HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-53 S03**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI originally transmitted via the Reference 1 letter and supplemented by an NRC request for clarification in Reference 2. DCD Markups related to this response are provided in Enclosure 2.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-167, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 33 Related to ESBWR Design Certification Application*, June 1, 2006
2. MFN 08-095, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application*, January 31, 2008

Enclosures:

1. MFN 08-302 - Response to Portion of NRC Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-53 S03
2. MFN 08-302 - Response to Portion of NRC Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-53 S03 - 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	0000-0081-8558

Enclosure 1

MFN 08-302

Response to Portion of NRC Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-53 S03

NRC RAI 6.2-53 S03:

GEH response to RAI 6.2-53, Supplement No. 2, provided additional TRACG outputs (transient air mass profiles in gravity drain cooling system, drywell (DW) head, and wetwell airspaces); and parametric results (impact of various model/plant parameters on the long-term DW pressures), for the limiting main steam line break design basis accident. The staff found the response to be acceptable except that the information was not incorporated into the DCD or a topical report. To support staff's safety evaluation, include the information in either the DCD Tier 2, or in one of the related topical reports, e.g., NEDC-33083P (TRACG Application for ESBWR Transient Analysis) or NEDE-32176P (TRACG Model Description).

GEH Response:

A new DCD Tier 2, Appendix 6H will be added to incorporate the information provided in the response to RAI 6.2-53 S02. In addition, DCD Tier 2, Subsection 6.2.1.1.3 will be revised to add a discussion related to the added appendix.

DCD Impact:

DCD Tier 2, Subsection 6.2.1.1.3, will be revised and a new DCD Tier 2, Appendix 6H will be added as shown in the attached markup.

Enclosure 2

MFN 08-302

Response to Portion of NRC Request for Additional Information Letter No. 147 Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-53 S03

DCD Markups

There is sufficient water volume in the suppression pool to provide adequate submergence over the top of the upper row of horizontal vents, as well as the PCCS return vent, when water level in RPV reaches one meter above the top of active fuel and water is removed from the pool during post-LOCA equalization of pressure between RPV and the WW. Water inventory, including the GDCS, is sufficient to flood the RPV to at least one meter above the top of active fuel.

6.2.1.1.3 Design Evaluation

Summary Evaluation

The key design parameters for the containment and their calculated values under the DBA conditions are shown in Tables 6.2-1 and 6.2-5, respectively.

The evaluation of the containment design is based on the analyses of a postulated instantaneous guillotine rupture of a feedwater line, a main steam line, a GDCS injection line, and a bottom head drain line. For plant operation with nominal feedwater temperature, the analysis results are discussed in this subsection. For plant operation with feedwater temperature maneuvering (increase and reduction), the limiting breaks were evaluated and results are discussed in Reference 6.2-7.

Table 6.2-6 provides the nominal and bounding values for the plant initial and operating conditions for this evaluation. This evaluation utilizes the GE-Hitachi Nuclear Energy (GEH) computer code TRACG (Reference 6.2-1). NRC has reviewed and approved the application of TRACG to ESBWR LOCA analyses, per the application methodology outlined in the report. The confirmatory items in the Staff's Safety Evaluation Report (SER) (Reference 6.2-1) concerning the TRACG computer code are addressed and provided in References 6.2-3 and 6.2-4. TRACG is applicable to LOCAs covering the complete spectrum of pipe break sizes, from a small break accident to a DBA, and covering the entire LOCA transient including the blowdown period, the GDCS period and the long-term cooling PCCS period.

Containment Design Parameters

Tables 6.2-1 through 6.2-4 provide a listing of key design and operating parameters of the containment system, including the design characteristics of the DW, WW and the pressure suppression vent system and key assumptions used for the design basis accident analysis.

Tables 6.3-1 through 6.3-4 provide the performance parameters of the related ESF systems, which supplement the design conditions of Table 6.2-1, for containment performance evaluation.

Accident Response Analysis

The containment functional evaluation is based upon the consideration of a representative spectrum of postulated accidents, which would result in the release of reactor coolant to the containment. These accidents include:

- Liquid Breaks
  - An instantaneous guillotine rupture of a feedwater line;
  - An instantaneous guillotine rupture of a GDCS line; and
  - An instantaneous guillotine rupture of a vessel bottom drain line.
- Steam Breaks

– An instantaneous guillotine rupture of a main steamline.

Containment design basis calculations are performed for a spectrum of possible pipe break sizes and the results show that the Double-Ended Guillotine (DEG) pipe break is limiting. Results of DEG pipe break analyses at 4 different locations show that an instantaneous guillotine rupture of a main steam line with failure of one Depressurization ~~Vavle~~Valve (DPV) produces the most limiting responses for the containment pressure evaluation. The second limiting case is an ~~instaneous~~instantaneous guillotine rupture of a feedwater line with failure of one ~~SRV~~DPV. Table 6.2-5 summarizes the results of these DEG pipe break calculations. Subsections 6.2.1.1.3.1 through 6.2.1.1.3.5 discuss the results of these calculations. Additional TRACG outputs for the limiting break base case (main steam line break), e.g., the transient air mass profiles in different regions such as the gravity driven cooling system, drywell (DW) head, and wetwell (WW) airspaces were generated. Also, additional parametric cases were performed to evaluate the impact of various model/plant parameters on the long-term containment pressure. The results of these additional outputs and parametric analyses are detailed in Appendix 6H.

6.2.1.1.3.1 Feedwater Line Break – Nominal Analysis

This analysis initializes the RPV and containment at the base conditions shown in the Nominal Value column of Table 6.2-6. Figure 6.2-6 and 6.2-7 show the TRACG nodalization of the RPV and the containment. Its fundamental structure is an axisymmetric "VSSL" component with 42 axial levels and eight radial rings. The inner 4 rings in the first 21 axial levels represent the RPV; the outer 4 rings in these levels are not utilized in the calculations. Axial levels 22 to 35 represent the DW, suppression pool, WW, and GDCS pools (Figure 6.2-7). Axial levels 36 to 42 represent the IC/PCC pool, expansion pools, and the Dryer/Separator Storage pool. Figure 6.2-8 shows the nodalization for the steam line system, including the SRVs and DPVs. Figure 6.2-8a shows the nodalization for the ESBWR isolation condenser system. Figure 6.2-8b shows the nodalization of the ESBWR feedwater line system.

This analysis follows the application methodology outlined in Reference 6.2-1. The TRACG nodalization approach in this analysis is similar to that used in Reference 6.2-1. However, this nodalization includes some additional features and details. Some of these features are implemented to address the confirmatory items listed in the Safety Evaluation Report of Reference 6.2-1. Other features are implemented due to design changes. Table 6.2-6a summarizes the list of these changes in the TRACG nodalization. The details of the TRACG application procedure of Reference 6.2-1 have been re-evaluated for the present configuration. Results of this evaluation show that the overall philosophy of the TRACG application procedure remains the same. Appendix 6A summarizes the details of this evaluation. Appendix 6B provides the justification for the use of the DCD nodalization (similar to that in Reference 6.2-1, as outlined in the first row of Table 6A-1), including the results of the tie-back calculations between these nodalizations.

The combined nodalization that integrates the responses between the containment and the reactor vessel is used for both the containment analyses (Subsection 6.2.1.1.3) and the ECCS analyses (Subsection 6.3.3). The impact of containment back pressure on the ECCS performance has been evaluated and the results show that the minimum chimney collapsed level is not sensitive for a wide range of change in the containment back pressure. Appendix 6C summarizes the details of this evaluation.

6H. ADDITIONAL TRACG OUTPUTS AND PARAMETRIC CASES

This appendix discusses the limiting DBA of the main steam line break base case that assumes a single failure of 1 DPV and bounding conditions and 100% double-ended guillotine break. This case is referenced as Case A in the following sections, and was documented in DCD Tier 2, Rev. 3, Section 6.2.1.1.3.5 and Table 6.2-6, DCD Tier 2 Rev 3. Subsequently, additional TRACG outputs for this limiting break case, e.g., the transient air mass profiles in different regions, were generated. Also, additional parametric cases were performed to evaluate the impact of various model/plant parameters on the long-term containment pressure. This Appendix summarizes these additional TRACG outputs for the limiting break case and the results from the additional parametric studies. Section 6H.1 provides the additional TRACG outputs for the limiting DBA break case. These are the transient air mass profiles in different regions. Section 6H.2 discusses the results from the additional parametric studies, performed to evaluate the impact of various model/plant parameters on the long-term containment pressure.

6H1 Transient Air Mass Profiles for the Limiting DBA (Main Steam Line) Break Case

This section provides the additional TRACG outputs for this limiting break case, e.g., the transient air mass profiles in different regions. Figures 6H-1 to 6H-3 show the air mass profiles in the GDCS, DW head and WW airspaces. After 20 hours into the transient, all the air mass in the GDCS and DW head airspaces is essentially purged and transferred into the wetwell airspace. After that time, the air mass in the wetwell airspace continues to increase gradually due to the generation of radiolytic gases in the core during the transient.

6H2 Description of Parametric Cases on the Main Steam Line Break

Additional parametric cases were performed to evaluate the impact of various model/plant parameters on the long-term containment pressure. This section summarizes the additional TRACG outputs for the limiting break case and the results of the additional parametric studies.

Table 6H-1 summarizes the eight cases that are discussed and compared with the base case. The base case is the limiting DBA of the main steam line break accident (DCD Tier 2, Rev. 3, Subsection 6.2.1.1.3.5). The parametric cases (E through L) use the same nodalization and conditions as those used in the base case, except the parameters that are noted in the 3rd column in the table.

The following paragraphs discuss the results of these parametric cases.

6H2.1 Effect of Wetwell Stratification (Case A versus Case E)

The base Case A (with bounding conditions) assumes stratification in the top level of the wetwell airspace due to vacuum break leakage (DCD Tier 2, Rev. 3, Table 6A-1, Item 5). The parametric Case E turns off the stratification model in the wetwell. Figure 6H-4 compares the drywell pressures from these 2 cases. Without the wetwell stratification, the calculated peak drywell pressure is 10.39 kPa lower than that for the base case at 72 hours.

6H2.2 Effect of Suppression Pool Stratification (Case A versus Case F)

The base Case A (with bounding conditions) assumes stratification in the suppression pool in the region above the highest source of mass and energy to the pool (DCD Tier 2, Rev. 3, Table 6A-1, Item 4). The parametric Case F turns off the stratification model in the suppression pool.

Figure 6H-5 compares the drywell pressures from these 2 cases. Without the suppression pool stratification, the calculated peak drywell pressure is 20.79 kPa lower than that for the base case at 72 hours.

6H2.3 Effect of IC Heat Transfer (Case A versus Case G)

The base Case A (with bounding conditions) assumes no credit for the heat transfer in the ICS (DCD Tier 2, Rev. 3, Table 6A-1, Item 19). The parametric Case G takes credit for the heat transfer in the ICs. Figure 6H-6 compares the drywell pressures from these 2 cases. With the credit for the heat transfer in the ICs, the calculated peak drywell pressure is 0.37 kPa lower than that for the base case at 72 hours.

6H2.4 Effect of Single Failure: 1 DPV versus 1 SRV (Case A versus Case H)

The base Case A (with bounding conditions) assumes a single failure of 1 DPV. The parametric Case H assumes a single failure of 1 SRV. Figure 6H-7 compares the drywell pressures from these 2 cases. The calculated peak drywell pressure for the case with a single failure of 1 SRV is 0.79 kPa lower than that for the base case at 72 hours.

6H2.5 Effect of Containment Outer wall Heat Transfer Area (Case A versus Cases I and J)

The parametric cases decrease the containment outer wall (in the wetwell airspace and suppression regions) heat transfer area by 10% (Case I) and 25% (Case J). Figures 6H-8 and 6H-9 compare the drywell pressures from these cases with that from the base case. With 10% reduction in the outer wall heat transfer area, the calculated peak drywell pressure at 72 hours is 1.07 kPa higher than that for the base case. With 25% reduction in the outer wall heat transfer area, the calculated peak drywell pressure at 72 hours is 6.69 kPa higher than that for the base case. The increase in the calculated peak drywell at 72 hours pressure is small comparing to the margin to the design pressure.

6H2.6 Effect of Containment Inner wall Heat Transfer Area (Case A versus Case K)

The parametric case increases the containment inner wall (in the vent wall between the drywell and the wetwell) heat transfer area by 25% (Case K). Figure 6H-10 compares the drywell pressures from this case with that from the base case. With 25% increase in the inner wall heat transfer area, the calculated peak drywell pressure at 72 hours is 3.64 kPa lower than that for the base case. The decrease in the calculated peak drywell pressure is small comparing to the margin to the design pressure.

6H2.7 Effect of Non-Condensable Gases: Air versus Nitrogen (Case A versus Case L)

The base Case A (with bounding conditions) uses air properties for the non-condensable gases inside the containment (DCD Tier 2, Rev. 3, Table 6A-1, Item 15). The parametric Case L uses nitrogen properties for the non-condensable gases inside the containment. Figure 6H-11 compares the drywell pressures from these 2 cases. The difference in the calculated peak drywell pressure at 72 hours is small (~ 0.53 kPa) comparing to the margin to the design pressure.

6H2.8 Summary of Results from the Parametric Cases on the Main Steam Line Break

Eight additional parametric cases were performed to evaluate the impact of various model/plant parameters on the long-term containment pressure. Table 6H-1 describes the parameters used in these eight parametric cases. This table also summarizes the calculated peak drywell pressures at 72 hours and the comparison to the base case.

Results from these parametric cases show the following:

(1) The bounding models (WW stratification and suppression pool stratification) are conservative. The calculated DW pressures are reduced by 10 to 20 kPa without these models, or the margins to the design pressure are improved by 3 to 6.5 %.

(2) The calculated long-term DW pressure is not sensitive to the credit of IC heat transfer, the assumption of single failure (1 DPV vs. 1 SRV), or the assumption of NC gas properties (air vs. nitrogen).

(3) The effect of the containment wall heat transfer areas on the calculated long-term DW pressure is small. For +/- 25% wall areas, the impact on the margin is small (-2% to +1%) compared to the base value of 9.3%.

Table 6H-1

Summary of Parametric Cases on the Main Steam Line Break

Case #	Case ID	Comment	Calculated Peak DW Pressure[1] (kPa)	PDW Difference (Parametric – Base) (kPa)	Margin to Design P of 45.3 psig (%)
Base Case					
A	MSL3_1DPVCB_NL2Pa-72	DCD Tier 2, Rev. 3, Subsection 6.2.1.1.3.5	384.18	0.00	9.4
Parametric Cases					
E	MSL3_1DPVCB_NL2P_NSTR-72	Turn-off WW stratification	373.79	-10.39	12.8
F	MSL3_1DPVCB_NL2Pb-72	Turn-off suppression pool stratification	363.39	-20.79	16.1
G	MSL3_1DPVCB_NL2PIC-72	Turn-on IC heat transfer	383.81	-0.37	9.6
H	MSL3_1SRVCB_NL2P-72	MSL break with failure of 1 SRV	383.39	-0.79	9.7
I	MSL3_1DPVCB_NL2P_M10-72	Decrease containment outer wall heat transfer area by 10%	385.25	+1.07	9.1
J	MSL3_1DPVCB_NL2P_M-72	Decrease containment outer wall heat transfer area by 25%	390.87	+6.69	7.3
K	MSL3_1DPVCB_NL2P_P-72	Increase vent wall (DW-WW) heat transfer area by 25%	380.54	-3.64	10.6
L	MSL3_1DPVCB_NL2P_N2-72	Change NC gas from air (in the base case) to nitrogen (N2)	384.71	+0.53	9.3

(1) The peak DW pressure calculated during the transient period from 0 to 72 hrs.

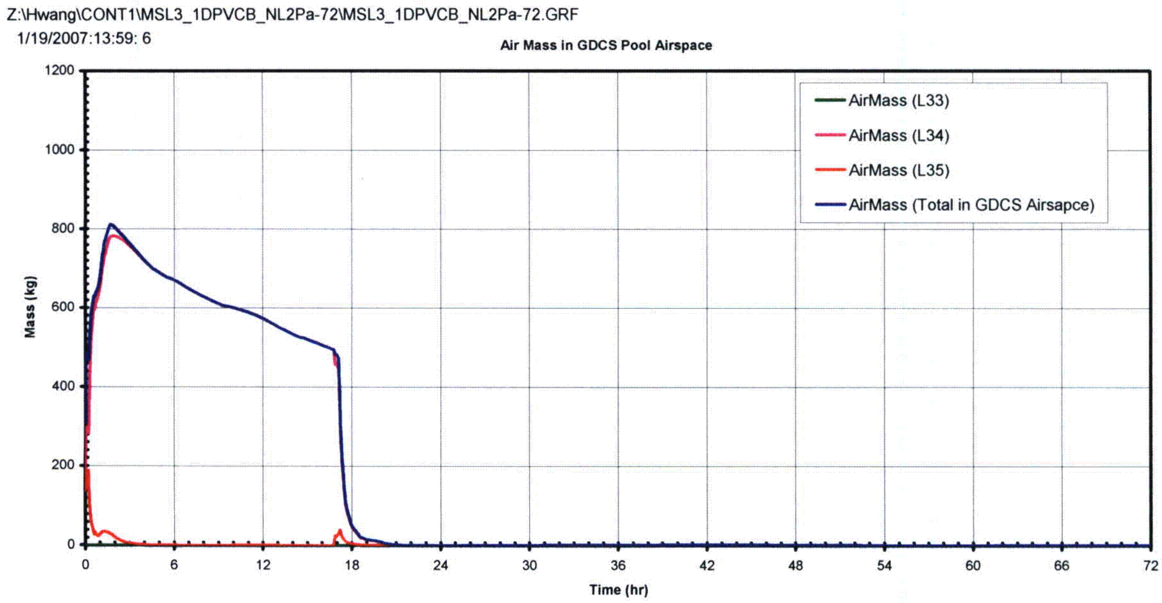

Figure 6H-1. Air Mass Profiles in the GDCS Airspace
(Case A: MSL3_1DPVCB_NL2Pa-72)

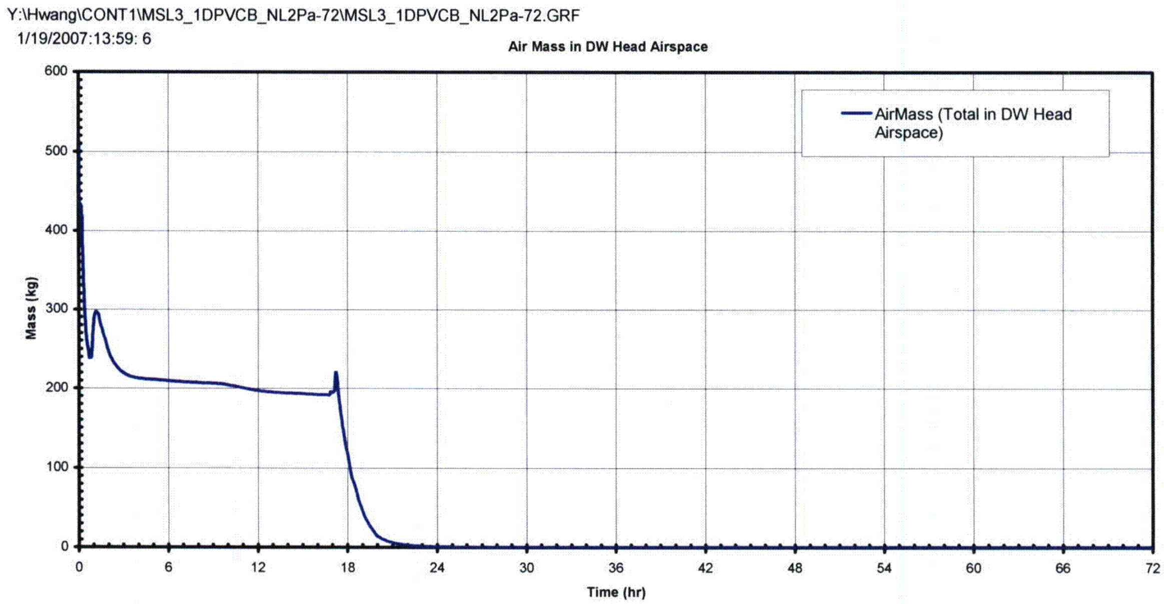

Figure 6H-2. Air Mass Profile in the DW Head Airspace
(Case A: MSL3_1DPVCB_NL2Pa-72)

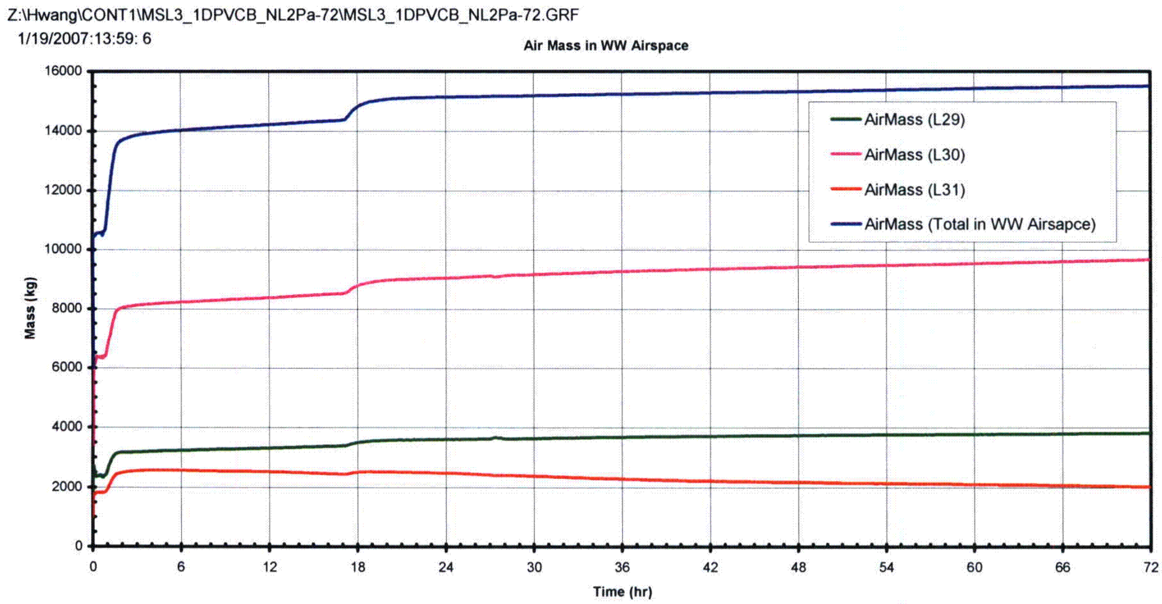

Figure 6H-3. Air Mass Profiles in the Wetwell Airspace
(Case A: MSL3_1DPVCB_NL2Pa-72)

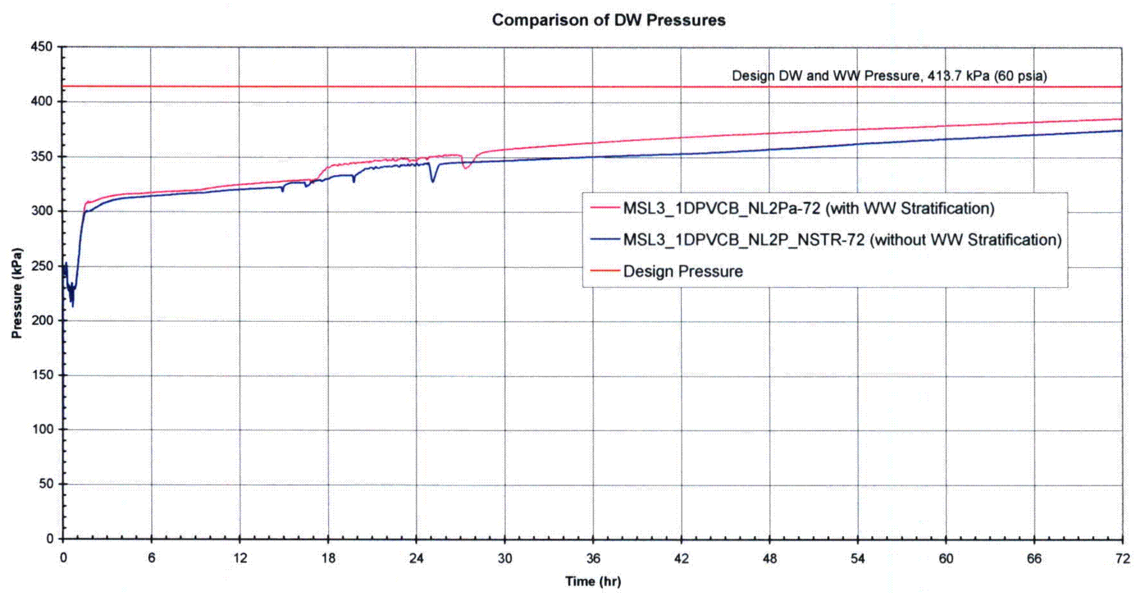

Figure 6H-4. Comparison of DW Pressures
(Case A vs. Case E: Effect of WW Stratification)

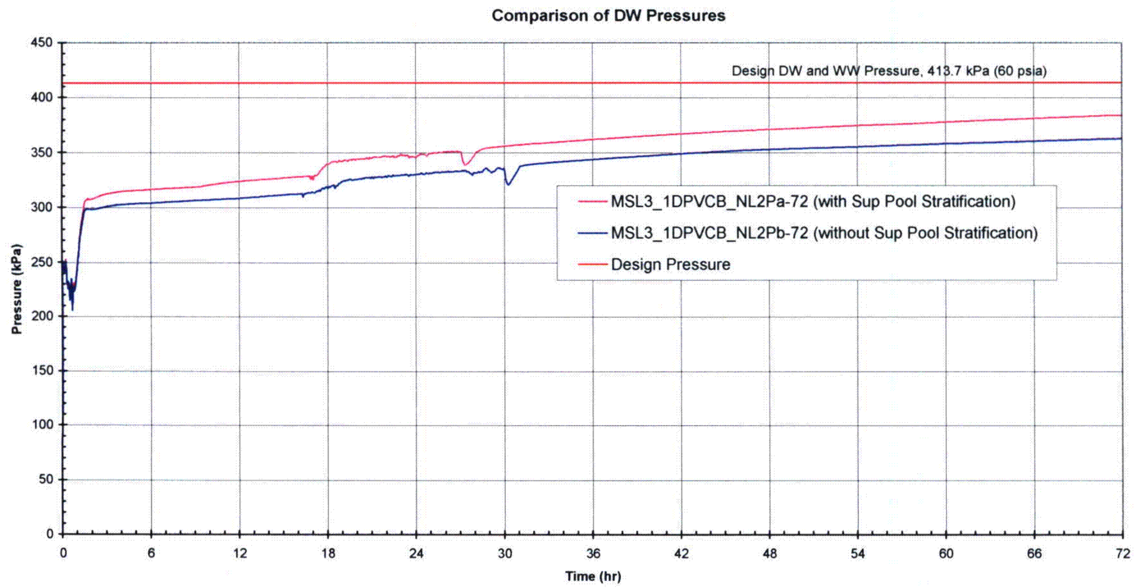

Figure 6H-5. Comparison of DW Pressures
(Case A vs. Case F: Effect of Suppression Pool Stratification)

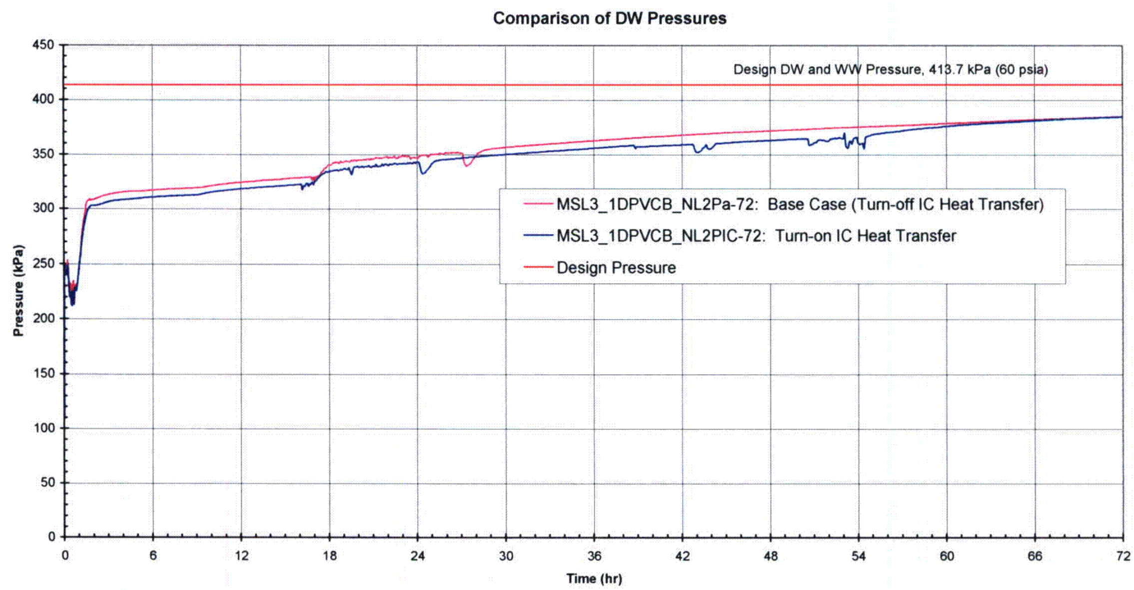

Figure 6H-6. Comparison of DW Pressures
(Case A vs. Case G: Effect of IC Heat Transfer)

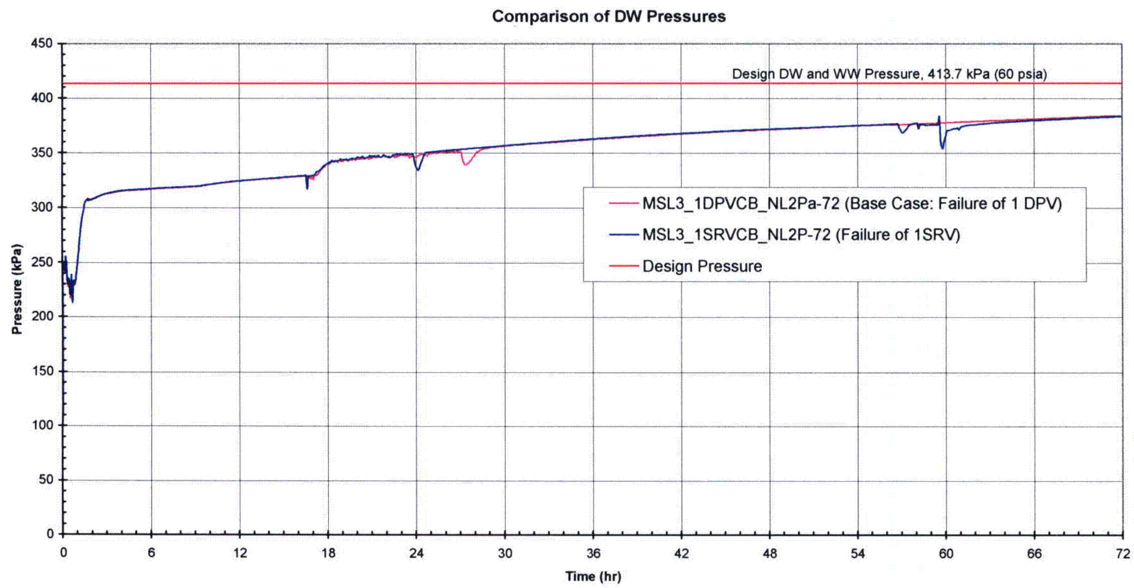

Figure 6H-7. Comparison of DW Pressures
(Case A vs. Case H: Effect of Single Failure, 1 DPV versus 1 SRV)

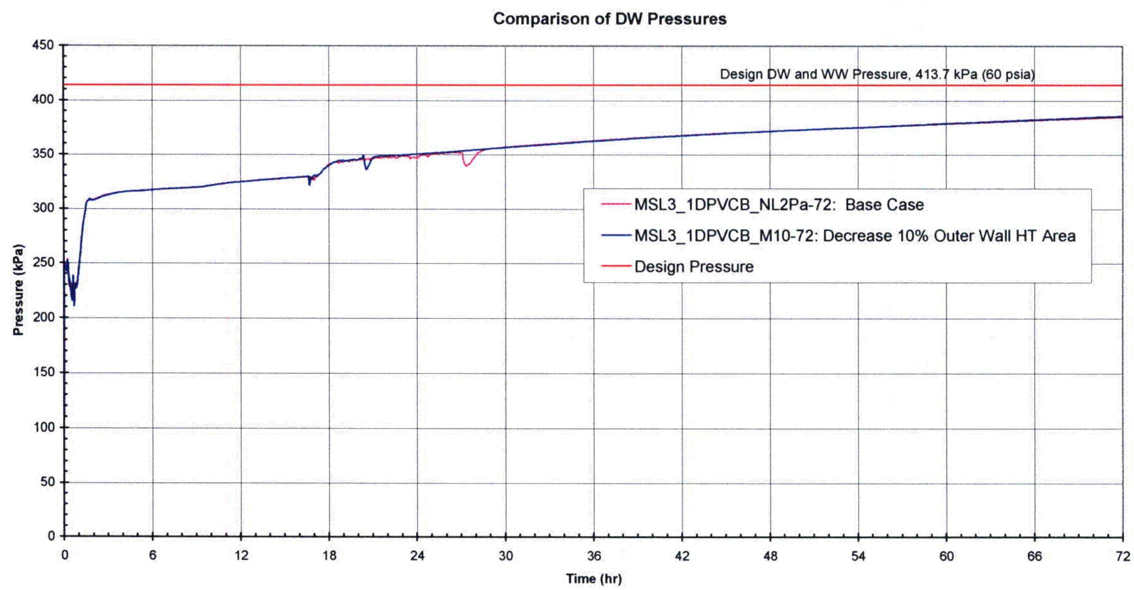

Figure 6H-8. Comparison of DW Pressures
(Case A vs. Case I: Effect of Outer Wall Heat Transfer Area –10%)

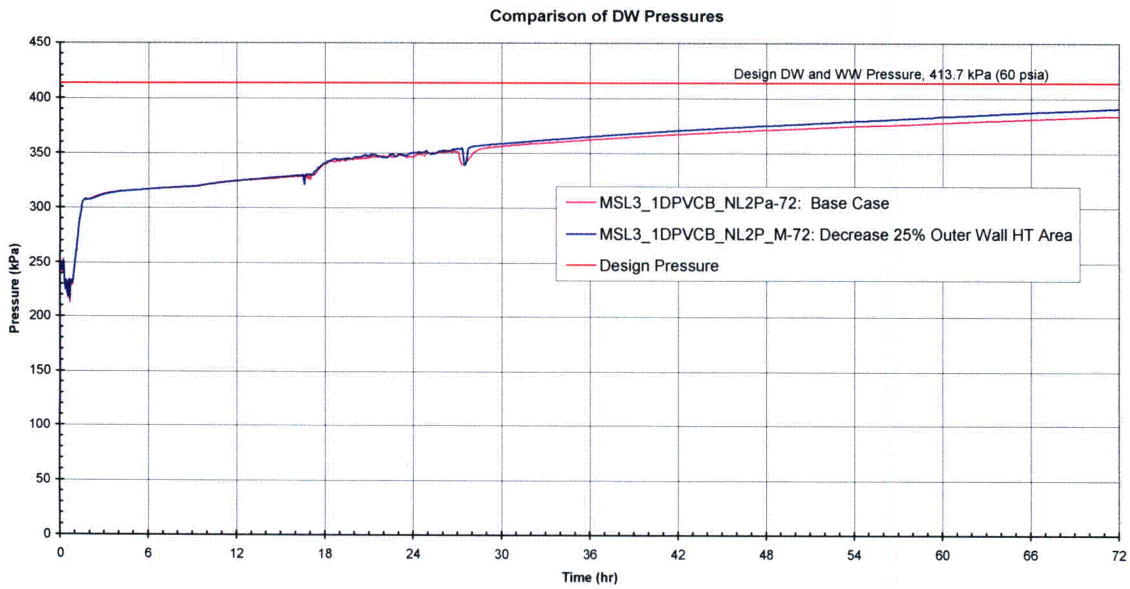

Figure 6H-9. Comparison of DW Pressures
(Case A vs. Case J: Effect of Outer Wall Heat Transfer Area –25%))

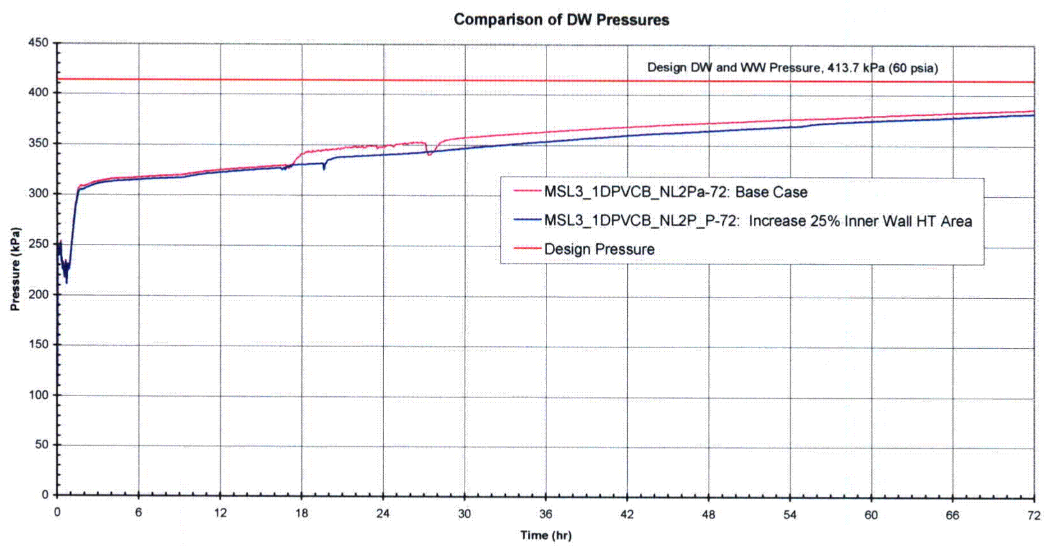

Figure 6H-10. Comparison of DW Pressures
(Case A vs. Case K: Effect of Inner Wall Heat Transfer Area +25%)

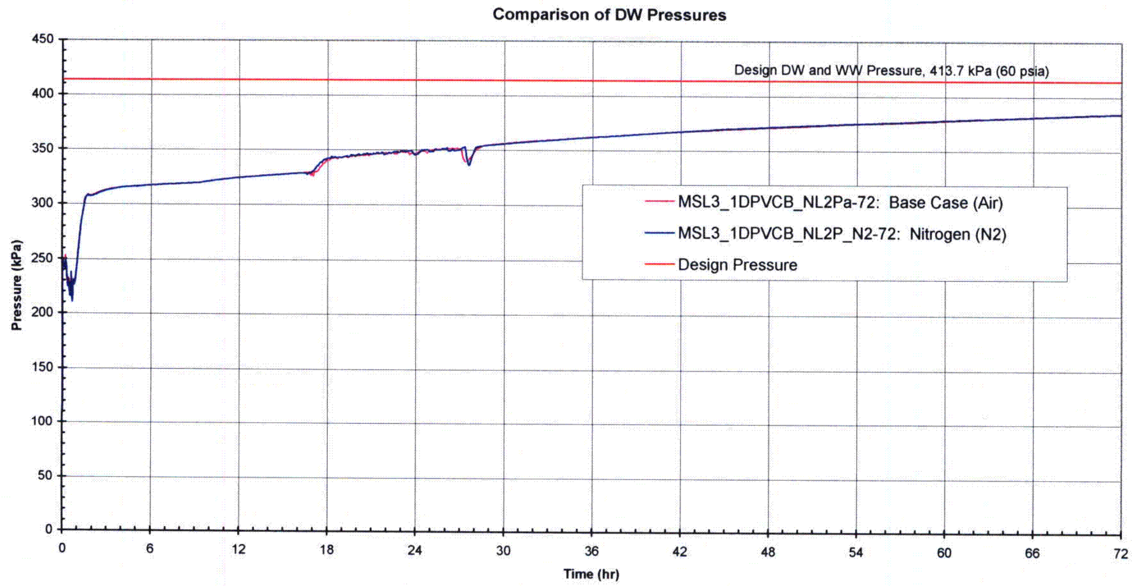

Figure 6H-11. Comparison of DW Pressures
(Case A vs. Case L: Effect of NC Gases, Air versus Nitrogen)