HITACHI

GE Hitachi Nuclear Energy

Richard E. Kingston
Vice President, ESBWR Licensing

P.O. Box 780
3901 Castle Hayne Road, M/C A-65
Wilmington, NC 28402 USA

T 910.819.6192
F 910.362.6192
rick.kingston@ge.com

MFN 08-357 Revision 1 Docket No. 52-010

September 18, 2009

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

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 Revision 1,14.3-235, and 14.3-236

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) revised response to a portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 80 sent by NRC letter dated November 2, 2006 (Reference 1).

Reference 2 transmitted our initial response to RAI Number 6.2-139. During the June 17th ACRS meeting on the subject RAI, an error was uncovered in Figure 9 of GEH's response to RAI 6.2-139 issued in Reference 2. Enclosure 1 contains RAI Number 6.2 – 139 Revision 1 which corrects this error. The DCD Markups issued in Reference 2 as a result of our response to RAI 6.2-139 are still valid and have been included in DCD Revision 6.

GEH's response to RAI 14.3-235 and RAI 14.3-236, transmitted by Reference 2, are not affected by this letter revision.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

References:

1. MFN 06-419, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, GEH, *Request For Additional Information Letter No. 80 Related To ESBWR Design Certification Application*, dated November 2, 2006

2. MFN 08-357, Letter from R. E. Kingston, GEH to the U.S. Nuclear Regulatory Commission *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*, dated April 19th, 2009

Enclosure:

1. Partial Response to NRC RAI Letter No. 80 Related to ESBWR Design Certification Application - DCD Tier 2 Section 6.2 – Containment Systems; RAI Number 6.2-139 (Revision 1)

cc:	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0071-3559 R7(RAIs 6.2-139, Revision 1)

ENCLOSURE 1

MFN 08-357 Revision 1

Response to NRC RAI Letter No. 80
Related to ESBWR Design Certification Application

DCD Tier 2 Section 6.2 – Containment Systems

RAI Number 6.2-139 (Revision 1)

NRC RAI 6.2-139

Question Summary: Rapidly reducing containment pressure and temperature requirement in GDC 38

Full Text: 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." This 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 post loss-of-coolant accident (LOCA) decay heat from the containment for a minimum of 72 hours without operator action to maintain containment pressure and temperature within design limits. Beyond 72 hours, mitigating measures would be in place to keep the containment pressure and temperature well below design limits. One of these measures consists of providing Isolation Condenser (IC)/PCCS pool makeup for the PCCS to continue removing decay heat at a rate that will maintain the containment pressure and temperature within design limits. Other 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 gases from the PCCS condensers, resulting in an improvement in the heat exchanger efficiency. As an additional enhancement to support and maintain the heat exchanger efficiency a passive autocatalytic recombiner system (PARS) is credited after 72 hrs. The operation of PCCS Vent Fans and PARS results in a rapid and continued long-term reduction in drywell pressure and temperature. The pressure and temperature are reduced to the levels that are well below design limits.

The PCCS Vent Fan takes suction from a tee on the PCCS vent line, and discharges to the GDCS pool region including submergence and passive check valves to ensure no back flow when the vent vans are not in operation. There is a fan and discharge line for each PCCS vent line, for a total of six fans. The system is initiated by a manual operator action and has the capability to be powered by backup power supplies, if normal power should become unavailable. Figure 1 shows the schematic of the PCCS HTX vent fan, submerged and discharging to the GDCS pool region.

The analysis to determine the drywell pressure and temperature behavior for the main steamline break (MSLB) for the licensing bounding conditions including refill of the IC/PCCS pool, operation of the PCCS Vent Fans and crediting PARS after 72 hours

were performed utilizing the ESBWR TRACG code. The analysis results indicate that the drywell pressure remains below the design pressure of 413.7 KPa (60 psia) for the first 72 hours after the incident, and then rapidly reduces and maintains the reduction with the refill of the IC/PCCS pool and operation of the PCCS Vent Fans, achieving lower pressures when the PARS were credited. Figures 6 to 11 present the key results of the base calculation. The base case and the parametric cases are performed with a DW/WW bypass leakage area of 1 cm^2.

Parametric Case – Vent fan discharging to the DW without credit from PARS

A parametric case was performed to assess the impact on the Drywell and Wetwell pressures with the PCCS vent fan discharging to the DW and without the credit from PARS. Figure 2 and Figure 3 show the results of this parametric case. This case assumes each 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 2 is a TRACG plot showing the rapid DW pressure decrease with the operation of the PCCS after the fans are put in service and the IC/PCCS pool is filled 72 hours after the LOCA event. The IC/PCCS pool is continuously and constantly refilled with 0.0127 m^3/s (201 gpm) of water at 310.9 K (100F).

Figure 3 is the TRACG plot showing the DW temperature response of this case.

Base Case – 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 vent discharge is relocated to the GDCS pool compartment (see Figure 1). This improvement is attributed to the relocation of noncondensibles to an area that is less accessible to the PCC 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 submergence, i.e. for a submergence of 0.254 m (10 in) of water in the GDC 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 vent fan 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 ^oK (130 ^oC) 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 vent fans are not in operation.

Furthermore, to prevent the possibility of any liquid back flow that may occur during the blow down phase of the event or any other time, a passive check valve is also 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 HTX vent fans discharging to the GDCS pool region including submergence and passive check valves to ensure no back flow when the vent fans are not in operation.

The credit of PARS is accounted and modeled only after 72 hrs. This simulation is implemented by having the rate of production of noncondensibles equal to the rate of their recombination. This implementation limits the amount of noncondensibles inside the containment to the amount accumulated in the first 72 hours.

For the base configuration of the vent fan, i.e., discharging to the GDCS pool, 3 cases were performed: (1) 6 PCCS vent fans with credit of PARS (Base Case), (2) 4 vent fans with the credit of PARS, and (3) 6 PCCS vent fans without the credit of PARS. The conditions and results of these 3 cases are summarized in Table 1. The comparison shows that, with the credit of PARS, the DW pressure at the end of 7 days is reduced by 6.1 kPa (0.885 psi). Figures 6 to 11 present the key results of the base case calculation (Case 1).

Figure 4 compares the DW pressures from two cases: the vent fans discharging to the DW and the vent fans discharging to the GDCS pool (0.254m or 10 in submergence). The results show that there is a small improvement in the pressure response if the vent discharge is relocated to the GDCS pool compartment.

Figure 5 compares the DW pressure from Cases 1 and 3. The results show that there is a small improvement in the pressure response with the credit of PARS. This figure also shows the DW pressure from Case 2 (with 4 vent fans). This result shows that the DW pressure reduction is larger with higher total PCC vent fan capacity.

Figures 6 to 11 present the key results of the base case calculation (Case1), from 3 to 7 days. Figure 6 shows the pressure response for the DW, WW and RPV. Figure 7 shows the temperature response for the DW, WW and suppression. Figure 8 shows comparison of the decay heat and the total PCC condensation power.

Figure 9 shows noncondensible (NC) gas pressures in DW annulus, DW head and GDCS gas space. This figure shows that, after the actuation of the PCC vent fans, significant amount of NC gas is redistributed back to the DW from the WW, via the opening of the vacuum breakers. Figure 10 shows the water level in the GDCS pool. The pool maintains a constant level that provides approximate 10 inches of submergence to the vent fan discharge line. Figure 11 shows the IC/PCC pool level. At continuous refilling rate of 200 gpm, the IC/PCC pool level rises to about the top of PCC tube at 156 hrs.

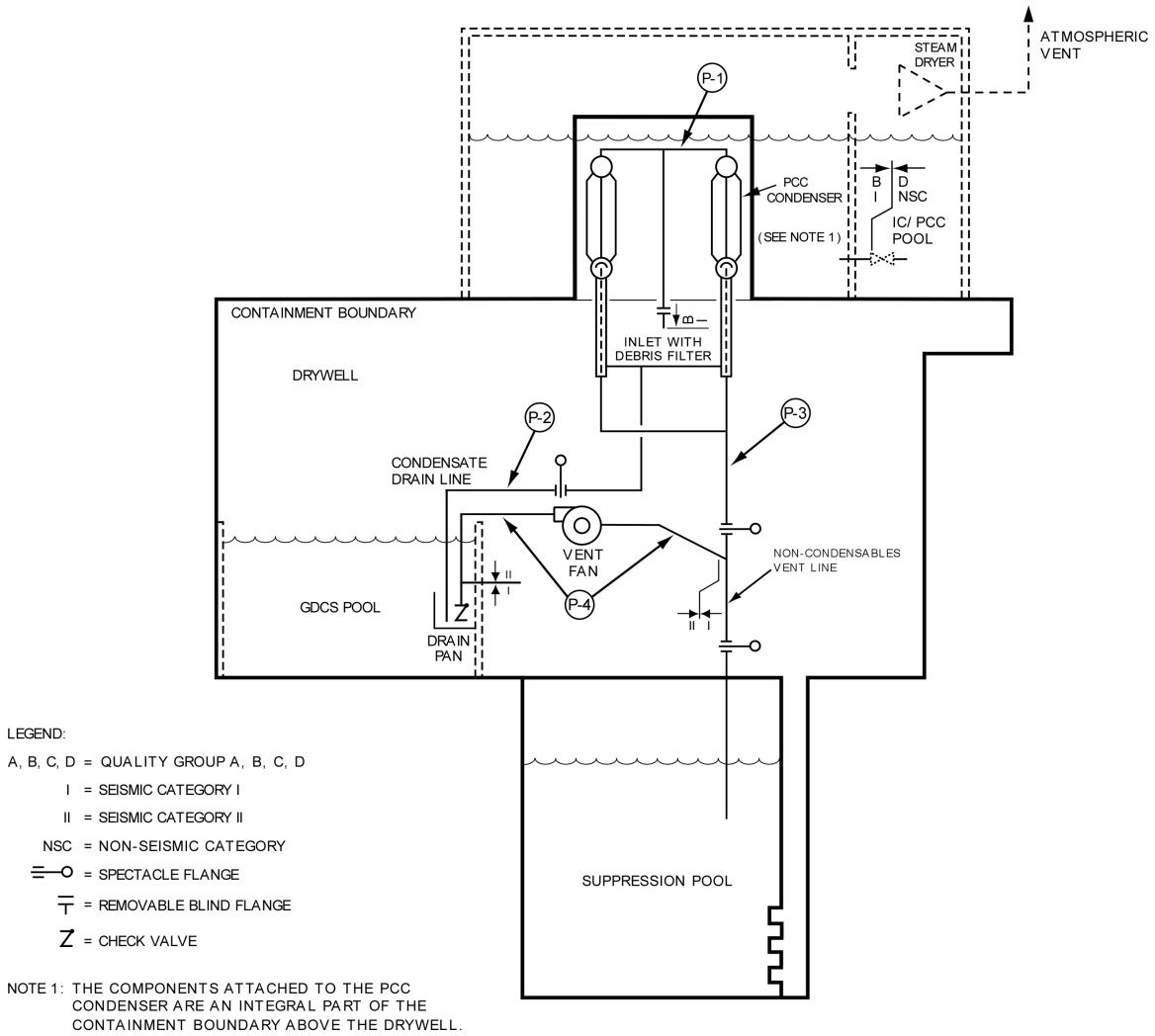
Table 1. Main Results

Case #	Case ID	PARS	NO PARS	200 GPM	6VF	4VF	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

DCD Impact

DCD impact. The DCD will be revised as shown in the markup pages that follow the Figures

FIGURES



TRAIN A SHOWN

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

Figure 1. Schematic of PCCS with Vent Fan

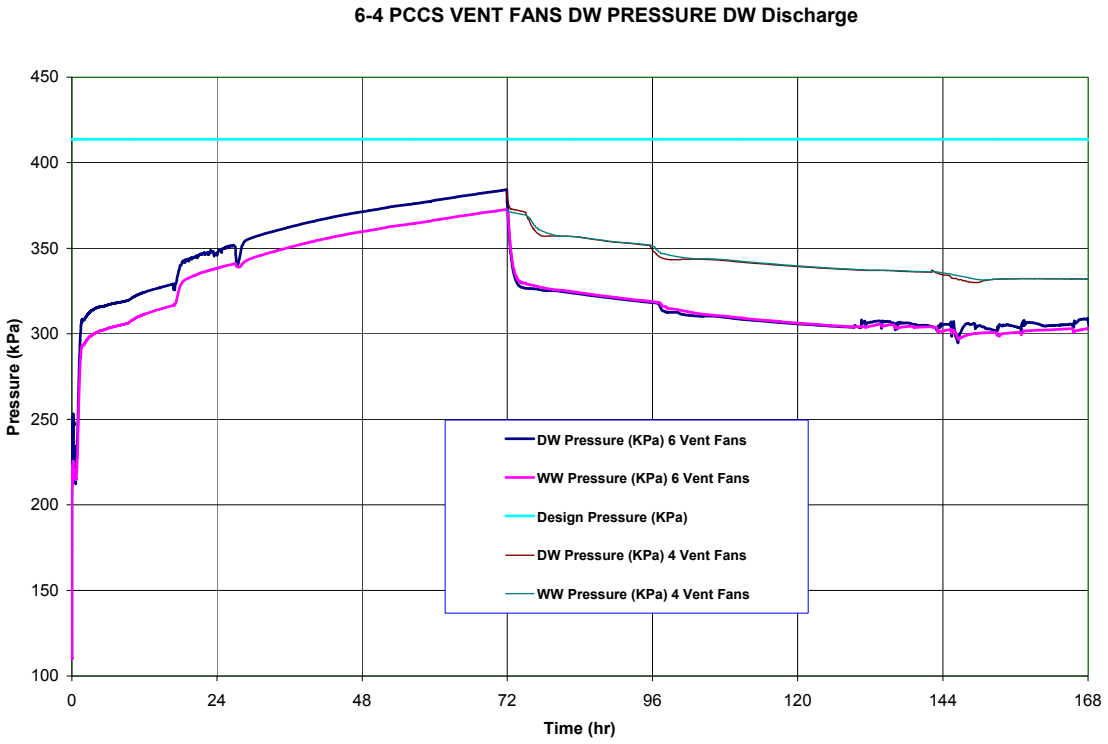


Figure 2. Drywell and Wetwell Pressures
(Parametric Case – vent fan discharging to DW, and no credit for PARS)

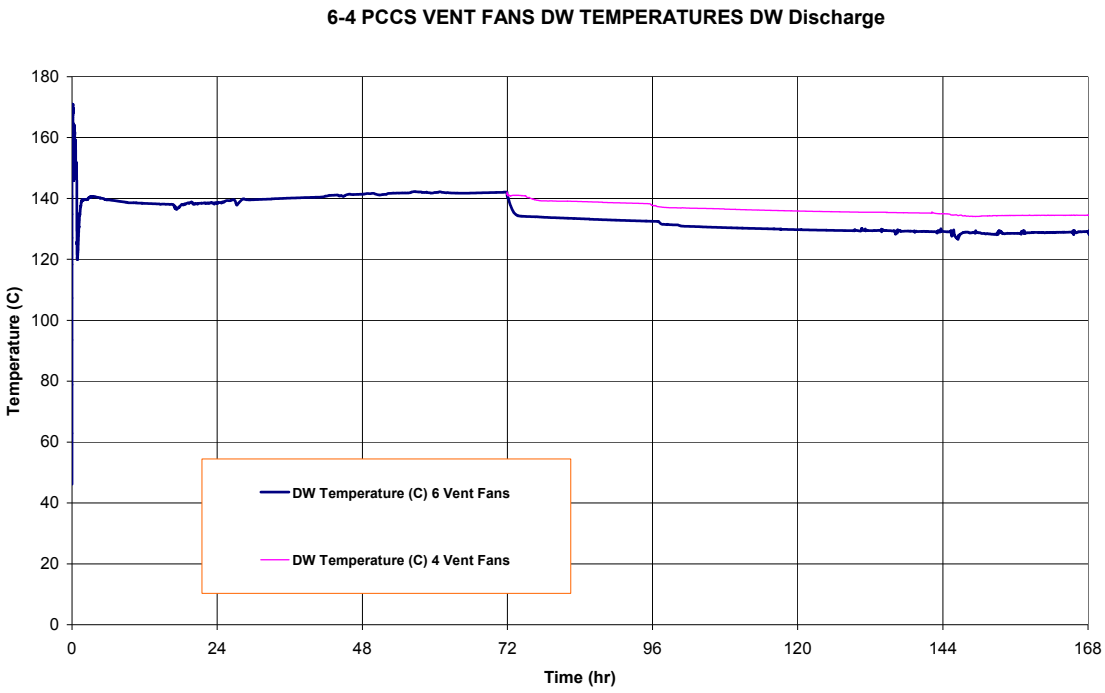


Figure 3. Drywell and Wetwell Temperatures
(Parametric Case – vent fan discharging to DW, and no credit for PARS)

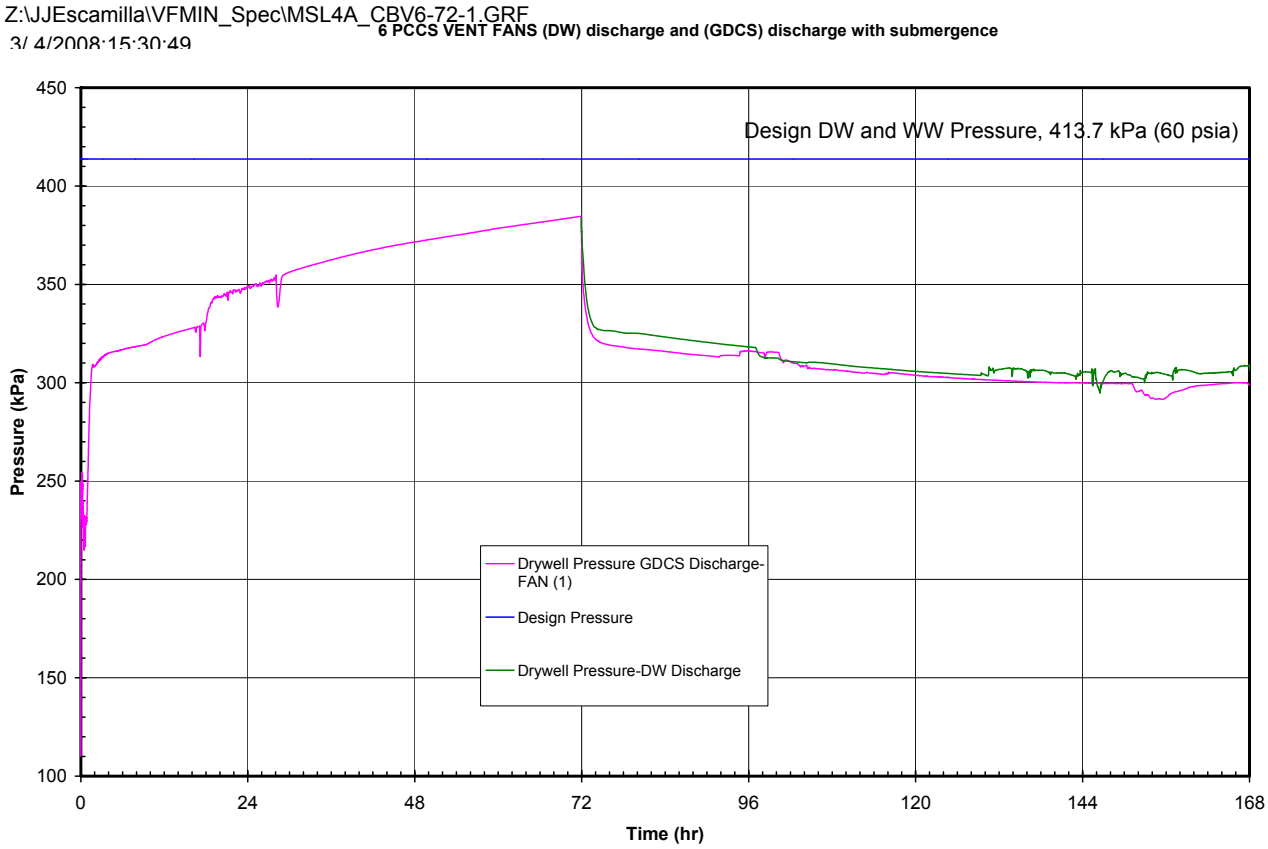


Figure 4. Comparison of Drywell Pressures with no credit for PARS (Vent Fan discharge location: DW versus GDCS pool)

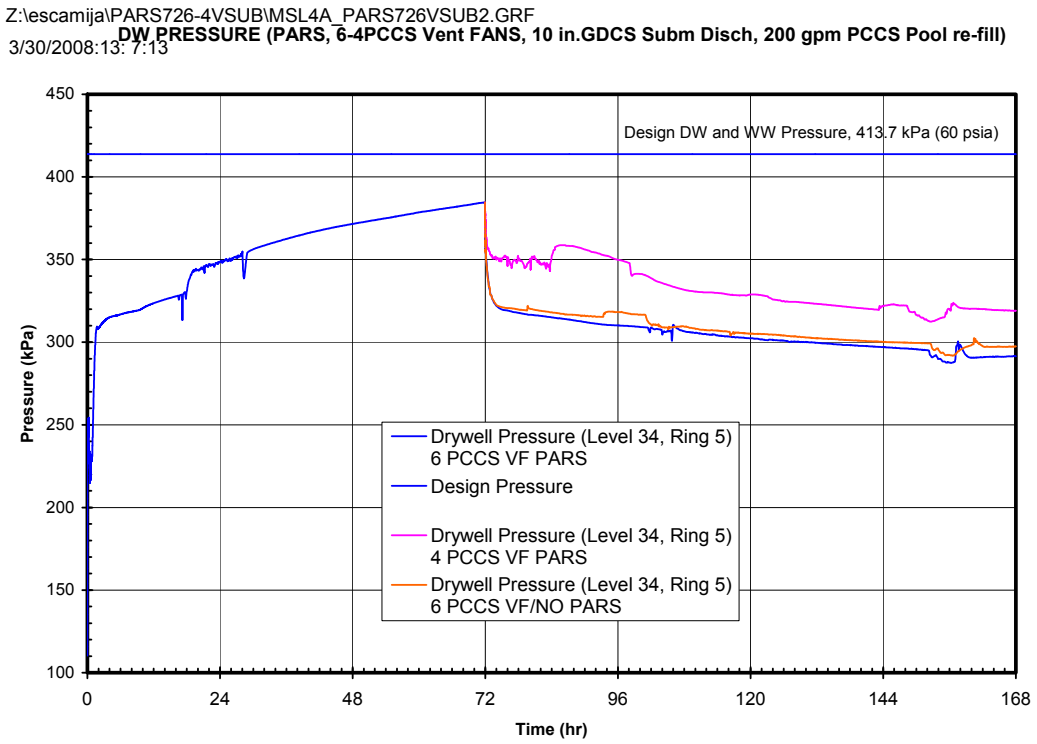


Figure 5. Comparison of Drywell Pressures with Vent Fan Discharging to GDCS Pool (6 Vent Fans with and without PARS; 6 versus 4 Vent Fans with PARS)

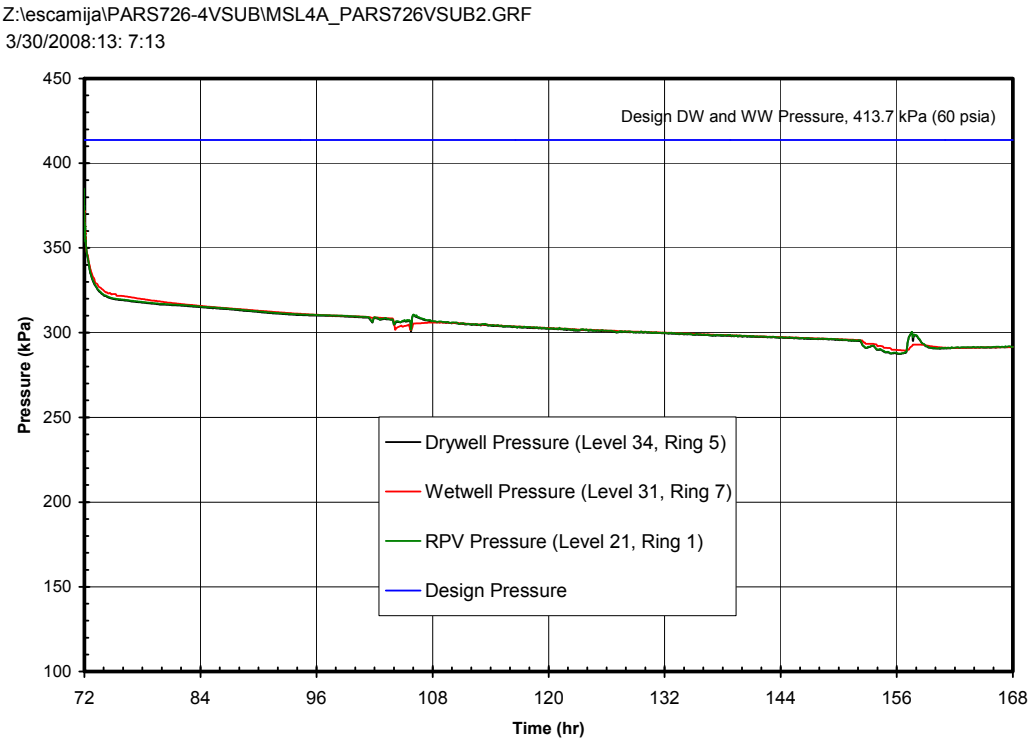


Figure 6. DW, WW, RPV Pressures
(Base Case: MSL4A_PARS726VSUB2)

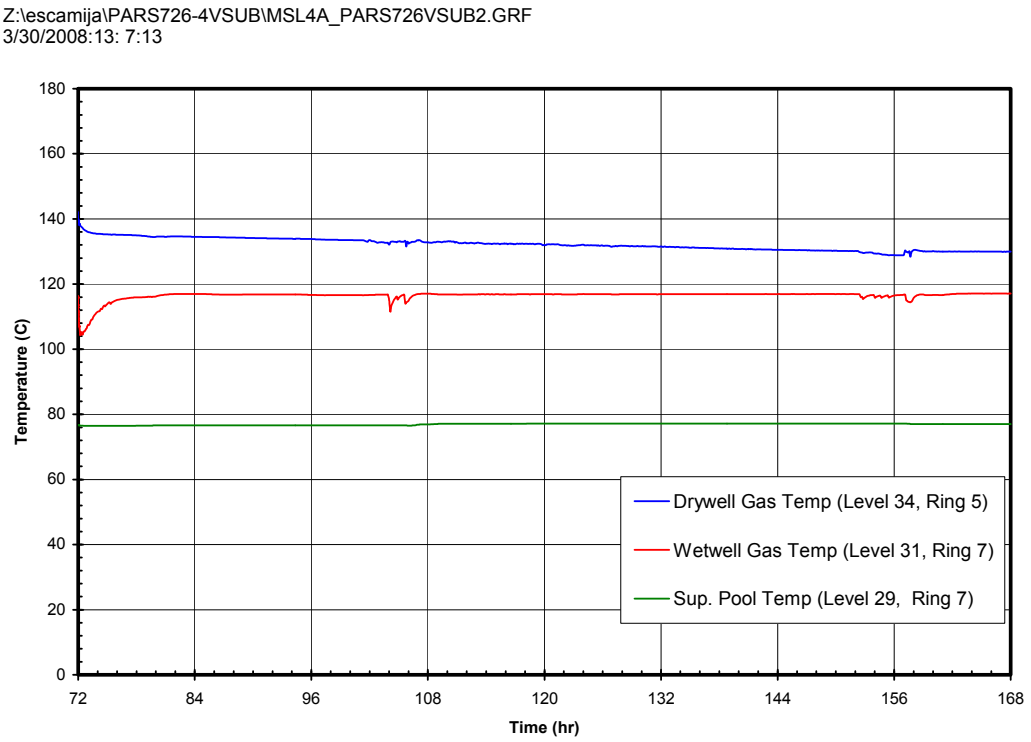


Figure 7. DW, WW and Suppression Pool Temperatures
(Base Case: MSL4A_PARS726VSUB2)

Z:\escamija\PARS726-4VSUB\MSL4A_PARS726VSUB2.GRF
3/30/2008:13: 7:13

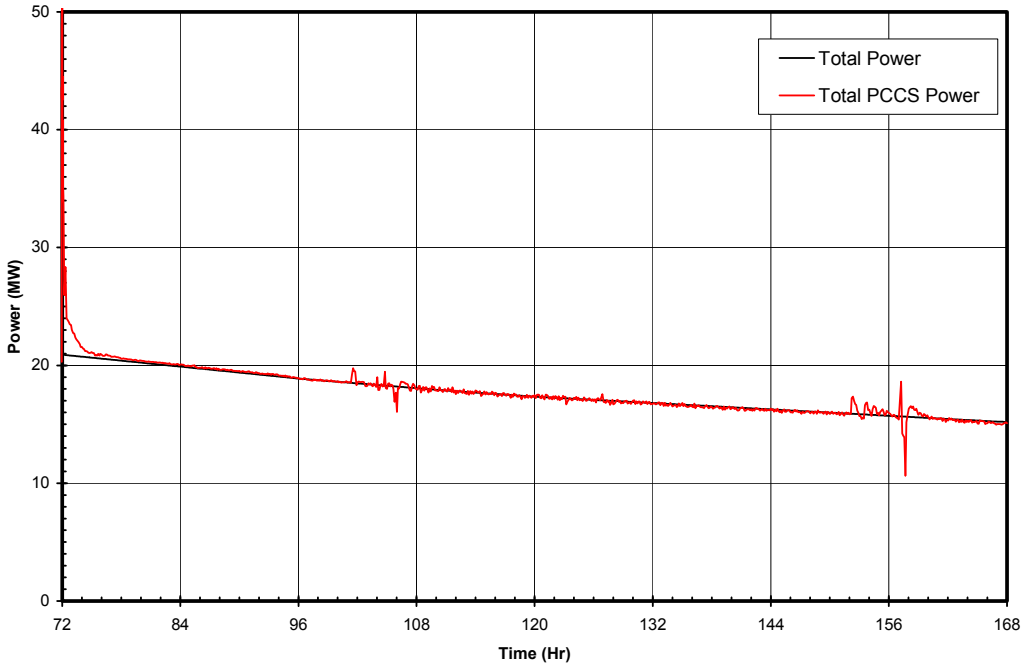


Figure 8. Decay Heat versus Total PCCS Condensation Power
(Base Case: MSL4A_PARS726VSUB2)

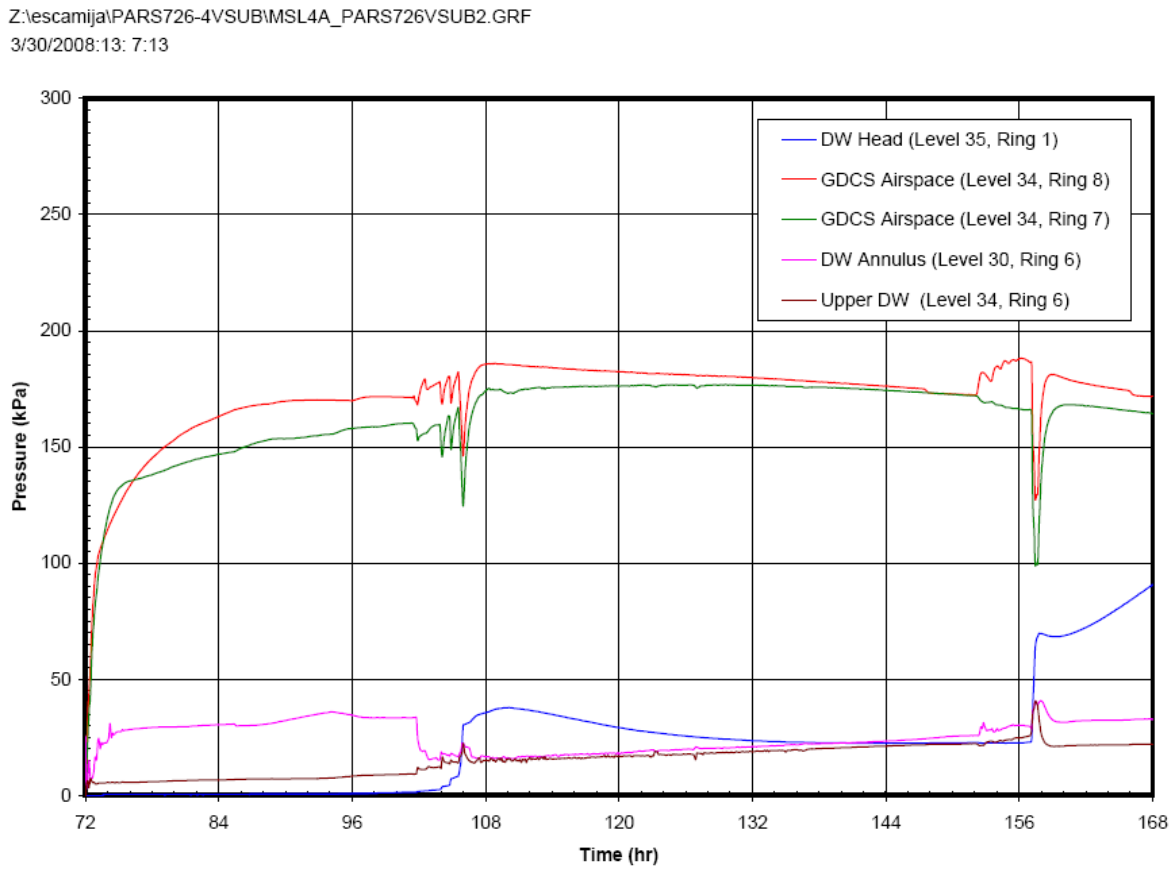


Figure 9. NC Gas Pressures in DW Annulus, DW Head and GDCS Gas Space (Base Case: MSL4A_PARS726VSUB2)

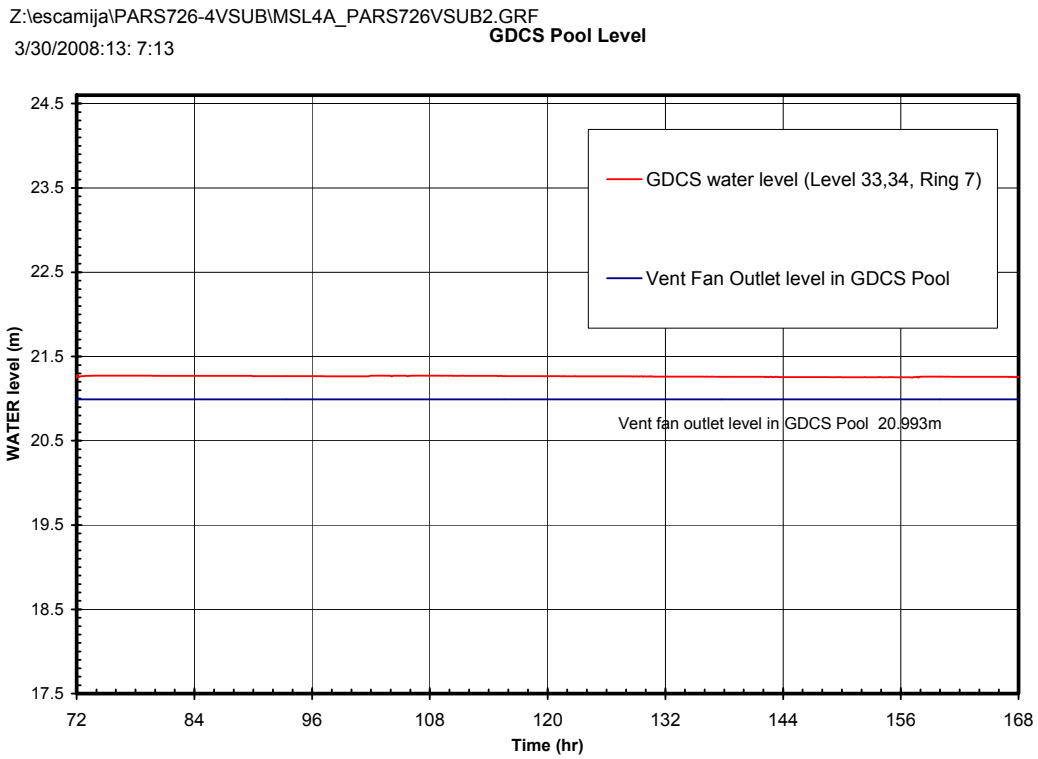


Figure 10. GDCS Pool Water Level
(Base Case: MSL4A_PARS726VSUB2)

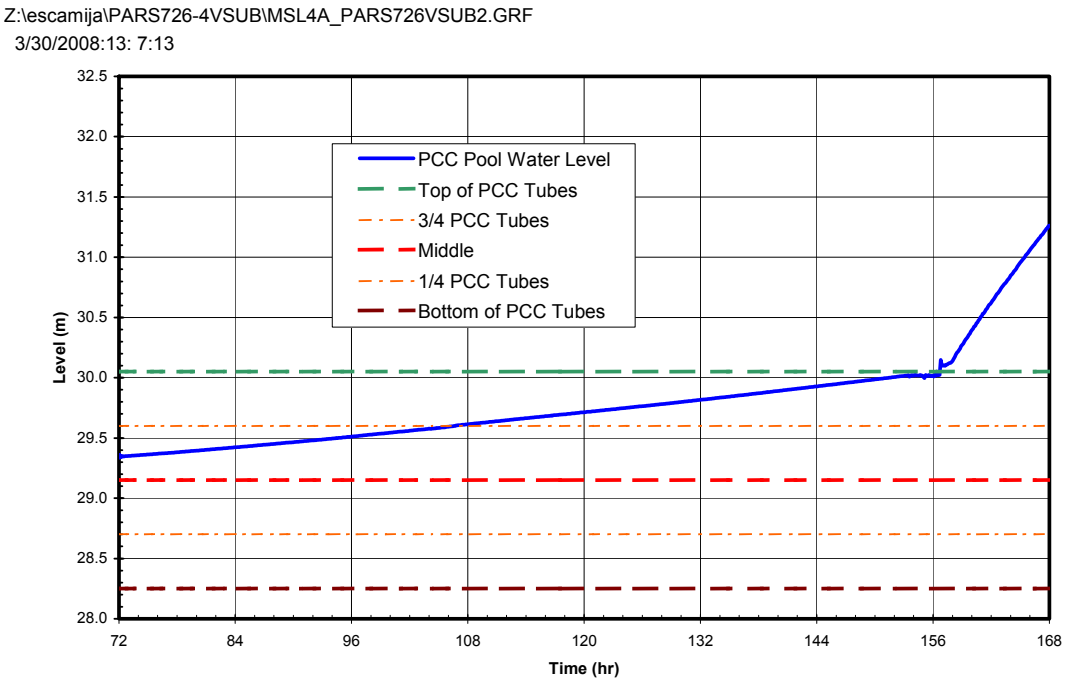


Figure 11. PCCS Pool Water Level
(Base Case: MSL4A_PARS726VSUB2)

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 markups

DCD Tier 2, Figure 1.1-2; Subsections 3.1.4.9 and 3.1.4.11; 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, and Table 3.9-8, as shown in the attached markups.