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.:	**101-8007**
SRP Section:	**09.05.05 – Emergency Diesel Engine Cooling Water System**
Application Section:	**09.05.05**
Date of RAI Issue:	**07/22/2015**

Question No. 09.05.05-1

Section 9.5.5 of NUREG-0800 states that the staff is to assure that essential emergency diesel engine cooling water system (EDECWS) portions, including the isolation valves separating essential and non-essential portions, are classified as quality Group C and Seismic Category I.

DCD Tier 2, Figure 9.5.5-1 contains the interface between the nonsafety-related pre-heat water system and the safety-related portions of the high temperature (HT) cooling water system. The figure shows an isolation valve classified as seismic category II and quality group D.

The applicant is requested to justify how this classification is sufficient to protect a safety-related, seismic category I system, in the event of failure of a nonsafety-related SSC.

Response

The isolation valve is designed and classified as seismic Category I and quality group C.

Affected material in DCD Tier 1 and Tier 2 will be revised.

Impact on DCD

DCD Tier 1, Table 2.6.2-2 and Tier 2, Figure 9.5.5-1 and Tables 3.9-4, 3.9-13, and 3.11-3 will be revised as indicated on the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

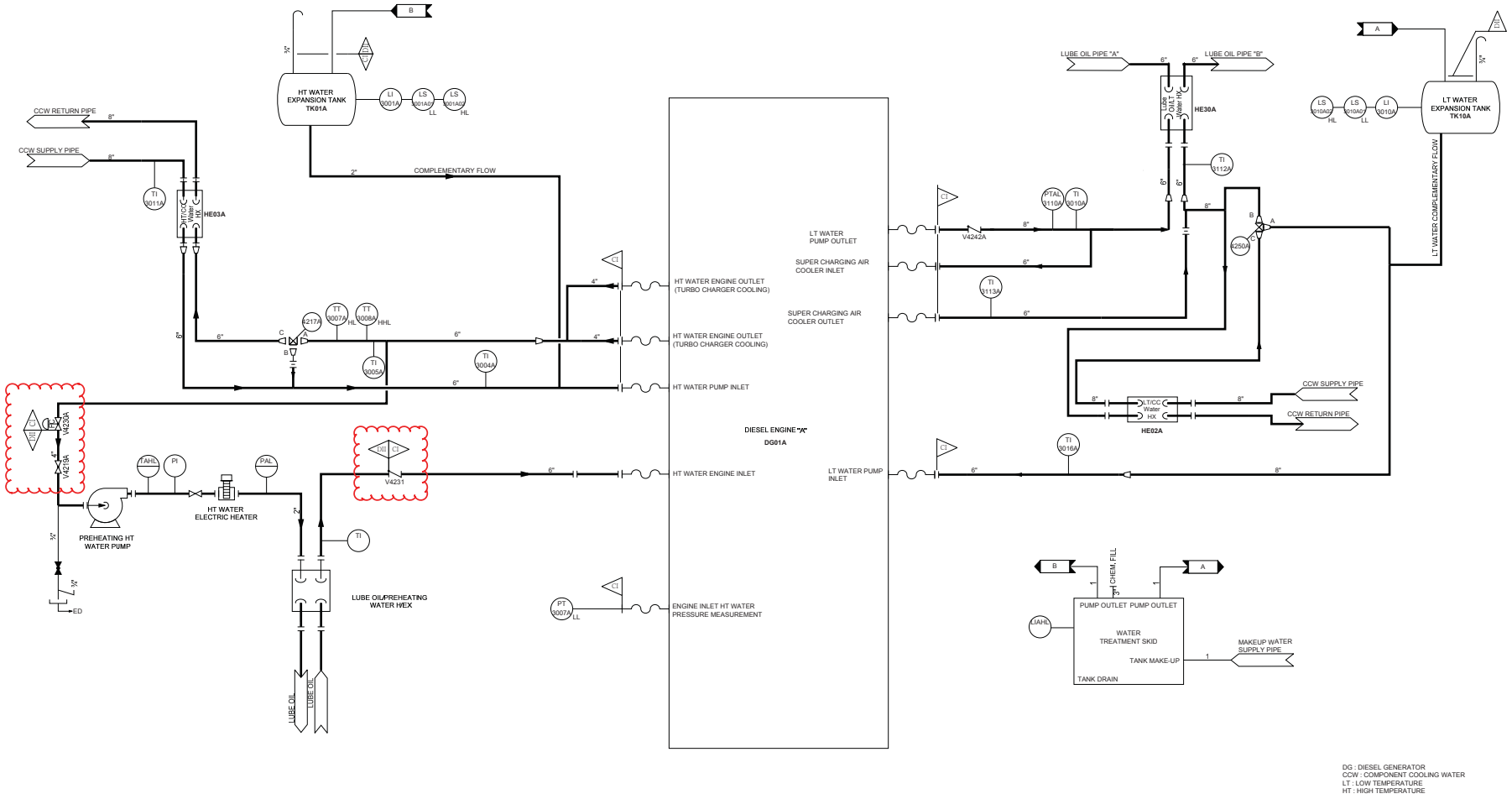
Impact on Technical/Topical/Environmental Reports

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

Table 2.6.2-2 (1 of 3)

Emergency Diesel Generator System Components List

Component Name	Item No. (1), (2)	Location (2)	ASME Section Class	Seismic Category	Class 1E/Qual. for Harsh Envir.	Display/ Control at MCR	Display/ Control at RSR	Active Safety Function	Position at Loss of Motive Power
EDG Engines and Generators	DG-DG01 A/B/C/D	EDG/Aux. Building	3	I	Yes/No	Yes/Yes	Yes/Yes	Start	-
EDG fuel oil storage tanks	DO-TK01 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
EDG fuel oil transfer pumps 01	DO-PP01 A/B/C/D	EDG/Aux. Building	3	I	Yes/No	No/No	No/No	Start	-
EDG fuel oil transfer pumps 02	DO-PP02 A/B/C/D	EDG/Aux. Building	3	I	Yes/No	No/No	No/No	Start	-
EDG fuel oil day tanks	DO-TK02 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
EDG fuel oil transfer pump discharge line check valves	DO-CV-1005 A/B/C/D DO-CV-1007 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
HT water expansion tanks	DG-TK01 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
HT/CC water heat exchangers	DG-HE03 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
HT water thermostat valves	DG-3W-4217 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	Open/Close	-
LT water expansion tanks	DG-TK10 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-
Preheating HT water pump inlet isolation valves	DG-GV-4230 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	Open/Close	Close
HT water inlet isolation valves	DG-CK-4231 A/B/C/D	EDG/Aux. Building	3	I	-/No	No/No	No/No	-	-



TRAIN A IS INDICATED AS REPRESENTATIVE OF TRAINS B, C, AND D.

Figure 9.5.5-1 Emergency Diesel Engine Cooling Water System Flow Diagram (Sheet 1 of 1)

Table 3.9-4 (13 of 22)

Valve No.	System Name (Safety Function) (1) (2) (3)	Valve Type	ASME Section III Class	Actuator Type
WM-1752	Demineralized water makeup system containment isolation (operate)	Check	2	None
DG-5023A	Safety relief valve	Safety	3	None
DG-5023B	Safety relief valve	Safety	3	None
DG-5023C	Safety relief valve	Safety	3	None
DG-5023D	Safety relief valve	Safety	3	None
DG-5031A	Safety relief valve	Safety	3	None
DG-5031B	Safety relief valve	Safety	3	None
DG-4030A	Gate valve	Gate	3	Pneumatic
DG-4030B	Gate valve	Gate	3	Pneumatic
DG-4030C	Gate valve	Gate	3	Pneumatic
DG-4030D	Gate valve	Gate	3	Pneumatic
DG-4037A	Globe valve	Safety	3	None
DG-4037B	Globe valve	Safety	3	None
DG-4037C	Globe valve	Safety	3	None
DG-4037D	Globe valve	Safety	3	None
DG-4059A	Gate valve	Gate	3	None
DG-4059B	Gate valve	Gate	3	None
DG-4059C	Gate valve	Gate	3	None
DG-4059D	Gate valve	Gate	3	None
DG-5098A	Globe valve	Globe	3	None
DG-5098B	Globe valve	Globe	3	None
DG-5098C	Globe valve	Globe	3	None
DG-5098D	Globe valve	Globe	3	None
DG-5099A	Globe valve	Globe	3	None
DG-5099B	Globe valve	Globe	3	None
DG-5099C	Globe valve	Globe	3	None
DG-5099D	Globe valve	Globe	3	None
DG-4114A	Three-way valve	Three-way	3	Self-controlled

Table 3.9-4 (15 of 22)

Valve No.	System Name (Safety Function) (1) (2) (3)	Valve Type	ASME Section III Class	Actuator Type
DG-4312A	Check valve	Check	3	None
DG-4312B	Check valve	Check	3	None
DG-4312C	Check valve	Check	3	None
DG-4312D	Check valve	Check	3	None
DG-4111A	Check valve	Check	3	None
DG-4111B	Check valve	Check	3	None
DG-4111C	Check valve	Check	3	None
DG-4111D	Check valve	Check	3	None
DG-4140A	Check valve	Check	3	None
DG-4140B	Check valve	Check	3	None
DG-4140C	Check valve	Check	3	None
DG-4140D	Check valve	Check	3	None
DG-4242A	Check valve	Check	3	None
DG-4242B	Check valve	Check	3	None
DG-4242C	Check valve	Check	3	None
DG-4242D	Check valve	Check	3	None
DG-4319A	Check valve	Check	3	None
DG-4319B	Check valve	Check	3	None
DG-4319C	Check valve	Check	3	None
DG-4319D	Check valve	Check	3	None
DG-4321A	Check valve	Check	3	None
DG-4321B	Check valve	Check	3	None
DG-4321C	Check valve	Check	3	None
DG-4321D	Check valve	Check	3	None
DG-4231A	Check valve	Check	3	None
DG-4231B	Check valve	Check	3	None
DG-4231C	Check valve	Check	3	None
DG-4231D	Check valve	Check	3	None

Table 3.9-13 (53 of 90)

DG-4230A	Preheating HT water pump inlet isolation valve	GT	AD	3	C		Note 37	Note 37
DG-4230B	Preheating HT water pump inlet isolation valve	GT	AD	3	C		Note 37	Note 37
DG-4230C	Preheating HT water pump inlet isolation valve	GT	AD	3	C		Note 37	Note 37
DG-4230D	Preheating HT water pump inlet isolation valve	GT	AD	3	C		Note 37	Note 37
DG-4231A	HT water inlet isolation valve	CK	SA	3	C		Note 37	Note 37
DG-4231B	HT water inlet isolation valve	CK	SA	3	C		Note 37	Note 37
DG-4231C	HT water inlet isolation valve	CK	SA	3	C		Note 37	Note 37
DG-4231D	HT water inlet isolation valve	CK	SA	3	C		Note 37	Note 37
	temperature control 3-way valve							
DG-4217B	HT/CC water heat exchanger temperature control 3-way valve	3W	SA	3	C		Note 37	Note 37
DG-4217C	HT/CC water heat exchanger temperature control 3-way valve	3W	SA	3	C		Note 37	Note 37
DG-4217D	HT/CC water heat exchanger temperature control 3-way valve	3W	SA	3	C		Note 37	Note 37
DG-4250A	CC/LT water heat exchanger temperature control 3-way valve	3W	SA	3	C		Note 37	Note 37

Table 3.11-3 (10 of 66)

Equipment Identification		Location		Required Operational Time	Environmental Condition [2]	Radiation Condition [6]	Influence of Immersion (Yes/No)	Seismic Cat.	Remark
		Building	Category[1]						
Emergency Diesel Engine Cooling Water System									
DG-V4217A	3-Way Thermostatic Control Valve	EDGB	I	Varies	Mild	Mild	No	I	(3)
DG-V4217B	3-Way Thermostatic Control Valve	EDGB	I	Varies	Mild	Mild	No	I	(3)
DG-V4217C	3-Way Thermostatic Control Valve	AB	I	Varies	Mild	Mild	No	I	
DG-V4217D	3-Way Thermostatic Control Valve	AB	I	Varies	Mild	Mild	No	I	
DG-V4250A	3-Way Thermostatic Control Valve	EDGB	I	Varies	Mild	Mild	No	I	(3)
DG-V4250B	3-Way Thermostatic Control Valve	EDGB	I	Varies	Mild	Mild	No	I	(3)
DG-V4250C	3-Way Thermostatic Control Valve	AB	I	Varies	Mild	Mild	No	I	
DG-V4250D	3-Way Thermostatic Control Valve	AB	I	Varies	Mild	Mild	No	I	
Emergency Diesel Engine Starting Air System									
DG-TK40A	Starting Air Receiver	EDGB	I	Continuous	Mild	Mild	No	I	
DG-TK40B	Starting Air Receiver	EDGB	I	Continuous	Mild	Mild	No	I	
DG-TK40C	Starting Air Receiver	AB	I	Continuous	Mild	Mild	No	I	
DG-TK40D	Starting Air Receiver	AB	I	Continuous	Mild	Mild	No	I	
DG-TK41A	Starting Air Receiver	EDGB	I	Continuous	Mild	Mild	No	I	
DG-TK41B	Starting Air Receiver	EDGB	I	Continuous	Mild	Mild	No	I	
DG-TK41C	Starting Air Receiver	AB	I	Continuous	Mild	Mild	No	I	
DG-TK41D	Starting Air Receiver	AB	I	Continuous	Mild	Mild	No	I	
DG-4230A	Preheating HT water pump inlet isolation valve	EDGB	I	Continuous	Mild	Mild	No	I	
DG-4230B	Preheating HT water pump inlet isolation valve	EDGB	I	Continuous	Mild	Mild	No	I	
DG-4230C	Preheating HT water pump inlet isolation valve	AB	I	Continuous	Mild	Mild	No	I	
DG-4230D	Preheating HT water pump inlet isolation valve	AB	I	Continuous	Mild	Mild	No	I	
DG-4231A	HT water inlet isolation valve	EDGB	I	Continuous	Mild	Mild	No	I	
DG-4231B	HT water inlet isolation valve	EDGB	I	Continuous	Mild	Mild	No	I	
DG-4231C	HT water inlet isolation valve	AB	I	Continuous	Mild	Mild	No	I	
DG-4231D	HT water inlet isolation valve	AB	I	Continuous	Mild	Mild	No	I	

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Docket No. 52-046

RAI No.:	**101-8007**
SRP Section:	**09.05.05 – Emergency Diesel Engine Cooling Water System**
Application Section:	**9.5.5**
Date of RAI Issue:	**07/22/2015**

Question No. 09.05.05-2

Section 9.5.5 of NUREG-0800 states that adequate volume should be available to maintain system water level and pump net positive suction head without refill, assuming expected water loss over a seven-day period of engine operation. SRP Section 9.5.5 also requests review of performance requirements to determine the time available to provide cooling water to the diesels and the other systems that must operate to assure onsite power capability.

The staff is unable to verify whether the system contains sufficient 7-day inventory.

The applicant is requested to justify that the system volume is sufficient to maintain the seven day period of engine operation and describe availability time criteria for the cooling water design. The DCD should be updated accordingly.

Response

DCD Tier 2, Subsection 9.5.5.2.2 will be revised as follows:

Current description : An expansion tank is provided in each cooling water subsystem to accommodate coolant expansion and venting due to temperature changes and to compensate for system losses due to minor leaks and evaporation. The expansion tanks are equipped with a low-level alarm.

Revised description : An expansion tank is provided in each cooling water subsystem to accommodate coolant expansion and venting due to temperature changes and to compensate for system losses due to minor leaks and evaporation. The expansion tanks are equipped with a low-level alarm, which is set below the normal operating water level. The water volume between the normal operating water level and the low-

level alarm is adequate for a seven-day period of diesel engine operation.

Impact on DCD

DCD Tier 2, Subsection 9.5.5.2.2 will be revised as indicated on the attached markup.

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 layout of the piping and components provides sufficient space to permit inspection, cleaning, maintenance, and repair of the system.

9.5.5.2.2 System Operation

The EDECWS maintains the temperature of the diesel engine within an optimum operating range during standby and during full-load operation to provide reasonable assurance of its fast starting and load-accepting capability and to reduce thermal stresses.

The engine-driven LT water pump drives water through the cold side of the lube oil/LT water heat exchanger to cool lube oil. Part of the LT water is circulated to two supercharging air coolers to cool the compressed combustion air. Water leaving the lube oil/LT water heat exchanger and two supercharging air coolers are circulated to the hot side of the LT/CCW heat exchanger cooled by the CCW. The LT water after LT/CCW heat exchanger is returned to the suction of the pump.

The HT water flows from the engine-driven HT water pump into the cylinder block to cool the cylinder liners and cylinder heads. Part of the cooling water is circulated to the cooling chamber of the turbochargers. After cooling the turbochargers and cylinder heads, the water flows through the thermostatic valve, which controls cooling water temperature by diverting flow between two different water passages.

A motor-driven preheating pump and electric heater circulate electrically heated warm water through the system while the engine is not running, to maintain the engine coolant at a preset temperature, and to enhance quick-starting capability by reducing lubrication oil viscosity and undue thermal stress on the mechanical portions of the engine during emergency starts.

An expansion tank is provided in each cooling water subsystem to accommodate coolant expansion and venting due to temperature changes and to compensate for system losses due to minor leaks and evaporation. The expansion tanks are equipped with a low-level ~~alarm.~~ alarm, which is set below the normal operating water level. The water volume between the normal operating water level and the low-level alarm is adequate for seven-day period of diesel engine operation. The engine-driven circulation pumps receive suction head from the respective expansion tank.

Air pockets produced from the cooling water system due to temperature rise are collected into the expansion tanks through the degassing tank or degassing piping, which is installed in a location for trapping air pockets easily. The collected air pockets and vapor in the

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Application Section:	**9.5.5**
Date of RAI Issue:	**07/22/2015**

Question No. 09.05.05-3

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefore, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 2, Section 9.5.5.3 of the diesel engine cooling water system indicates that “[e]ach EDG has a separate and independent EDECWS so that the EDECWS performs the safety function under accident conditions, assuming a single active component failure.”

The staff finds this statement confusing since it seems to indicate that a single active failure of any emergency EDECWS component does not result in EDECWS loss of safety function.

The applicant is requested to clarify how EDECWS can perform its safety function, upon loss of a heat exchanger. (This RAI also applies to other emergency diesel generator (EDG) support system Section 9.5.4, 9.5.6, 9.5.7, and 9.5.8 containing similar statement)

Response

DCD Tier 2, Subsection 9.5.5.3 states as follows:

> “Each EDG has a separate and independent EDECWS so that the EDECWS performs the safety function under accident conditions, assuming a single active component failure. The four trains of the EDG provide reasonable assurance that a single active failure in an EDECWS does not lead to a loss of more than one EDG.”

The emergency diesel generator system consists of four trains (A, B, C, and D). In the event that EDG A cannot perform its safety function due to loss of its EDECWS, EDG B, C, or D, which all have a separate EDECWS, can be available to perform its safety function.

Since each EDG has separate and independent subsystems, this scenario will be applied to other EDG subsystems in Subsections 9.5.4, 9.5.6, 9.5.7, and 9.5.8.

Impact on DCD

There is no impact on the DCD.

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.

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Application Section:	**9.5.5**
Date of RAI Issue:	**07/22/2015**

Question No. 09.05.05-4

The recommendations of NUREG/CR-0660 suggest use of three-way thermostatic valves to direct engine water to the bypass or heat exchanger as required.

DCD Tier 2, Figure 9.5.5-1 shows the use of a three-way thermostatic valve in two locations high temperature and low temperature (HT and LT) circuits. DCD Tier 2, Section 9.5.5.2.2 states that “[t]he three-way thermostat valve splits the cooling water flow so only as much water passes through the heat exchanger as needed to maintain the proper water outlet temperature. The remainder bypasses the heat exchanger and returns directly to the water pump so that the total water flowing through the pump and engine remains essentially constant regardless of the ambient temperature of engine loading.”

This description seems consistent with the HT valve operation, but the LT valve operation is not included in the DCD. DCD Tier 2, Section 9.5.5 lacks a clear description of these three-way thermostatic valves and their operation and function.

The applicant is requested to provide additional details on the system’s use of three-way thermostatic valves and update the DCD accordingly.

Response

The role of the three-way thermostat valve in the HT and LT circuits is the same. For both HT/CCW and LT/CCW heat exchangers, the three-way thermostat valve splits the cooling water flow by bypassing the heat exchanger to maintain the proper water outlet temperature.

DCD Tier 2, Subsection 9.5.5.2.2 will be revised as follows:

Current description : The three-way thermostat valve splits the cooling water flow so only as much water passes through the heat exchanger as needed to maintain the proper water outlet temperature. The remainder

bypasses the heat exchanger and returns directly to the water pump so that the total water flowing through the pump and engine remains essentially constant regardless of the ambient temperature of engine loading.

Revised description : For both the HT/CCW and LT/CCW heat exchangers, the three-way thermostat valve splits the cooling water flow so only as much water passes through the heat exchanger as needed to maintain the proper water outlet temperature. The remainder bypasses the heat exchanger and returns directly to the water pump so that the total water flowing through the pump and engine remains essentially constant regardless of the ambient temperature of engine loading.

Impact on DCD

DCD Tier 2, Subsection 9.5.2.2 will be revised as indicated on the attached markup.

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.

expansion tanks are vented through vent piping to atmosphere. The system is monitored for expansion tank level and system temperature alarms. Leakage in the EDECWS is made up by gravity from the expansion tanks. Two expansion tanks are manually filled from a common water treatment tank/pump skid connected to the demineralized water makeup distribution system.

For both the HT/CCW and LT/CCW heat exchangers, the

In the event of a failure in the cooling water system such as rupture of a pipe, the engine trips under test conditions but continues to run under emergency accident conditions.

~~The~~ three-way thermostat valve splits the cooling water flow so only as much water passes through the heat exchanger as needed to maintain the proper water outlet temperature. The remainder bypasses the heat exchanger and returns directly to the water pump so that the total water flowing through the pump and engine remains essentially constant regardless of the ambient temperature of engine loading.

9.5.5.3 Safety Evaluation

The portions of the EDECWS that are required for the performance of its safety function are classified as safety-related, seismic Category I, safety Class 3. The EDECWS is designed to quality standards consistent with the quality group classification assigned by NRC RG 1.26 and the seismic Category assigned by NRC RG 1.29.

Each EDG unit is housed separately in a structure designed to seismic Category I requirements. Each EDG has a separate and independent EDECWS so that the EDECWS performs the safety function under accident conditions, assuming a single active component failure. The four trains of the EDG provide reasonable assurance that a single active failure in an EDECWS does not lead to a loss of more than one EDG. The three-way thermostat valve meets the recommendation of NUREG/CR-0660.

The safety-related portion of the EDECWS provides the necessary cooling to dissipate heat from the diesel engine coolant and lubricating oil to maintain temperatures within normal operating limits during engine operation condition.

The EDECWS is initially tested prior to initial operation. Periodic inspection and functional testing are also performed along with the complete EDG system in accordance with the Technical Specifications.