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MFN 08-357

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Subject: **Response to Portion of NRC Request for Additional Information Letter Nos. 80 and 126 Related to ESBWR Design Certification Application - Containment Systems - RAI Numbers 6.2-139, 14.3-235, and 14.3-236**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAIs transmitted via the Reference 1 (RAI 6.2-139) and Reference 2 (RAIs 14.3-235 and 14.3-236) letters. DCD Markups related to the response to RAI 6.2-139 are provided in Enclosure 2.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey
James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

References:

1. MFN 06-419, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 80 Related to ESBWR Design Certification Application*, November 2, 2006
2. MFN 07-718, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 126 Related to ESBWR Design Certification Application*, December 20, 2007

Enclosures:

1. MFN 08-357 - Response to Portion of NRC Request for Additional Information Letter Nos. 80 and 126 Related to ESBWR Design Certification Application - Containment Systems - RAI Numbers 6.2-139, 14.3-235, and 14.3-236
2. MFN 08-357 - Response to Portion of NRC Request for Additional Information Letter Nos. 80 and 126 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-139 - DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	RAI 6.2-139: 0000-0071-3559R5
		RAI 14.3-235: 0000-0080-8462
		RAI 14.3-236: 0000-0082-1194

Enclosure 1

MFN 08-357

Response to Portion of NRC Request for

Additional Information Letter Nos. 80 and 126

Related to ESBWR Design Certification Application

Containment Systems

RAI Numbers 6.2-139, 14.3-235, and 14.3-236

NRC RAI 6.2-139:

Explain how the ESBWR design complies with 10 CFR 50, Appendix A, Criterion 38.

DCD, Tier 2, Revision 1, Section 6.2.2.3 states that "In conjunction with the pressure suppression containment (Subsection 6.2.1.1), the PCCS [passive containment cooling system] is designed to remove heat from the containment to comply with 10 CFR 50, Appendix A, Criterion 38." However, Criterion 38 requires that the containment heat removal system "safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels." The PCCS does not reduce rapidly the containment pressure and temperature as evident from the TRACG results presented in the DCD.

GEH Response:

The Passive Containment Cooling System (PCCS) is a passive engineered safety feature of the containment that will remove decay heat from containment after a loss-of-coolant accident (LOCA) for a minimum of 72 hours without operator action maintaining containment pressure and temperature within design limits. Beyond 72 hours, mitigating measures are in place to keep the containment pressure and temperature well below design limits. One of these mitigating measures consists of providing Isolation Condenser (IC)/Passive Containment Cooling (PCC) pool makeup for the PCCS to continue removing decay heat at a rate that will maintain the containment pressure and temperature within design limits. An additional measure not taken credit for during the initial 72 hours will be the operation of the PCCS Vent Fans. The PCCS Vent Fans assist the removal of the non-condensable (NC) gases from the PCCS condensers, resulting in an improvement in heat exchanger efficiency. As an additional enhancement to reduce the buildup of NC gases affecting the operation of the PCCS condensers, a Passive Autocatalytic Recombiner System (PARS) is credited after 72 hours. The operation of PCCS Vent Fans and PARS results in a rapid and continued long-term reduction in drywell (DW) pressure and temperature. The pressure and temperature are reduced to the levels that are well below design limits.

Each of the six PCCS Vent Fans takes suction from a tee in the associated PCCS vent line, and discharges to the Gravity-Driven Cooling System (GDCS) pool region. The PCCS Vent Fan discharge line includes submergence in the GDCS pool and a passive check valve to ensure no back flow when the PCCS Vent Fan is not in operation. The PCCS Vent Fans are initiated by a manual operator action, and have the capability to be powered by backup power supplies if normal power should become unavailable. Figure 6.2-139-1 shows the schematic of one of the six PCCS Vent Fans.

An analysis is performed utilizing the ESBWR TRACG code to determine the DW pressure and temperature behavior for the main steam line break (MSLB) design basis accident using the licensing bounding conditions, which includes refill of the IC/PCC pool, operation of the PCCS Vent Fans, and crediting PARS after 72 hours. The analysis results indicate that the DW pressure remains below the design pressure of 413.7 KPa (60 psia) for the first 72 hours after the MSLB, and then rapidly reduces and maintains the reduction with the refill of the IC/PCC pool and operation of the PCCS Vent Fans, achieving even lower pressures when the PARS were credited.

Figures 6.2-139-6 to 6.2-139-11 present the key results of the base calculation. The base case and the parametric cases are performed with a DW-to-wetwell (WW) bypass leakage area of 1 cm^2.

Parametric Case – PCCS Vent Fan Discharging to the DW Without Credit for PARS

A parametric case was performed to assess the impact on the DW and WW pressures with the PCCS Vent Fans discharging to the DW and without crediting PARS. Figure 6.2-139-2 and Figure 6.2-139-3 show the results of this parametric case. This case assumes each PCCS Vent Fan has the capability to deliver 0.343 m^3/s (727 cfm) at a calculated rated head of ($\Delta P/\rho$) = 602 m^2/s^2 (6480 ft^2/s^2) and fluid density (ρ) of 2.27 Kg/m^3 (0.137 lb/ft^3).

Figure 6.2-139-2 is a TRACG plot showing the rapid decrease of DW pressure after the PCCS Vent Fans are placed in service, coincident with filling of the IC/PCC pool beginning 72 hours after the MSLB. The IC/PCC pool is continuously and constantly refilled with 0.0127 m^3/s (201 gpm) of water at 310.9°K (100°F).

Base Case – PCCS Vent Fan Discharging to the GDCS Pool

Based on the results from the parametric case, an improvement in the pressure response can be attained if the PCCS Vent Fan discharge is relocated to the GDCS pool compartment (see Figure 6.2-139-1). This improvement is attributed to the relocation of NC gases to an area that is less accessible to the PCCS inlet. In the cases when the PCCS Vent Fans have a submerged discharge to the GDCS pool, the rated head value needs to increase to a value that accounts for the water hydrostatic head resistance and the fluid dynamic resistance due to a submergence of 0.254 m (10 in) of water in the GDCS pool. The rated head is expected to increase about 1798 m^2/s^2 (19354 ft^2/s^2) for a total of about 2400 m^2/s^2 (25833 ft^2/s^2). This rated head increase accounts for 2488 Pa/2.29 Kg/m^3 = 1086 m^2/s^2 (11690 ft^2/s^2) due to the static water head, and about 1798-1086 = 712 m^2/s^2 (7664 ft^2/s^2) for the dynamic resistance due to submergence. The PCCS Vent Fans submerged 0.254 m (10 in) and discharging to the GDCS pool at the rated head discussed above under 299 kPa (43.4 psia) of pressure and 403°K (130°C) temperature will be able to supply a minimum volumetric flow rate of about 0.145 m^3/s (307 cfm) and a fluid density (ρ) of 2.29 Kg/m^3 (0.143 lb/ft^3).

The use of submergence for the PCCS Vent Fan outlet discharge to the GDCS pool is a measure to ensure proper functioning of PCCS, and to prevent direct flow from DW to the suppression pool through the vent line when the PCCS Vent Fans are not in operation. Furthermore, to prevent the possibility of any liquid back flow that may occur during the blowdown phase of the event or any other time, a passive check valve is installed at the discharge side of the PCCS Vent Fan to ensure that no back flow occurs.

From the above discussions and calculated results, GEH opted to implement the PCCS Vent Fans discharging to the GDCS pool region, including submergence and passive check valves to ensure no back flow when the PCCS Vent Fans are not in operation.

PARS is credited and modeled after 72 hours. This simulation is implemented by having the rate of production of NC gases equal to the rate of their recombination. This implementation limits the amount of NC gases inside the containment to the amount accumulated in the first 72 hours.

For the base configuration of the PCCS Vent Fans discharging to the GDCS pool, three cases were performed:

1. 6 PCCS Vent Fans with credit for PARS (Base Case),
2. 4 PCCS Vent Fans with credit for PARS, and
3. 6 PCCS Vent Fans without credit for PARS.

The conditions and results of these three cases are summarized in Table 6.2-139-1. The comparison shows that, with credit for PARS, the DW pressure at the end of 7 days is reduced by 6.1 kPa (0.885 psi). Figures 6.2-139-6 to 6.2-139-11 present the key results of the base case calculation (Case 1).

Figure 6.2-139-4 compares the DW pressures from two cases:

1. 6 PCCS Vent Fans discharging to the DW, and
2. 6 PCCS Vent Fans discharging to the GDCS pool (0.254 m or 10 in submergence).

The results show that there is a small improvement in the pressure response if the PCCS Vent Fan discharge is relocated to the GDCS pool compartment.

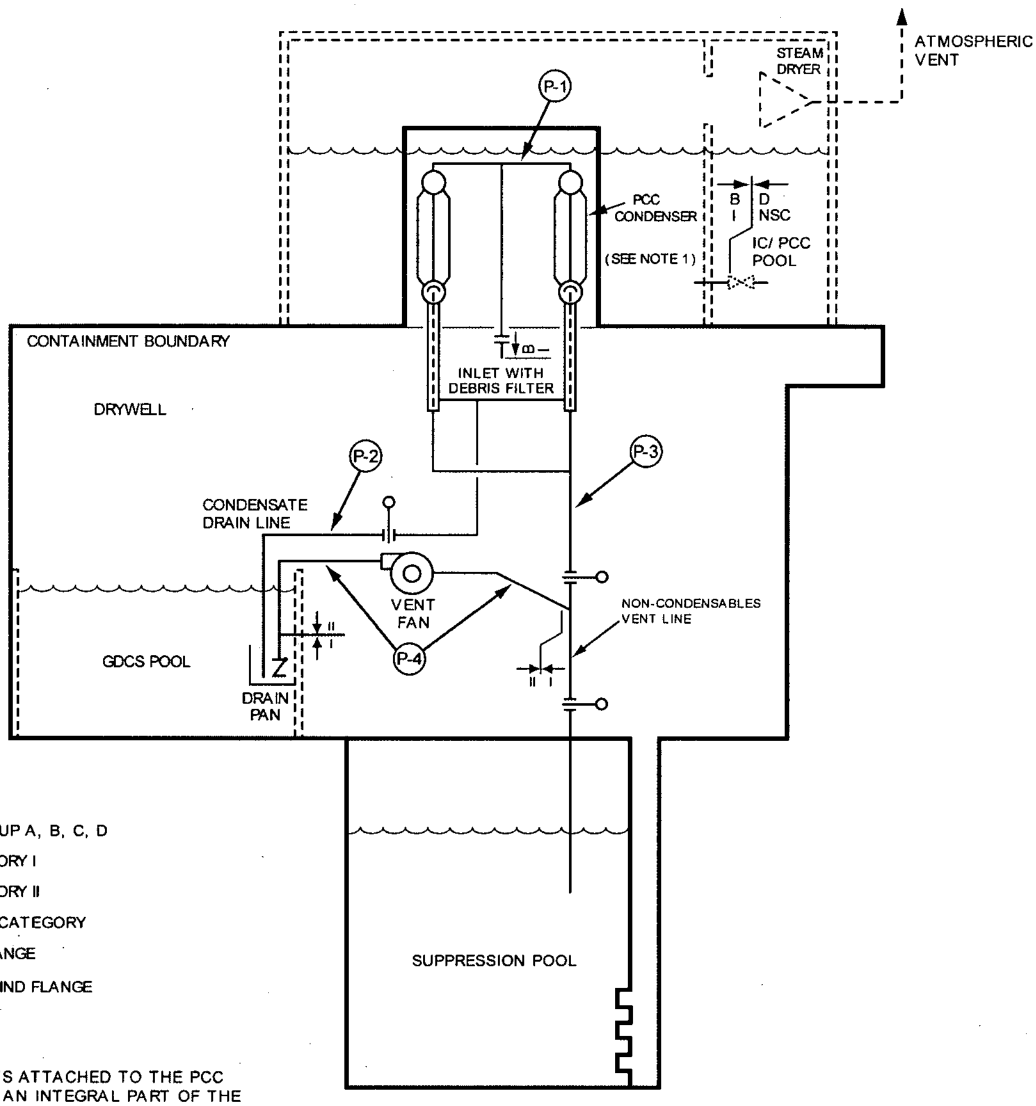
Figure 6.2-139-5 compares the DW pressure from Cases 1 and 3. The results show that there is a small improvement in the pressure response with credit for PARS. This figure also shows the DW pressure from Case 2 (with 4 PCCS Vent Fans). This result shows that the DW pressure reduction is larger with higher total PCCS Vent Fan capacity.

Figures 6.2-139-6 to 6.2-139-11 present the key results of the base case calculation (Case 1), from 3 to 7 days. Figure 6.2-139-6 shows the pressure response for the DW, WW, and reactor pressure vessel (RPV). Figure 6.2-139-7 shows the temperature response for the DW, WW, and suppression pool. Figure 6.2-139-8 shows comparison of the decay heat and the total PCCS condensation power.

Figure 6.2-139-9 shows NC gas pressures in DW annulus, DW head and GDCS gas space. This figure shows that, after the actuation of the PCCS Vent Fans, significant amount of NC gas is redistributed back to the DW from the WW via the opening of the vacuum breakers. Figure 6.2-139-10 shows the water level in the GDCS pool. The pool maintains a constant level that provides approximate 10 inches of submergence to the PCCS Vent Fan discharge line. Figure 6.2-139-11 shows the IC/PCC pool level. At a continuous refilling rate of 200 gpm, the IC/PCC pool level rises to about the top of PCCS condenser tubes at 156 hours.

Table 6.2-139-1. Main Results

Case #	Case ID	PARS	NO PARS	200 GPM	6 Vent Fans	4 Vent Fans	DW Pressure (KPa)/psia At 168 Hrs
1 (Base Case)	MSL4A_PARS726VSUB2	X		X	X		291.5/42.28
2	MSL4A_PARS724VSUB2	X		X		X	319.0/46.27
3	MSL4A_726VSUB200		X	X	X		297.6/43.16



LEGEND:

A, B, C, D = QUALITY GROUP A, B, C, D

I = SEISMIC CATEGORY I

II = SEISMIC CATEGORY II

NSC = NON-SEISMIC CATEGORY

═─O = SPECTACLE FLANGE

╤ = REMOVABLE BLIND FLANGE

Z = CHECK VALVE

NOTE 1: THE COMPONENTS ATTACHED TO THE PCC CONDENSER ARE AN INTEGRAL PART OF THE CONTAINMENT BOUNDARY ABOVE THE DRYWELL.

TRAIN A SHOWN

TYPICAL OF TRAIN B, C, D, E & F

Figure 6.2-139-1. Schematic of PCCS with Vent Fan

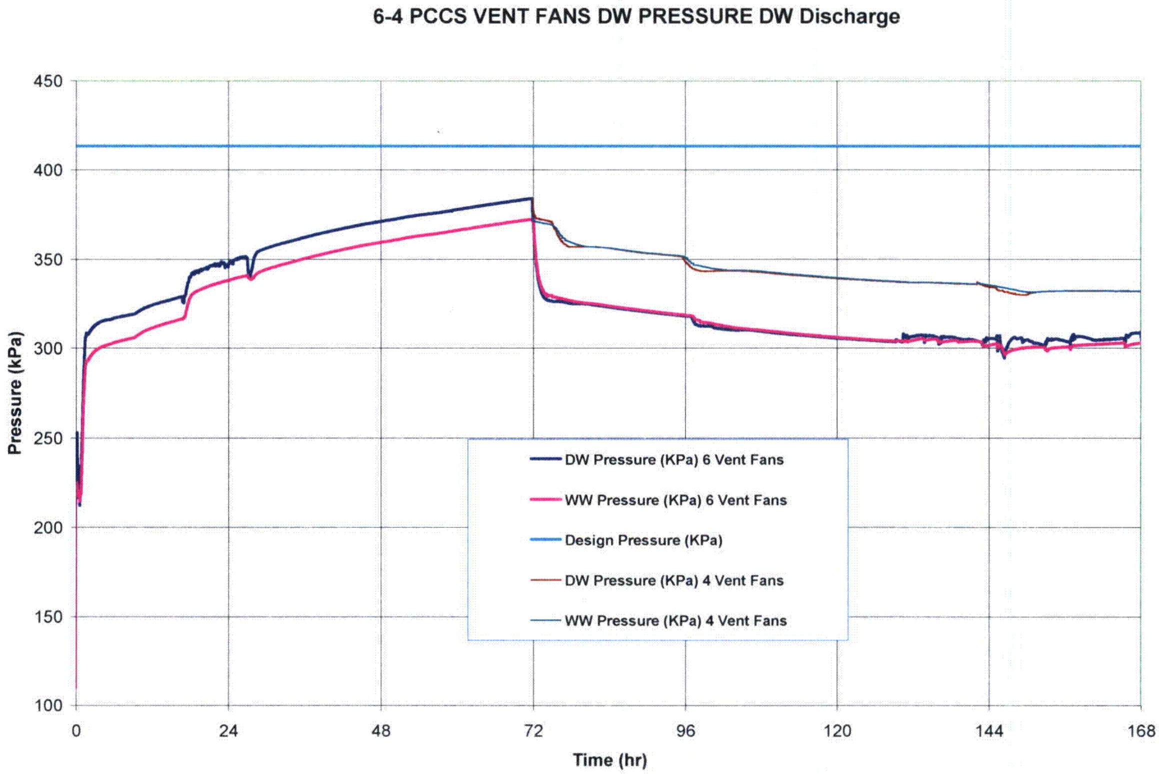


Figure 6.2-139-2. Drywell and Wetwell Pressures (Parametric Case – Vent Fan Discharging to DW, and No Credit for PARS)

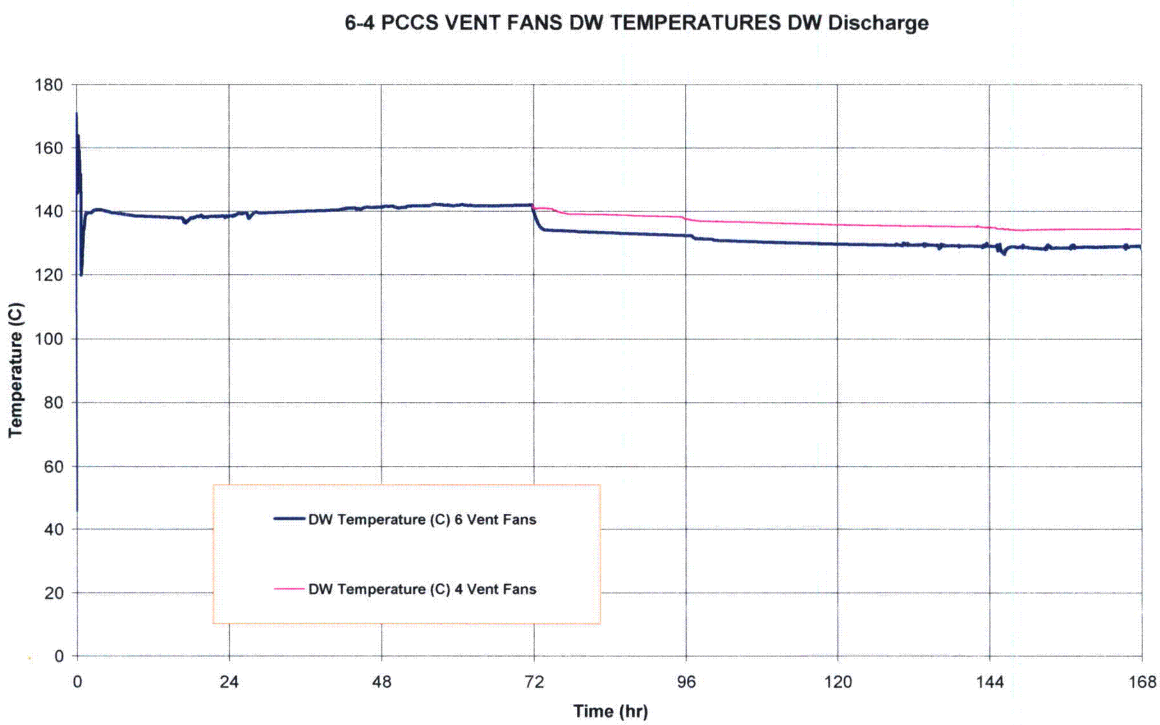


Figure 6.2-139-3. Drywell and Wetwell Temperatures (Parametric Case – Vent Fan Discharging to DW, and No Credit for PARS)

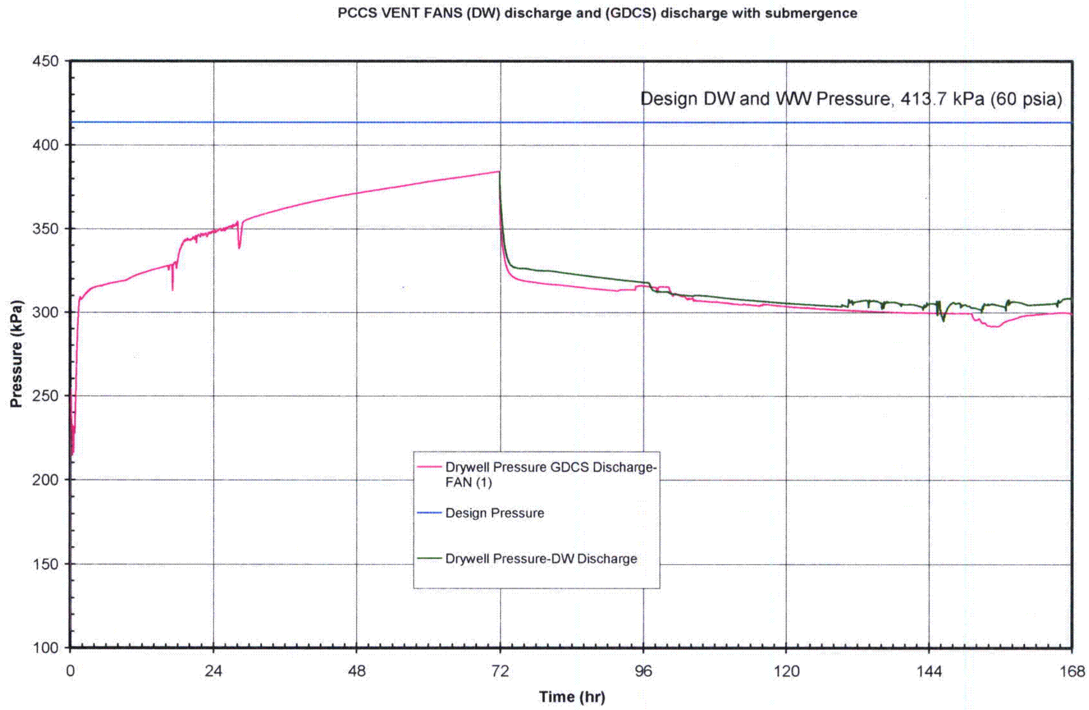


Figure 6.2-139-4. Comparison of Drywell Pressures with No Credit for PARS (Vent Fan Discharge Location: DW Versus GDCS Pool)

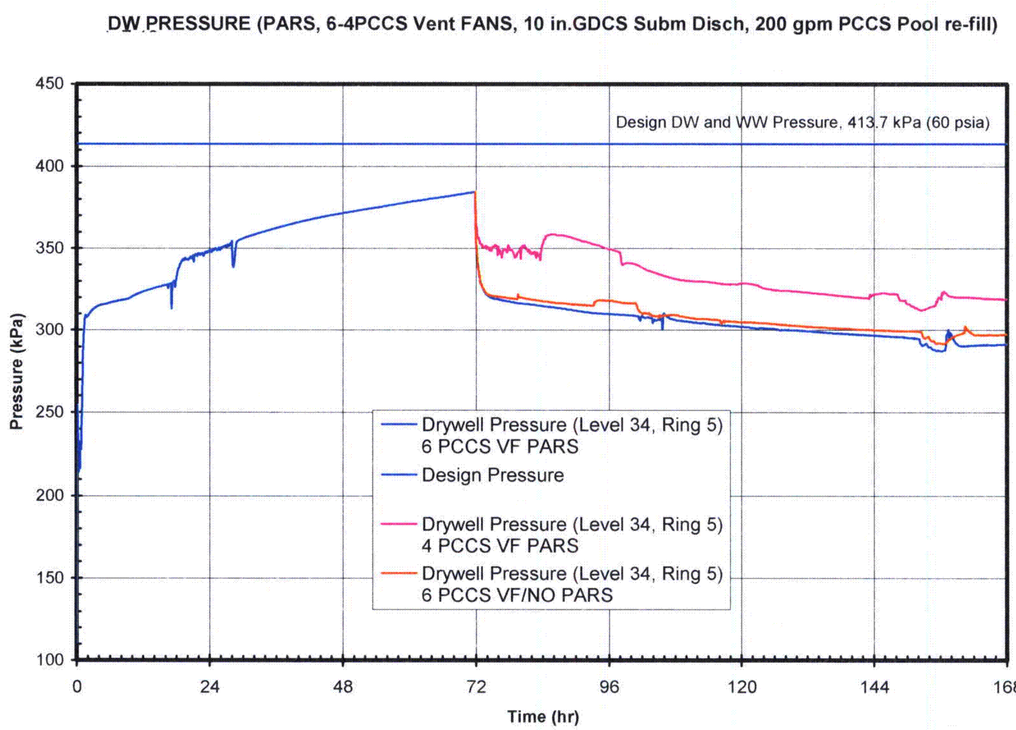


Figure 6.2-139-5. Comparison of DW Pressures with Vent Fan Discharging to GDCS Pool (6 Vent Fans With and Without PARS; 6 Versus 4 Vent Fans With PARS)

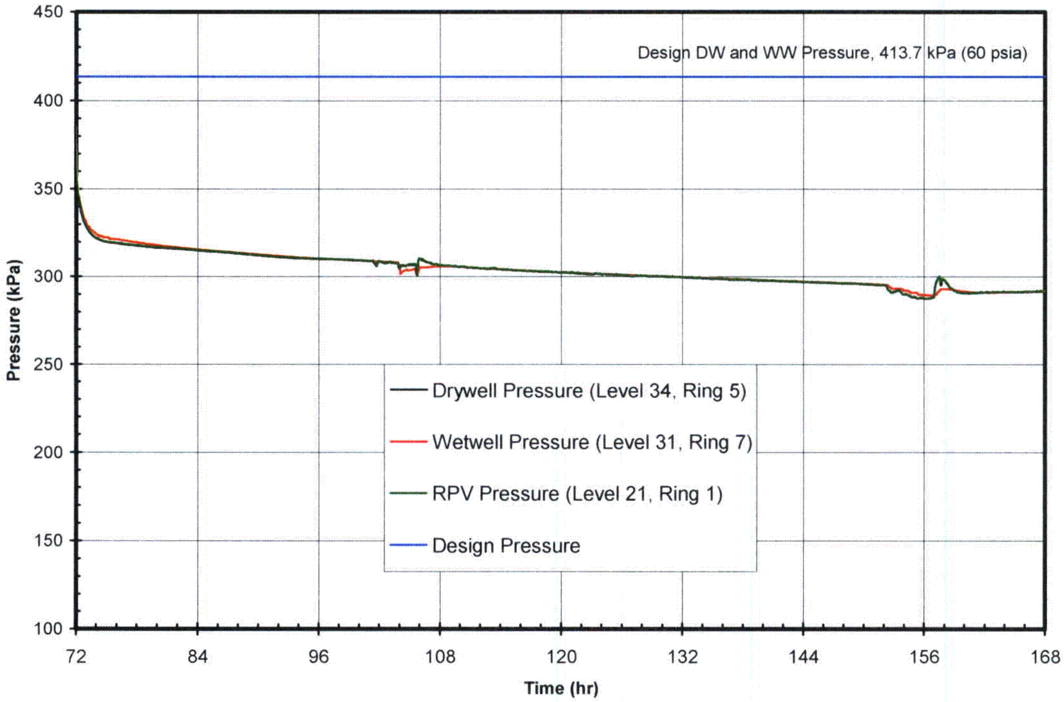


Figure 6.2-139-6. Drywell, Wetwell, and Reactor Pressure Vessel Pressures (Base Case: MSL4A_PARS726VSUB2)

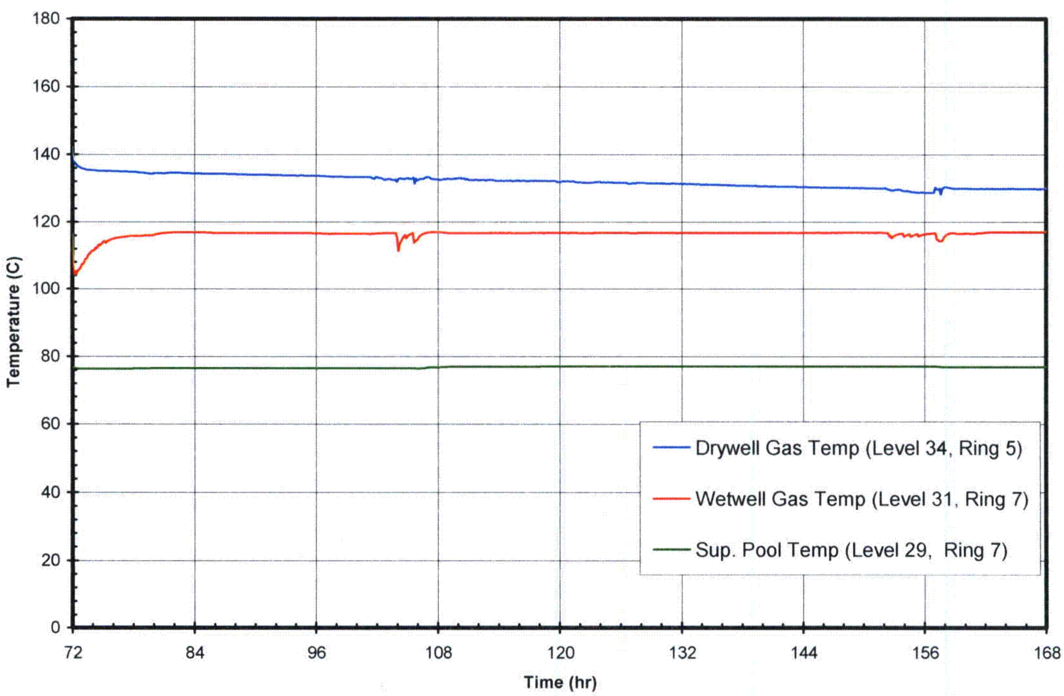


Figure 6.2-139-7. Drywell, Wetwell, and Suppression Pool Temperatures (Base Case: MSL4A_PARS726VSUB2)

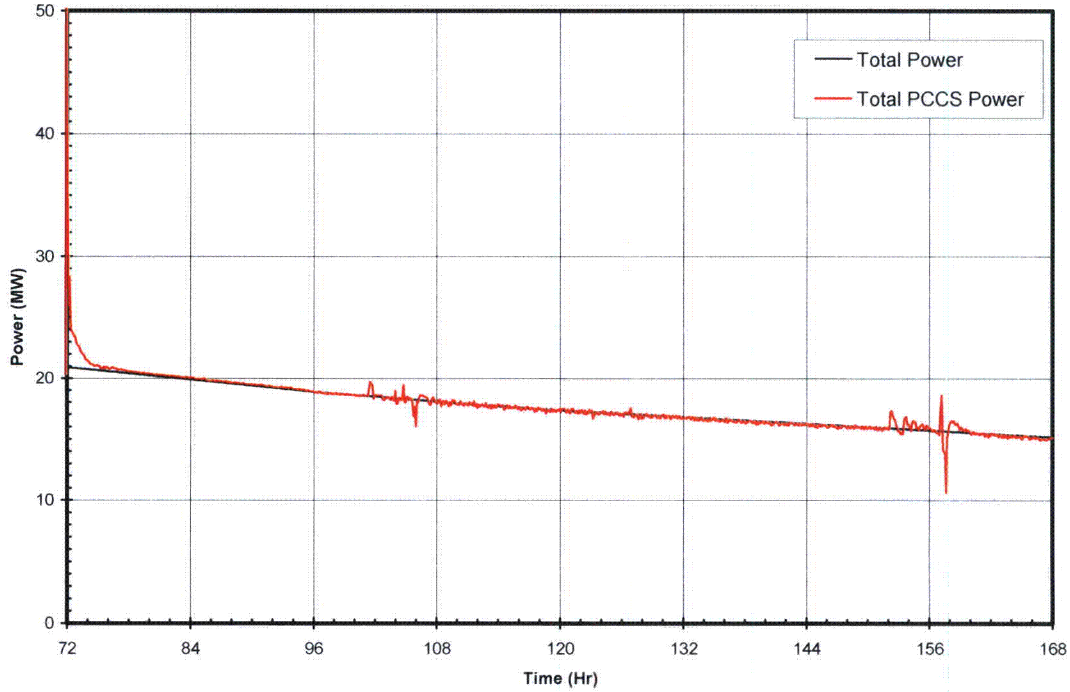


Figure 6.2-139-8. Decay Heat Versus Total PCCS Condensation Power (Base Case: MSL4A_PARS726VSUB2)

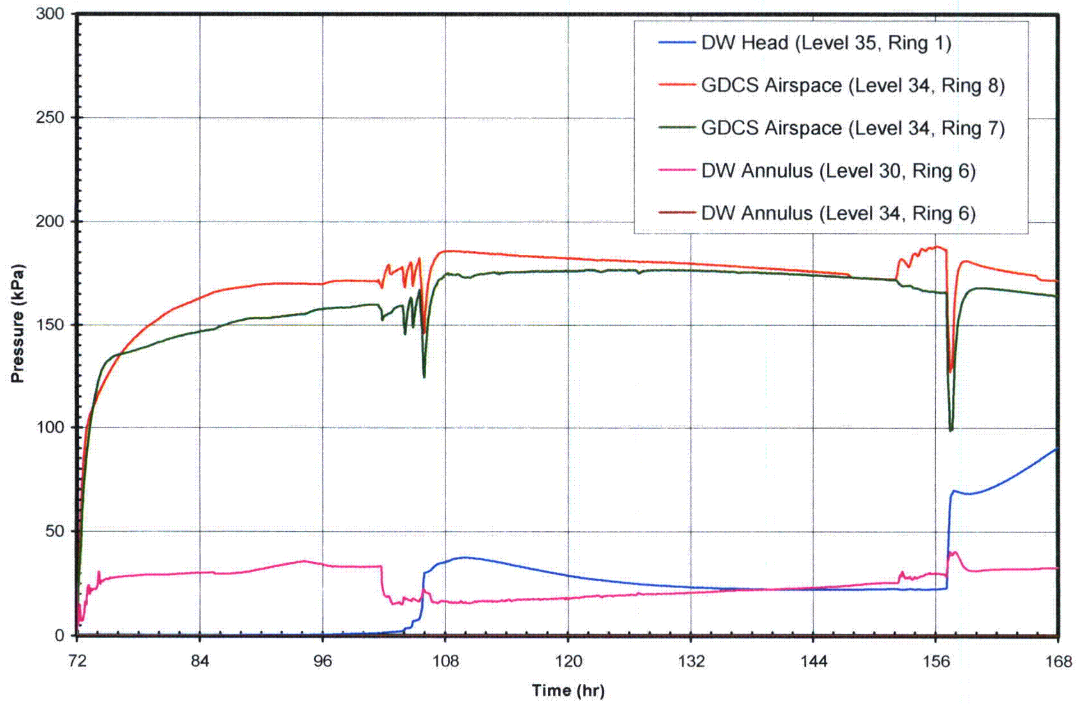


Figure 6.2-139-9. NC Gas Pressures in DW Annulus, DW Head, and GDCS Gas Space (Base Case: MSL4A_PARS726VSUB2)

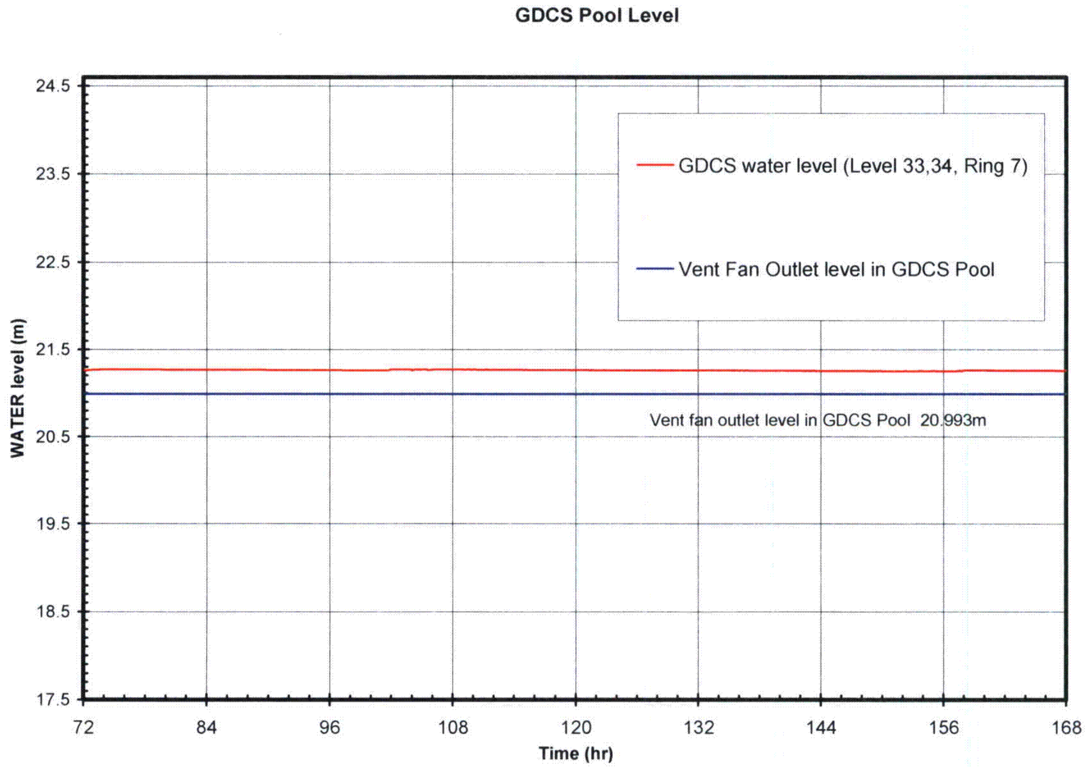


Figure 6.2-139-10. GDCS Pool Water Level (Base Case: MSL4A_PARS726VSUB2)

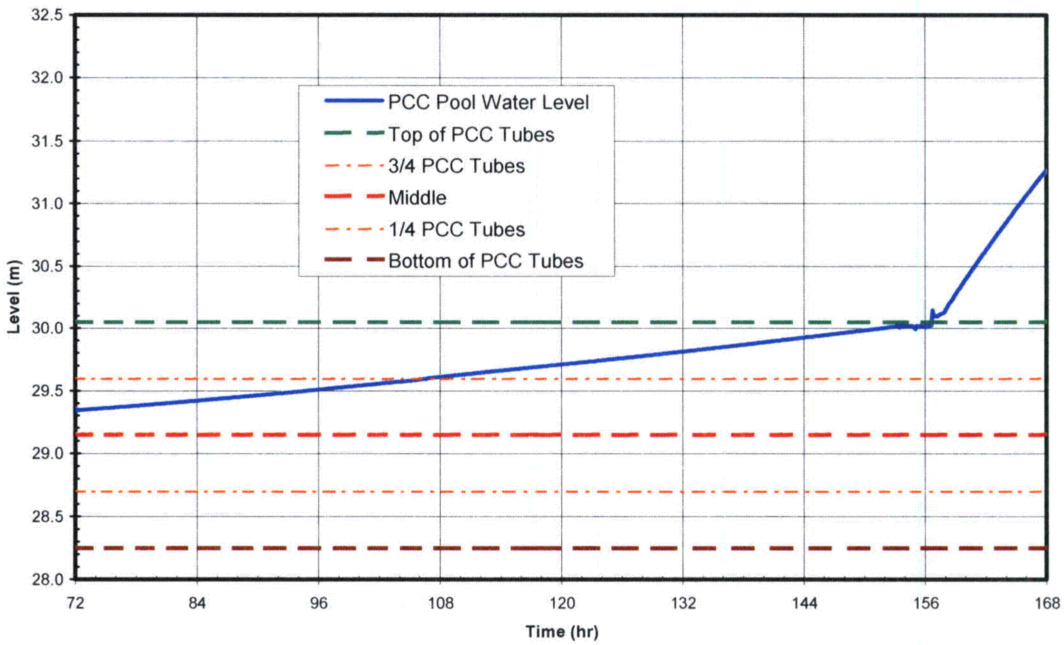


Figure 6.2-139-11. PCCS Pool Water Level (Base Case: MSL4A_PARS726VSUB2)

DCD Impact:

DCD Tier 1, Subsection 2.15.4, Table 2.15.4-1, Table 2.15.4-2, and Figure 2.15.4-1 will be revised as shown in the attached markup.

DCD Tier 2, Figure 1.1-2; Subsections 3.1.4.9 and 3.1.4.11; Table 3.9-8; Subsections 6.2.2.1, 6.2.2.2.2, 6.2.2.2.3, and 6.2.2.5; Figures 6.2-7, 6.2-15, and 6.2-16; Subsections 7.1.2.8.3.9, 7.1.3.2.2.4, and 7.3.2; Subsection 14.2.8.1.64; Subsections 19A.3.1.2, 19A.3.2, and 19A.6.1.5.1; and Table 19A-2 will be revised, and new Chapter 19 Administrative Controls Manual (ACM), Administrative Controls (AC) 3.6.4 and AC Bases 3.6.4 will be added, as shown in the attached markup.

NRC RAI 14.3-235:

DCD Tier 1, Revision 4, Section 2.15.4, states that the passive containment cooling system "is entirely passive, with no moving parts." However, GEH has informed the staff that the PCCS is to be supplemented with a drywell gas recirculation system (DGRS) after 72 hours following a LOCA. When the DGRS system design is submitted for staff review, provide an update to DCD Tier 1 to indicate that the DGRS is an active system.

GEH Response:

GEH agrees. See the response above to RAI 6.2-139 for DCD Tier 1 markups addressing the addition of the Passive Containment Cooling System (PCCS) Vent Fans and associated components.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 14.3-236:

DCD Tier 1, Revision 4, Section 2.15.4, states that the passive containment cooling system "together with the pressure suppression containment system will limit containment pressure to less than its design pressure for 72 hours after a LOCA."

The PCCS with other systems (fuel and auxiliary pool cooling system, drywell gas recirculation system, etc.) continues to remove heat from the containment to limit containment pressure to less than its design pressure beyond 72 hours after a LOCA. Please update DCD Tier 1 (in Section 2.15.4 and Item 7 of Table 2.15.4- 2) to identify these additional systems and to recognize that limiting containment pressure to less than its design pressure is required even beyond 72 hours after a LOCA.

GEH Response:

GEH agrees. See the response above to RAI 6.2-139 for DCD Tier 1 markups addressing the addition of the Passive Containment Cooling System (PCCS) Vent Fans and associated components. The post-accident heat removal functions for other systems such as the Fuel and Auxiliary Pools Cooling System are already described in their respective DCD Tier 1 sections.

DCD Impact:

No DCD changes will be made in response to this RAI.

Enclosure 2

MFN 08-357

Response to Portion of NRC Request for

Additional Information Letter Nos. 80 and 126

Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-139

DCD Markups

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

b. Each of the lines identified in Table 2.15.4-1 for which functional capability is required is designed to withstand combined normal and seismic design basis loads without a loss of its functional capability.

(6) ~~Each mechanical train of the PCCS (A, B, C, D, E & F)* is physically separated from the other trains. *As indicated on Figure 2.15.4-1. Physical separation is not required in the Primary Containment~~Deleted~~.~~

(7) The PCCS together with the pressure suppression containment system will limit containment pressure to less than its design pressure for 72 hours after a LOCA.

(8) The equipment qualification of PCCS components is addressed in Tier 1 Section 3.8.

(9) In order to ensure the PCCS can maintain the drywell to wetwell differential pressure to a limit less than the value that causes pressure relief through the horizontal vents, the vent line discharge point is submerged at an elevation below low water level but above the uppermost horizontal vent.

(10) The PCCS will be designed to limit the fraction of containment leakage through the condensers to an acceptable value.

(11) The PCCS vent fans flow rate is sufficient to meet beyond 72 hours containment cooling requirements.

(12) The PCCS vent fans can be remotely operated from the MCR.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.15.4-2 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria for the Passive Containment Cooling System.

Table 2.15.4-1

Passive Containment Cooling System Mechanical Equipment

Equipment Name (Description)	Equipment Identifier see Figure 2.15.4-1	ASME Code Section III	Seismic Cat. I	RCPB Component	Functional Capability Required	Containment Isolation Valve	Remotely Operated Valve	Loss of Motive Power Position	Functional Capability Required
PCC Heat Condenser	PCC Condenser	Yes	Yes	No	Passive	-	-	-	Yes
PCC Inlet Line	P-1(A[1])	Yes	Yes	No	Passive	-	-	-	Yes
Condensate Drain Line	P-2(A[1])	Yes	Yes	No	Passive	-	-	-	Yes
Vent Fan Check Valve	Check Valve	Yes	Yes	No	Active	-	-	-	Yes
Non-Condensables Vent Line	P-3(A[1])	Yes	Yes	No	Passive	-	-	-	Yes
Vent Fan	Vent Fan	Yes	No	No	Active	-	-	-	Only after 72 hours
Non-Condensables Vent Line Sparger	Sparger	Yes	Yes	No	Passive	-	-	-	Yes
PCCS Inlet Pipe Debris Filter	N/A	Yes	Yes	No	Passive	-	-	-	Yes
PCCS Vent Fan Line	P-4 (A[1])	Yes	No	No	Passive	-	-	-	Yes

Note: A dash means not applicable.

[1] Train A; Typical for Trains B, C, D, E & F.

Table 2.15.4-2

ITAAC For The Passive Containment Cooling System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
		pressure for 72 hours after a LOCA is less than containment design pressure.
8. The equipment qualification of PCCS components is addressed in Tier 1 Section 3.8.	See Tier 1 Section 3.8.	See Tier 1 Section 3.8.
9. The elevation of the PCCS vent discharge point is submerged in the suppression pool at an elevation below low water level and above the uppermost horizontal vent.	A visual inspection will be performed of the PCCS vent discharge point relative to the horizontal vents.	The elevation of the discharge on the PCCS vent line is > 0.85 m (33.5 in) and < 0.90 m (35.4 in) above the top of the uppermost horizontal vent.
10. The PCCS will be designed to limit the fraction of containment leakage through the condensers to an acceptable value.	A pneumatic leakage test of the PCCS will be conducted.	Test report(s) and analysis document that the combined leakage from each of the PCCS heat exchangers is ≤0.025L_a
11. The PCCS vent fans flow rate is sufficient to meet the beyond 72 hours containment cooling requirements.	Flow rate will be measured. A type test of the vent fan to be installed will be performed.	Test and Analyses show that the PCC vent fans can provide a flow rate of 0.271 m^3/s (575 CFM) under the following conditions: • Pressure 299 KPa (43.4 psi) • Density 2.29 Kg/m^3 (0.143 Lbs/ft^3) • Head across fan 5.50 KPa (0.80 psi)

Table 2.15.4-2

ITAAC For The Passive Containment Cooling System

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
12. The PCCS vent fans can be remotely operated from the MCR.	PCCS vent fans will be started using manually initiated signals from the MCR.	Report(s) exist and conclude that the PCCS vent fans start when manually imitated signals are sent from the MCR.

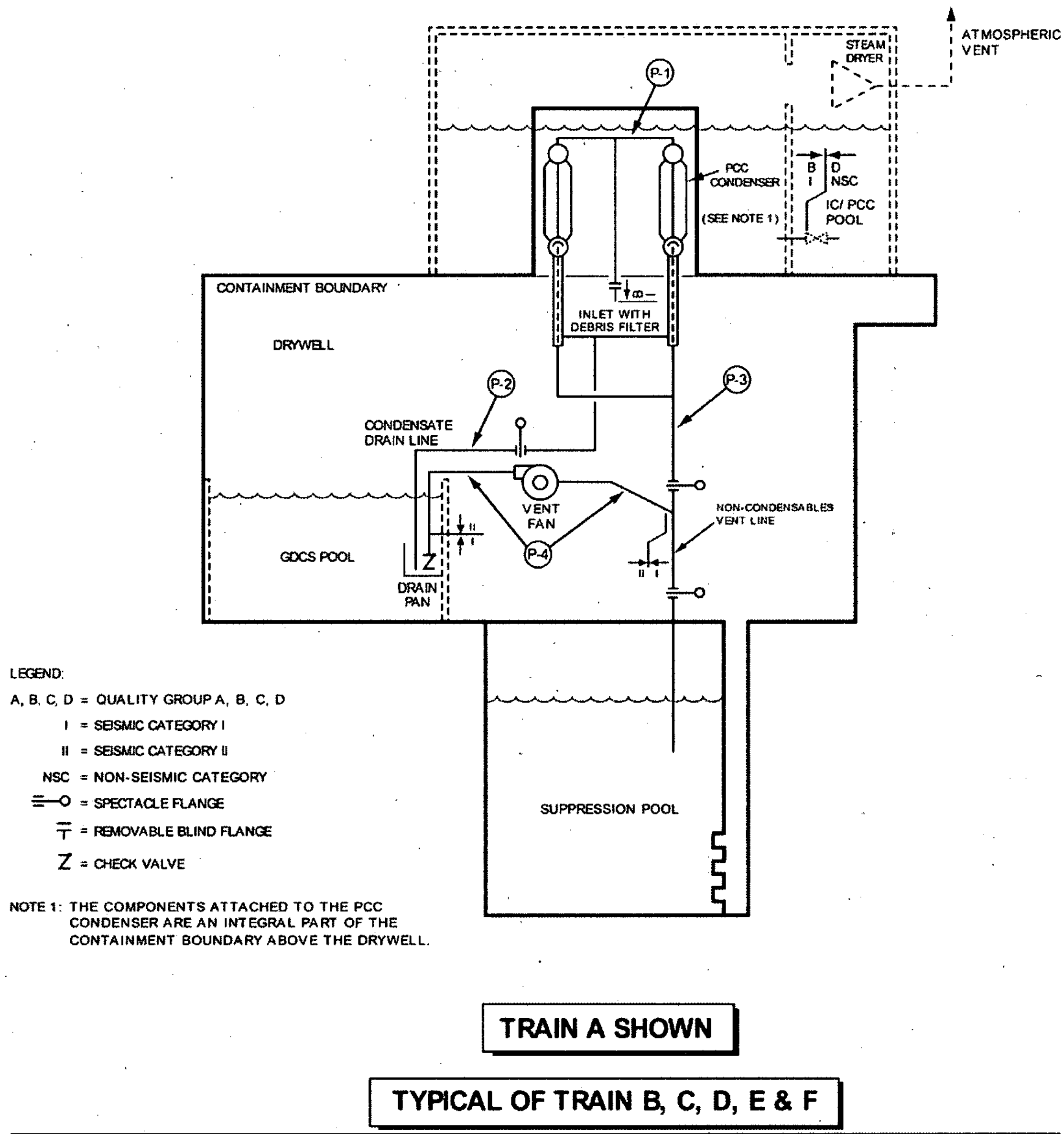


Figure 2.15.4-1. Passive Containment Cooling System Schematic

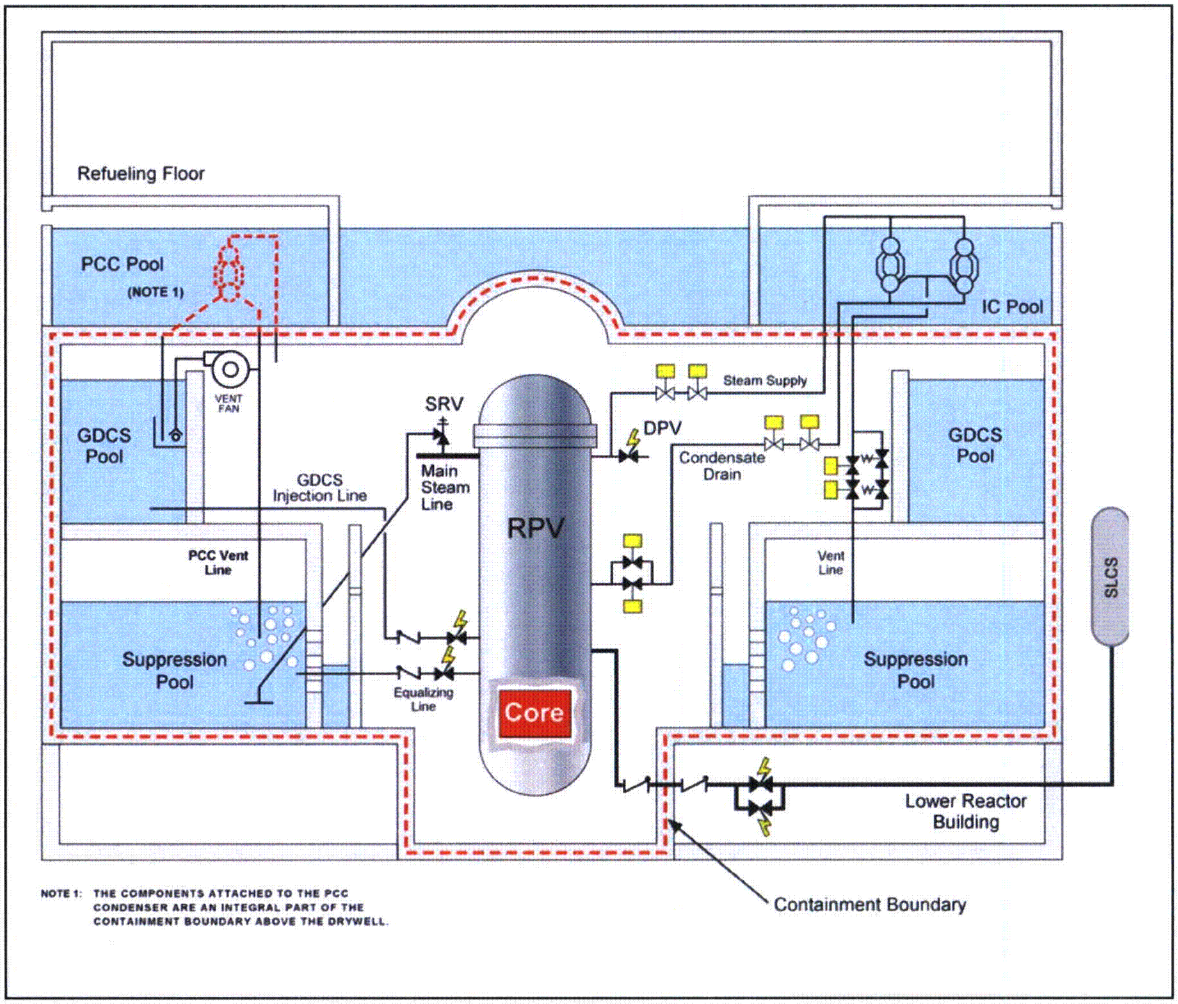


Figure 1.1-2. Safety System Configuration (not to scale)

operation (assuming on-site power is not available), the system safety function can be accomplished, assuming a single failure.

Evaluation Against Criterion 38

The containment heat removal function is accomplished by the Passive Containment Cooling System (PCCS). The PCCS provides sufficient decay heat removal post-LOCA, to assure that containment pressure never exceeds its design pressure and temperature.

The PCCS consists of six independent steam condensers that are an integral part of the containment. Each PCCS condenser contains two heat exchanger modules that condense steam on the tubeside and transfer heat to water in the Isolation Condenser/Passive Containment Cooling (IC/PCC) pool which is vented to atmosphere. The IC/PCC pool is positioned above, and outside, the ESBWR containment (drywell). To assure availability, no valves are employed, thus precluding inadvertent isolation of the Passive Containment Cooling (PCC) condensers. Long-term effectiveness of the PCCS credits, an active gas recirculation system, which uses in-line fans to pull drywell gas through the PCC condensers. These manually actuated fans (one per train) are located on a branch from the vent line and discharge to the GDCS pool.

The PCCS condensers receive a steam-gas mixture supply directly from the drywell. PCCS flow is driven by the pressure difference created between the containment drywell and the suppression pool during a LOCA. The PCCS does not require power supplies, sensors, control logic, power-actuated devices or operator actions to function in the first 72 hours after a LOCA. During normal plant operation, the PCCS condensers are in "ready standby".

The PCCS is designed to Quality Group B Requirements per Regulatory Guide 1.26. The system is designed as Seismic Category I per RG 1.29. The common pool that the PCC condensers share with the ICs of the Isolation Condenser System is an Engineered Safety Feature (ESF). This pool is designed such that no locally generated force (such as an IC tube rupture) can destroy its function. Protection requirements against mechanical damage, fire and flood apply to the common IC/PCC pool.

The safety-related IC/PCC pool subcompartments provide protection for the PCCS condensers to comply with 10 CFR 50, Appendix A, Criteria 2 and 4.

The PCC condensers do not fail in a manner that damages the safety-related IC/PCC pool because it is designed to withstand the induced dynamic loads, which are caused by combined seismic, DPV/SRV or LOCA conditions in addition to PCC operating loads.

The PCCS provides the containment heat removal function required in Criterion 38. For further discussion, see the following subsections:

Chapter/ Section	Title
6.2.2	Passive Containment Cooling System

3.1.4.10 Criterion 39 — Inspection of Containment Heat Removal System

Criterion 39 Statement

The Containment Heat Removal System shall be designed to permit appropriate periodic inspection of important components, such as torus, sumps, spray nozzles, and piping, to assure the integrity and capability of the system.

Evaluation Against Criterion 39

The PCCS condenser is an integral part of the containment (drywell) pressure boundary and it is used to mitigate the consequences of an accident. Because of this function it is classified as a safety-related Engineered Safety Feature (ESF). The PCCS is designed to ASME Code Section III, Class MC and Section XI, IWE requirements for design and accessibility of welds for in-service inspection to meet 10 CFR 50 Appendix A, Criterion 16. Ultrasonic testing of tube-to-header welds and eddy current testing of tubes can be done with the PCC condenser in place.

The containment heat removal system is designed to permit periodic inspection of major components to meet the requirements of Criterion 39. For further discussion, see the following subsections:

Chapter/ Section	Title
6.2.2	Passive Containment Cooling System

3.1.4.11 Criterion 40 — Testing of Containment Heat Removal System

Criterion 40 Statement

The Containment Heat Removal System shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole, and, under conditions as close to the design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.

Evaluation Against Criterion 40

The Passive Containment Cooling System accomplishes the containment heat removal function. The PCCS is an integral part of the containment boundary. It is designed to be periodically pressure tested as part of overall Containment Leakage Rate Testing Program (Subsections 6.2.6.1, 6.2.6.2 and 6.2.6.3) to demonstrate structural and leaktight integrity. Also, the PCCS loops can be isolated for individual pressure testing during maintenance or in-service inspection using various non-destructive examination methods.

Functional and operability testing of the PCCS is not needed because there are no active components of the system needed in the first 72 hours after a LOCA. Long term effectiveness of the PCCS requires that the vent fans are manually actuated by operator action. Performance testing during power operation is not feasible; however, the performance capability of the PCCS is proven by full-scale PCC condenser prototype tests at a test facility before their application to

Table 3.9-8

Inservice Testing

No.	Qty	Description (g)	Valve Type (i)	Act (b)	Code Class (a)	Code Cat. (c)	Valve Func. (d)	Norm Pos	Safety Pos.	Fail Safe Pos	CIV	Test Para (e)	Test Freq. (f)
F010	1	N2 supply line inboard isolation check valve to ADS, SRV and ICIV accumulator (g5~~h~~)	CK	SA	2	A, C	A	O/C	C	N/A	Y	L SC SO	App J RO RO
T10 Containment													
F001	3	Drywell wetwell vacuum breaker isolation valve	~~QT~~QBF QBL	NO~~,~~ SO	2	~~B~~A	A	O	~~C/O~~O/ C	as-is	--	P L SO SC	2 yrs 2 yrs 3 mo 3 mo
F002	3	Drywell wetwell vacuum breaker valve	~~CK~~VB	~~VB~~S A	2	A, C	A	C	O/C	N/A	--	SO SC L P R	3 mo 3 mo 2 yrs 2 yrs ~~E3~~RO
T15 Passive Containment Cooling System Valves													
F001	6	Vent fan ball check valves	CK	SA	2	A, C	A	C	O/C	N/A	--	L SO SC	2 yrs RO RO

- GDC 38 as it relates to:
  - The Passive Containment Cooling System (PCCS) being capable of reducing the containment pressure and temperature following a LOCA, and maintaining them at acceptably low levels;
  - The PCCS performance being consistent with the function of other systems;
  - The PCCS being a safety-related design; that is, having suitable redundancy of components and features, and interconnections, that ensures that for a loss of offsite power, the system function can be accomplished assuming a single failure; and
  - Leak detection, isolation and containment capabilities being incorporated in the design of the PCCS; and
- GDC 39, as the PCCS is designed to permit periodic inspection of components.
- GDC 40, as the PCCS is designed to permit periodic testing to assure system integrity, and operability of the system and its active components.

6.2.2.1 Design Basis

Functions

PCCS removes the core decay heat rejected to the containment after a LOCA. It provides containment cooling for a minimum of 72 hours post-LOCA, with containment pressure never exceeding its design pressure limit, and without makeup to the Isolation Condenser/Passive Containment Cooling (IC/PCC) pools, dryer/separator pool, and reactor well.

The PCCS is an ESF, and therefore a safety-related system.

General System Level Requirements

The PCCS condenser is sized to maintain the containment within its pressure limits for DBAs. The PCCS is designed as a passive system without power actuated valves or other components that must actively function in the first 72 hours. Also, it is constructed of stainless steel to design pressure, temperature and environmental conditions that equal or exceed the upper limits of containment system reference severe accident capability.

Performance Requirements

The PCCS consists of six PCCS condensers. Each PCCS condenser is made of two identical modules and each entire PCCS condenser two-module assembly is designed for 11 MWt capacity, nominal, at the following conditions:

- Pure saturated steam in the tubes at 308 kPa absolute (45 psia) and 134°C (273°F); and
- Pool water temperature at atmospheric pressure and 102°C (216°F).

Design Pressure and Temperature

The PCCS design pressure and temperature are provided in Table 6.2-10.

The PCCS condenser is in a closed loop extension of the containment pressure boundary. Therefore, ASME Code Section III Class 2, Seismic Category I, and Tubular Exchanger

Manufacturers Association (TEMA) Class R apply. Material is nuclear grade stainless steel or other material, which is not susceptible to Intergranular Stress Corrosion Cracking (IGSCC).

6.2.2.2 System Description

6.2.2.2.1 Summary Description

The PCCS consists of six independent closed loop extensions of the containment. Each loop contains a heat exchanger (PCCS condenser) that condenses steam on the tube side and transfers heat to water in a large pool, which is vented to atmosphere.

The PCCS operates by natural circulation. Its operation is initiated by the difference in pressure between the Drywell and the Wetwell, which are parts of the ESBWR pressure suppression type containment system. The drywell and WW vacuum breaker must fully close after each demand to support the PCCS operation. If the vacuum breaker does not close, a backup isolation valve will close.

The PCCS condenser, which is open to the containment, receives a steam-gas mixture supply directly from the drywell. The condensed steam is drained to a GDCS pool and the gas is vented through the vent line, which is submerged in the pressure suppression pool.

The PCCS loop does not have valves, so the system is always available.

6.2.2.2.2 Detailed System Description

The PCCS maintains the containment within its pressure limits for DBAs. The system is designed as a passive system with no components that must actively function in the first 72 hours after a DBA, and it is also designed for conditions that equal or exceed the upper limits of containment reference severe accident capability.

The PCCS consists of six, low-pressure, independent loops, each containing a steam condenser (Passive Containment Cooling Condenser), as shown Figure 6.2-16. Each PCCS condenser loop is designed for 11 MWt capacity and is made of two identical modules. Together with the pressure suppression containment (Subsection 6.2.1.1), the PCCS condensers limit containment pressure to less than its design pressure for at least 72 hours after a LOCA without makeup to the IC/PCC pool~~, and beyond 72 hours with pool makeup~~. Long-term effectiveness of the PCCS (beyond 72 hours) credits pool makeup and an active gas recirculation system, which uses in-line fans to pull drywell gas through the PCC condensers.

The PCCS condensers are located in a large pool (IC/PCC pool) positioned above, and outside, the ESBWR containment (DW).

Each PCCS condenser is configured (see Figure 6.2-16) as follows.

A central steam supply pipe is provided which is open to the containment at its lower end, and it feeds two horizontal headers through two branch pipes at its upper end. Steam is condensed inside vertical tubes and the condensate is collected in two lower headers.

The vent and drain lines from each lower header are routed to the DW through a single containment penetration per condenser module as shown on the diagram.

The condensate drains into an annular duct around the vent pipe and then flows in a line that connects to a large common drain line, which also receives flow from the other header. The vent line goes to the Suppression pool and is submerged below the water level.

A Passive Containment Cooling vent fan is teed off of each PCCS vent line and exhausts to the GDCS pool. The fan aids in the long-term removal of non-condensable gas from the PCCS for continued condenser efficiency. The fans are operated by operator action and are powered by a reliable power source which has a diesel generator backed up by an ancillary diesel if necessary without the need to enter the primary containment. The discharge of each PCC vent fan is submerged below the GDCS pool water level to prevent backflow that could otherwise interfere with the normal venting of the PCCS. The vent fan discharge line terminates in a drain pan within the GDCS pool so that the gas seal is maintained after the GDCS pool drains. To further prevent reverse flow through an idle fan, a ball check is installed at the end of the fan discharge line.

The PCCS loops receive a steam-gas mixture supply directly from the DW. The PCCS loops are initially driven by the pressure difference created between the containment DW and the suppression pool during a LOCA and then by gravity drainage of steam condensed in the tubes, so they require no sensing, control, logic or power-actuated devices to function. The PCCS loops are an extension of the safety-related containment and do not have isolation valves.

Spectacle flanges are included in the drain line and in the vent line to conduct post-maintenance leakage tests separately from Type A containment leakage tests.

~~Located on the~~ The drain line ~~and~~ is submerged in the GDCS pool~~, just upstream of the discharge point, is a loop seal: it~~to prevent~~s~~ back-flow of steam and gas mixture from the DW to the vent line, which would otherwise short circuit the flow through the PCCS condenser to the vent line. It also provides long-term operational assurance that the PCCS condenser is fed via the steam supply line. The drain line terminates in the same drain pan as the vent fan discharge to replace any evaporation loss in the drain pan after the GDCS pool drains.

Each PCCS condenser is located in a subcompartment of the IC/PCC pool, and all pool subcompartments communicate at their lower ends to enable full use of the collective water inventory independent of the operational status of any given IC/PCCS sub-loop.

A valve is provided at the bottom of each PCC subcompartment that can be closed so the subcompartment can be emptied of water to allow PCCS condenser maintenance.

Pool water can heat up to about 102°C (216°F); steam formed, being non-radioactive and having a slight positive pressure relative to station ambient, vents from the steam space above each PCCS condenser where it is released to the atmosphere through large-diameter discharge vents.

A moisture separator is installed at the entrance to the discharge vent lines to preclude excessive moisture carryover and loss of IC/PCC pool water.

IC/PCC expansion pool makeup clean water supply for replenishing level is normally provided from the Makeup Water System (Subsection 9.2.3).

Level control is accomplished by using a pneumatic powered or equivalent Power Operated Valve (POV) in the make-up water supply line. The valve opening and closing is controlled by water level signal sent by a level transmitter sensing water level in the IC/PCC expansion pool.

Cooling and cleanup of IC/PCC pool water is performed by the FAPCS (Subsection 9.1.3).

The FAPCS provides safety-related dedicated makeup piping, independent of any other piping, which provides an attachment connection at grade elevation in the station yard outside the RB, whereby a post-LOCA water supply can be connected.

6.2.2.2.3 System Operation

Normal Plant Operation

During normal plant operation, the PCCS loops are in "ready standby."

Plant Shutdown Operation

During refueling, the PCCS condenser maintenance can be performed, after closing the locked open valve, which connects the PCCS pool subcompartment to the common parts of the IC/PCC pool, and drying the individual partitioned PCCS pool subcompartment.

Passive Containment Cooling Operation

The PCCS receive a steam-gas mixture supply directly from the DW; it does not have any valves, so it immediately starts into operation, following a LOCA event. Non-condensibles, together with steam vapor, enter the PCCS condenser; steam is condensed inside PCCS condenser vertical tubes, and the condensate, which is collected in the lower headers, is discharged to the GDCS pool. The non-condensibles are purged to the Wetwell through the vent line.

The PCC vent fan can be started to assist the natural venting action to remove non-condensible gases that could accumulate in the PCCs. TRACG studies have shown that the PCCS meets its design function without the use of the PCC vent fan for at least 72 hours.

6.2.2.3 Design Evaluation

The PCCS condenser is an extension of the containment DW pressure boundary and it is used to mitigate the consequences of an accident. This function classifies it as a safety-related ESF. ASME Code Section III, Class 2 and Section XI requirements for design and accessibility of welds for inservice inspection apply to meet 10 CFR 50, Appendix A, Criterion 16. Quality Group B requirements apply per RG 1.26. The system is designed to Seismic Category I per RG 1.29. The common cooling pool that PCCS condensers share with the ICs of the Isolation Condenser System is a safety-related ESF, and it is designed such that no locally generated force (such as an IC system rupture) can destroy its function. Protection requirements against mechanical damage, fire and flood apply to the common IC/PCC pool.

As protection from missile, tornado and wind, the PCCS parts outside the containment are located in a subcompartment of the safety-related IC/PCC pool to comply with 10 CFR 50, Appendix A, Criteria 2 & 4.

The PCCS condenser can not fail in a manner that damages the safety-related ICS/PCC pool because it is designed to withstand induced dynamic loads, which are caused by combined seismic, DPV/ SRV or LOCA conditions in addition to PCCS operating loads.

In conjunction with the pressure suppression containment (Subsection 6.2.1.1), the PCCS is designed to remove heat from the containment to comply with 10 CFR 50, Appendix A, Criterion 38. Provisions for inspection and testing of the PCCS are in accordance with Criteria 39, 52 & 53. Criterion 51 is satisfied by using nonferritic stainless steel in the design of the PCCS.

The intent of Criterion 40, testing of containment heat removal system is satisfied as follows:

- The structural and leak-tight integrity can be tested by periodic pressure testing;
- Functional and operability testing is not needed because there are no active components of the system; and
- Performance testing during in-plant service is not feasible; however, the performance capability of the PCCS was proven by full-scale PCCS condenser prototype tests at a test facility before their application to the plant containment system design. Performance is established for the range of in-containment environmental conditions following a LOCA. Integrated containment cooling tests have been completed on a full-height reduced-section test facility, and the results have been correlated with TRACG computer program analytical predictions; this computer program is used to show acceptable containment performance, which is reported in Subsection 6.2.1.1 and Chapter 15.

6.2.2.4 Testing and Inspection Requirements

The PCCS is an extension of the containment, and it will be periodically pressure tested as part of overall containment pressure testing (Subsection 6.2.6). Also, the PCCS loops can be isolated for individual pressure testing during maintenance.

If additional inservice inspection becomes necessary, it is unnecessary to remove the PCCS condenser because ultrasonic testing of tube-to-header welds and eddy current testing of tubes can be done with the PCCS condensers in place during refueling outages.

6.2.2.5 Instrumentation Requirements

The PCCS does not have instrumentation that is separate from the Containment System. Control logic is not needed for it's functioning. There are no sensing and power actuated devices except for the vent fans. Containment System instrumentation is described in Subsection 6.2.1.7.

6.2.3 Reactor Building Functional Design

Relevant to the function of a secondary containment design, this subsection addresses (or references to other DCD locations that address) the applicable requirements of GDC 4, 16, and 43 and Appendix J to 10 CFR 50 discussed in SRP 6.2.3 R2. The plant meets the relevant and applicable requirements of:

- GDC 4 as it relates to safety-related structures, systems and components being designed to accommodate the effects of normal operation, maintenance, testing and postulated accidents, and being protected against dynamic effects (for example, the effects of missiles, pipe whipping, and discharging fluids) that may result from equipment failures;
- GDC 16 as it relates to reactor containment and associated systems being provided to establish an essentially leak-tight barriers against the uncontrolled release of radioactive material to the environment;

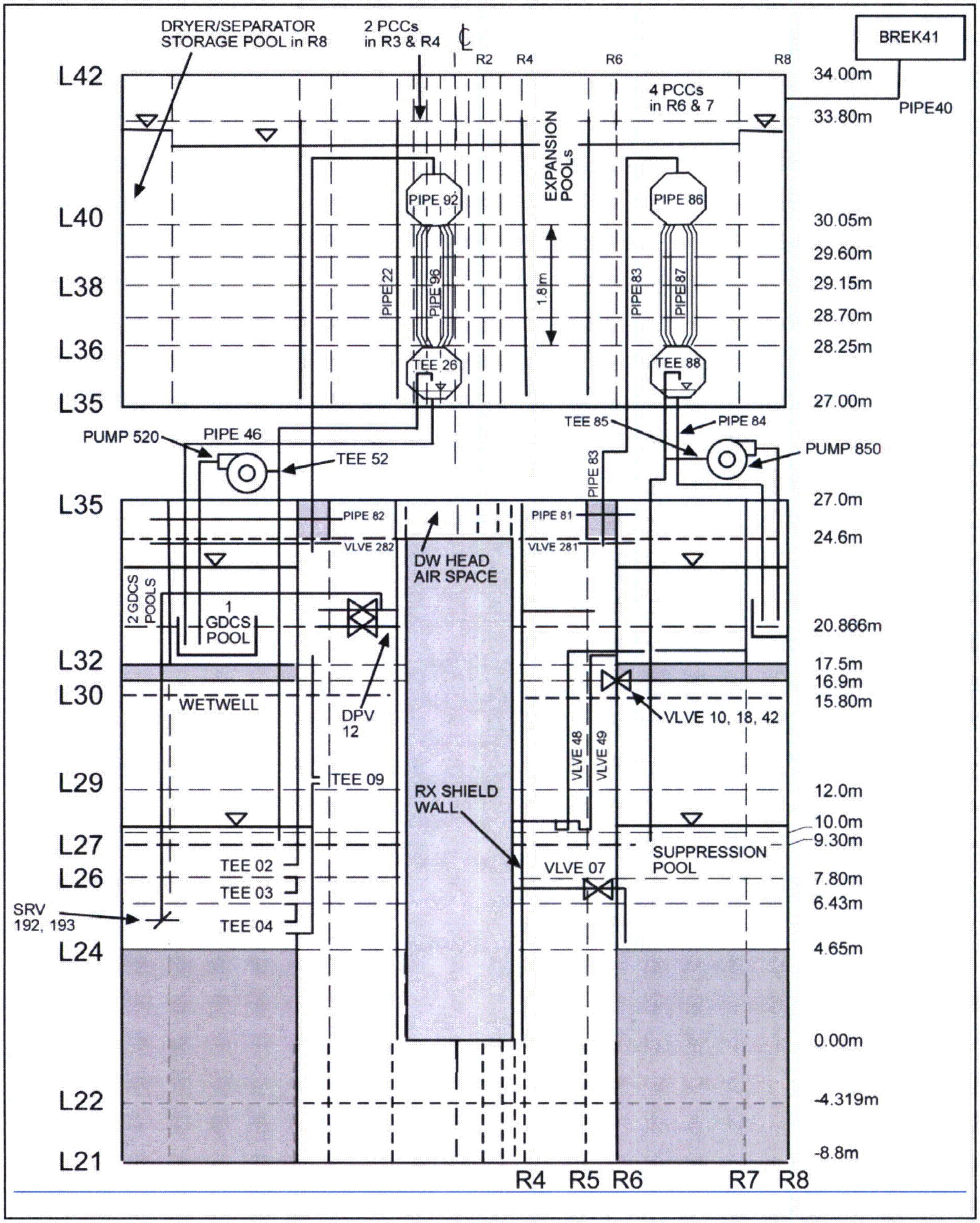


Figure 6.2-7. TRACG Nodalization of the ESBWR Containment

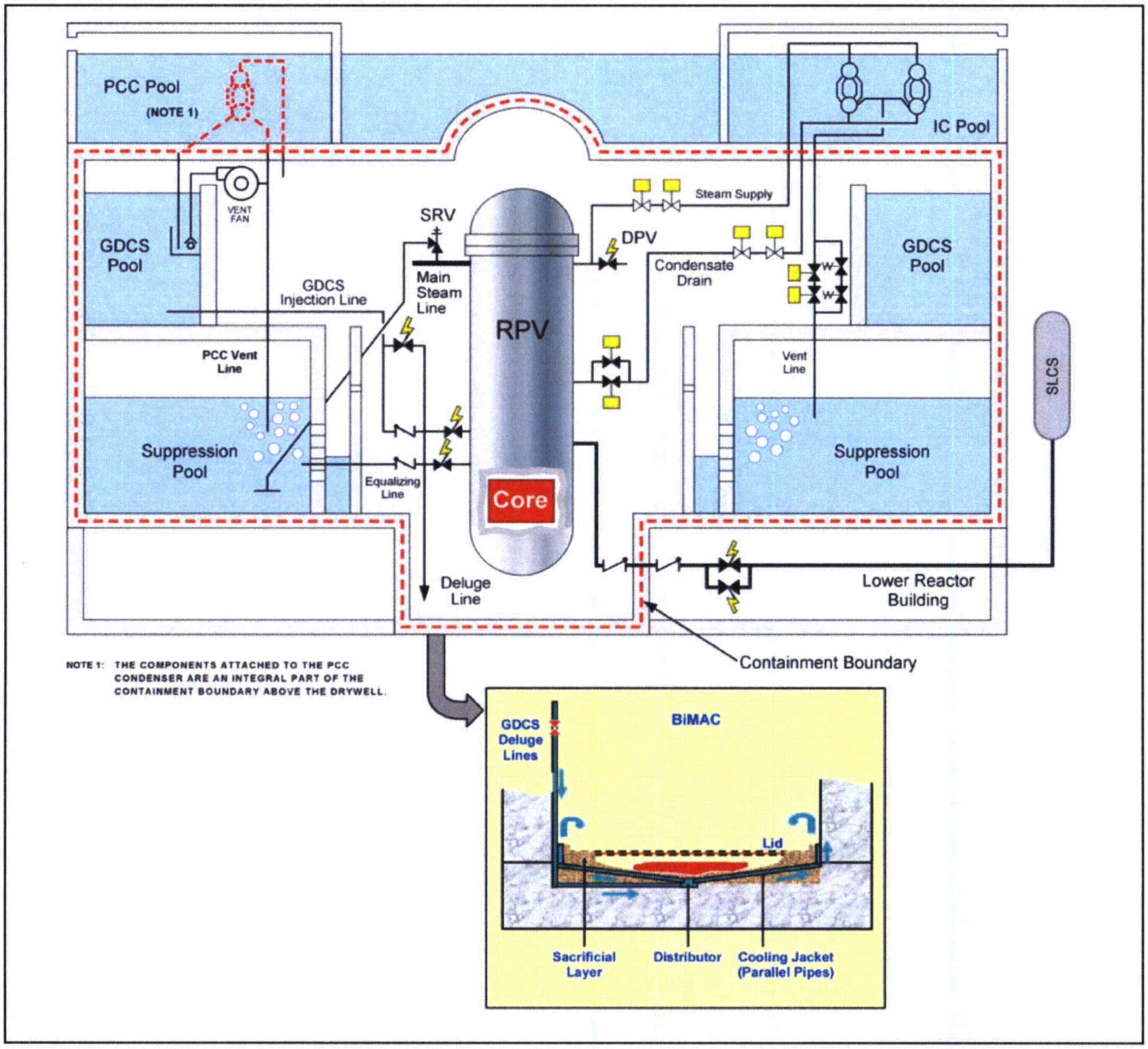


Figure 6.2-15. Summary of Severe Accident Design Features

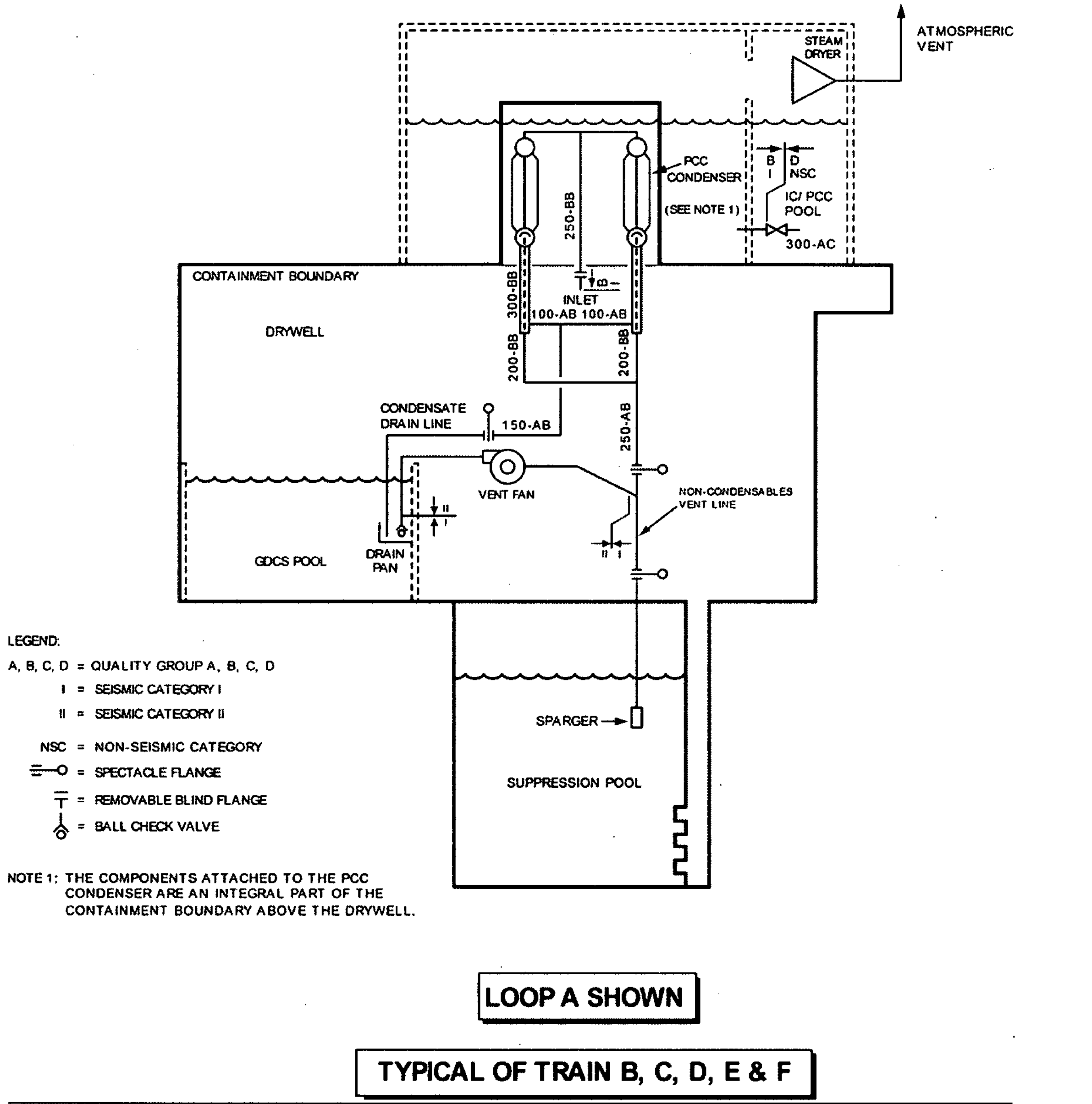


Figure 6.2-16. PCCS Schematic Diagram

7.1.2.8.3.9 Passive Containment Cooling System Description Summary

The Passive Containment Cooling System (PCCS) cools the containment following a rise in containment pressure and temperature without requiring any component actuation. The PCCS does not have instrumentation, control logic, or power-actuated valves, and does not need or use electrical power for its operation in the first 72 hours after a LOCA. For long-term effectiveness of the PCCS, the vent fans are manually initiated by operator actionThe PCCS does not need electric power and does not have instrumentation, control logic, or power actuated valves. This brief description is included here for completeness.

7.1.2.8.4 Containment Monitoring System Description Summary

The CMS provides the functions identified in Subsections 7.1.2.8.4.1 and 7.1.2.8.4.2. Refer to Subsection 7.5.2 for additional information.

7.1.2.8.4.1 Suppression Pool Temperature Monitoring Subsystem Function Description Summary

The safety-related Suppression Pool Temperature Monitoring System (SPTMS) Subsystem is part of the CMS and monitors suppression pool temperatures under all operating and accident conditions._ Should the suppression pool temperature exceed established limits, the SPTMS provides input for both a reactor scram and for automatic initiation of the suppression pool cooling mode of the Fuel Auxiliary Pools Cooling System (FAPCS) operation. The RTIF cabinet houses the equipment that performs the Suppression Pool Temperature Monitoring functions for the Containment Monitoring System (CMS) discussed in Subsection 7.5.2.

7.1.2.8.4.2 Other Containment Monitoring Systems Functions Description Summary

Other CMS functions, some of which are nonsafety-related, include monitoring several key containment parameters. These include fluid and radiation levels, pressures, hydrogen/oxygen concentrations, and dew point values. These parameters are monitored during normal reactor operations and post accident conditions to evaluate the containment integrity and other conditions. Abnormal measurements and indications initiate alarms in the MCR.

7.1.3 Q-DCIS Specifics

The Q--DCIS architecture, its relationships, and its acceptance criteria are described below. A simplified functional block diagram of the DCIS is shown as part of Figure 7.1--1. The Q--DCIS data communication systems are embedded in the DCIS,; the DCISwhich performs the data communication functions that are part of or support the systems described in Sections 7.2 through 7.8. A network diagram of the DCIS appears as part of Figure 7.1--2, which shows the elements of the Q--DCIS and the N--DCIS., The figureand is a functional representation of the design.

variables exceed preset limits. This action limits the loss of coolant from the ~~reactor coolant pressure boundary~~RCPB and the release of radioactive materials to the environment. Refer to Subsection 7.3.3 for additional information.

7.1.3.2.2.3 Control Room Habitability Systems

The safety-related CRHS ~~is an ESF system that~~ provides a safe environment within the ~~control room~~MCR that allows the operator(s) to:

- Control the nuclear reactor and its auxiliary systems during normal conditions,~~;~~
- Safely shut down the reactor~~;~~, and
- Maintain the reactor in a safe condition during abnormal events and accidents.

The CRHS includes CB shielding, area radiation monitoring and a CRHA Heating, Ventilation, and Air Conditioning (HVAC) System. The CRHS provides emergency food and water storage; emergency kitchen and sanitary facilities; protection from and removal of airborne radioactive contaminants; and the capability to remove smoke. The CRHA envelope, ventilation inlet/return isolation dampers, redundant Emergency Filter Units (EFUs) in the emergency HVAC system, and associated controls are safety-related. Refer to Subsection 7.3.4 for more information.

~~**Safety System Logic and Control Engineered Safety Features System**~~

~~The safety-related SSLC/ESF includes the control functions of the safety-related actuation devices of the safety-related plant systems. Input signals from redundant channels of safety-related instrumentation are used to perform logic operations that result in decisions for safety-related action. Trip logic outputs to the actuation devices, such as pilot solenoid valves and squib valves, initiate the appropriate plant protection actions. Refer to Subsection 7.3.5 for additional information.~~

7.1.3.2.2.4 Passive Containment Cooling System

The safety-related PCCS cools the containment following a rise in containment pressure and temperature without requiring any component actuation. The PCCS does not have instrumentation, control logic, or power-actuated valves, and does not need or use electrical power for its operation in the first 72 hours after a LOCA. For long-term effectiveness of the PCCS, the vent fans are manually initiated by operator action~~The PCCS does not need electric power and does not have instrumentation, control logic, or power actuated valves~~. This brief description is included here for completeness. Refer to Subsection 7.3.2 for additional information.

7.1.3.2.3 Safe Shutdown Systems

Safe shutdown systems include the SLC system and the RSS.

discussion on the GDCS instrumentation is contained in Subsection 7.3.1.2.2 and in Subsection 6.3.2.7.5):

- Status indication of locked-open maintenance valves;
- Status indication and alarm of the squib-actuated valves;
- Position indication of the GDCS check valves;
- Drywell and RPV pressure indication;
- Suppression pool high/low level alarm;
- GDCS pool high/low level alarm;
- Water level indication for the GDCS pools, suppression pool~~s~~ and RPV; and
- Squib valve open alarm.

The safety-related GDCS instrumentation ~~that is essential for system operation~~ is designed to operate in a drywell environment resulting from a LOCA. The thermocouples that initiate the deluge valves are qualified to operate in a severe accident environment. Safety-related instruments, located outside the drywell, are qualified for the environment in which they must perform their safety-related functions.

7.3.2 Passive Containment Cooling System

The Passive Containment Cooling System (PCCS) consists of ~~heat exchanger loops~~condensers that are an ~~extension~~ integral part of the containment pressure boundary. The PCCS heat exchanger tubes are located in ~~a pool of water~~ the Isolation Condenser/Passive Containment Cooling (IC/PCC) pool~~)~~ outside the containment. ~~A rise in c~~Containment (drywell) pressure above the ~~pressure~~ suppression pool (wetwell) pressure, similar to the situation ~~what occurs~~ during a loss of reactor coolant into the drywell, forces flow through the PCCS condensers~~heat exchanger loops~~. Condensate from the PCCS drains to the GDCS pools. As the flow passes through the PCCS condensers~~heat exchangers~~, heat is rejected to the IC/PCC pool, thereby cooling the containment atmosphere. This action occurs automatically, without the need for actuation of components. The PCCS does not have instrumentation, control logic, or power-actuated valves, and does not need or use electrical power for its operation in the first 72 hours after a LOCA. For long-term effectiveness of the PCCS, the vent fans are manually initiated by operator action. Other information on the PCCS is given in Subsection 6.2.2 and leak rates are discussed in ~~s~~Subsection 16B.3.3.

7.3.3 Leak Detection and Isolation System

The primary function of the Leak Detection and Isolation System (LD&IS) is to detect and monitor leakage from the RCPB and to initiate the appropriate safety action to isolate the source of the leak. The system is designed to automatically initiate the isolation of certain designated process lines penetrating the containment, to prevent release of radioactive material from the RCPB. The initiation of the isolation functions closes the appropriate containment isolation

Prerequisites

The construction tests have been successfully completed and the integrated containment leak rate test has been completed successfully. Makeup Water System is available to support the proper level control of IC/PCCS pool. The SCG has reviewed the test procedure and approved this visual inspection.

General Test Methods and Acceptance Criteria Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Verification that PCCS steam supply, drain and vent piping is unobstructed;
- Verification that PCCS condenser air flow versus differential pressure is within acceptable test limits;
- Verification that PCCS pool subcompartment valves are locked open;
- Proper operation of IC/PCCS pool level control; and
- Verification of the system interface with Fuel and Auxiliary Pools Cooling System (FAPCS) for IC/PCCS pool cooling.
- Verification that the PCCS Vent fans operate as required from the Main Control Room from normal power and from alternative power.
- Verification that the PCCS fans will meet the flow requirements in Tier 1 Table 2.15.4-2.

14.2.8.1.65 Gravity-Driven Cooling System Preoperational Test

Purpose

The objective of this test is to verify that the operation of the four divisions of the GDCS, including valves, logic and instrumentation, is as specified.

Prerequisites

The construction tests have been successfully completed and the SCG has reviewed the test procedure and approved the initiation of testing. The reactor vessel shall be ready to accept GDCS flow. The required electrical power shall be available for squib type valve power supply. Instrument calibration and instrument loop checks have been completed. To prevent actuation of single use squib valves during the logic portion of this testing process, the valve(s) may be isolated electrically to prevent actuation. This isolation, verification of the firing signal during the test, and reconnection process must be controlled within the test document.

General Test Method and Acceptance Criteria

Performance shall be observed and recorded during a series of individual component and integrated system tests to demonstrate the following:

- Proper calibration of instrumentation;
- Proper operation of instrumentation and equipment in appropriate design combinations of logic and instrument channel trip;
- Proper functioning of instrumentation and alarms used to monitor system operation and availability;

load, a sufficient quantity of water is available in the spent fuel pool to allow boiling for 72 hours and still provide acceptable fuel coverage in the pool. A dedicated external connection to the FAPCS line allows for manual hook-up of external water sources, if needed, at 7 days for either upper containment pool replenishment and for spent fuel pool makeup. These functions are manually actuated from the yard area and can be performed without any support systems.

After 72 hours, the PCCS Vent Fans are operated to redistribute the non-condensable gases from the wetwell to the drywell so that overall containment pressure is reduced.

The following components are within the scope of RTNSS, with the exception of those components described as safety-related in Tier 2 Subsection 9.1.3: the diesel-driven makeup pump system, FAPCS piping connecting to the diesel-driven makeup pump system, the external connection.

19A.3.1.3 *Control Room Habitability*

Safety-related portions of the Control Room Habitability Area Ventilation System maintain control room habitability. This function is operated on safety-related battery power for the first 72 hours following an event. For longer term operation, the system can be powered by two (2) ancillary diesel ~~a small, portable AC power~~ generators that are~~is~~ kept on the plant site.

These~~is~~ generators ~~is~~are included within the scope of RTNSS.

19A.3.1.4 *Post-Accident Monitoring*

Operator actions are not required for successful operation of safety-related systems for the first 72 hours following an event. Beyond that, operator actions are necessary to support continued operation of decay heat removal and control room ventilation systems. These functions can be performed without any support systems or indications (other than local indications on the equipment to be operated).

However, the operators can use information on the condition of the plant to determine ways to augment the functions needed for beyond design basis response. This provides an additional flexibility (defense-in-depth) for the operators to respond in the post-72 hour time frame.

The Distributed Control and Instrumentation System (DCIS) that is powered by the safety-related power systems is used to perform this monitoring. In order to support monitoring beyond 72 hours, it is necessary to provide power for the Q-DCIS components. Two 6.9 kV Plant Investment Protection (PIP) nonsafety-related buses (PIP-A and PIP-B) provide power for the nonsafety-related PIP loads. PIP-A and PIP-B buses are each backed by a separate standby onsite AC power supply source. Cooling for the areas containing the DCIS components may also be required, depending on the outcome of the detailed building heatup analyses. These functions are provided by nonsafety-related SSCs that are candidates for RTNSS.

The standby diesel generators and the PIP buses provide power for Q-DCIS. Portions of the HVAC systems in the Reactor Building, Electrical Building, Fuel Building, Control Building, and some areas of the Turbine Building perform component and area cooling. In addition, support for these nonsafety-related functions is required from Reactor Component Cooling Water, Plant Service Water, and the Chilled Water System.

19A.3.2 Seismic Assessment

The seismic margins analysis described in section 19.2.3.~~5~~2.4 assesses the seismic ruggedness of safety-related plant systems and the non-safety systems required for decay heat removal after 72 hours. No accident sequence has a High Confidence for Low Probability of Failure (HCLPF) ratio less than 1.67 times the peak ground acceleration magnitude of the safe shutdown earthquake (SSE).

Therefore, there are no additional RTNSS candidates due to seismic events.

19A.4 CRITERION C: PRA MITIGATING SYSTEMS ASSESSMENT

Criterion C requires an assessment of safety functions that are relied upon at-power and during shutdown conditions to meet the NRC's safety goal guidelines. A comprehensive assessment to identify RTNSS candidates includes focused PRA sensitivity studies for internal events, evaluations of external events, an assessment of the effects of nonsafety-related systems on initiating event frequencies, and an assessment of uncertainties in these analyses and uncertainties that may be introduced by first of a kind passive components.

19A.4.1 Focused PRA Sensitivity Study

A focused PRA sensitivity study evaluates whether passive systems alone are adequate to meet the NRC safety goals of CDF less than 1.0 E-4 per year and LRF less than 1.0 E-6 per year. The focused PRA retains the same initiating event frequencies as the baseline PRA, and sets the status of nonsafety-related systems to failed, while safety-related systems remain unchanged in the model. The focused PRA model is evaluated using only the safety-related systems and RTNSS systems determined from criteria A or B. Additional nonsafety-related systems are included only if they are required to meet the CDF or LRF goals. The additional nonsafety-related systems required to meet the CDF and LRF goals are candidates for RTNSS.

The CDF and LRF goals will be met with the addition of portions of the Diverse Protection System (DPS) as RTNSS. This is needed to counter the effects of a dominant risk contribution due to common cause failures of actuation instrumentation and controls.

19A.4.2 Assessment of Non-Safety Systems on External Events

The effects of nonsafety-related systems relative to external events, at power and during shutdown, have a negligible effect on the CDF and LRF goals. The insights described in this subsection support this conclusion.

19A.4.2.1 *Fire*

The Fire PRA is a bounding analysis that incorporates several conservative assumptions. The fire analysis does not account for the amount of combustible material present, or for the distance between fire sources and targets. The analysis assumes that a fire ignition in any fire area grows into a fully developed fire. Therefore, fires are conservatively assumed to propagate unsuppressed in each fire area and damage all functions in the fire area.

19A.6.1.4 *Standby Liquid Control System (SLCS)*

19A.6.1.4.1 Design Features

SLCS provides a diverse backup capability for reactor shutdown, independent of normal reactor shutdown with control rods. It also provides makeup water to the RPV to mitigate the consequences of a LOCA.

19A.6.1.4.2 System Interfaces

Control Building, Containment, DC Power

19A.6.1.4.3 Analysis of Potential Adverse System Interactions

Electrical heating of the accumulator tank and the injection line is not necessary because the saturation temperature of the solution is less than 15.5°C (60°F) and the equipment room temperature is maintained above that value at all times when SLCS injection is required to be operable.

The design features of SLCS and its supporting systems are adequate to ensure that potential adverse systems interactions are not significant.

19A.6.1.5 *Passive Containment Cooling System (PCCS)*

19A.6.1.5.1 Design Features

PCCS removes the core decay heat rejected to the containment after a LOCA. It provides containment cooling for a minimum of 72 hours post-LOCA, with containment pressure never exceeding its design pressure limit, and with the Isolation Condenser/Passive Containment Cooling (IC/PCC) pool inventory not being replenished. After 72 hours, the PCCS Vent Fans are operated to redistribute the non-condensable gases from the wetwell to the drywell so that overall containment pressure is reduced.

19A.6.1.5.2 System Interfaces

Containment, FAPCS, ICS, Suppression Pool

19A.6.1.5.3 Analysis of Potential Adverse System Interactions

Due to their similar passive designs and physical arrangements, PCCS and ICS have similar considerations for potential adverse interactions. In addition, PCCS is dependent on successful operation of the drywell to wetwell vacuum breakers, which are safety-related.

19A.6.1.5.4 Monitoring Instrumentation

This is covered under the discussion above on actions required beyond 72 hours.

19A.7 SELECTION OF IMPORTANT NON-SAFETY SYSTEMS

The selection of RTNSS systems considers nonsafety-related SSCs that are necessary to meet NRC regulations, safety goal guidelines, and containment performance goal objectives. RTNSS

Table 19A-2
RTNSS Systems

Table System	Function	RTNSS Criterion	Regulatory Treatment
PAM Instruments (DCIS)	Provide post accident monitoring (use RG 1.97 to determine scope.)	B2	LRO
PIP Buses	Provides post 72-hour AC power from standby diesel generators to support Post-Accident Monitoring, and FAPCS.	B2 C	Support Support
PCCS	Provides post 72-hour reduction in containment pressure by redistributing non-condensable gases from the wetwell to the drywell.	B1	LRO
PSW	Provide post 72-hour cooling for RCCWS. Provide cooling support for FAPCS.	B2 C	Support Support
RB HVAC	Provide post 72-hour cooling for DCIS.	B2	Support
RCCWS	Provide post 72-hour cooling for Chillers and DGs. Provide cooling support for FAPCS.	B2 C	Support Support
SLCS Actuation	Backup actuation logic to initiate SLCS and isolate RWCU/SDC.	A	LRO
TB HVAC	Provide post 72-hour cooling for DCIS in Turbine Building. Provide room cooling for RCCW pumps.	B2 C	Support Support

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ACM 3.6 CONTAINMENT SYSTEMS

AC 3.6.3 Passive Containment Cooling System (PCCS) Vent Fans

ACLCO 3.6.3 Five PCCS vent fans shall be AVAILABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One required PCCS vent fan unavailable.	A.1 Restore required PCCS vent fan to AVAILABLE status.	Prior to entering MODE 2 or 4 from MODE 5
B. Two or more required PCCS vent fans unavailable.	B.1 Restore required PCCS vent fans to AVAILABLE status.	24 hours
C. Required Action and associated Completion Time not met.	C.1 Enter ACLCO 3.0.3.	Immediately

PCCS Vent Fans
AC 3.6.3

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
ACSR 3.6.3.1	Operate each required PCCS vent fan ≥ 15 minutes.	31 days
ACSR 3.6.3.2	Verify required PCCS vent fan flow rate is greater than or equal to that assumed in long term containment heat removal analyses.	24 months on a STAGGERED TEST BASIS for each PCCS condenser

ACM B 3.6 CONTAINMENT SYSTEMS

AC B 3.6.3 Passive Containment Cooling System (PCCS) Vent Fans

BASES

A branch line from each of the 6 PCCS system vent in the drywell contains a fan and discharge line that terminates in a submerged location in the GDCS pool. When in operation, the fan will actively circulate the drywell atmosphere (steam and non-condensables) through the PCCS condensers to enhance the rate of heat removal.

The PCCS vent fan function is a nonsafety-related function that provides the ability to reduce drywell pressure and temperature after 72 hours following a DBA by forced containment cooling through the PCCS system condensers. Satisfactory results are obtained by successful operation of four out of the six fans; therefore, the ACLCO requires the AVAILABILITY of five fans. PCCS vent fans provide post 72-hour reduction in containment pressure by redistributing noncondensable gases from the wetwell to the drywell; therefore, regulatory oversight is provided. The short-term availability controls for this function, which are specified as Completion Times, are acceptable to ensure that the availability of this function is consistent with the functional unavailability in the ESBWR PRA. The surveillance requirements also provide an adequate level of support to ensure that component performance is consistent with the functional reliability in the ESBWR PRA.