REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**269-8319**
SRP Section:	**09.02.02 – Reactor Auxiliary Cooling Water System**
Application Section:	**09.02.07**
Date of RAI Issue:	**10/22/2015**

Question No. 09.02.02-12

The essential chilled water system (ECWS) must be capable of removing heat from structures, system and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance GDC 44 requirements. The ECWS description and flow diagrams in DCD Tier 2, Section 9.2.7, were reviewed to assess the design adequacy of the ECWS for performing its heat removal functions. While the description and figures show the ECWS components and identifies the boundaries between safety-related and nonsafety-related parts of the system, some of the information is incomplete, or inconsistent. The staff notes that:

a) Nominal pipe sizes are not shown on the DCD Tier 2, Section 9.2.7, figures and the system description does not explain the criteria that are used for establishing the appropriate pipe sizes (e.g. limiting flow velocities).

b) Filters or strainers are not shown in the DCD Tier 2, Section 9.2.7 figures and DCD Tier 2, Section 9.2.7, does not discuss how particulate and other foreign material will be controlled in the system.

c) SRP 9.2.2 specifies that essential components and subsystems can function as required in a loss of offsite power and instrument air systems. DCD Tier 2 describes the ECW control valves as air-operated three-way control valves that fail open upon a loss of control signal or electrical power. However, the DCD does not discuss or evaluate the impact the ECW control vales have on the system when they fail closed due to loss of instrument air.

d) SRP 9.2.2 states the system should be designed for removal of heat loads during normal operation and for emergency core cooling heat loads during accident conditions with appropriate design margins for adequate operation. It is not apparent to the staff that the design of the ECWS pumps and chillers have appropriate design margin to

account for uncertainties, component wear and aging effects, fouling of heat exchangers.

e) SRP 9.2.2 states the application should describe allowable component operational degradation (e.g., pump leakage) and the procedures followed to detect and correct these conditions when degradation becomes excessive. In addition, it states the seismic source of makeup can be made available within a time frame consistent with the surge tank capacity (time zero starts at low level alarm). DCD Tier 2, Section 9.2.7.2.1.2, describes the ECW compression tank; however, it does not include an evaluation of the assumed leak rate through sources such as boundary valves, packing, pump seals, and unidentified leakage, or the timeliness of the ECW makeup pump to provide water to the system.

Response - (Rev. 1)

a) Figure 9.2.7-1 is a simplified flow diagram; therefore, nominal pipe sizes are not shown. The pipe in the essential chilled water system is sized in accordance with engineering practices that determine appropriate pipe size to limit chilled water velocity in the pipe to below the design guideline velocity.

b) Strainers are installed in the construction phase and removed prior to plant operation. The essential chilled water system is a closed-loop system, and impurities cannot infiltrate into the system. The essential chilled water system is filled and circulated with clean demineralized water; therefore, a filter or strainer is not required or provided in the system during plant operation and is not shown in Figure 9.2.7-1.

c) The ECW control valves are air-operated three-way valves that are designed to be fail open upon loss of instrument air. DCD Tier 2, Subsection 9.2.7.2.1 will be revised to indicate that the ECW control valves are fail open upon loss of instrument air and DCD Tier 2, Figure 9.2.7-1 will be revised to change the symbol of the ECW control valves to be consistent with the symbol used as fail open for control valves in DCD Tier 2, Figure 1.7-1.

d) The ECWS pumps are designed to have at least 10 percent margin on the pump head as described in DCD Tier 2, Subsection 9.2.7.2.1.2, considering uncertainty and performance degradation. The chilled water flow rate of the ECWS is calculated using a cooling load, which has 10 percent margin. The ECWS chillers are sized based on the calculated chilled water flow rate and are designed to have no additional margin because the chilled water flow rate already accounts for 10 percent margin. ECW chillers are manufactured applying tube fouling factor of 0.0005 $hr \cdot ft^2 \cdot °F/btu$. The essential chilled water system is filled and circulated with clean demineralized water and corrosion inhibitors are manually fed into the system from the essential chilled water chemical additive tank for anticorrosion. KHNP believes that these design considerations will minimize the potential for future fouling and tube plugging and the 10 percent chilled water flow margin is adequate to compensate for future fouling and potential tube plugging.

e) The normal leak rate of the ECWS is calculated as 80 gallons per day (gpd) based on the leak rate from pumps as 50 gpd and the leak rate from valves as 30 gpd in accordance with ANS 56.6. The ECWS compression tanks are designed to have a capacity to accommodate the normal leakage for at least 7 days without normal makeup as described in DCD Tier 2, Subsection 9.2.7.1.2. DCD Tier 2, Subsection 9.2.7.1.2 will be revised to identify the normal ECWS leak rate that the compression tank accommodates. In addition, the makeup demineralizer system provides makeup water to the ECWS when the compression tank does not maintain its required level and the ECWS makeup pump provides makeup water to the ECWS in case of a loss of demineralized water, as described in DCD Tier 2, Subsection 9.2.7.2.1.

Impact on DCD

DCD Tier 2, Subsections 9.2.7.1.2, 9.2.7.2.1, and Figure 9.2.7-1 will be revised as shown in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

The pump is selected to overcome the system pressure at the design operating conditions. The pump is a horizontal, centrifugal type with single-speed electric motor drive. The essential chilled water pump is designed in accordance with the requirements of ASME Section III, Class 3. The pumps provide a 10 percent margin for the head at the pump design point. The pumps have sufficient available NPSH as a result of the static pressure pressurized by the essential chilled water compression tank. The available NPSH is a minimum of 25 percent greater than the required NPSH specified by the pump vendor. The available NPSH is calculated with the highest expected operating temperature, maximum flow, and minimum expected compression tank water level.

Essential Chilled Water Makeup Pump

The essential chilled water makeup pump is provided to supply makeup water from the AFWST to the ECWS in case of a loss of demineralized water. The pump is selected to overcome the system pressure in the design operating conditions. The pump is a horizontal, centrifugal type with single-speed electric motor drive. The essential chilled water pump is designed in accordance with the requirements of ASME Section III, Class 3. The pumps are provided with a margin of at least 10 percent in the head at the pump design point.

Essential Chilled Water Compression Tank

The essential chilled water compression tank is provided to accommodate the thermal expansion and contraction of the chilled water and potential leakage from the ECWS. The compression tank is connected to the suction of the essential chilled water pumps to prevent pump cavitation. The compression tank is also provided to maintain a minimum pressure in the ECWS because it prevents in-leakage of air into the water. The tank is compressed by nitrogen gas.

The compression tank accommodates

The compression tank contains sufficient water volume to provide reasonable assurance of reliable system operation without normal makeup for at least 7 days. ~~The tank capacity includes~~ the water volume due to thermal expansion and contraction and minor system leakage ~~such as pump seal and valve seat leaks~~ for 7 days.

The compression tank is designed in accordance with the requirements of the ASME Section III, Class 3.

of 80 gallons per day from pump and valve seals

The air-operated three-way control valves are supplied on return lines from each cooling coil of the safety-related AHUs. 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 three-way control valves fail open upon a loss of ~~control signal or electric power.~~ control signal, electric power, or instrument air.

9.2.7.2.2 Plant Chilled Water System

The PCWS provides chilled water for cooling to all non-safety-related HVAC equipment cooling coils and process equipment in the auxiliary building, turbine generator building, and compound building.

The PCWS consists of the following subsystems:

a. Central chilled water subsystem

b. Compound building chilled water subsystem

The central chilled water subsystem consists of four chillers, two chilled water pumps, an air separator, a compression tank, a chemical additive tank, associated piping, valves, and instrumentation and controls. Cooling water for each chiller condenser is supplied from the CCWS. This subsystem provides chilled water to the non-safety-related cooling coils of reactor containment fan coolers (RCFCs) and reactor cavity air handling unit (AHU) located in the reactor containment building. This subsystem also provides the non-safety-related cooling coils of AHUs and cubicle coolers located in the auxiliary building and turbine generator building.

The compound building chilled water subsystem consists of three chillers, two chilled water pumps, an air separator, a compression tank, a chemical additive tank, associated piping, valves, and instrumentation and controls. Cooling water for each chiller condenser is supplied from the CCWS. Two chillers and one pump in this subsystem provide chilled water to the non-safety-related cooling coils of AHUs and cubicle coolers in the compound building and the shellsides of waste gas dryers in the GRS in the compound building when required.

The compression tanks maintain the required minimum pressure in the system and accommodate the liquid volume expansion and contraction resulting from system

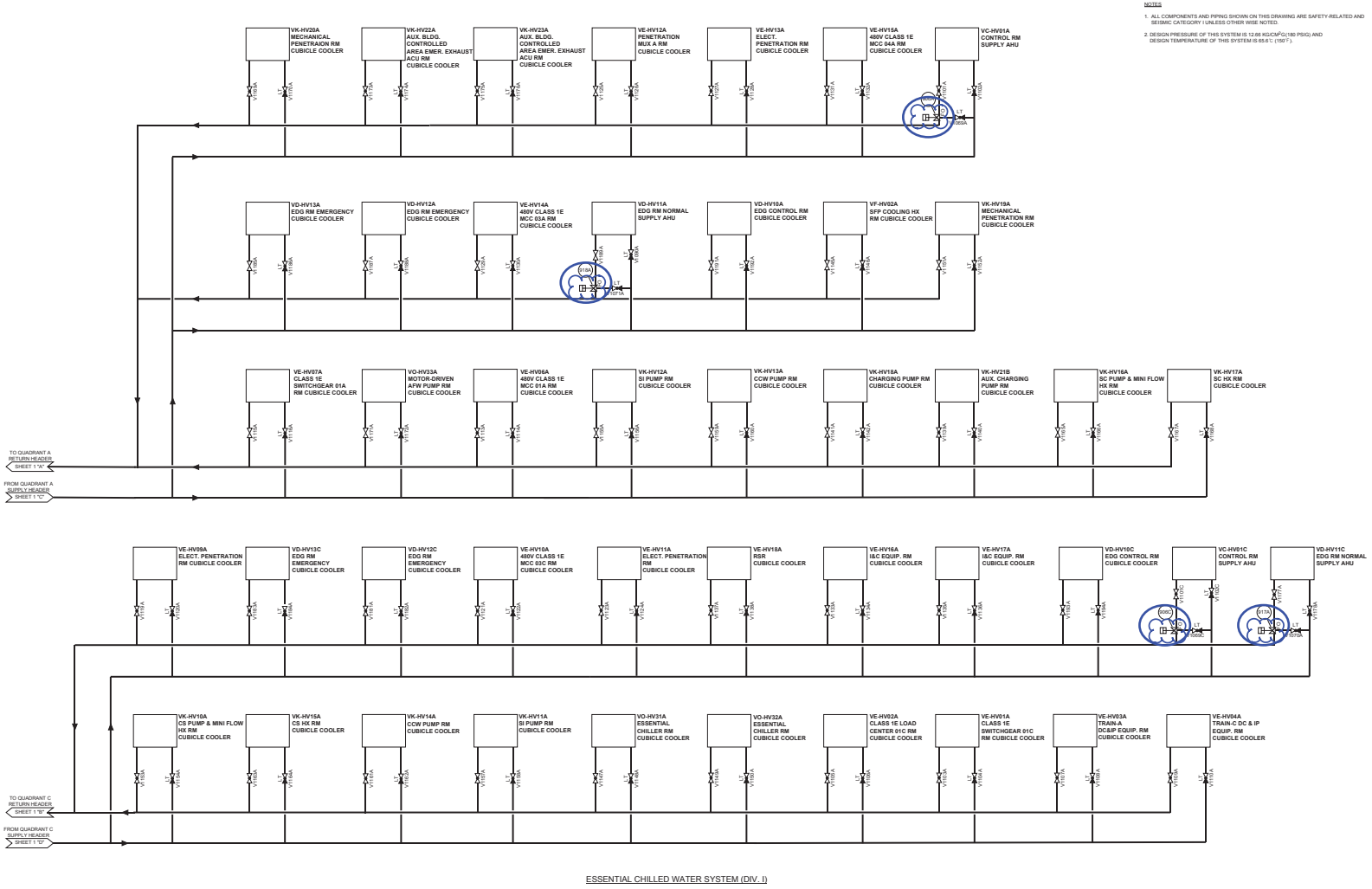

Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 2 of 4)

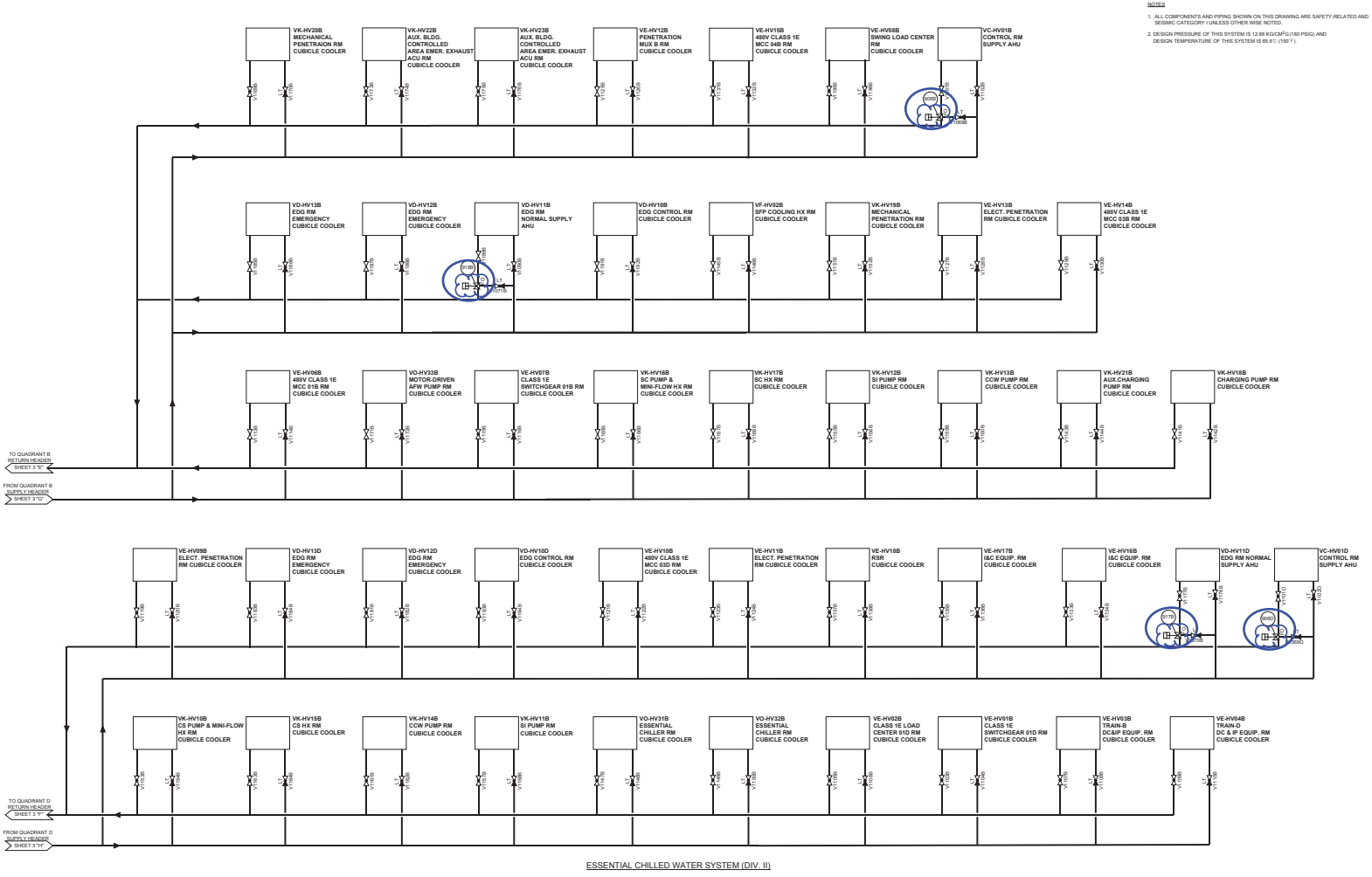

Figure 9.2.7-1 Essential Chilled Water System Flow Diagram (Sheet 4 of 4)

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Question No. 09.02.02-13

GDC 45 and 46 require that the essential cooling water system (ECWS) be designed to allow for periodic inspection and testing, respectively. SRP 9.2.2 specifies that the application delineates a testing and inspection program, and the system drawings show the necessary test recirculation loops around pumps or isolation valves necessary for this program.

The staff reviewed DCD Tier 2, Section 9.2.7, and associated tables and figures to determine whether the design of the ECWS allows periodic testing and inspection. However, it is not clear to the staff whether:

a) All portions of the ECWS are accessible in the auxiliary building

b) The current design allows for component maintenance due to the absence of isolation/maintenance valves.

Response - (Rev. 1)

a) DCD Tier2, subsection 9.2.7.1.1.1.i states that the essential components are accessible for inspection. It will be revised to say that the ECWS components are accessible for periodic inservice testing, inspection, and maintenance.

b) Isolation valves are provided on the inlet and outlet of components such as essential chillers and essential chilled water pumps to provide component isolation during component maintenance. Butterfly valves are provided on the inlet and outlet of the essential chillers as shown in Figure 9.2.7-1. And a butterfly valve is provided on the suction side of each essential chilled water pump and a globe valve is provided on the discharge side of each essential chilled water pump. However, the globe valves are not currently shown in Figure 9.2.7-1. Figure 9.2.7-1 will be revised to add a globe valve on the discharge side of each essential chilled water pump. The existence of isolation valves will not be described additionally in the DCD.

Impact on DCD

DCD Tier 2, subsection 9.2.7.1.1.1 and Figure 9.2.7-1 will be revised as shown in the Attachment.

Impact on PRA

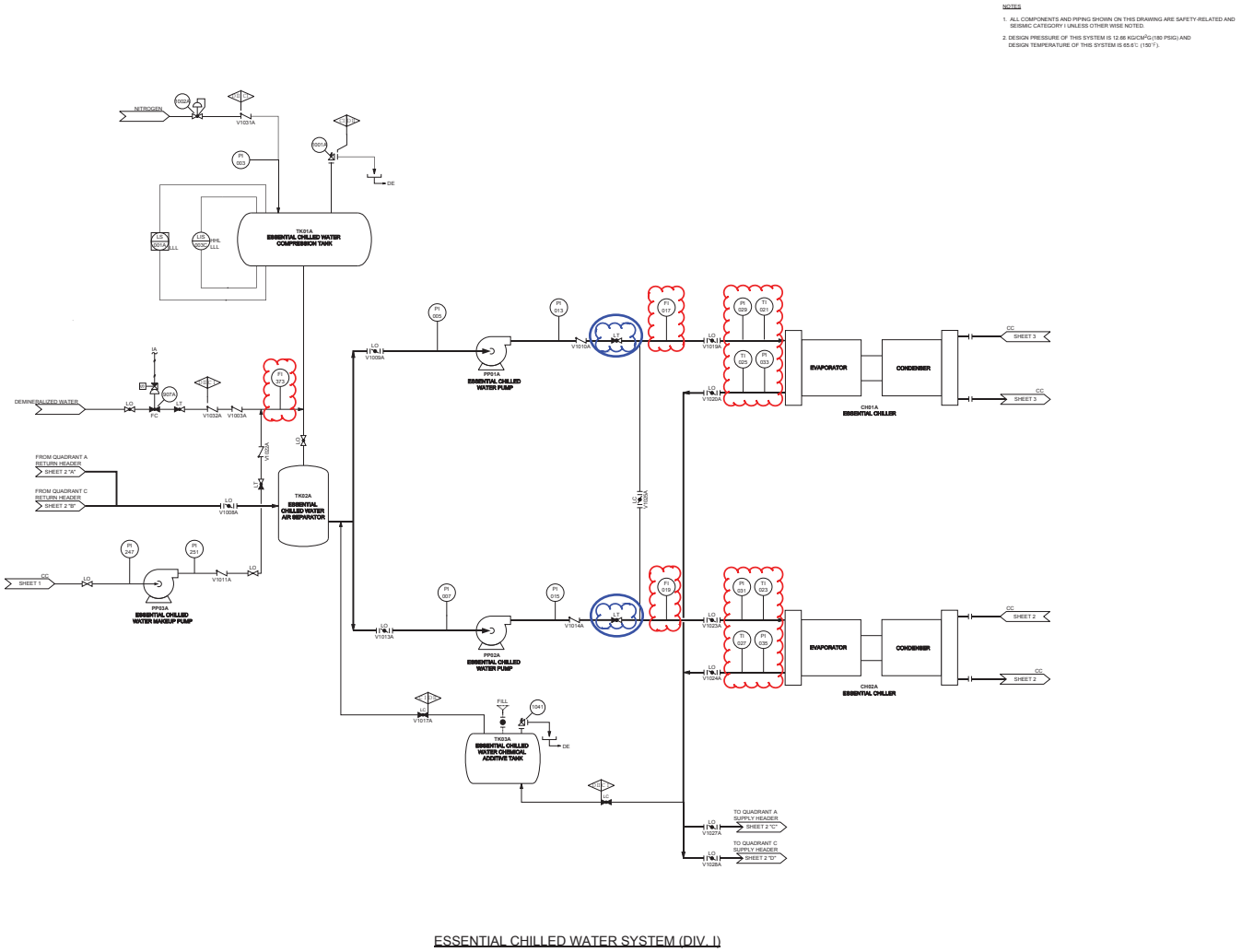
There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

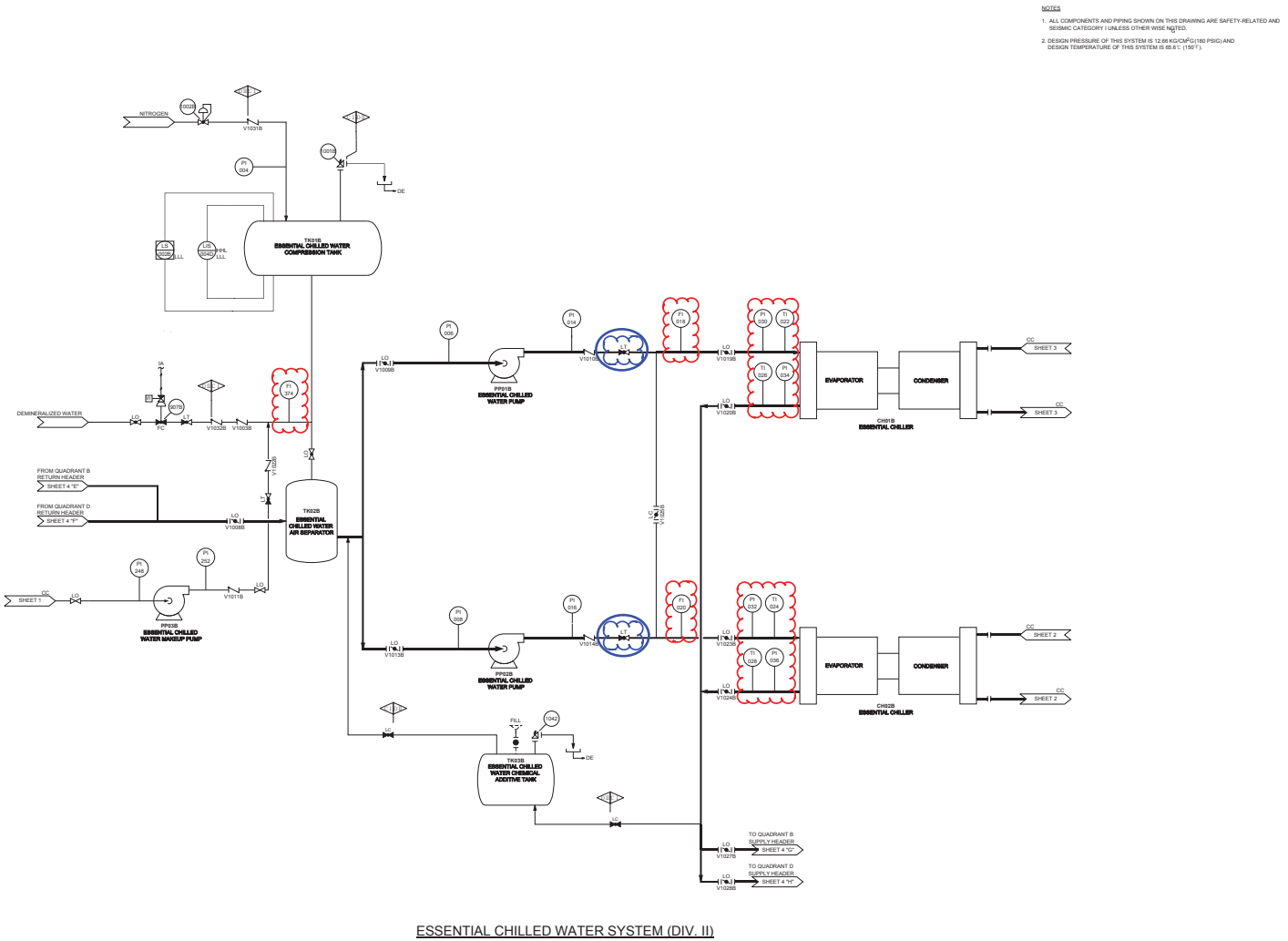
Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.



ESSENTIAL CHILLED WATER SYSTEM (DIV. I)

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



ESSENTIAL CHILLED WATER SYSTEM (DIV. II)

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