise the DCD as necessary to address the above inconsistency with respect to seismic classification of non-ECWS piping and components.

Answer 1:
As described in DCD Section 3.2.1, Seismic Classification, SSCs that must maintain their structural integrity to prevent unacceptable structural interaction or failure with seismic category I SSCs are designated as seismic category II. Portions of the non-ECWS are routed through areas containing safety-related, seismic category I SSCs in the PCCV, R/B, and the PS/B. Where these portions of the non-ECWS are determined to have the potential, upon loss of structural integrity during a SSE, to degrade the functioning or integrity of a seismic category I SSC to an unacceptable level, the system piping and valves are analyzed and designed to seismic category II requirements described in DCD Section 3.2.1.1.2, Seismic Category II.

As a clarification, a note will be added to Table 3.2-2, for the non-ECWS item "Piping and valves (except portion of the containment penetration)" to indicate that the system piping and valves within an area containing safety-related, seismic category I equipment are seismic category II. Additionally, DCD Section 9.2.7.1.2.1 will be clarified to eliminate the phrase 'non-seismic category I system.'

Question 2:
Describe to what extent failures of non-ECWS piping and components can adversely impact safety-related SSCs, including the basis for this determination.

Answer 2:
As stated in Part 1 above, portions of the non-ECWS in areas of safety-related equipment are designated as seismic category II. As described in DCD Section 3.2.1.1.2, seismic category II SSCs are designed so that the SSE could not cause unacceptable structural interaction or failure with seismic category I SSCs.

Question 3:
Parts of the non-ECWS which are non-safety related were designated as Equipment Class 4, Seismic Category NS, and Quality Group D. However, Rev 2 of the DCD changed this to Equipment Class 9, Seismic Category NS, and Quality Group N/A. The reason for this change in non-ECWS classification is unclear. In addition, more confusion is added by the designation of Equipment Class 5 that is assigned to the Auxiliary Building air handling unit (AHU) as shown in Tier 2 Table 9.4.3-1; which appears to be inconsistent with the equipment classification that was assigned for non-ECWS which provides the chilled water that is used for cooling this AHU. Therefore, additional explanation and justification is needed for the changes that were made to the non-ECWS classification designations that were made and the apparent inconsistencies that exist.

Answer 3:
Equipment classification system is changed and Class 8, 9 and 10 are added in DCD Revision 2. The non-ECWS equipment and components are classified as Equipment Class 9 except the portion of seismic Category II piping and valves. The portions of the seismic Category II are classified as Equipment Class 5. Table 3.2-2 will be revised to clarify the equipment class of non-ECWS.

Question 4:
Tier 2 Table 3.2-2 (page 55 of 57) references "Valves VWS-MOV-425, -426" as Seismic Category I. However, Valve "-426" is not shown on non-ECWS Figure 9.2.7-2.

Answer 4:
VWS-MOV-426 was erroneously listed in DCD Table 3.2-2. In addition, as described in the response to DCD RAI 697-5502, Question 09.02.02-80, the valve numbers VWS-MOV-424 and 425 shown in DCD Revision 3 will be changed to NCS-MOV-241 and 242. Therefore, Table 3.2-2 will be revised to remove the valves VWS-MOV-424 and 425. Figure 9.2.7-2 will be revised to incorporate these changes.

Impact on DCD

DC applicant will revise the information on the non-essential chilled water system in Tier 2, DCD Table 3.2-2, to clarify seismic category II non-ECWS piping and valves, identify components as Equipment Class 5, and provide the correct isolation valves description, and clarify DCD Section 9.2.7.1.2.1 related to the seismic classification of the system, as follows:

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards(3)	Seismic Category	Notes
46. Non-Essential Chilled Water System							
Non-essential chiller units Evaporator side Condenser side	 9 9	 A/B A/B	 N/A N/A	 N/A N/A	 5 5	 NS NS	
Non-essential chilled water pumps	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water compression tanks	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water system cooling towers	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water system condenser water pumps	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water chemical feed tank	10	A/B	N/A	N/A	5	NS	
Piping and valves (except portion of the containment penetration)	9	PCCV R/B A/B PS/B T/B	N/A	N/A	5	NS	~~Piping and valves within areas containing safety-related equipment are designed as Seismic Category II.~~
Piping and valves within areas containing safety-related equipment (except portion of the containment penetration)	**5**	**PCCV** **R/B** **A/B** **PS/B** **T/B**	**N/A**	**N/A**	**5**	**II**	
(Deleted)							
Piping and valves between and including the containment isolation valves VWS-MOV-403 and 421, VWS-MOV-422, VLV-423 and 407	2	PCCV R/B	B	YES	2	I	
~~Valves VWS-MOV 424,425, 426~~	~~3~~	~~R/B~~	~~C~~	~~YES~~	~~5~~	~~I~~	
Non-essential chilled water chemical feed tank supply and return line piping and valves between VWS-VLV-571 and VWS-VLV- 574	10	A/B	N/A	N/A	5	NS	

DCD Firgure 9.2.7-2 will be revised to delete the CCW supply and return line isolation valves, VWS-MOV-424, 425, since the valves are changed to NCS-MOV-241 and 242 as described in the response to DCD RAI 697-5502, Question 09.02.02-80.

Revise the first paragraph of DCD Section 9.2.7.1.2.1 as follows:

The non-essential chilled water system, with the exception of piping and valves between and including the safety-related and seismic category I containment isolation valves, is classified as non-safety related~~,~~ ~~non-seismic category I system~~. This system is designed to satisfy the following safety design basis.

See attachment 2 mark-up DCD Revision 3 Tier 2, pages 3.2-69, 3.2-70 and 9.2-44.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-71

This is a follow-up to RAI 343-2208, Question 09.02.02-6:

Standard Review Plan (SRP) 9.2.2 Section III, which is being utilized as guidance for the review of the chilled water system, specifies in Section III confirmation of the overall arrangement of the system. The chilled water system description and flow diagrams in Tier 2, Design Control Document (DCD), Figure 9.2.7-1, were reviewed to assess the design adequacy of the chilled water system for performing its heat removal functions. While the flow diagrams show the essential chilled water system (ECWS) components, some of the information is incomplete, inaccurate, or inconsistent. Consequently, the applicant was asked, in RAI 09.02.02-6 to revise the DCD to address a large number of technical issues identified by the staff. The applicant responded to each of the RAI 09.02.02-6 issues identified by the staff. In reviewing the Rev. 2 of the DCD, submitted in October 2009, the staff found that the majority of the issues were satisfactorily incorporated; however, there were a few that were not satisfactory. These remaining issues are discussed below.

1. The staff asked the applicant to revise the DCD to address Tier 2, DCD Figure 9.2.7-1 not showing where indications are displayed (e.g., local, remote panel, control room), and what instruments provide input to a process computer and/or have alarm and automatic actuation functions. This item was not addressed anywhere in the applicant's RAI response. Therefore, the applicant is asked to address the original staff request to show on Figure 9.2.7-1 where indications are displayed and what instruments provide input to a process computer and/or have alarm and automatic actuation functions. Or, as indicated in RG 1.206 (C.I.9.2.1.5), describe the system alarms, instrumentation, and controls. Include a description of the adequacy of instrumentation to support required testing, as well as the adequacy of alarms to notify operators of degraded conditions.

2. Answer (4) in the applicant's response states that "Instrumentation of ECWS is designed as non-safety related." However, DCD Section 9.2.7.5.1 indicates that instrumentation is safety-related. Confirm whether the instrumentation is safety-related.

3. Answer (11) in the applicant's response states that Sections 9.2.7 will be revised to state that GDC 4 and 44 are met for the ECWS. In addition, revisions to Section 9.2.7.1.1.1 and 9.2.7.3.1 were proposed to correct errors in the system descriptions. The staff reviewed DCD Rev. 2 to determine if the proposed revisions have been acceptably incorporated. The staff found that the proposed revision to Section 9.2.7.1.1.1 to correct system errors has been incorporated; however, the revision to Subsection 9.2.7.3.1 has not been incorporated. Additionally, the staff could not locate the incorporation into DCD Rev. 2 of the

applicant's proposed statement that GDC 4 and 44 are met for the ECWS. The applicant should address these possible omissions.

Reference:
MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

Question 1:
The staff asked the applicant to revise the DCD to address Tier 2, DCD Figure 9.2.7-1 not showing where indications are displayed (e.g., local, remote panel, control room), and what instruments provide input to a process computer and/or have alarm and automatic actuation functions. This item was not addressed anywhere in the applicant's RAI response. Therefore, the applicant is asked to address the original staff request to show on Figure 9.2.7-1 where indications are displayed and what instruments provide input to a process computer and/or have alarm and automatic actuation functions. Or, as indicated in RG 1.206 (C.I.9.2.1.5), describe the system alarms, instrumentation, and controls. Include a description of the adequacy of instrumentation to support required testing, as well as the adequacy of alarms to notify operators of degraded conditions.

Answer 1:
DCD, Revision 2, incorporated changes to Figure 9.2.7-1 to include additional details related to instrumentation and controls for the essential chilled water system (ECWS), such as compression tank level indication, control and alarm; air handling unit temperature control; and chiller and chilled water pump automatic start signals. The instrumentation and control level of detail shown on Figure 9.2.7-1 is consistent with other system P&IDs within DCD Chapter 9. Additional description of ECWS instrumentation and control is provided in DCD Section 9.7.2.5.1. The automatic start of standby ECWS chillers and pumps upon receipt of an ECCS actuation signal is described in DCD Section 9.2.7.2.1.

Question 2:
Answer (4) in the applicant's response states that "Instrumentation of ECWS is designed as non-safety related." However, DCD Section 9.2.7.5.1 indicates that instrumentation is safety-related. Confirm whether the instrumentation is safety-related.

Answer 2:
Consistent with Answer (4) to RAI No.343-2208 Question No.09.02.02-6, the instrumentation of the ECWS is designed as non-safety related. DCD Section 9.2.7.5.1 will be revised to delete the first sentence in the first paragraph.

Question 3:
Answer (11) in the applicant's response states that Sections 9.2.7 will be revised to state that GDC 4 and 44 are met for the ECWS. In addition, revisions to Section 9.2.7.1.1.1 and 9.2.7.3.1 were proposed to correct errors in the system descriptions. The staff reviewed DCD Rev. 2 to determine if the proposed revisions have been acceptably incorporated. The staff found that the proposed revision to Section 9.2.7.1.1.1 to correct system errors has been incorporated; however, the revision to Subsection 9.2.7.3.1 has not been incorporated. Additionally, the staff could not locate the incorporation into DCD Rev. 2 of the applicant's proposed statement that GDC 4 and 44 are met for the ECWS. The applicant should address these possible omissions.

Answer 3:
DCD Section 9.2.3.7.1 will be revised as indicated in Answer (11) to RAI No.343-2208 Question No. 09.02.02-6. In addition, DCD Section 9.2.7.1.1 will be revised to indicate that the ECWS is designed to meet the relevant requirements of GDC 2, GDC 4, GDC 44, GDC 45, and GDC 46.

Impact on DCD

DC applicant will revise Tier 2, DCD Section 9.2.7 to clarify instrumentation as non-safety related; clarify the natural phenomena and missile protection basis; and clarify the applicability of GDC.

Delete the first sentence of the first paragraph of Section 9.2.7.5.1 as follows:

> "~~Safety-related instrumentation and control associated with the essential chilled water system meets the requirements of IEEE Std. 603 and are qualified in accordance with IEEE Std. 323 and IEEE Std. 344.~~"

Revise the fourth paragraph in Section 9.2.7.3.1 as follows:

> "~~Casings of the chiller refrigerant compressor and the chilled water pumps are designed to withstand penetration by internally generated~~ **<u>The safety-related portions of the ECWS are protected against natural phenomena and internal</u>** missiles."

Revise the second sentence of the first paragraph in Section 9.2.7.1.1 as follows:

> "The essential chilled water system is designed to meet the relevant requirements of **<u>GDC 2, GDC 4, GDC 44</u>**, GDC45, and GDC 46 (Ref.9.2.11-1)"

See attachment 2 mark-up DCD Revision 3 Tier 2, pages 9.2-43, 9.2-48 and 9.2-50.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-72

This is a follow-up to RAI 343-2208, Questions 09.02.02-7 and 09.02.02-9:

General Design Criterion (GDC) 44 requires the essential chilled water system (ECWS) to be capable of removing heat from structures, system and components (SSCs) important to safety during normal operation. RAI 09.02.02-7 and 09.02.02-9 requested additional information regarding the heat transfer and flow requirements. In its response, the applicant proposed the addition of Table 9.2.7-2. Based upon review of this response, the staff does not find this response to provide the information requested by the RAI. The RAI requested a description of the excess head margin for the pumps along with the basis for this determination. The excess margin and basis should include a quantitative statement of the losses and the resulting excess capacity that is provided by the design. Therefore, additional information is needed to provide a more quantitative description of the excess flow and head capacity that are provided by the ECWS pumps, including the basis for these determinations. In particular:

1. Section 9.2.7 should fully describe and explain what the minimum system heat transfer and flow requirements are for normal operating, refueling, and accident conditions, the bases for these requirements including limiting assumptions that apply (such as temperature and heat load considerations), how much excess margin is available and how this was determined, and what limiting system temperatures and pressures are assumed with supporting basis. The RAI response should re-address these items and clearly address excess margin that is available, and explain why the excess margins that are available are considered to be sufficient to ensure adequate performance over the life of the plant.

2. The addition of Table 9.2.7-2 provides the flow rates for Normal and Abnormal operation. Abnormal flow demand is indicated as 440 gpm and the ECWS pump is sized for 440 gpm. This table provides an overall demand for all 4 trains of the ECWS. Describe the basis for the pump flow rating and how many ECWS trains are required to cool the respective rooms during normal and abnormal operation.

3. The system description in DCD, Tier 2 Section 9.2.7, should provide design details for ECWS such as system operating temperatures, pressures, and flow rates for all operating modes and alignments. Alternatively, bounding values could be provided.

4. Table 9.2.7-2 provides the Normal and Abnormal operation flow and heat load and is misleading in regards to the chilled water system demands. In accordance with Table 9.2.7-2 and Table 9.4.5-1, Class 1E Electrical Room air handling unit (AHU) abnormal heat load operation per train (A, B) is 1,650,000 btu/hr and heat load operation per train (C, D) is 2,250,000 btu/hr. The reason for this large difference in

heat loads needs to be explained, including to what extent ECWS is capable (during normal and abnormal operation) of providing adequate cooling with only A & B trains operable (i.e. train C in maintenance and failure of train D). This assessment should include operation with and without offsite power available.

5. For both ECWS and non-ECWS, Section 9.2.7 is missing an "operating section", which usually includes the system configuration during normal and abnormal operation. It is not clear how many ECWS trains are normally operating and the normal required heat load and flow requirements are not clearly defined. The staff requests the applicant to include a normal and emergency operation section in Section 9.2.7 of the DCD and, as a minimum, clearly define the following for normal and abnormal operation and update the DCD accordingly:

a. Provide details of valve configuration: normally open or closed during modes of operation
b. Define whether some trains running and other standby. Provide description of signal and process for starting standby trains.
c. Provide description of how many ECWS and non-ECWS trains are required to provide cooling during normal and accident conditions to ensure the operating requirements for the various rooms are met.
d. Include details of the configuration of the ECWS and non-ECWS on safety injection signal or LOOP.
e. Discuss any adjustments which require automatic or manual configuration.
f. Describe what actions are needed for by the operators to align makeup to the compression tank on low level.

6. Section 9.4.7 of the DCD contains a COL 9.4(4) for the air handling units (AHUs) indicating that "The COL Applicant is to determine the capacity of cooling and heating coils provided in the air handling units that are affected by site specific conditions." It is not clear why the standard plant heat load would not bound the plant-specific situation in most cases. Therefore, address the need, if any, for the ECWS to contain a similar COL item to account for any changes to the ECWS as a result of COL 9.4(4) items that will directly affect the ECWS capacity.

Reference:
MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

Question 1:
Section 9.2.7 should fully describe and explain what the minimum system heat transfer and flow requirements are for normal operating, refueling, and accident conditions, the bases for these requirements including limiting assumptions that apply (such as temperature and heat load considerations), how much excess margin is available and how this was determined, and what limiting system temperatures and pressures are assumed with supporting basis. The RAI response should re-address these items and clearly address excess margin that is available, and explain why the excess margins that are available are considered to be sufficient to ensure adequate performance over the life of the plant.

Answer 1:
The ECWS flowrate and heat removal capacity design assumes the worst-case requirements as input to the sizing calculations. The flowrate requirements for the ECWS pumps are determined by the heat removal requirements of the system loads. The flowrate necessary to remove the design heat load for each air handling unit served, while limiting the temperature rise across the cooling coil to 16°F, is summed for all of the heat loads to arrive at the total required ECWS train flowrate. The highest train flowrate requirement, based on the heat loads served under the worst-case conditions, is used as the basis for the design flowrate for all ECWS trains. These flowrate requirements are conservatively determined to ensure available margin for detailed design. A conservative heat removal capability margin

is provided in the design of the air handling units as stated in the response to RAI Question No.09.02.02-7. The worst-case condition for heat load requirements, and therefore ECWS flowrate requirements, is the Abnormal Operation case indicated in DCD Table 9.2.7-2. This case is the LOCA case, and results in the operation of safety-related equipment for accident response and the greatest heat removal requirement for the safety-related HVAC systems and the ECWS.

As stated above, heat removal capability margin is accounted for in the design of the air handling units for safety-related HVAC systems. Therefore, the ECWS is not required to be designed with significant additional margin for heat removal. In addition, other than providing margin through the conservative methods used for calculating flow requirements, additional margin for system resistance increases due to changes in pipe roughness and heat transfer surface fouling is not required since the ECWS is a closed-loop system with deaerated, demineralized water treated with corrosion inhibitors. Significant corrosion or fouling is not expected in this system.

Excess margin available in the ECWS design will not be determined until the detailed design phase. At that time, the system flowrate requirements will be finalized, along with system resistances, to confirm that the ECWS pump design provides a 10% design margin for pump head.

DCD Section 9.2.7.2.1 will be revised to provide a description of the design margins for the ECWS.

Question 2:
The addition of Table 9.2.7-2 provides the flow rates for Normal and Abnormal operation. Abnormal flow demand is indicated as 440 gpm and the ECWS pump is sized for 440 gpm. This table provides an overall demand for all 4 trains of the ECWS. Describe the basis for the pump flow rating and how many ECWS trains are required to cool the respective rooms during normal and abnormal operation.

Answer 2:
As described in Answer 1 above, ECWS pump flow requirements are based on the design heat removal requirements for the safety-related HVAC air handling units while limiting the temperature rise across the cooling coil to 16°F. The ECWS train with the highest flowrate requirement under worst-case heat load conditions defines the flowrate requirement for all trains. The conservatively determined maximum flowrate requirement for the ECWS pumps is 440 gpm.

As described in DCD Section 9.2.7.2.1, the ECWS consists of four independent trains and each train consists of one 50% capacity system. Each 50% capacity ECWS train provides the cooling capacity required for a HVAC equipment train. DCD Section 9.2.7 will be revised to add a FMEA Table that includes ECWS train chiller unit and chilled water pump failure evaluations.

Question 3:
The system description in DCD, Tier 2 Section 9.2.7, should provide design details for ECWS such as system operating temperatures, pressures, and flow rates for all operating modes and alignments. Alternatively, bounding values could be provided.

Answer 3:
As described in Answer 1, the Abnormal Operation condition in DCD Table 9.2.7-2 constitutes the worst-case for ECWS heat removal and flowrate requirements. Therefore, the flow rate values in the table are the bounding values for ECWS flowrate requirements for each heat load. DCD Table 9.2.7-1 provides ECWS equipment and component operating data including system operating temperatures, total flowrate, and pump head. The operating data in Table 9.2.7-1 are determined at the system operating point, which is based on the abnormal operation condition, and are considered bounding values. DCD Section 9.2.7.2.1 will be revised to state that Table 9.2.7-1 values are bounding values.

Question 4:
Table 9.2.7-2 provides the Normal and Abnormal operation flow and heat load and is misleading in regards to the chilled water system demands. In accordance with Table 9.2.7-2 and Table 9.4.5-1, Class 1E Electrical Room air handling unit (AHU) abnormal heat load operation per train (A, B) is 1,650,000

btu/hr and heat load operation per train (C, D) is 2,250,000 btu/hr. The reason for this large difference in heat loads needs to be explained, including to what extent ECWS is capable (during normal and abnormal operation) of providing adequate cooling with only A & B trains operable (i.e. train C in maintenance and failure of train D). This assessment should include operation with and without offsite power available.

Answer 4:
The Class 1E Electrical Room HVAC air handling unit trains C and D provide cooling to additional non-safety related spaces (refer to DCD Figure 9.4.5-2) that are not heat loads for trains A and B. As such, the heat load for trains C and D is 2,250,000 Btu/hr each whereas the heat load for trains A and B is 1,650,000 Btu/hr each. Conservatively, these non-safety related heat loads are assumed to remain in the Abnormal Operation condition.

Each train of ECWS is designed for a heat removal requirement assuming the Class 1E Electrical Room HVAC heat load is 2,250,000 per train. This is evidenced by the fact that the Class 1E Electrical Room AHU flowrate requirement identified in DCD Table 9.2.7-2 for ECWS train A and B is identical to the corresponding flowrate requirement for trains C and D. Therefore, each of the ECWS trains is capable of removing the maximum heat load. A note will be added to Table 9.2.7-2 for clarification.

Question 5:
For both ECWS and non-ECWS, Section 9.2.7 is missing an "operating section", which usually includes the system configuration during normal and abnormal operation. It is not clear how many ECWS trains are normally operating and the normal required heat load and flow requirements are not clearly defined. The staff requests the applicant to include a normal and emergency operation section in Section 9.2.7 of the DCD and, as a minimum, clearly define the following for normal and abnormal operation and update the DCD accordingly:

a. Provide details of valve configuration: normally open or closed during modes of operation

b. Define whether some trains running and other standby. Provide description of signal and process for starting standby trains.

c. Provide description of how many ECWS and non-ECWS trains are required to provide cooling during normal and accident conditions to ensure the operating requirements for the various rooms are met.

d. Include details of the configuration of the ECWS and non-ECWS on safety injection signal or LOOP.

e. Discuss any adjustments which require automatic or manual configuration.

f. Describe what actions are needed for by the operators to align makeup to the compression tank on low level.

Answer 5:
DCD Section 9.2.7.2.1.2 System Operations will be added to the DCD to provide a description of the normal and abnormal operation of the ECWS. DCD Section 9.2.7.2.2.1 System Operations will be added to the DCD to provide a description of the normal and abnormal operation of the non-ECWS.
The automatic level control for the compression tank is shown on Figure 9.2.7-1 for ECWS and Figure 9.2.7-2 for non-ECWS.

DCD Section 9.2.7.2.1 will be revised to indicate the ECWS response to a SBO event.

Question 6:
Section 9.4.7 of the DCD contains a COL 9.4(4) for the air handling units (AHUs) indicating that "The COL Applicant is to determine the capacity of cooling and heating coils provided in the air handling units that are affected by site specific conditions." It is not clear why the standard plant heat load would not bound the plant-specific situation in most cases. Therefore, address the need, if any, for the ECWS to contain a similar COL item to account for any changes to the ECWS as a result of COL 9.4(4) items that will directly affect the ECWS capacity.

Answer 6:
For the safety-related HVAC systems served by the ECWS, COL 9.4(4) is only applicable to heating coil capacity. For these HVAC systems, the COL item is worded "The COL Applicant is to determine the capacity of heating coils that are affected by site specific conditions." Therefore, the safety-related

cooling coils are not subject to change based on COL 9.4(4) and there is no affect on ECWS heat removal requirements. No similar COL item is needed. DCD Section 9.4.7 will be revised to clarify COL 9.4(4).

Impact on DCD

DC applicant will revise Tier 2, DCD Revision 3, Section 9.2.7 to add the system design margins, clarify the Class 1E Electrical Room HVAC heat load in Table 9.2.7-2, describe the ECWS response to a SBO event, and add the system operations description for the ECWS and non-ECWS.

Add the following sentence to the end of the first paragraph in Section 9.2.7.2.1.

The operating data in Table 9.2.7-1 are determined at the system operating point, which is based on the abnormal operation condition, and are considered bounding values.

Add the following paragraph after the eighth paragraph in Section 9.2.7.2.1.

Essential chilled water system heat removal capacity is determined from the design requirements for the air handling unit cooling coils for safety-related HVAC systems, which include a conservative design margin (Section 9.4). The flowrate requirements for the chilled water pumps are determined by the heat removal requirements of the system loads. The required flowrate limits the temperature rise across individual AHU cooling coils to 16°F. The total pump flowrate is that required for all cooling coils in the train. Flowrate and heat load for each cooling load are provide in Table 9.2.7-2.

Revise the tenth paragraph in Section 9.2.7.2.1 as follows:

The ECWS is a closed-loop system and water chemistry control of ECWS is performed by adding chemicals to the chemical feed tank to prevent long-term corrosion that may degrade system performance. The chemical feed tank...

Revise the third paragraph in Section 9.2.7.2.1.1 as follows:

Essential Chilled Water Pump

Each essential chilled water pump is designed to supply chilled water to all the cooling coils of safety-related HVAC system for the respective train it serves during all plant condition. The pump is designed in consideration of fluctuation in the supplied electrical frequency, increased pipe roughness, and maximum pressure drop through the system components. The pumps are horizontal centrifugal pumps and driven by an ac induction motor. The pumps are designed quality group C as defined in Regulatory Guide 1.26, seismic category I, and are designed in accordance with the requirements of the ASME Section III, Class 3. **The chilled water pump capacity provides a 10% design margin for required pump head.** The essential chilled water pumps have....

Add Note 2 for the Class 1 Electrical Room AHU – Abnormal Operation heat load in Table 9.2.7-2 as follows:

Note:
(1) Dash (-) indicates no requirement.
(2) The trains C and D Class 1 Electrical Room AHU heat load conservatively includes additional non-safety related heat loads. This higher heat load is used for the heat removal capability design for each of the ECWS trains.

Revise the fourth paragraph in Section 9.2.7.2.1, as follows:

During LOOP, each of the essential chilled water system is powered from the respective safety emergency power source. **The essential chiller units stop for one hour after a SBO occurs until the alternate ac gas turbine generator restores power (Chapter 8, Section 8.4).**

Add the last paragraph in Section 9.2.7.2.2, as follows:

The non-ECWS is capable of performing alternate cooling of the containment fan cooler units through CCWS and the alternate source of component cooling water to the charging pump in a severe accident. The non-ECWS cooling tower and condenser water pump are capable of providing the alternate source of component cooling water to the charging pump in order to maintain RCP seal water injection.

Add Section 9.2.7.2.1.2 and 9.2.7.2.2.1, and associated subsections, as follows:

9.2.7.2.1.2 System Operations

Table 9.2.7-2 provides heat loads and water flow rates for individual ECWS heat loads for normal and abnormal operating modes.

9.2.7.2.1.2.1 Normal Power Operation

During normal operation, two trains of ECWS are placed in service. A total of two essential chilled water pumps and two essential chiller units are in operation. An operating essential chilled water pump supplies chilled water to cooling coils of safety-related HVAC systems through the chiller units. The chiller units and pumps that are not in service are placed in standby. In the event that a required chiller unit malfunctions or trips, a standby chiller unit can be manually placed in service.

The essential chiller units can be controlled manually from the MCR or RSC.

The chiller unit includes a start permissive that ensures that chilled water and condenser water flows are established prior to chiller unit start.

9.2.7.2.1.2.2 Loss of Offsite Power

In the event of a LOOP, four essential chilled water pumps and four essential chiller units are powered from the emergency power source and they are actuated automatically by the LOOP load sequence signal. As a minimum, two trains are required to operate during a LOOP.

9.2.7.2.1.2.3 Loss of Coolant Accident

In the event of a LOCA, four essential chilled water pumps and four essential chiller units are actuated automatically upon receipt of the ECCS actuation signal, and are loaded onto their respective Class 1E power source. As a minimum, two trains are required to operate during a LOCA."

9.2.7.2.2.1 System Operations

9.2.7.2.2.1.1 Normal Power Operation

During plant startup, shutdown, and power operation, and while in cold shutdown/refueling conditions, three non-essential chilled water pumps and three non-essential chiller units, including dedicated cooling towers and condenser pumps, are operated. The additional train of equipment is placed in standby.

9.2.7.2.2.1.2 Loss of Offsite Power

During the LOOP conditions, two non-essential chilled water pumps and two non-essential chiller units are powered from the permanent non-safety power distribution system and are actuated automatically. In the event of a LOOP, the non-essential chilled water pumps and the non-essential chiller units are actuated to protect property and assets.

9.2.7.2.2.1.3 Loss of Coolant Accident

In the event of a LOCA, the non-ECWS containment isolation valves are automatically closed upon receipt of the containment isolation signal.

9.2.7.2.2.1.4 Severe Accident

The CCWS can be manually aligned to supply the cooling water to the containment fan cooler units via the non-ECWS for mitigating containment failure in a severe accident condition.

The non-ECWS can be manually aligned to provide an alternate source of component cooling water to the charging pumps in order to maintain RCP seal water injection in the event of a loss of component cooling water in a severe accident condition.

DC applicant will revise Tier 2, DCD Revision 3, Section 9.4.7, to clarify COL 9.4(4), as follows:

COL 9.4(4) *The COL Applicant is to determine the capacity of* ***heating coils provided in the safety-related HVAC system and the capacity of*** *cooling and heating coils provided in the* ***non-safety related HVAC system*** *air handling units that are affected by site specific conditions.*

DC applicant will revise Tier 2, DCD Revision 3, Section 9.2.7 to add the ECWS FMEA in Table 9.2.7-3.

Revise the first paragraph in Section 9.2.7.3.1, as follows:

The essential chilled water system is designed to perform its safety function with only two out of four trains operating. **As shown in Table 9.2.7-3, the**~~The~~ essential chilled water system is completely separate and a single failure does not compromise the system's safety function even if one train is out of service for maintenance.

Add Table 9.2.7-3, as follows:

Table 9.2.7-3 Essential Chilled Water System Failure Modes and Effects Analysis

Item	Component	Safety Function	Failure Mode	Effect on System Safety Function	Failure Detection Method
1	Essential Chiller Unit	Provides chilled water to safety-related HVAC AHU cooling coils	Fails to provide chilled water	None Three 50% capacity Essential Chiller Units remain available. Only two are required.	Essential Chiller Unit operating information in the MCR includes RUN indication, high temperature alarm, temperature indication and flow indication.
2	Essential Chilled Water Pump	Provides chilled water flow to safety-related HVAC AHU cooling coils	Fails to provide chilled water flow	None Three 50% capacity Essential Chilled Water Pumps remain available. Only two are required.	Essential Chilled Water Pump operating information in the MCR includes RUN indication and flow indication.

See attachment 2 mark-up DCD Revision 3 Tier 2, page 9.2-45, 9.2-46, 9.2-48, 9.2-91 and 9.4-49.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-73

This is a follow-up to RAI 343-2208, Question 09.02.02-10:

The essential chilled water system (ECWS) must be capable of removing heat from structures, systems and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. In order to satisfy system flow requirements, the ECWS design must assure that the required minimum net positive suction head (NPSH) for the ECWS pumps will be met for all postulated conditions, including consideration of vortex formation.

RAI 09.02.02-10 requested the applicant to provide additional information in Tier 2, DCD Section 9.2.7 to fully explain how the required minimum NPSH for the ECWS pumps is satisfied by the system design. In its response, the applicant proposed a simple revision to Tier 2 subsection 9.2.7.2.1.1 that states that the ECWS pumps have sufficient NPSH available based on pressurization of the system by the compression tank. The applicant provided a more complete description in the response but did not propose to add this description to the Tier 2 DCD. Based upon review of this response, the staff does not find this response to provide the information requested by the RAI. The RAI requested that the DCD provide the minimum required NPSH and how the required minimum NPSH is satisfied by the system design when vortex formation is included, and how much excess margin is available for the limiting case. The proposed revision to the Tier 2 DCD does not address the information requested.

1. The applicant should provide a more complete description in the Tier 2 DCD Section 9.2.7 of the minimum net positive suction head and how this is satisfied by the system design considering the possibility of vortex formation. This will enable the staff to independently confirm that the design is adequate in this regard, including limiting assumptions that were used along with supporting justification

2. The applicant should address how the potential for dissolved gas (i.e. nitrogen) in the liquid does not negatively impact pump performance.

3. In addition, 10CFR52.47 requires that a DCD to contain the ITAAC that are necessary and sufficient to provide reasonable assurance that, if the ITAAC are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification. US-APWR has included an ITAAC in Tier 1, Table 2.7.3.5-5 to confirm that the NPSH available exceeds the required NPSH. However, in the absence of the available or required NPSH details, this ITAAC does not include measurable criteria in order to be closed. The applicant should

provide the NPSH ITAAC details similar to those provided in Section 10.4.9.3 for the emergency feedwater system.

Reference: MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF- 09350; Dated July 17, 2009; ML092080395.

ANSWER:

__Question (1):__
The applicant should provide a more complete description in the Tier 2 DCD Section 9.2.7 of the minimum net positive suction head and how this is satisfied by the system design considering the possibility of vortex formation. This will enable the staff to independently confirm that the design is adequate in this regard, including limiting assumptions that were used along with supporting justification.

__Answer (1):__
Each ECWS train is a closed-loop, recirculating system. As described in DCD Section 9.2.7.2.1, each train includes a compression tank that functions to maintain system pressure within the design operating range. The compression tank is connected to the ECWS pump suction line (ECWS return line) and provides a surge volume for system fluid thermal expansion and contraction. As such, there is normally no significant amount of water flow from the compression tank so vortex formation is not a credible concern.

The ECWS pumps will not be specified or selected until the detailed design phase so the required NPSH for these pumps is not yet determined. However, as described in DCD Section 9.2.7.2.1.1, the compression tank is pressurized in order to provide a positive pressure at the ECWS pump suction such that sufficient NPSH will be provided. In addition, the ECWS is a low temperature system such that saturation pressure at the pump suction will be relatively high. The combination of positive gauge pressure at the pump suction and low temperature suction fluid provides high confidence that the required NPSH of the selected pump will be satisfied. The system design will include a minimum 10% margin for available NPSH above the required NPSH.

__Question (2):__
The applicant should address how the potential for dissolved gas (i.e. nitrogen) in the liquid does not negatively impact pump performance.

__Answer (2):__
As described in DCD Section 9.2.7.2.1.1, the ECWS is initially filled with deaerated water from the primary makeup water system. Make-up to the ECWS is from the demineralized water system line that taps into the piping between the compression tank and the ECWS pump suction line. No dissolved gas in the system fluid is expected from these water sources. Although the compression tank is pressurized with nitrogen, there is no flow through the tank and the volume of fluid out of the tank during thermal contraction is not significant relative to the volume of the system. Therefore, even with an assumption of nitrogen saturated water within the tank, there is no potential for dissolved gas to affect pump performance.

__Question (3):__
In addition, 10CFR52.47 requires that a DCD to contain the ITAAC that are necessary and sufficient to provide reasonable assurance that, if the ITAAC are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification. US-APWR has included an ITAAC in Tier 1, Table 2.7.3.5-5 to confirm that the NPSH available exceeds the required NPSH. However, in the absence of the available or required NPSH details, this ITAAC does not include measurable criteria in order to be closed. The applicant should provide the NPSH ITAAC details similar to those provided in Section 10.4.9.3 for the emergency feedwater system.

<u>Answer (3):</u>
As discussed in Answer (1) above, ECWS pump selection will be made during the detailed design phase. In addition, based on the positive overpressure at the pump suction provided by the compression tank and the low temperature suction fluid, there is limited concern with meeting the selected pump NPSH requirements. The ITAAC provided in Tier 1 DCD Table 2.7.3.5-5 (ITAAC Item 13) is established to confirm that the NPSH requirement of the ECWS pump is met by system design and installation. The ITAAC provides for testing, inspection, and analysis to determine the available NPSH at the ECWS pump suction and establishes the acceptance criterion that the available NPSH exceeds the required NPSH. This ITAAC provides reasonable assurance that NPSH requirements will be met for the ECWS pump.

The ECWS pump NPSH conditions are not similar to the emergency feedwater pump NPSH conditions. The emergency feedwater system is not a closed-loop system and the pumps take suction from a defined volume of fluid (i.e., the EFW pit) with no overpressure system. Since the EFW pit volume can be drawn down, the head available to the pump suction will decrease as the EFW pit level decreases. These concerns are not applicable to the ECWS pumps. Therefore, a similar level of detail for ECWS pump NPSH as that for the emergency feedwater pump is not required.

Impact on DCD

DC applicant will revise Tier 2, DCD Revision 3, Section 9.2.7 to include a description of the margin to chiller pump required NPSH and the potential for dissolved gasses in the system fluid.

Revise the last sentence in the third paragraph in Section 9.2.7.2.1.1 as follows:

> The essential chilled water pumps have **<u>a minimum 10% margin to the required</u>** ~~sufficient~~ NPSH ~~available~~ due to system pressure pressurized by compression tank.

Revise the fourth paragraph in Section 9.2.7.2.1.1 as follows:

> **Essential Chilled Water Compression Tank**
>
> The essential chilled water compression tanks are connected to the suction side of the respective essential chilled water pump. The compression tank accommodates the thermal expansion and contraction of the cooling water and potential leakage from the ECWS. The compression tank provides the net positive suction head (NPSH) at the essential chilled water pump suction. The compression tanks are compressed by nitrogen gas (compressed gas supply system (GGS)). **<u>Although the compression tank is pressurized with nitrogen, there is no flow through the tank and the volume of fluid out of the tank (such as during thermal contraction of the system fluid) is not significant relative to the volume of the system. Therefore, even with an assumption of nitrogen-saturated water within the tank, there is no potential for dissolved gas to affect pump performance.</u>**

See attachment 2 mark-up DCD Revision 3 Tier 2, page 9.2-46 and 9.2-47.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-74

This is a follow-up to RAI 343-2208, Question 09.02.02-12:

Under seismic or post-accident conditions where the demineralized water system (DWS) or the primary make-up system (PWS) may be unavailable for ECWS makeup, the compression tanks need to provide sufficient water volume to assure reliable operation without makeup. Makeup water to the compression tank is shown in Tier 2, DCD Figure 9.2.7-1; however, the DCD does not discuss compression tank capabilities in the event of a makeup source interruption. Consequently, the staff prepared RAI 09.02.02-12 to request further information on expected or assumed system leakage and the capabilities of the compression tank to operate without a makeup source for an extended period of time. In its response, the applicant addressed the staff questions and proposed a revision to Tier 2 DCD section 9.2.7.2.1.1.1 (actually added to 9.2.7.2.1.1) for clarification. The compression makeup water is provided with deaerated water from the primary makeup water system (PMWS) or with demineralized water from the demineralized water system (DMS). The deaerated water is used for initial filling of this system and demineralized water is used for makeup when the tank water level reaches a low-level setpoint during normal plant operation. The blowdown discharge of the compression tank relief valves (non-radioactive drain sump) was described as discharging to the non-radioactive drain sump. The applicant stated that the compression tank capacity is designed with sufficient water for at least 7 days of operation in the event of a loss of makeup water.

However, the applicant did not define the basis for this 7-day tank capacity and what the minimum level and volume of tank water is based on to assure the tank contains sufficient inventory during all conditions (i.e normal and abnormal). The assumptions used to define the tank capacity, including most limiting system leakage was not provided.

1. Describe whether compression tank is sized to ensure adequate NPSH available and prevent vortexing for its associated SCW pump under worst case conditions.
2. Explain what controls and features are provided to monitor and ensure the compression tank quantity is adequate to support the 7-day supply at all times. Discuss whether a technical specification is needed to verify the 7-day supply is available.
3. Define the most limiting leak rate and assumptions used to define compression tank capacity during normal and abnormal operation.

Reference: MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July

17, 2009; ML092080395.

ANSWER:

Question (1):
Describe whether compression tank is sized to ensure adequate NPSH available and prevent vortexing for its associated SCW pump under worst case conditions.

Answer (1):
Refer to the response to RAI Question No. 09.02.02-73 for the discussion of the potential for vortex formation within the compression tank and ECWS pump NPSH provided by the compression tank.

Question (2):
Explain what controls and features are provided to monitor and ensure the compression tank quantity is adequate to support the 7-day supply at all times. Discuss whether a technical specification is needed to verify the 7-day supply is available.

Answer (2):
As described in DCD Section 9.2.7.2.1.1, the ECWS compression tank is provided to accommodate thermal expansion and contraction of the system fluid and potential leakage from the ECWS. Make-up to the compression tank during normal operation is provided from the demineralized water system by the automatic level controller shown in DCD Figure 9.2.7-1. The level control maintains the compression tank level in the normal operating range during operation of the ECWS. A low-level alarm is provided to alert operators that make-up water flow to the ECWS is inadequate and to initiate actions to restore compression tank water level to the normal range.

The compression tank contains sufficient water volume to assure reliable system operation without makeup for at least seven days. The capacity of the compression tank is based on the thermal contraction of the volume of water within the ECWS due to cooling from an initial system fill temperature equal to outdoor temperature to a normal operating chilled water temperature. The ECWS volume is conservatively determined by adding 50% greater piping run than expected and accounting for system load (cooling coils) volumes. The calculated volume requirement is then doubled to provide added tank capacity.

The tank is sized to accommodate minor leakages and maintain system operation for seven days without make-up. Leakage is not normally expected from the ECWS and accommodating significant amounts of volume loss is not the intent of the compression tank design. Major leakage from a pipe failure, pump seal failure, or other significant source would constitute a train failure, and the redundant train would provide the heat removal function. The tank capacity calculation includes margin in the volume requirement to accommodate the minor system leakages since the tank capacity is double the required volume for thermal expansion and contraction alone. DCD Section 9.2.7.2.1.1 will be revised to include a description of the tank sizing basis with regard to system leakage.

Since the tank design includes margin to accommodate minor leakages, no Technical Specification is required to ensure that the seven day supply is available.

Question (3):
Define the most limiting leak rate and assumptions used to define compression tank capacity during normal and abnormal operation.

Answer (3):
As discussed in Answer (2) above, significant leakage from the ECWS is not expected. Compression tank capacity is determined based on a conservative calculation of system volume thermal expansion and contraction. The required volume from that calculation is then doubled to add margin to accommodate

minor leakages without make-up available. Since leakage is expected to be minor, this added volume requirement is judged to be adequate for a minimum seven day period. Significant leakage, such as from piping failure, pump seal failure, or other significant source would constitute a train failure and the redundant train would provide the necessary heat removal function.

Impact on DCD

MHI will revise Tier 2, DCD Revision 3, Section 9.2.7 to describe the potential system leakages assumed for the sizing of the compression tank.

Revise the seventh paragraph of Section 9.2.7.2.1.1 as follows:

> The compression tank contains sufficient water volume to assure reliable system operation without makeup for at least seven days. **The tank capacity includes margin in the volume requirement to accommodate minor system leakages, such as minor pump seal or valve packing leaks, since the tank capacity is double the required volume for thermal expansion and contraction alone.**

See attachment 2 mark-up DCD Revision 3 Tier 2, page 9.2-47.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-76

This is a follow-up to RAI 343-2208, Question 09.02.02-19:

Standard Review Plan (SRP) 9.2.2, which is being utilized as guidance for the review of the essential chilled water system (ECWS), specifies in Section III confirmation of the overall arrangement of the component cooling system (CCWS). SRP 14.3, Appendix C, Item 1B.ix states that Tier 1 figures for safety-related systems should include most of the valves on the DCD Tier 2 drawings. The staff found that the Tier 1 and Tier 2 information is incomplete, inconsistent, inaccurate, or that clarification is needed and asked the applicant in RAI 09.02.02-19 to revise the information in Design Control Document (DCD), Tier 1 Section 2.7.3.5 and applicable Tier 2 Sections (as appropriate) to address the following considerations in this regard. In the response, a single issue addressed by the applicant was not found to be acceptable to resolve the staff's question. This issue is addressed in the paragraph below.

Although the Introduction Section in Chapter 1 of the Tier 1 DCD states that "information contained in the Tier 1 document was derived from the Tier 2 document," the staff found that much of the information provided in DCD Tier 1 is not described in Tier 2 DCD Section 9.2.7 (e.g., active safety function, loss of motive power position, harsh environment considerations, MCR alarm and display, control function, and RCS display). This information needs to be added to Tier 2. The applicant proposed to revise Tier 2 Section 9.2.7 to add the missing information that is included in Tier 1. However, the applicant did not provide a markup of the proposed Tier 2 DCD changes; therefore, the staff is unable to determine the acceptability of the proposed changes until the next DCD revision.

In addition, the staff has the following related requests:

1. Review DCD to ensure all Tier 1 information is provided in Tier 2, including table and figure content.

2. During a review of DCD Rev. 2, the staff noted that Section 9.2.7.5.1 specifies the compression tanks contain MCR alarms, but Table 2.7.3.5-4 seems to indicate that the tanks do not have any MCR/RSC Alarm. The applicant is asked to resolve this inconsistency.

3. In addition, provide a reason why non-ECWS Tier 1 Section 2.7.3.6.1 does not include valves VLV-421/422 and MOV-424/425 in a table similar to Table 2.7.3.5-2 with the pertinent ITAAC.

4. Table 2.7.3.6-2 should include valves VWS-MOV-424, -425, which are Seismic Category I.

Reference: MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

Please note that the changes to DCD Section 9.2.7 proposed in response to RAI Question 09.02.02-19, Question 1, have been incorporated into Revision 2 of the US-APWR DCD. Changes to Section 9.2.7 are indicated with revision bars in the right margin.

Question 1:
Review DCD to ensure all Tier 1 information is provided in Tier 2, including table and figure content.

Answer 1:
DCD Tier 1, Section 2.7.3.5 and 2.7.3.6, for the ECWS and non-ECWS, respectively, was reviewed and it has been confirmed that the content of these sections, including associated tables and figures, is consistent with the content in DCD Tier 2, as appropriate.

Question 2:
During a review of DCD Rev. 2, the staff noted that Section 9.2.7.5.1 specifies the compression tanks contain MCR alarms, but Table 2.7.3.5-4 seems to indicate that the tanks do not have any MCR/RSC Alarm. The applicant is asked to resolve this inconsistency.

Answer 2:
As described in answer to Question No.09.02.02-71, the instrumentation of the ECWS is designed as non-safety related. Thus these alarms should not be included in Table 2.7.3.5-4 because Table 2.7.3.5-4 shows the safety-related displays and control functions. The essential chilled water compression tanks in 3rd row of Table 2.7.3.5-4 will be deleted since there is no "Yes" answer for safety related alarms displays or controls in the MCR or RSC. In addition, the MCR/RSC alarm for the chiller units and chilled water pumps are non-safety related, and Table 2.7.3.5-4 will be revised to indicate "No" for these alarms.

Question 3:
In addition, provide a reason why non-ECWS Tier 1 Section 2.7.3.6.1 does not include valves VLV-421/422 and MOV-424/425 in a table similar to Table 2.7.3.5-2 with the pertinent ITAAC.

Answer 3:
Non-ECWS valves VWS-VLV-421 and VWS-MOV-422 are containment isolation valves and are part of the CIS. As indicated in DCD Tier 1, Section 2.7.3.6.2, the ITAAC associated with non-ECWS components that comprise a portion of the CIS are described in DCD Tier 1, Table 2.11.2-2.

As described in DCD RAI 697-5502, Question 09.02.02-80, the valve number VWS-MOV-424 and 425 shown in DCD Revision 3 will be changed to NCS-MOV-241 and 242. Therefore, the valves VWS-MOV-424 and 425 are not required to be added in a table similar to DCD Table 2.7.3.5-2 because the valves NCS-MOV-241 and 242 will be added in Table 2.7.3.3-2. ~~Non-ECWS valves VWS-MOV-424 and 425~~ These valves are component cooling water system supply and return line isolation valves. The valves support the non-safety related ~~non-ECWS~~ function to provide an alternate supply of ~~component~~ cooling water to the containment fan cooler units in the event of a severe accident. The ~~valves do not perform an active safety function. Therefore, the~~ ITAAC listed in DCD Tier 1, Table 2.7.3.6-3 ~~to verify~~verifies the functional arrangement of the cross-connection between the CCWS and non-ECWS~~-capability to provide alternate component cooling water to the containment fan cooler units is considered adequate to confirm the function of these valves~~.

Therefore, Tier 1 DCD Section 2.7.3.6 will be revised to delete Tables 2.7.3.6-1, -2, and Figure 2.7.3.6-1 since they are no longer required to be included in the DCD.

Question 4:
Table 2.7.3.6-2 should include valves VWS-MOV-424, -425, which are Seismic Category I.

Answer 4:
As described in DCD RAI 697-5502, Question 09.02.02-80, the valve number VWS-MOV-424 and 425 shown in DCD Revision 3 will be changed to NCS-MOV-241 and 242. Therefore, the valves VWS-MOV-424 and 425 do not require to be added in Table 2.7.3.6-2 because the valves NCS-MOV-241 and 242 will be added in Table 2.7.3.3-2.

Impact on DCD

MHI has deleted the chilled water compression tanks in the 3rd row of Table 2.7.3.5-4 and revised the MCR/RSC Alarm column to "No" for the Essential Chiller Units and the Essential Chilled Water Pumps.

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Essential Chiller Units (VWS-PEQ-001 A, B, C, D)	~~Yes~~No	Yes	Yes	Yes
Essential Chilled Water Pumps (VWS-PPP-001 A, B, C, D)	~~Yes~~No	Yes	Yes	Yes
~~Essential Chilled Water Compression Tanks (VWS-PTK-001 A, B, C, D)~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~

Tier 1 DCD Section 2.7.3.6 will be revised to delete Tables 2.7.3.6-1, -2, and Figure 2.7.3.6-1. Tier 1 DCD Section 2.7.3.6.1 will be revised as follows:

1. The functional arrangement of the non-ECWS is as described in the Design Description of Subsection 2.7.3.6.1~~ and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1~~.

Tier 1 DCD Table 2.7.3.6-3 will be revised as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the non-ECWS is as described in the Design Description of Subsection 2.7.3.6.1~~ and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1~~.	1. Inspection of the as-built non-ECWS will be performed.	1. The as-built non-ECWS conforms to the functional arrangement described in the Design Description of Subsection 2.7.3.6.1~~ and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1~~.

See attachment 2 mark-up DCD Revision 3 Tier 1, page 2.7-138, 2.7-149 through 2.7-152.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO.584-4468 REVISION 0
SRP SECTION:	09.02.02 – Reactor Auxiliary Cooling Water Systems
APPLICATION SECTION:	DCD Tier 2 Section 9.2.7
DATE OF RAI ISSUE:	05/10/2010

QUESTION NO. : 09.02.02-77

This is a follow-up to RAI 343-2208, Question 09.02.02-20:

Standard Review Plan (SRP) Section 9.2.2, which is being utilized as guidance for the review of the essential chilled water system (ECWS), specifies in Section III confirmation of the overall arrangement of the component cooling system (CCWS). The staff found that the proposed ITAAC in DCD Tier 1, Section 2.7.3, Table 2.7.3.5-5, are incomplete, inconsistent, inaccurate, or that clarification is needed. Consequently, in RAI 09.02.02-20, the staff identified that the Tier 1 information needed to be revised to address a number of issues. The applicant provided a response to each of the identified issues. Based on the response, the staff has the following questions:

1. The applicant responded that, consistent with the response to RAI 192-1847, question 14.03.04-15, item 7 will require a report to conclude that the ECWS as built provides adequate flow rates for heat removal for all operating conditions. This approach provides sufficient assurance that acceptance criteria are met without adding excessive detail to Tier 1. The staff believes a report should be prepared to confirm the adequacy of the ECWS design (assumptions, sizing, etc.), but testing is needed to confirm that the ECWS will perform in accordance with design specifications, and inspection is needed to confirm functional arrangement. This issue will remain open until the applicant establishes quantitative acceptance criteria for all ITAAC.

2. The applicant added new ITAAC #13 to address ECWS pump and compression tank testing. The staff reviewed the response and found that it was not sufficient. First, the ITAAC should verify the sizing of the compression tank (including the 7-day makeup water supply), not just the ECWS pump performance at minimum tank level. Second, while the nitrogen make-up and relief valve on the compression tank may be non-safety, an ITAAC is needed for where the nitrogen is relieved so that the staff can confirm that it will not pose a hazard for occupancy. Finally, the ITAAC for ECWS pump NPSH only accounts for minimum compression tank level. The ITAAC should also account for minimum tank pressure and temperature limitations.

References:

MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

MHI's Responses to US-APWR DCD RAI No. 192-1847; MHI Ref: UAP-HF-09167; Dated April 10, 2009;

ML091040326.

ANSWER:

Question 1:
The applicant responded that, consistent with the response to RAI No.192-1847, Question No.14.03.04-15, item 7 will require a report to conclude that the ECWS as built provides adequate flow rates for heat removal for all operating conditions. This approach provides sufficient assurance that acceptance criteria are met without adding excessive detail to Tier 1. The staff believes a report should be prepared to confirm the adequacy of the ECWS design (assumptions, sizing, etc.), but testing is needed to confirm that the ECWS will perform in accordance with design specifications, and inspection is needed to confirm functional arrangement. This issue will remain open until the applicant establishes quantitative acceptance criteria for all ITAAC.

Answer 1:
As indicated in DCD Tier 1, Table 2.7.3.5-5, ITA 7.i., an inspection for the existence of a report that determines the heat removal capability of the as-built ECWS will be performed. The associated AC 7.i. is that a report exists and concludes that the heat removal capability of the as-built ECWS is greater than or equal to the design values for all plant operating conditions, including normal plant operating, abnormal and accident conditions.

As further indicated in Table 2.7.3.5-5, ITA 7.ii., tests will be performed to confirm that the as-built ECWS pumps identified in Table 2.7.3.5-2 provide flow to the ECWS cooling unit. The associated AC states that the as-built ECWS pumps identified in Table 2.7.3.5-2 are capable of achieving their design flow rate.

Table 2.7.3.5-5, ITA 1.a. requires that an inspection of the as-built ECWS will be performed. The associated AC is that the as-built ECWS conforms with the functional arrangement as described in the Design Description of Subsection 2.7.3.5 and as shown in Figure 2.7.3.5-1.

Based on the above, sufficient quantitative acceptance criteria are provided to conclude that the ECWS as-built provides adequate flow rates for heat removal for all operating conditions.

Question 2:
The applicant added new ITAAC #13 to address ECWS pump and compression tank testing. The staff reviewed the response and found that it was not sufficient. First, the ITAAC should verify the sizing of the compression tank (including the 7-day makeup water supply), not just the ECWS pump performance at minimum tank level. Second, while the nitrogen make-up and relief valve on the compression tank may be non-safety, an ITAAC is needed for where the nitrogen is relieved so that the staff can confirm that it will not pose a hazard for occupancy. Finally, the ITAAC for ECWS pump NPSH only accounts for minimum compression tank level. The ITAAC should also account for minimum tank pressure and temperature limitations.

Answer 2:
A new ITAAC item 14 to identify that the as-built compression tank meets the design sizing requirements, including accommodating system thermal expansion and contraction, and 7-day system operation without make-up, will be added to DCD Tier 1, Table 2.7.3.5-5.

The compression tanks are located in the PS/B in an open area that is subject to continuous ventilation air flow. Nitrogen relief from the compression tank would not create a hazard to occupancy of the PS/B due to the small relief volume in comparison to the space volume, and in consideration of the ventilation air flow. On this basis, no ITAAC is required related to compression tank nitrogen pressure relief. Note that this answer amends the response to RAI No.343-2208, Question No.09.02.02-6, in that the compression tank relief valve discharge line routing will be changed to be open-ended at the local floor drain in the PS/B.

Table 2.7.3.5-5, Item 13 will be clarified to ensure ECWS pump NPSH is confirmed at compression tank minimum operating pressure and level conditions. Since the temperature range for the ECWS is small (40°F - 56°F), the effect of pumped fluid temperature variation on pump NPSH is insignificant and need not be considered.

Impact on DCD

DC applicant will revise Figure 9.2.7-1 and 9.2.7-2 to indicate that the ECWS compression tank relief valve discharge is routed to a local floor drain. .

DC applicant will revise Tier 1, DCD Table 2.7.3.5-5 to identify as-built ECWS compression tanks meet design requirements and to ensure that ECWS pump NPSH is confirmed at compression tank minimum operating pressure and level conditions, as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13. The ECWS pumps have sufficient net positive suction head (NPSH).	13. Tests to measure the as-built ECWS pump suction pressure will be performed**.** ~~**at minimum compression tank operating pressure and water level conditions**~~. Inspections and analysis to determine NPSH available to each pump **will be performed.** ~~will be performed~~ **The analysis will consider vendor test results of required NPSH and the effects of:** **- pressure losses for pump inlet piping and components,** **- suction from the ECWS compression tank with operating pressure and water level at their minimum value.**	13. ~~The as-built system meets the design, and the analysis confirms~~ **A report exists and concludes** that the NPSH available exceeds the required NPSH.
14. The ECWS compression tank volume ~~meets design requirements~~ accommodates system thermal expansion and contraction, and 7-day system operation without make-up.	**14. Inspection and analysis of the as-built compression tank size will be performed to verify that the tank volume accommodates system thermal expansion and contraction, and 7-day system operation without makeup.**	**14. A report exists and concludes that the as-built compression tank ~~size meets the design requirement~~ accommodates system thermal expansion and contraction, and 7-day system operation without make-up ~~for compression tank volume~~.**

See attachment 1 and attachment 2 mark-up DCD Revision 3 Tier 1, page 2.7-146.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-78

This is a follow-up to RAI 343-2208, Question 09.02.02-13:

The essential chilled water system (ECWS) must be capable of removing heat from structures, systems and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. The Design Control Document (DCD) does not adequately describe the various operating modes and operator actions that are required and how the ECWS control system functions. RAI 09.02.02-13 was initiated, requesting the applicant to address several technical deficiencies. These considerations need to be fully described in Tier 2, DCD Tier 2 Section 9.2.7 In its response, the applicant addressed the five identified RAI issues. During the staff review of DCD Rev. 2, most of these issues were satisfactorily resolved; however, the staff noted that several will require additional revisions to the DCD by the applicant. The applicant is requested to address the remaining issues as described below.

- For question 4, instrumentation and controls (I&C) related to ECWS automatic operation such as pump and chiller starts signals, trip signals, lock-outs, and permissives should be described in the DCD. This should include loss of offsite power (LOOP) signals and emergency core cooling system (ECCS) actuation signals. The applicant proposed adding the initiation signals to the flow diagram. During a review of DCD Rev. 2, the staff did not find that the I&C automatic initiation signals were added to the flow diagrams nor were they described in the DCD. The applicant needs to address this deficiency.

- For question 5, explain why all instrumentation described in Section 9.2.7.5 are not found on Figure 9.2.7-1 and 9.2.7-2. In addition, indicate whether expansion tank level alarm should be included in Section 9.2.7.5.

Reference: MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

<u>Question 1:</u>
For question 4 [from RAI 343-2208, Question 09.02.02-13 response], instrumentation and controls (I&C) related to ECWS automatic operation such as pump and chiller starts signals, trip signals, lock-outs, and

permissives should be described in the DCD. This should include loss of offsite power (LOOP) signals and emergency core cooling system (ECCS) actuation signals. The applicant proposed adding the initiation signals to the flow diagram. During a review of DCD Rev. 2, the staff did not find that the I&C automatic initiation signals were added to the flow diagrams nor were they described in the DCD. The applicant needs to address this deficiency.

Answer 1:
The automatic initiation signals for the ECWS chiller units and chiller pumps are indicated on DCD Figure 9.2.7-1 as "S, BO" with an indicator pointing to the chiller unit and the chiller pump. As indicated on DCD Figure 1.7-3, Legend for Piping and Instrumentation Diagrams of Primary Systems, "S" indicates a Safety Injection Signal (i.e., the ECWS automatic start on an ECCS initiation signal) and "BO" indicates a Blackout Sequence Signal (i.e., the ECWS automatic start on a LOOP initiation signal).

Question 2:
For question 5 [from RAI 343-2208, Question 09.02.02-13 response], explain why all instrumentation described in Section 9.2.7.5 are not found on Figure 9.2.7-1 and 9.2.7-2. In addition, indicate whether expansion tank level alarm should be included in Section 9.2.7.5.

Answer 2:
Instrumentation described in DCD Section 9.2.7.5 that is part of the system design is shown on Figures 9.2.7-1 and 9.2.7-2. Instrumentation that is part of vendor-supplied equipment, such as the chiller package, is not shown on the figures.

For the ECWS instrumentation described in Section 9.2.7.5.1:

- Temperature indication of chiller units entering and leaving chilled water with an alarm for leaving chilled water temperature exceeding the design limit – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-1*
- High and low pressure indication with an alarm of the compression tanks – *shown on Figure 9.2.7-1 {ex.: PICA-041-N}*
- Chilled water flow failure of the chilled water pumps – *shown on Figure 9.2.7-1 {ex.: FI-001-N}*
- Categorical alarms for chiller operation malfunction – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-1*
- Temperature indicator for chillers, chilled water and condenser water entering and leaving water flows – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-1*
- Pressure indicator at chilled water and condenser water entering and leaving water flows – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-1*
- Pressure indicator at the chilled water pumps suction and discharge nozzles – *shown on Figure 9.2.7-1 {ex.: PI-002-N and PI-003-N}*
- Chiller oil pressure indicators, suction pressure indicator and discharge pressure indicators – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-1*

For the non-ECWS instrumentation described in Section 9.2.7.5.2:

- Temperature indication of entering and leaving chilled water and condenser water with an alarm for leaving chilled water temperature exceeding the design limit – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-2*
- High and low pressure alarms of the compression tank – *shown on Figure 9.2.7-2 {PICA-401-N}*
- Chilled water flow failure of the chilled water pumps – *shown on Figure 9.2.7-2 {ex.: FI-301-N}*
- Categorical alarms for chiller operation malfunction – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-2*

- Temperature indicator for chillers, chilled water and condenser water entering and leaving water flows – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-2*
- Pressure indicator at chilled water and condenser water entering and leaving water flows – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-2*
- Pressure indicator at the chilled water pumps suction and discharge nozzles – *shown on Figure 9.2.7-2 {ex.: PI-311-N and PI-312-N}*
- Chiller oil pressure indicators, suction pressure indicator and discharge pressure indicators – *supplied as part of the ECWS chiller package and not shown on Figure 9.2.7-2*

The ECWS compression tank level is indicated in the main control room and abnormal level actuates a MCR alarm. This instrumentation should have been included in DCD Section 9.2.7.5.1.

DCD Section 9.2.7.5.1 will be revised to provide a description of the function of the MCR instrumentation.

Impact on DCD

DC applicant will revise Tier 2, DCD Revision 3, Section 9.2.7.5.1 to include ECWS compression tank level indication and alarm in the list of MCR instrumentation and to provide additional description of the function of the MCR instrumentation. The compression tank level indication symbols in Figure 9.2.7-1 and 9.2.7-2 will be revised to be consistent with following change:

Revise the bullet items in the second paragraph of Section 9.2.7.5.1 as follows:

- **Chiller units entering and leaving chilled water temperature**~~Temperature~~ **– Chiller unit entering and leaving chilled water temperature is indicated in the MCR.** ~~indication of chiller units entering and leaving chilled water with an alarm for leaving~~ **Leaving** chilled water temperature exceeding the design limit **actuates an alarm in the MCR to alert the operator to an abnormal chiller unit condition.**
- **Compression tank pressure – Compression tank pressure is indicated in the MCR. The compression tank nitrogen gas supply valve is controlled with open-closed control so that the tank pressure is maintained within a pre-set range.** High and low **compression tank** pressure **is** ~~indication with an~~ alarm**ed in the MCR to alert the operator to an abnormal condition** of the compression tank~~s~~**.**
- **Compression tank level - Compression tank level is indicated in the MCR. The compression tank makeup water control valve is modulated so that the tank level is maintained within a pre-set range. High and low compression tank level is alarmed in the MCR to alert the operator to an abnormal condition of the compression tank.**
- Chilled water flow**rate – Chilled water flowrate is indicated in the MCR. Abnormally low flowrate indicates a potential malfunction or** failure of the chilled water pump~~s~~**. The low flowrate indication alerts the operator to an abnormal chiller unit condition.**
- **Chiller unit malfunction -** Categorical alarm~~s~~ **is provided in the MCR to alert the operator to a** ~~for~~ chiller operation malfunction**.**

Add a new third bullet to the second paragraph of Section 9.2.7.5.2 as follows:

- High and low level indication with an alarm of the compression tanks

Correct editorial error at second paragraph of Section 9.2.7.5.1.

Revise Table 9.2.7-1 and Table 9.2.7-2 to be consistent with Table 9.4.5-1 and correct editorial error.

See attachment 2 mark-up DCD Revision 3 Tier 2, page 9.2-50 and 9.2-89 through 9.2-90.

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 the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/15/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.584-4468 REVISION 0**
SRP SECTION:	**09.02.02 – Reactor Auxiliary Cooling Water Systems**
APPLICATION SECTION:	**DCD Tier 2 Section 9.2.7**
DATE OF RAI ISSUE:	**05/10/2010**

QUESTION NO. : 09.02.02-79

This is a follow-up to RAI 343-2208, Question 09.02.02-17

Means must be provided for monitoring effluent discharge paths and the plant environs for radioactivity that may be released in accordance with General Design Criteria GDC 64 requirements. Also, 10 CFR 52.47(a)(6) and 10 CFR 20.1406 require applicants for standard plant design certifications to describe how facility design and procedures for operation will minimize contamination of the facility and the environment. The staffs review criteria (Standard Review Plan Section 9.2.1, Paragraph III.3.D) specify that provisions should be provided to detect and control leakage of radioactive contamination into and out of the essential service water system (ESWS) which is the heat sink for the essential chilled water system (ECWS). The staff generated RAI 09.02.02-17 to address this concern for the ECWS. In its response, the applicant stated that radiation monitors in the ECWS were not necessary because the compression tanks maintained the system at a higher pressure than potentially contaminated systems. In addition, the applicant stated that the makeup water sources to ECWS contained no contamination. The staff disagrees with the applicant that the ECWS will not contain radioactive material because one of the makeup water paths is the Primary Water System (PWS). As discussed below, the PWS is a contaminated system:

Figure 9.2.7-1 "Essential Chilled Water System Flow Diagram" shows an interface to PWS VLV-265(A-D)-N. FSAR Section 9.2.7.2.1.1 "Component Descriptions", states, "Makeup water is supplied to the respective surge line. The makeup water is supplied from the following systems.
- Demineralized water system (DWS) which supplies the demineralized water
- Primary makeup water system (PMWS) which supplies the deaerated water"

Section 9.2.6.2.6 "Primary Makeup Water Tanks", states that the tanks also receive distilled water discharged from the boric acid evaporator (subsection 9.3.4). This is shown on Figure 9.2.6-2 "Primary Makeup Water System Flow Diagram".

Section 9.3.4.2.5 "Boron Recycle Subsystem" states "that the boric acid evaporator feed pump transfers water from the holdup tank to the boric acid evaporator by first passing the waste through the boric acid evaporator feed demineralizer, where lithium and radioactive ions are removed. The coolant is then separated into boric acid water of approximately 7,000 ppm Boron and distilled water. The distilled water coming from the boric acid evaporator is transferred to the primary makeup water tank or released to the liquid waste management system (LWMS).

Table 12.2-51 "Miscellaneous Sources - Primary Makeup Water Tank" indicates that the PWS storage tanks contain Cobalt-60.

The applicant should address the staff concerns about this potential for contaminating the ECWS and the possible measures to be used to control and minimize it.

Reference: MHI's Response to US-APWR DCD RAI No. 343-2208; MHI Ref: UAP-HF-09350; Dated July 17, 2009; ML092080395.

ANSWER:

The ECWS is initially filled with deaerated water from the PMWS and makeup to the system is provided by demineralized water from the DWS. However, as indicated on DCD Figure 9.2.6-2, Primary Makeup Water System Flow Diagram, the PMWS water source for the supply to the ECWS (refer to the upper right portion of the figure) is from the DWS (indicated as 3746 Deaerated Water Supply). The PMWS supply to the ECWS is a branch line from the DWS supply line to the PMWS tank. As indicated in Figure 9.2.6-2, the PMWS tanks are not a source for the supply from PMWS to the ECWS. Additionally, check valves installed in the supply line to the PMWS tank prevent its contents from flowing to the ECWS. Therefore, there is no potential for radioactive contamination of the ECWS from the PMWS tank contents and measures to control and minimize radioactive contamination within the ECWS are not required.

Impact on DCD

DC applicant will revise Tier 2, DCD Revision 3, Section 9.2.7 to clarify that potentially radioactive water from the PMWS tank is not used for ECWS make-up.

Revise the sixth paragraph of Section 9.2.7.2.1.1 as follows:

> Deareated water is used for initial filing of this system and demineralized water is used for makeup when the tank water level reaches a low level setpoint. **<u>The potentially radioactively contaminated primary makeup water tank contents are prevented from flowing to the ECWS during filling by installed check valves (Figure 9.2.6-2). The ECWS is not expected to contain radioactively contaminated water.</u>**

See attachment 2 mark-up DCD Revision 3 Tier 2, page 9.2-47.

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 the PRA.

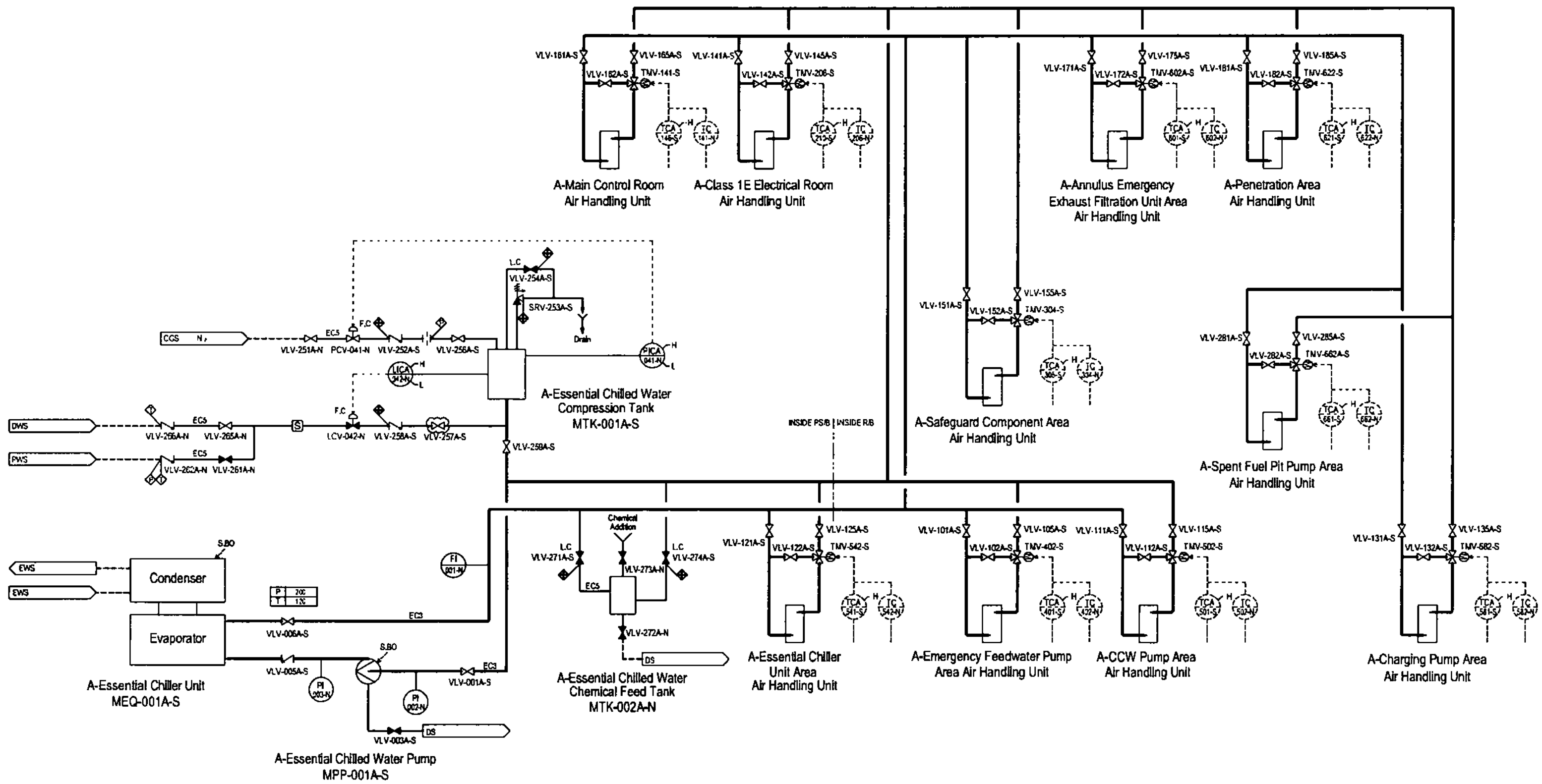


Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 1 of 4)

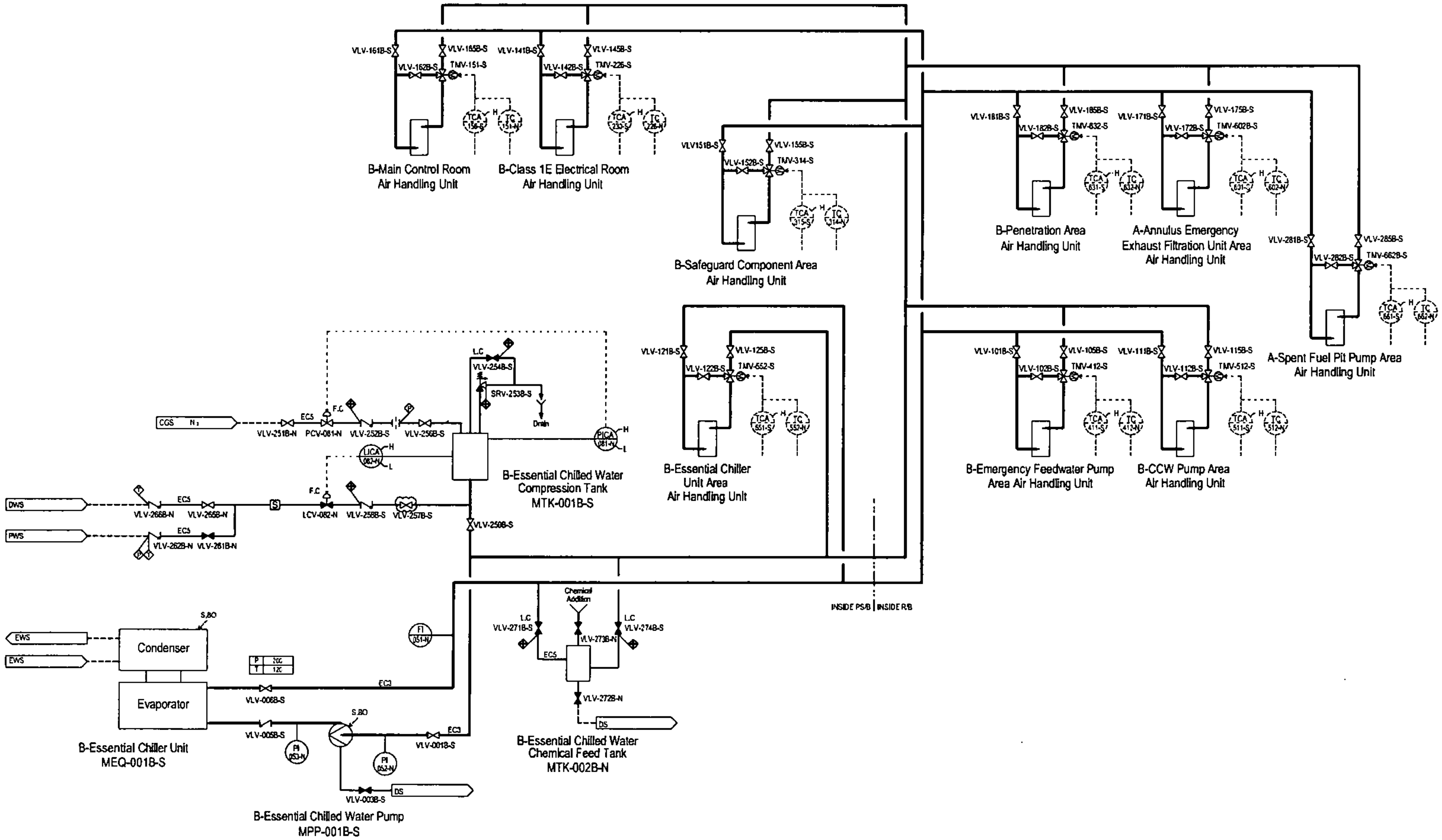


Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 2 of 4)

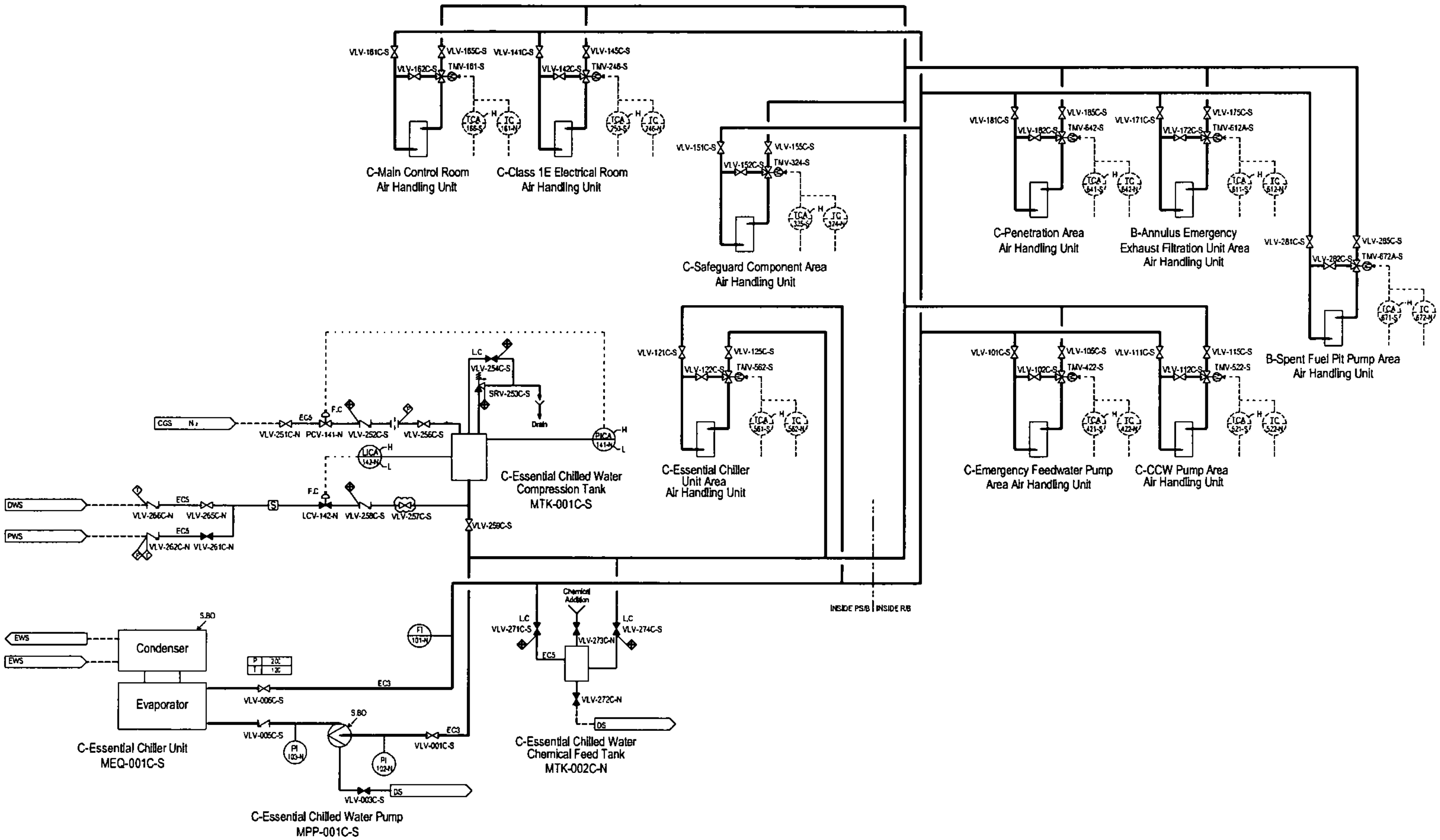


Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 3 of 4)

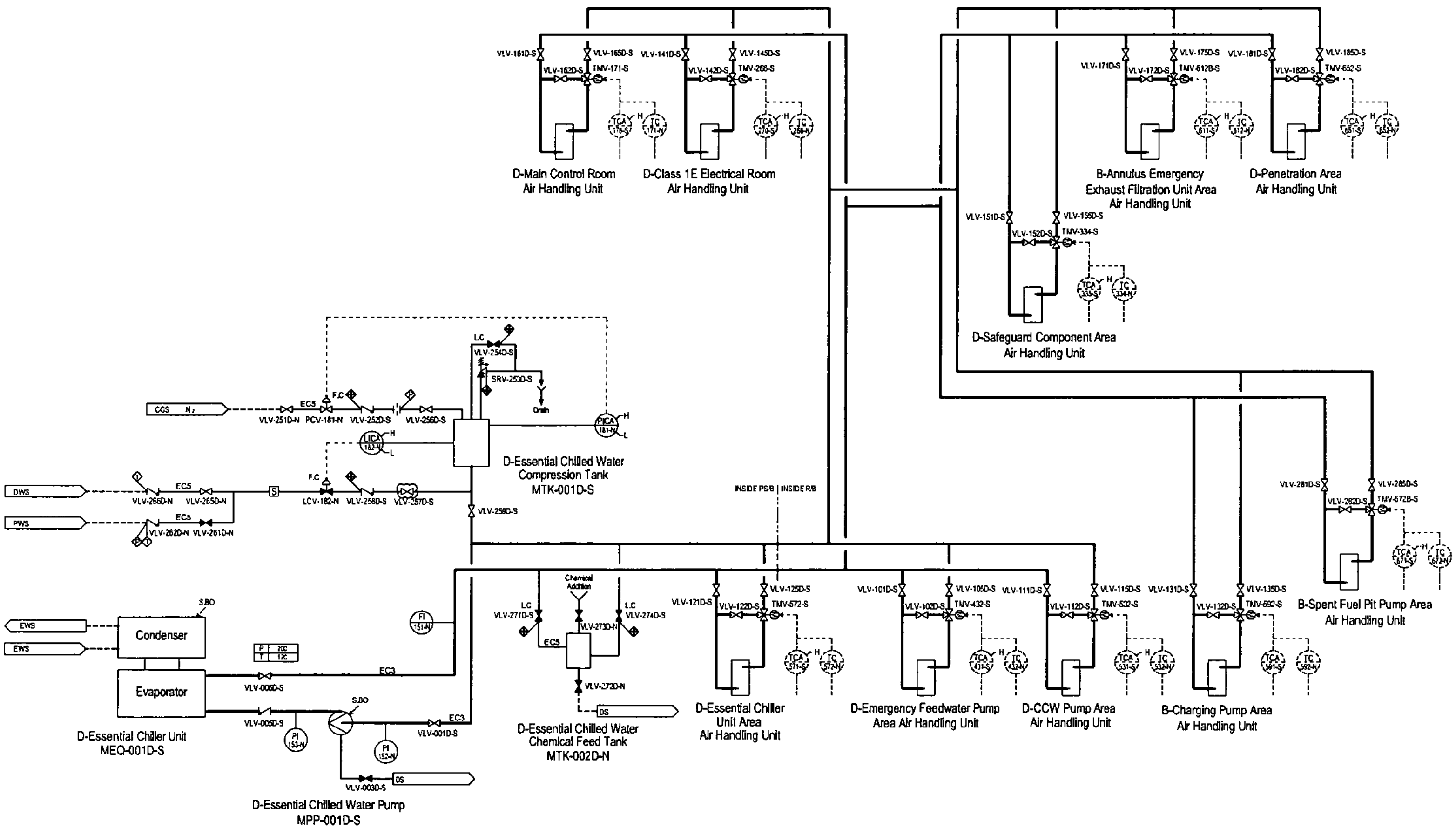


Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 4 of 4)

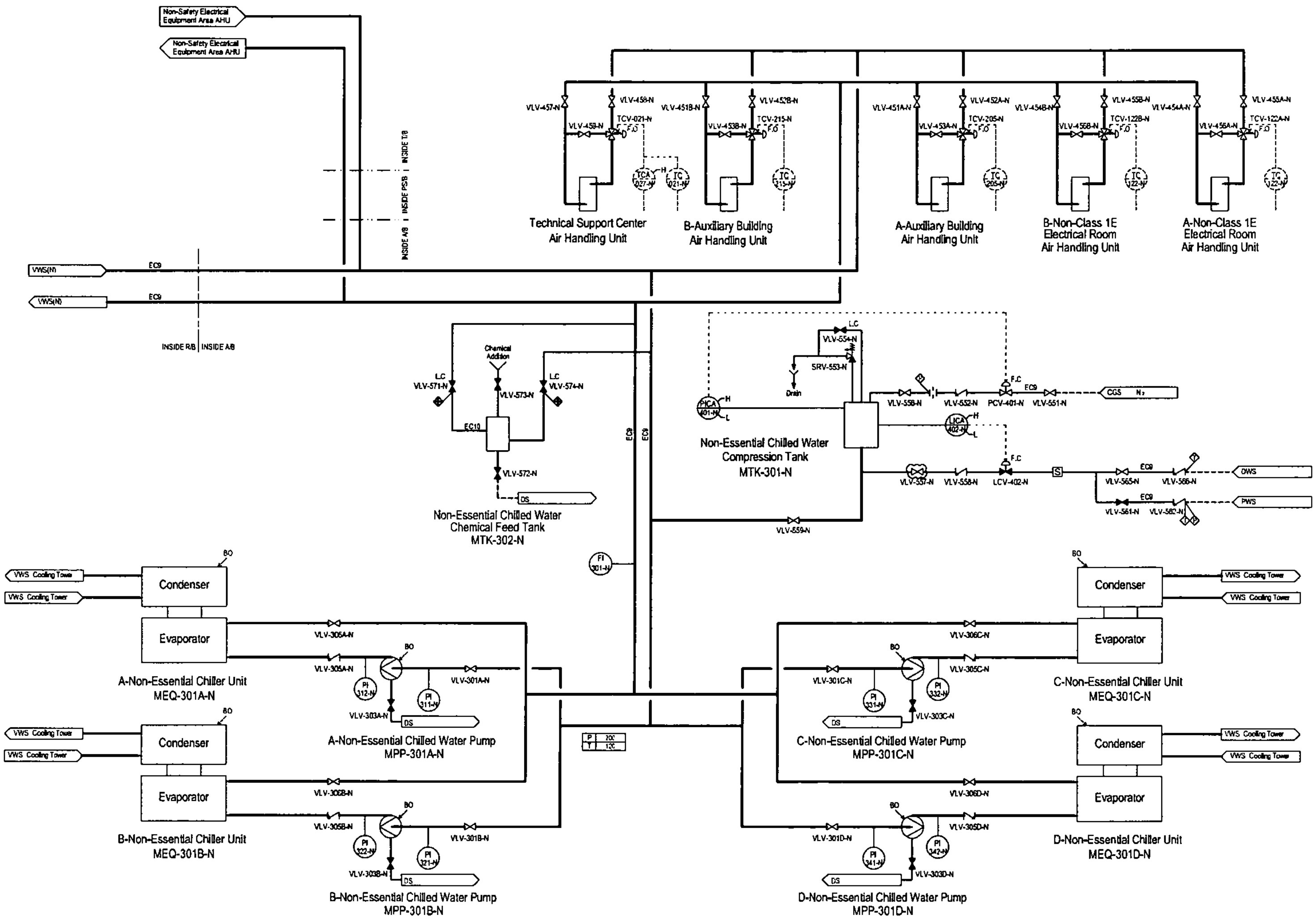


Figure 9.2.7-2 Non-Essential Chilled Water System Flow Diagram (1 of 3)

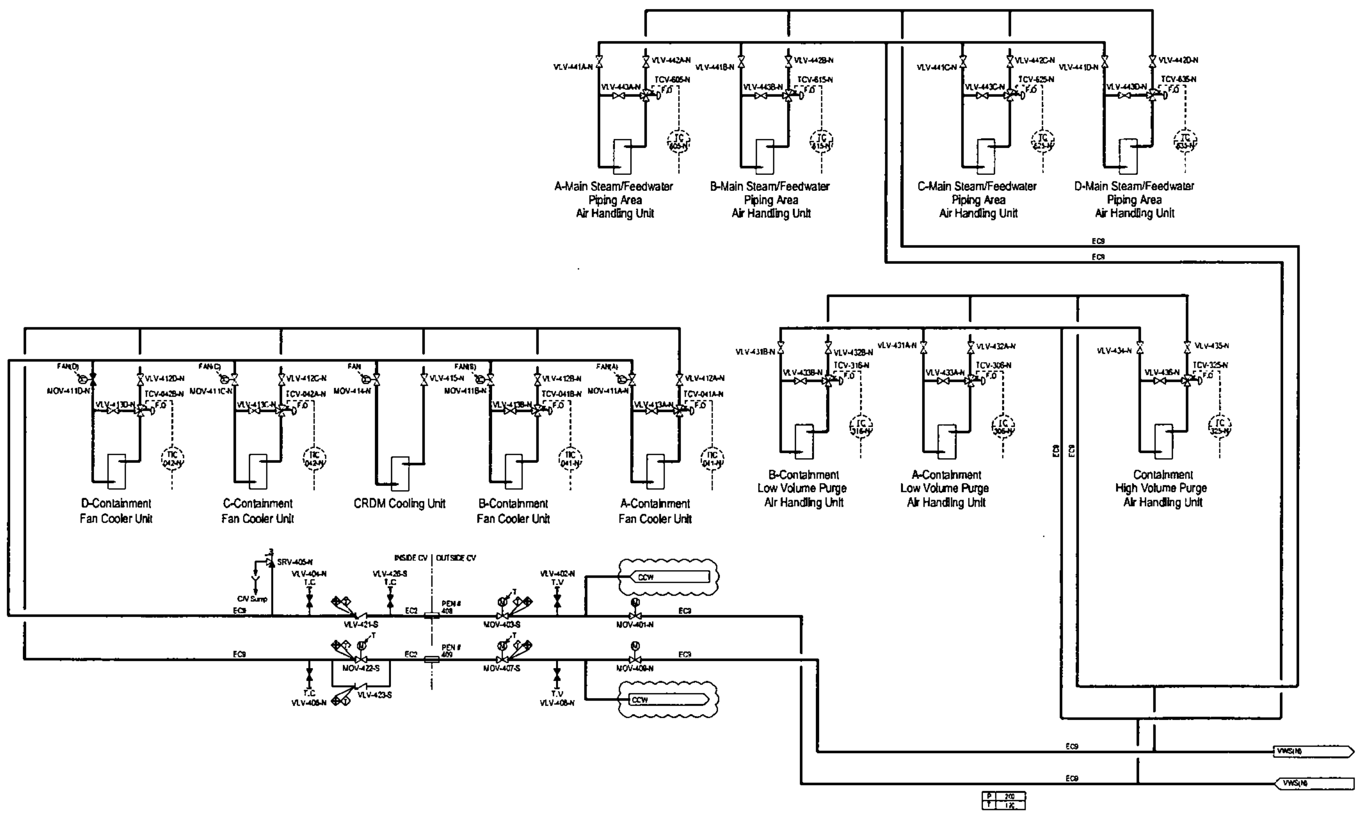


Figure 9.2.7-2 Non-Essential Chilled Water System Flow Diagram (2 of 3)

Table 2.7.3.5-4 Essential Chilled Water System Equipment Alarms, Displays, and Control Functions (Sheet 1 of 2)

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Essential Chiller Units (VWS-MEQ-001 A, B, C, D)	No	Yes	Yes	Yes
Essential Chilled Water Pumps (VWS-MPP-001 A, B, C, D)	No	Yes	Yes	Yes
Main Control Room Air Handling Unit Chilled Water Control Valves (VWS-TMV-141, 151, 161, 171)	No	Yes	No	Yes
Class 1E Electrical Room Air Handling Unit Chilled Water Control Valves (VWS-TMV-206, 226, 246, 266)	No	Yes	No	Yes
Safeguard Component Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-304, 314, 324, 334)	No	Yes	No	Yes
Emergency Feedwater Pump Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-402, 412, 422, 432)	No	Yes	No	Yes
Component Cooling Water Pump Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-502, 512, 522, 532)	No	Yes	No	Yes
Essential Chiller Unit Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-542, 552, 562, 572)	No	Yes	No	Yes
Charging Pump Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-582, 592)	No	Yes	No	Yes
Annulus Emergency Exhaust Filtration Unit Area Air Handling Unit Chilled Water Control Valves (VWS-TMV-602A, 602B, 612A, 612B)	No	Yes	No	Yes

Incorporated in DCD Revision 3

Table 2.7.3.5-5 Essential Chilled Water System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 7 of 7)

Incorporated in DCD Revision 3

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13. The ECW pumps have sufficient net positive suction head (NPSH).	13. Tests to measure the as-built ECW pump suction pressure will be performed. Inspections and analysis to determine NPSH available to each pump will be performed. The analysis will consider vendor test results of required NPSH and the effects of: – pressure losses for pump inlet piping and components, – suction from the ECWS compression tank with operating pressure and water level at their minimum value.	13. A report exists and concludes that the NPSH available exceeds the required NPSH.
14. The ECW compression tank volume accommodates system thermal expansion and contraction, and 7-day system operation without make-up.	14. Inspection and analysis of the as-built ECW compression tank size will be performed.	14. A report exists and concludes that the as-built ECW compression tank accommodates system thermal expansion and contraction, and 7-day system operation without make-up.

Incorporated in DCD Revision 3

Incorporated in DCD Revision 3

to verify that the tank volume accommodates system thermal expansion and contraction, and 7-day system operation without makeup.

2.7.3.6 Non-Essential Chilled Water System (non-ECWS)

2.7.3.6.1 Design Description

The non-ECWS provides chilled water for the non safety-related HVAC systems during normal plant operation and loss of offsite power (LOOP). With the exception of the piping and valves between and including the containment isolation valves, which are safety-related ASME Code Section III Class 2 seismic Category I, the non-ECWS is a non safety-related system. The non-ECWS provides the containment isolation function, as described in Section 2.11.2, for the non-ECWS lines penetrating the containment. The major components of the non-ECWS are located in the auxiliary building and on the roof of the auxiliary building. The non-ECWS includes chiller units, chilled water pumps, condenser water pumps, and cooling towers. A non-ECWS condenser line is connected to the CCWS to provide alternate component cooling water to the charging pumps.

1. The functional arrangement of the non-ECWS is as described in the Design Description of Subsection 2.7.3.6.1 ~~and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1.~~

2. Deleted.

3. Deleted.

2.7.3.6.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.3.6-3 describes the ITAAC for the non-ECWS.

The ITAAC associated with the non-ECWS equipment, components, and piping that comprise a portion of the CIS are described in Table 2.11.2-2.

Table 2.7.3.6-1 Non-Essential Chilled Water System Location of Equipment and Piping

System and Components	Location
Non-Essential chilled water system piping and valves between and including the containment isolation valves, VWS-MOV-403,-407, -422 and VWS-VLV-421, -423.	Containment Reactor Building
CCW supply and return line isolation valves, VWS-MOV-424, -425	Reactor Building

Table 2.7.3.6-2 Non-Essential Chilled Water System Piping Characteristics

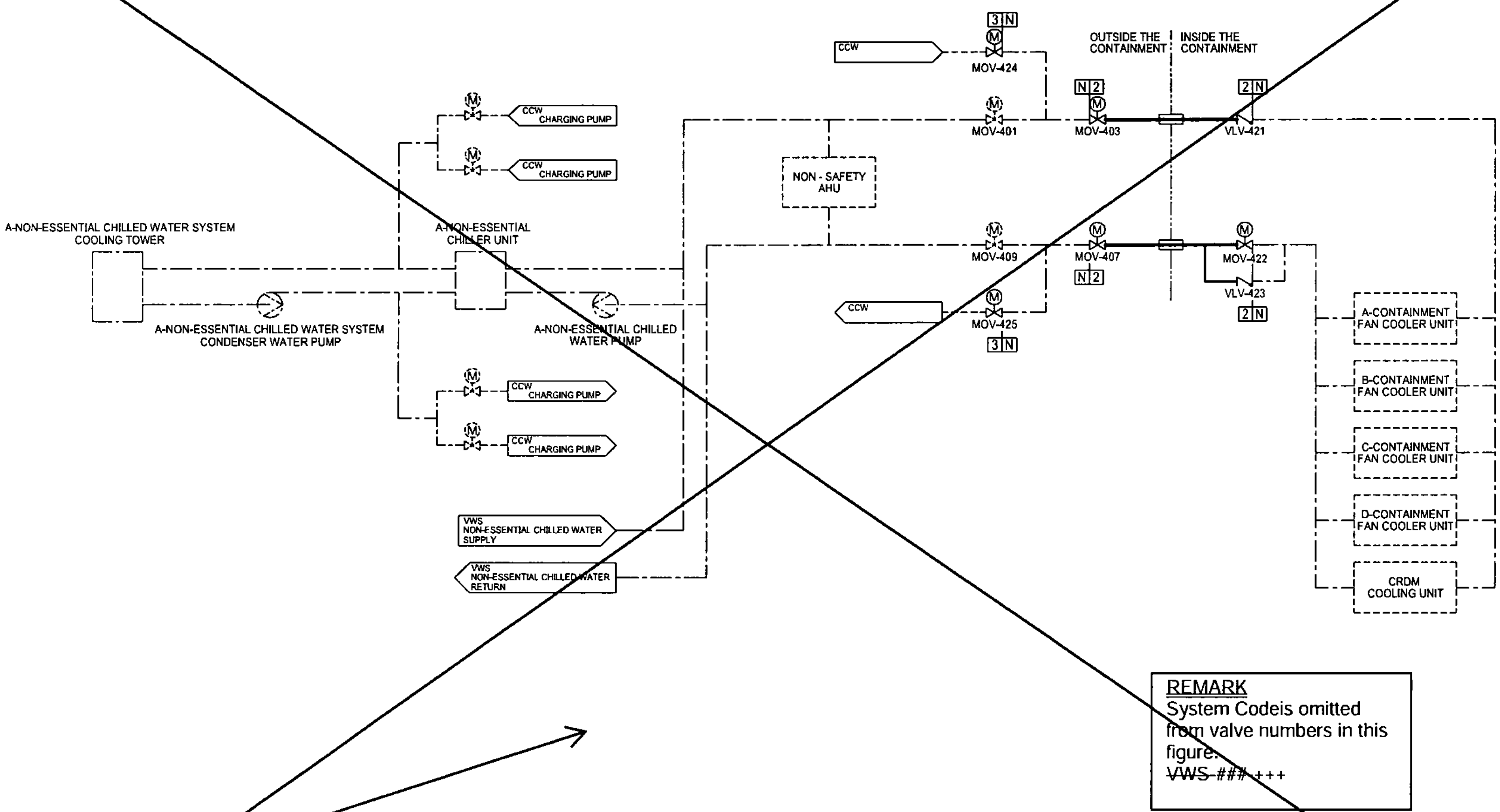
Pipe Line Name	ASME Code Section III Class	Seismic Category I
Non-Essential chilled water system piping and valves between and including the containment isolation valves, VWS-MOV-403,-407, -422 and VWS-VLV-421, -423.	2	Yes
CCW supply and return line isolation valves, VWS-MOV-424 and -425	3	Yes

NOTE:
Dash (-) indicates not applicable

Delete Tables 2.7.3.6-1 and 2.7.3.6-2

Table 2.7.3.6-3 Non-Essential Chilled Water System Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the non-ECWS is as described in the Design Description of Subsection 2.7.3.6.1 ~~and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1~~.	1. Inspection of the as-built non-ECWS will be performed.	1. The as-built non-ECWS conforms to the functional arrangement described in the Design Description of Subsection 2.7.3.6.1 ~~and in Table 2.7.3.6-1, and as shown in Figure 2.7.3.6-1~~.
2. Deleted.	2. Deleted.	2. Deleted.
3. Deleted.	3. Deleted.	3. Deleted.



Delete Figure 2.7.3.6-1

Figure 2.7.3.6-1 Non-Essential Chilled Water System

Table 3.2-2 Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 53 of 56)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards(3)	Seismic Category(4)	Notes
Essential chilled water chemical feed tank supply and return line piping and between and excluding the valves VWS-VLV0271A,B,C,D and VWS-VLV-274A,B,C,D	5	PS/B	N/A	N/A	4	II	
Piping from essential chilled water compression tank to and including the valves VWS-SRV-253A,B,C,D and VWS-VLV-254A,B,C,D	3	PS/B	C	YES	3	I	
46. Non-Essential Chilled Water System							
Non-essential chiller units Evaporator side Condenser side	 9 9	 A/B A/B	 N/A N/A	 N/A N/A	 5 5	 NS NS	
Non-essential chilled water pumps	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water compression tanks	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water system cooling towers	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water system condenser water pumps	9	A/B	N/A	N/A	5	NS	
Non-essential chilled water chemical feed tank	10	A/B	N/A	N/A	5	NS	
Piping and valves (except portion of the containment penetration)	9	PCCV R/B A/B PS/B T/B	N/A	N/A	5	NS	~~Piping and valves within areas containing safety-related equipment are designed as seismic category II.~~
(Deleted)							

Add row:

Piping and valves within areas containing safety-related equipment (except portion of the containment penetration)	**5**	**PCCV R/B A/B PS/B T/B**	**N/A**	**N/A**	**5**	**II**

Table 3.2-2 Classification of Mechanical and Fluid Systems, Components, and Equipment (Sheet 54 of 56)

System and Components	Equipment Class	Location	Quality Group	10 CFR 50 Appendix B (Reference 3.2-8)	Codes and Standards(3)	Seismic Category(4)	Notes
Piping and valves between and including the containment isolation valves VWS-MOV-403 and 421, VWS-MOV-422, VLV-423 and 407	2	PCCV R/B	B	YES	2	I	
~~Valves VWS-MOV-424,425~~	~~3~~	~~R/B~~	~~C~~	~~YES~~	~~3~~	~~I~~	
Non-essential chilled water chemical feed tank supply and return line piping and valves between VWS-VLV-571 and VWS-VLV-574	10	A/B	N/A	N/A	5	NS	
<u>47. Containment Hydrogen Control System</u>							
Igniters	4	PCCV	D	N/A	5	II	
<u>48. Radiation monitoring system</u>							
Piping and valves between and including the containment isolation valves	2	PCCV R/B	B	YES	2	I	
<u>49. Condensate Storage and Transfer System</u>							
Condensate storage tank	8	O/B	D	N/A	4	NS	
The components downstream condensate storage tank	8	O/B T/B	D	N/A	4	NS	
<u>50. Turbine Component Cooling Water System</u>							
All system components	8	T/B	D	N/A	5	NS	
<u>51. Non-Essential Service Water System</u>							
All system components	9	T/B	N/A	N/A	5	NS	
<u>52. Secondary Sampling System (SSS)</u>							

- Safeguard component area HVAC system
- Emergency feedwater pump area HVAC system
- Safety related component area HVAC system

Non-Essential Chilled Water System

The function of the non-essential chilled water system is to provide, during plant normal operation and LOOP, chilled water for the plant air cooling and ventilation systems serving the non-safety related areas.

9.2.7.1 Design Bases

9.2.7.1.1 Essential Chilled Water System

The essential chilled water system provides cooling water to various HVAC components during all plant operating conditions, including normal plant operation, abnormal and accident conditions. The essential chilled water system is designed to meet the relevant requirements of GDC 45, and GDC 46 (Ref.9.2.11-1).

9.2.7.1.1.1 ~~S~~ GDC 2, GDC 4, GDC 44,

The essential chilled water system is designed to satisfy the following safety design bases.

- The essential chilled water system equipment and component pressure boundary are designed in compliance with ASME Section III.
- A single failure of any active component, or LOOP, cannot result in a loss of chilled water service to the plant safety-related cooling and ventilation systems.
- The essential chilled water system and its distribution piping loop are designed to equipment class 3 and seismic category I to remain functional during and following a SSE.
- The safety-related portions of the ECWS are protected against natural phenomena and internal missiles.
- The essential chilled water system withstands the effects of adverse environmental, operating and accidental conditions.
- The essential chilled water system withstands the effects of tornadoes and tornado missiles.
- The essential chilled water system withstands the design loadings.
- The essential chilled water system meets GDC 2, by compliance, meeting the guidance of Regulatory Guide (RG) 1.29. The applicable sections of RG 1.29 include Position C.1 for safety related portions and Position C.2 for non-safety related portions.

9.2.7.1.1.2 Power Generation Design Bases

The essential chilled water system is designed to satisfy the following power generation design bases.

- The essential chilled water system supplies 40° F chilled water to the HVAC systems cooling coils during normal operation and design basis accidents.
- The essential chilled water system provides accessibility for adjustment, periodic inspection, and maintenance activities to assure continuous functional reliability.

9.2.7.1.2 Non-Essential Chilled Water System

The non-essential chilled water system is designed to meet the relevant requirements of GDC 45, and GDC 46 (Ref.9.2.11-1).

9.2.7.1.2.1 Safety Design Bases

The non-essential chilled water system, with the exception of piping and valves between and including the safety-related and seismic category I containment isolation valves, is classified as non-safety related~~, non-seismic category I system~~. This system is designed to satisfy the following safety design basis.

- The non-essential chilled water system provides containment isolation of the chilled water lines penetrating the containment.
- The safety-related portion of the non-essential chilled water system meets GDC 2, by compliance, meeting the guidance of Regulatory Guide (RG) 1.29. The applicable sections of RG 1.29 include Position C.1 for safety-related portions and Position c.2 for non-safety related portions.

9.2.7.1.2.2 Power Generation Design Bases

The non-essential chilled water system is designed to satisfy the following power generation design bases.

- The non-essential chilled water system supplies 40° F chilled water to the HVAC systems cooling coils during plant normal operation and LOOP.
- The non-essential chilled water system pressure boundary and pressure boundary components are designed to meet ASME Section VIII, and ASME/ANSI B31.1.
- The non-essential chilled water system does not serve any safety function. Therefore, the single failure criterion does not apply.
- The non-essential chilled water system provides accessibility for adjustment, periodic inspection, and maintenance activities to assure continuous functional reliability.

9.2.7.2 System Description

9.2.7.2.1 Essential Chilled Water System

The essential chilled water system flow diagram is shown in Figure 9.2.7-1, equipment and component data is presented in Table 9.2.7-1.

The operating data in Table 9.2.7-1 are determined at the system operating point, which is based on the abnormal operation condition, and are considered bounding values.

~~The essential chilled water system consists of four in~~dependent trains and each train ...cludes, a water-cooled chiller, a ~~up-w~~ater line, a chilled water ...em. The condenser (heat rejection) ~~section of each chiller is supplied with cooling water f~~rom the respective essential service water system during both normal and emergency operating conditions. The ECWS heat transfer and flow requirements for normal plant operation and abnormal conditions are shown in Table 9.2.7-2.

The motor operated three-way control valves are located on the retune lines from each safety-related air handling unit cooling coils. These valves control the heat removal capacity by modulating the flow rate of chilled water through the AHU cooling coils in response to a temperature control signal. ~~The motor operated three-way control valves~~ fail "as is" upon a loss of control signal or e...

The essential chiller units stop for one hour after a SBO occurs until alternate ac gas turbine generator restores power (Chapter 8, Section 8.4).

During LOOP, each of the essential chilled ... safety emergency power source.

The chiller of each essential chilled water system is equipped with an integral chilled water temperature control system.

The chillers are protected by a pressure-relief device to safely relieve pressure and are piped to outside of ... chiller mechanical ... refrigerating machi... that can actuate a... ~~each chiller is desi...~~

The essential chill... temperature. The ... operating range.

Essential chilled water system heat removal capacity is determined from the design requirements for the air handling unit cooling coils for safety-related HVAC systems, which include a conservative design margin (Section 9.4). The flowrate requirements for the chilled water pumps are determined by the heat removal requirements of the system loads. The required flowrate limits the temperature rise across individual AHU cooling coils to 16°F. The total pump flowrate is that required for all cooling coils in the train. Flowrate and heat load for each cooling load are provided in Table 9.2.7-2.

Upon receipt of an ECCS actuation signal, the operating essential chillers and pumps continue to run and the standby essential chillers and pumps start.

Demineralized quality water with corrosion inhibitors is circulated in the ECWS. No outsi~~de impurities are expected to be infiltrated in~~ the system, therefore, the ECWS filter is not ~~necessary.~~

The ECWS is a closed-loop system and water

~~Water~~ chemistry control of ECWS is performed by adding chemicals to the chemical feed tanks to prevent long-term corrosion that may degrade system performance. The chemical feed tanks are constructed of carbon steel. The chemical feed tanks are designed as non safety-related but seismic category II and are designed in accordance with ASME Section VIII. Manual isolation valves are installed in the piping between the chemical feed tank and the ECWS piping. These valves are normally locked closed.

The essential chilled water system is designed in consideration of the water hammer prevention and mitigation of its in accordance with the following as discussed in NUREG-0927.

- A compression tank to keep the system filled
- Vents for venting components and piping at all high points in the system.
- After any system drainage, venting is assured by personnel training and procedures.
- System valves are slow acting.

The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention. The procedures should address the plant operating and maintenance procedures for adequate measures to avoid water hammer due to a voided line condition.

9.2.7.2.1.1 Component Descriptions

The ECWS components are described below.

Essential Chiller Unit

The essential chiller unit is water-cooled type. Each essential chiller unit is designed to remove heat load from all the cooling coil of safety-related HVAC system of respective train it serves during all plant condition. Each essential chiller unit is designed to provide a sufficient quantity of chilled water to associated HVAC system chilled water cooling coils at a minimum 40°F of water temperature. Environmental safe refrigerants are being utilized in the chilled water systems chillers.

Essential Chilled Water Pump

Each essential chilled water pump is designed to supply chilled water to all the cooling coils of safety-related HVAC system for the respective train it serves during all plant condition. The pump is designed in consideration of fluctuation in the supplied electrical frequency, increased pipe roughness, and maximum pressure drop through the system components. The pumps are horizontal centrifugal pumps and driven by an ac induction motor. The pumps are designed quality group C as defined in Regulatory Guide 1.26, seismic category I, and are designed in accordance with the requirements of the ASME Section III, Class 3. The essential chilled water pumps have ~~sufficient~~ NPSH ~~available~~ due to system pressure pressurized by compression tank.

a minimum 10% margin to the required

The chilled water pump capacity provides a 10% design margin for required pump head.

Essential Chilled Water Compression Tank

The essential chilled water [illegible] respective essential chilled water pump. The compression tank accommodates the

Although the compression tank is pressurized with nitrogen, there is no flow through the tank and the volume of fluid out of the tank (such as during thermal contraction of the system fluid) is not significant relative to the volume of the system. Therefore, even with an assumption of nitrogen-saturated water within the tank, there is no potential for dissolved gas to affect pump performance.

the cooling water and potential leakage from the ...s the net positive suction head (NPSH) at the ... The compression tanks are compressed by nitrogen gas (compressed gas supply system (GGS)).

The potentially radioactively contaminated primary makeup water tank contents are prevented from flowing to the ECWS during filling by installed check valves (Figure 9.2.6-2). The ECWS is not expected to contain radioactively contaminated water.

Makeup water is supplied to the respective surge line. The makeup ... the following systems.

- Demineralized water system (DWS) which supplies the demine...
- Primary makeup water system (PMWS) which supplies the dea...

Deareated water is used for initial filing of this system and demineralized water is used for makeup when the tank water level reaches a low level setpoint.

The compression tank contains sufficient water volume to assure reliable system operation without makeup for at least seven days.

Chemical Feed Tank

The tank capacity includes margin in the volume requirement to accommodate minor system leakages, such as minor pump seal or valve packing leaks, since the tank capacity is double the required volume for thermal expansion and contraction alone.

...d by adding chemicals to the chemical feed ...egrade system performance. The chemical ...hemical feed tanks are designed as non safety-related but seismic category II and are designed in accordance with ASME Section VIII. Manual isolation valves are installed in the piping between the chemical feed tank and the ECWS piping. These valves are normally locked closed.

Piping

Carbon steel piping designed, fabricated, installed and tested in accordance with ASME Section III, class 3 requirements, is used for the safety-related portion of the ECWS. Piping is arranged to permit access for inspection.

Valves

- **ECW Compression Tank relief Valve**

The ECW compression tank relief valve provides compression tank and system overpressure protection. The valves discharge to the non-radioactive drain sump.

- **Check Valves**

The nitrogen supply line and makeup water supply line check valves are designed to maintain ECW system pressure in the event of failure of the non-seismic support system.

- **Chilled Water Control Valves**

The motor operated three-way control valves are located on retune lines from each safety-related air handling unit cooling coils. These valves control the heat removal capacity by modulating the flow rate of chilled water through the AHU cooling coils in

Insert A

response to a temperature control signal. The motor operated three-way control valves fail "as is" upon a loss of control signal or electrical power.

9.2.7.2.2 Non-Essential Chilled Water System

The non-essential chilled water system flow diagram is shown in Figure 9.2.7-2. The non-essential chilled water system consists of four water-cooled chillers, four chilled water pumps, a compression tank with a make-up water line, a chilled water distribution loop, and an instrumentation and control system. The condenser (heat rejection) section of each chiller is supplied with cooling water from a dedicated cooling tower. Each chiller is sized for one-third of the total non-essential chilled water load.

The chillers are protected by a pressure-relief device to safely relieve pressure and are piped to outside of the building in accordance with ANSI/ASHRAE Standard 15. And the chiller mechanical equipment rooms meet ANSI/ASHRAE Standard 15 requirements for refrigerating machinery rooms including being equipped with refrigerant leak detectors that can actuate an alarm in MCR and tightfitting doors. The pressure-relief device for chiller is designed to prevent the discharge from entering any building.

When the non-essential chilled water system is energized, the chilled water pump, the condenser water pump, and the cooling tower fans will start. When both the chilled and condenser water flows are established, the chillers will start to satisfy the plant non-safety cooling load. The non-essential chilled water system control maintains the chilled water supply temperature at the design setpoint. The compression tank maintains the system pressure within the design operating range.

Insert B

During the LOOP condition, the non-essential chilled water system is powered from the alternate ac power source.

9.2.7.3 Safety Evaluation

9.2.7.3.1 Essential Chilled Water System

As shown in Table 9.2.7-3, the

The essential chilled water system is designed to perform its safety function with only two out of four trains operating. ~~The~~ essential chilled water system is completely separate and a single failure does not compromise the system's safety function even if one train is out of service for maintenance.

The physical separation of the redundant system and the associated components assures the continuous operation of the essential chilled water system.

The system is classified as equipment class 3, seismic category I. The system pressure boundary is designed in accordance with ASME Section III to assure the continuous integrity of the system pressure boundary under all modes of operation.

R The safety-related portions of the ECWS are protected against natural phenomena and internal and their heat r ate safety related essential service water system.

~~Casings of the chiller refrigerant compressor and the chilled water pumps are designed to withstand penetration by internally generated~~ missiles.

The description of the inspection and testing of equipment class 2 containment isolation components is provided in Chapter 6, Section 6.6, Inservice Inspection of Class 2 and 3 Components.

9.2.7.5 Instrumentation Requirements

9.2.7.5.1 Essential Chilled Water System

Delete.

~~Safety-related instrumentation and control associated with the essential chilled water system meets the requirements of IEEE Std. 603 and are qualified in accordance with IEEE Std. 323 and IEEE Std. 344.~~

from

The chiller units and pumps are operable ~~form~~ the MCR. The following instrumentation and controls servicing the essential chilled water system and provided in the MCR include:

Insert C

- ~~Temperature indication of chiller units entering and leaving chilled water with an alarm for leaving chilled water temperature exceeding the design limit~~
- ~~High and low pressure indication with an alarm of the compression tanks~~
- ~~Chilled water flow failure of the chilled water pumps~~
- ~~Categorical alarms for chiller operation malfunction~~

The following local instrumentation is provided for surveillance and maintenance:

- Temperature indicator for chillers, chilled water and condenser water entering and leaving water flows
- Pressure indicator at chilled water and condenser water entering and leaving water flows
- Pressure indicator at the chilled water pumps suction and discharge nozzles
- Chiller oil pressure indicators, suction pressure indicator and discharge pressure indicators

9.2.7.5.2 Non-Essential Chilled Water System

• High and low level indication with an alarm of the compression tanks

The following instrumentation and controls serving the non-essential chilled system and provided in the MCR include:

- Temperature indication of entering and leaving chilled water and condenser water with an alarm for leaving chilled water temperature exceeding the design limit
- High and low pressure alarms of the compression tanks
- Chilled water flow failure of the chilled water pumps
- Categorical alarms for chiller operation malfunction

Table 9.2.7-1 Essential Chilled Water System Component Design Data

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

Table 9.2.7-2 Essential Chilled Water Heat Load and Flow Rate (Sheet 1 of 2)

Train	Component	Flow rate (gpm)		Heat Load (10^3 Btu/h)	
		Normal Operation	Abnormal Operation	Normal Operation	Abnormal Operation
A	Main Control Room AHU	45	5	1	341
	Class 1E electrical room AHU	~~285~~ 288	~~285~~ 288	1,650	1,650
	Safeguard component area AHU	-	26	-	0
	Emergency feedwater pump area AHU	11	11	~~60~~ 62	~~60~~ 62
	Penetration area AHU	-	42	-	330
	Annulus emergency exhaust filtration unit area AHU	-	4	-	10
	CCW pump area AHU	-	4	-	30
	Essential chiller unit area AHU	-	4	-	30
	Charging pump area AHU	-	4	-	10
	Spent fuel pit pump area AHU	-	15	-	100
B	Main Control Room AHU	45		41	341
	Class 1E electrical room AHU	~~285~~ 288	~~285~~ 288	1,650	1,650
	Safeguard component area AHU	-	26	-	180
	Emergency feedwater pump area AHU	-	15	-	110
	Penetration area AHU	-	42	-	330
	Annulus emergency exhaust filtration unit area AHU	-	4	-	10
	CCW pump area AHU	-	4	-	30
	Essential chiller unit area AHU	-	4	-	30
	Spent fuel pit pump area AHU	-	15	-	100

Note:
(1) Dash (-) indicates no requirement:

Table 9.2.7-2 Essential Chilled Water Heat Load and Flow Rate (Sheet 2 of 2)

Train	Component	Flow rate (gpm)		Heat Load (10^3 Btu/h)	
		Normal Operation	Abnormal Operation	Normal Operation	Abnormal Operation
C	Main Control Room AHU	45	288	288	341
	Class 1E electrical room AHU	~~285~~	~~285~~	~~2,250~~ 2,290	~~2,250~~ 2,290
	Safeguard component area AHU	-	26	-	180
	Emergency feedwater pump area AHU	-	15	-	110
	Penetration area AHU	-	42	-	330
	Annulus emergency exhaust filtration unit area AHU	-	4	-	10
	CCW pump area AHU	-	4	-	30
	Essential chiller unit area AHU	-	4	-	30
	Spent fuel pit pump area AHU	-	15	-	100
D	Main Control Room AHU	45	288	288	341
	Class 1E electrical room AHU	~~285~~	~~285~~	~~2,250~~ 2,290	~~2,250~~ 2,290
	Safeguard component area AHU	-	26	-	180
	Emergency feedwater pump area AHU	11	11	~~60~~ 62	~~60~~ 62
	Penetration area AHU	-	42	-	330
	Annulus emergency exhaust filtration unit area AHU	-	4	-	10
	CCW pump area AHU	-	4	-	30
	Essential chiller unit area AHU	-	4	-	30
	Charging pump area AHU	-	4	-	10
	Spent fuel pit pump area AHU	-	15	-	100

Note:
(1) Dash (-) indicates no requirement:

(2) The trains C and D Class 1 Electrical Room AHU heat load conservatively includes additional non-safety related heat loads. This higher heat load is used for the heat removal capability design for each of the ECWS trains.

Insert D

9.4.6.5.4.2 Containment High Volume Purge System

The instrumentation and controls serving the containment high volume purge system includes:

- Alarm on low airflow.
- Indication of differential pressure across the filters and differential pressure high alarm.
- Alarm high radiation for the containment purge air.

9.4.7 Combined License Information

COL 9.4(1) Deleted

heating coils provided in the safety-related HVAC system and the capacity of

COL 9.4(2) Deleted

COL 9.4(3) Deleted

COL 9.4(4) The COL Applicant is to determine the capacity of cooling and heating coils provided in the air handling units that are affected by site specific conditions.

non-safety related HVAC system

COL 9.4(5) Deleted

COL 9.4(6) The COL Applicant is to provide a system information and flow diagram of ESW pump area ventilation system if the ESW pump area requires the heating, ventilating and air conditioning.

9.4.8 References

9.4.8-1 "Nuclear Power Plant Air-Cleaning Units and Components," ASME N509-1989.

9.4.8-2 "Code on Nuclear Air and Gas Treatment," ASME AG-1-2003.

9.4.8-3 "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plans," Regulatory Guide (RG) 1.52, Revision 3.

9.4.8-4 "Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors," Regulatory Guide (RG) 1.195.

9.4.8-5 "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Regulatory Guide (RG) 1.183.

9.4.8-6 "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," Regulatory Guide (RG) 1.197.

Insert A

9.2.7.2.1.2 System Operations

Table 9.2.7-2 provides heat loads and water flow rates for individual ECWS heat loads for normal and abnormal operating modes.

9.2.7.2.1.2.1 Normal Power Operation

During normal operation, two trains of ECWS are placed in service. A total of two essential chilled water pumps and two essential chiller units are in operation. An operating essential chilled water pump supplies chilled water to cooling coils of safety-related HVAC systems through the chiller units. The chiller units and pumps that are not in service are placed in standby. In the event that a required chiller unit malfunctions or trips, a standby chiller unit can be manually placed in service.

The essential chiller units can be controlled manually from the MCR or RSC.

The chiller unit includes a start permissive that ensures that chilled water and condenser water flows are established prior to chiller unit start.

9.2.7.2.1.2.2 Loss of Offsite Power

In the event of a LOOP, four essential chilled water pumps and four essential chiller units are powered from the emergency power source and they are actuated automatically by the LOOP load sequence signal. As a minimum, two trains are required to operate during a LOOP.

9.2.7.2.1.2.3 Loss of Coolant Accident

In the event of a LOCA, four essential chilled water pumps and four essential chiller units are actuated automatically upon receipt of the ECCS actuation signal, and are loaded onto their respective Class 1E power source. As a minimum, two trains are required to operate during a LOCA."

Insert B

The non-ECWS is capable of performing alternate cooling of the containment fan cooler units through CCWS and the alternate source of component cooling water to the charging pump in a severe accident. The non-ECWS cooling tower and condenser water pump are capable of providing the alternate source of component cooling water to the charging pump in order to maintain RCP seal water injection.

9.2.7.2.2.1 System Operations

9.2.7.2.2.1.1 Normal Power Operation

During plant startup, shutdown, and power operation, and while in cold shutdown/refueling conditions, three non-essential chilled water pumps and three non-essential chiller units, including dedicated cooling towers and condenser pumps, are operated. The additional train of equipment is placed in standby.

9.2.7.2.2.1.2 Loss of Offsite Power

During the LOOP conditions, two non-essential chilled water pumps and two non-essential chiller units are powered from the permanent non-safety power distribution system and are actuated automatically. In the event of a LOOP, the non-essential chilled water pumps and the non-essential chiller units are actuated to protect property and assets.

9.2.7.2.2.1.3 Loss of Coolant Accident

In the event of a LOCA, the non-ECWS containment isolation valves are automatically closed upon receipt of the containment isolation signal.

9.2.7.2.2.1.4 Severe Accident

The CCWS can be manually aligned to supply the cooling water to the containment fan cooler units via the non-ECWS for mitigating containment failure in a severe accident condition.

The non-ECWS can be manually aligned to provide an alternate source of component cooling water to the charging pumps via the CCWS in order to maintain RCP seal water injection in the event of a loss of component cooling water in a severe accident condition.

Insert C

- Chiller units entering and leaving chilled water temperature – Chiller unit entering and leaving chilled water temperature is indicated in the MCR. Leaving chilled water temperature exceeding the design limit actuates an alarm in the MCR to alert the operator to an abnormal chiller unit condition.

- Compression tank pressure – Compression tank pressure is indicated in the MCR. The compression tank nitrogen gas supply valve is controlled with open-closed control so that the tank pressure is maintained within a pre-set range. High and low compression tank pressure is alarmed in the MCR to alert the operator to an abnormal condition of the compression tank.

- Compression tank level - Compression tank level is indicated in the MCR. The compression tank makeup water control valve is modulated so that the tank level is maintained within a pre-set range. High and low compression tank level is alarmed in the MCR to alert the operator to an abnormal condition of the compression tank.

- Chilled water flowrate – Chilled water flowrate is indicated in the MCR. Abnormally low flowrate indicates a potential malfunction or failure of the chilled water pump. The low flowrate indication alerts the operator to an abnormal chiller unit condition.

- Chiller unit malfunction - Categorical alarms is provided in the MCR to alert the operator to a chiller operation malfunction.

Insert D

Table 9.2.7-3 Essential Chilled Water System Failure Modes and Effects Analysis

Item	Component	Safety Function	Failure Mode	Effect on System Safety Function	Failure Detection Method
1	Essential Chiller Unit	Provides chilled water to safety-related HVAC AHU cooling coils	Fails to provide chilled water	None Three 50% capacity Essential Chiller Units remain available. Only two are required.	Essential Chiller Unit operating information in the MCR includes RUN indication, high temperature alarm, temperature indication and flow indication.
2	Essential Chilled Water Pump	Provides chilled water flow to safety-related HVAC AHU cooling coils	Fails to provide chilled water flow	None Three 50% capacity Essential Chilled Water Pumps remain available. Only two are required.	Essential Chilled Water Pump operating information in the MCR includes RUN indication and flow indication.