VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

10 CFR 50.90

June 18, 2004

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 03-407B
NLOS/ETS
Docket No. 50-338
License No. NPF-4

**VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
NORTH ANNA POWER STATION UNIT 1
REVISED REALISTIC LARGE BREAK LOCA (RLBLOCA) RESULTS
ADDRESSING ERROR CORRECTIONS FOR
USE OF FRAMATOME ANP ADVANCED MARK-BW FUEL**

In a letter dated July 18, 2003 (Serial No. 03-407), Dominion submitted results of the Realistic Large Break LOCA (RLBLOCA) analyses for Advanced Mark-BW fuel in North Anna Unit 1. The RLBLOCA information was presented in the form of supplements to the evaluation report provided in our March 28, 2002 letter (specifically, report Section 7.2). The results of letter 03-407 were later supplemented by revisions in a letter dated August 26, 2003 (Serial No. 03-313B) which reported a limiting case peak cladding temperature (PCT) of 2025°F. In subsequent review of these results, Framatome ANP has discovered three errors that affect the analyses for North Anna Unit 1. The errors are summarized in the attachment to this letter.

The limiting case peak cladding temperature (PCT) result for the revised Unit 1 analysis is 1853°F. This result represents a 172°F reduction from the result reported in the August 26, 2003 letter (Serial No. 03-313B). The previous results are conservative, while the revised results are more consistent with the 3-loop Westinghouse sample plant analysis reported in topical report EMF-2103(P)(A), "Realistic Large Break LOCA Methodology for Pressurized Water Reactors." Dominion has reviewed the conclusions established in the NRC Staff's SER for the North Anna Unit 2 analysis and believes that this revised analysis supports the same conclusions for Unit 1. Dominion has also reviewed the content of each of the responses to Requests for Additional Information (RAI). We plan to provide confirmation of the adequacy of prior responses and any necessary clarifications resulting from the revised analyses in separate correspondence.

The attachment to this letter provides revised material in the form of replacement pages for the Unit 1 portion (Section 7.2) of the Advanced Mark-BW evaluation report. This

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information supplements the previous material. Dominion is available to support any subsequent discussions or meetings, as needed for review of this additional information.

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

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering

Attachment

Commitments made in this letter:

Provide confirmation of the adequacy of previous responses to Requests for Additional Information, and any necessary clarifications, resulting from the revised Unit 1 Realistic Large Break LOCA analyses.

cc: U.S. Nuclear Regulatory Commission
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SN: 03-407B
Docket No.: 50-338
Subject: Proposed Technical Specifications Changes and Exemption Request
Framatome ANP Advanced Mark-BW Fuel

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz who is Vice President – Nuclear Engineering of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 18TH day of June, 2004.

My Commission Expires: May 31, 2006.

Vicki L. Hull
Notary Public

(SEAL)

Attachment 1

Revised Realistic Large Break LOCA (RLBLOCA) Results
Reflecting Error Corrections
North Anna Unit 1 Loss of Coolant Analyses

Framatome Fuel Transition Program
Technical Specification Change

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Unit 1

NORTH ANNA, UNIT 1 – Revised RLBLOCA Analysis

The North Anna Unit 1 Realistic Large Break LOCA (RLBLOCA) analysis was revised to correct three errors. These errors are summarized and characterized below:

- Initial steady-state core power in the original analysis was incorrectly apportioned between the top and bottom halves of the core. The axial power distribution input was developed assuming a uniform size for each axial fuel rod heat structure. In fact, the heat structures above the mid-plane where the Mid Span Mixing Grids (MSMGs) are located, are smaller. This input error caused the North Anna plant model to contain too much power in the top half of the core and too little in the bottom half. Total core power was correctly modeled. Such modeling led to over prediction of PCTs. This item is characterized as an error in application of the evaluation model per 10CFR50.46(a)(3)(i).

- The North Anna units have Westinghouse 93A reactor coolant pumps. The original RLBLOCA analysis used the built-in S-RELAP5 Westinghouse pump parameters, which apply to the Type 93 pump. For the original analysis case set, the effect of this difference was evaluated and concluded to be negligible. For the reanalysis, however, it was determined that the North Anna plant model would be changed to include the appropriate Westinghouse 93A pump homologous parameters. The 93A pump parameters were input to the S-RELAP5 North Anna plant model and applied in all analysis cases. This item is characterized as an error in application of the evaluation model per 10CFR50.46(a)(3)(i).

- The revised case set experienced execution failures and instabilities in several cases. This behavior, which had not been observed in previous case sets, was traced to an incorrect prediction of choked flow applied during the period at the end of accumulator injection when the nitrogen cover gas enters the system. The logic in the S-RELAP5 code was revised to correct this problem, and the updated S-RELAP5 code version was certified and used in the Unit 1 reanalysis. This item is characterized as an error in the evaluation model per 10CFR50.46(a)(3)(i).

The limiting PCT for the Unit 1 case set decreased significantly, confirming the over prediction of PCT in the prior analysis. The Unit 1 reanalysis showed that the 10CFR50.46(b) criteria were met with ample margins. The subsequent pages reflect revisions to Section 7.2 of the Advanced Mark-BW evaluation report which account for the revised Unit 1 analysis. The information that has changed due to the reanalysis is identified with change bars.

during the first cycle of Advanced Mark-BW operation because of the small percentage of FANP fuel that is present in the core. As the percentage of FANP fuel increases in subsequent reload cycles, the potential for flow diversion is lowered. Because provision for this flow diversion is explicitly modeled in the North Anna mixed-core RLBLOCA calculations, the expected results for subsequent reload cycles would demonstrate lower PCTs and oxidation results. Together, the results of the Reference 7-1, Appendix B study and the increase in the number of Advanced Mark-BW fuel assemblies in the core lead to the conclusion that first cycle calculations bound subsequent cycles of operation with FANP fuel.

7.2.4 Realistic Large Break LOCA Results

The analyses assume full-power operation at 2,893 MWt (plus uncertainties), a steam generator tube plugging level of 12 percent in all generators, a total peaking factor (F_Q) of 2.32, and a nuclear enthalpy rise factor ($F_{\Delta H}$) of 1.65. These analyses accommodate operation within specified ranges for sampled parameters: pressurizer pressure and level, accumulator pressure, temperature (containment temperature) and level, RCS average temperature, core flow, and containment pressure and temperature.

A set of fifty-nine calculations was performed for NAPS Units 1 and 2 sampling the parameters listed in Table 7.2-1. The remainder of this section provides results from those analyses.

7.2.4.1 NAPS Unit 1 Large Break LOCA Results

The limiting PCT case (1,853°F) was number 28. It is characterized in Tables 7.2-6 and Table 7.2-7. The maximum oxidation (2.6%) and total oxidation (0.03%) results are also reported in Table 7.2-7. The fraction of total hydrogen generated was not directly calculated; however, it is conservatively bounded by the calculated total percent oxidation that is well below the 1 percent limit. A nominal 50/50 PCT case was identified as case 22. The nominal PCT is 1,441 °F. This result can be used to quantify the relative conservatism in the limiting PCT case result. In this analysis, it is 412 °F.

The hot fuel rod results, event times and analysis plots for the limiting PCT case are shown in Table 7.2-7, Table 7.2-8, and in Figures 7.2-4 through 7.2-18, respectively. Figure 7.2-4 shows linear scatter plots of the important parameters sampled for the 59 calculations. Parameter labels appear to the left of each individual plot. These figures show the parameter ranges used in the analysis. Figures 7.2-5 and 7.2-6 show PCT scatter plots versus the time of PCT and versus break size from the 59 calculations. Figure 7.2-7 shows the maximum oxidation versus PCT for the 59 calculations. Figures 7.2-8 through 7.2-18 show important parameters from the S-RELAP5 calculation. Figure 7.2-8 is the plot of PCT independent of elevation.

and effectiveness of the hot leg injection is established by demonstrating that the in-vessel concentration of boric acid is below solubility limits. There is no dependency on the fuel element design since concentrations depend on ECCS injection rate, RCS geometry, and core power level. Since the Framatome ANP fuel does not alter these factors, the current evaluation remains valid and is equally applicable to Advanced Mark-BW fuel. Emergency operating procedures provide guidance to address the boric acid precipitation issue and ensure that long-term cooling is maintained.

7.2.6.4 Adherence to Long-Term Cooling Criterion

Compliance with this criterion is demonstrated in the NAPS UFSAR. It is independent of fuel design. The initial phase of core cooling results in low clad and fuel temperatures. A pumped injection system, capable of re-circulation, is available and operated by the plants to provide extended coolant injection. The concentration of dissolved solids is limited to acceptable levels through the timely implementation of hot leg injection. Hence, long-term cooling is established and compliance to 10CFR50.46 demonstrated.

7.2.7 Large Break LOCA Conclusions

The analyses reported herein support operations at a power level of 2,893 MWt, a steam generator tube plugging level of 12 percent in each generator, a total peaking factor (F_Q) of 2.32 and a nuclear enthalpy rise factor ($F_{\Delta H}$) of 1.65. The analyses support peak rod average exposures of up to 62,000 MWd/mtU. The analyses applied no K_Z restraint on axial peaking; that is, K_Z is set equal to one for all core elevations. The impact of NAIF co-resident fuel on FANP Advanced Mark-BW fuel is included within the analyses—the analyses consider the initial core composition of both NAIF and Advanced Mark-BW fuel. The analysis of the Westinghouse fuel remains valid. The co-resident FANP fuel, being 2.5 psi (based on rated flow) more resistive than NAIF, will promote favorable flow diversion to NAIF, thereby improving its LBLOCA performance. Hence, the NAIF will be positively (lower clad temperature and metal-water oxidation) affected by the co-resident FANP fuel.

The results of the North Anna Unit 1 RLBLOCA analysis demonstrate compliance with the 10CFR50.46 acceptance criteria.

Table 7.2-6: Summary of Major Parameters for Limiting NAPS Unit 1 Transient

Time (hrs)	4,242
Burnup (MWd/mtU)	9,100
Core Power (MWt)	2,940
Core Peaking (F_Q)	2.144
Radial Peak ($F_{\Delta H}$)	1.65
Local Peaking (Fl)	1.068
Break Type	DEGB
Break Size per Side (ft^2)	3.26 (~79 %)
Offsite Power Availability	No
Decay Heat Multiplier	0.9841

Table 7.2-7: Summary of Results for the NAPS Unit 1 Limiting PCT Case

Case Number	28
PCT	
Temperature	1,853 °F
Time	87.4 seconds
Elevation	~8.4 ft
Metal-Water Reaction	
% Oxidation Maximum	2.6 %
% Total Oxidation	0.03 %
Total Hydrogen	0.50 lbm

Table 7.2-8: Calculated Event Times for the NAPS Unit 1 Limiting PCT Case

Event	Time (sec)
Begin Analysis	0.0
Break Opens	0.0
RCP Trip	0.0
SI Actuation Signal Issued	0.7
Start of Broken Loop Accumulator Injection	7.0
Start of Intact Loop Accumulator Injection	10.5
Beginning of Core Recovery (Beginning of Reflood)	24.2
Start of HHSI	27.7
Start of LHSI	27.7
Broken Loop Accumulator Empties	34.3
Intact Loop Accumulators Empty	36.0, 36.1
PCT Occurs (1,853 °F)	87.4

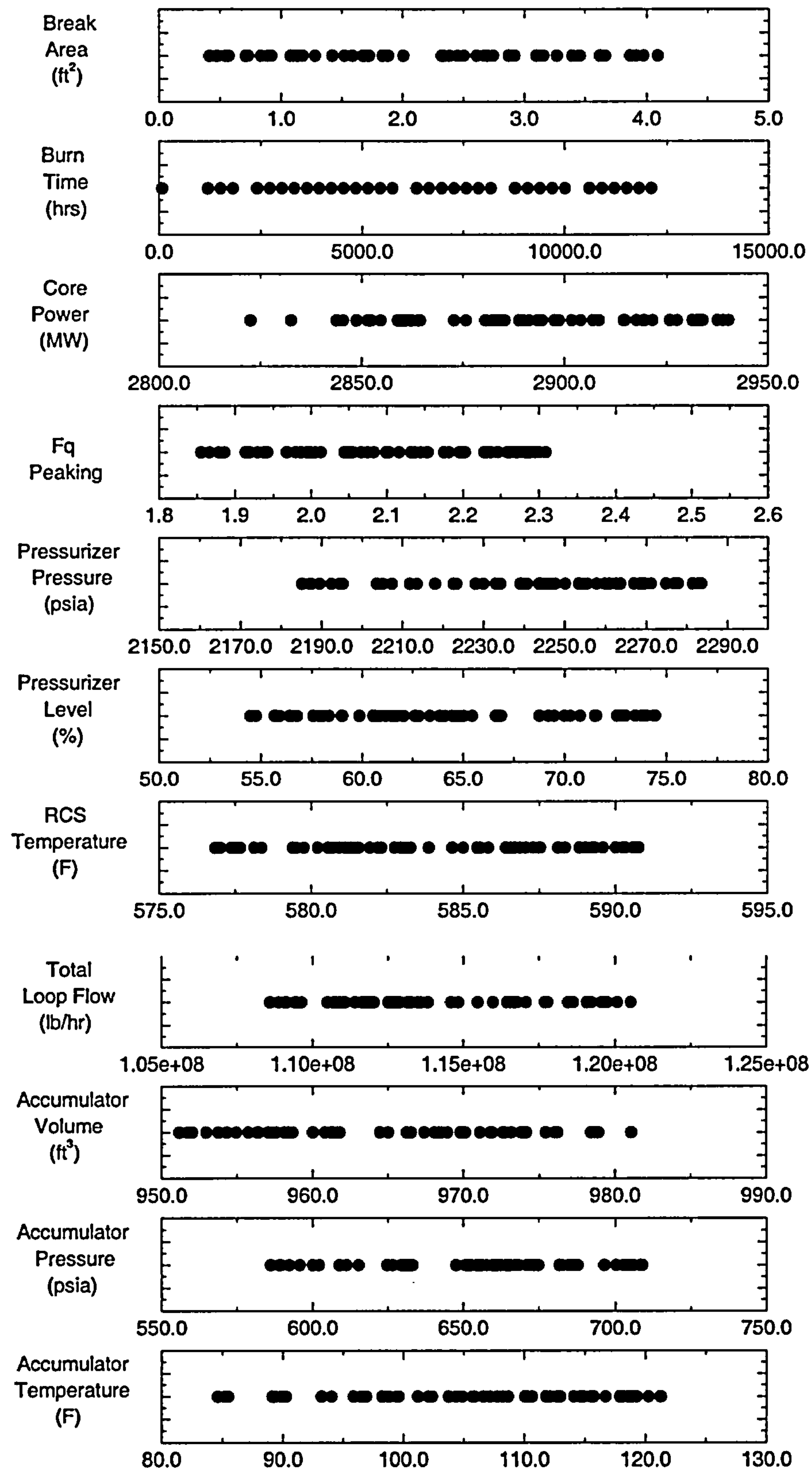

Figure 7.2-4: NAPS Unit 1 Scatter Plots of Operational Parameters

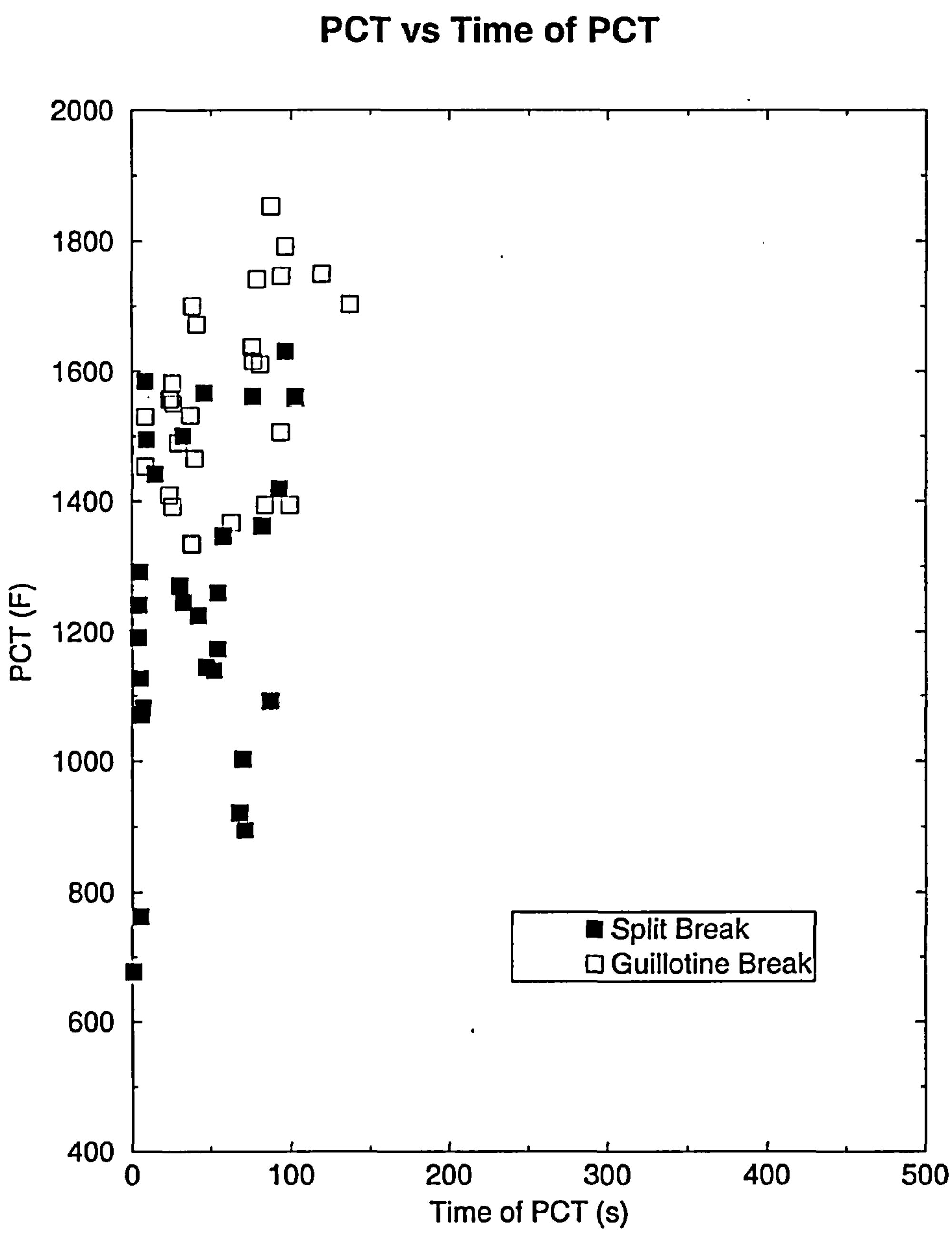

Figure 7.2-5: NAPS Unit 1 PCT versus PCT Time Scatter Plot

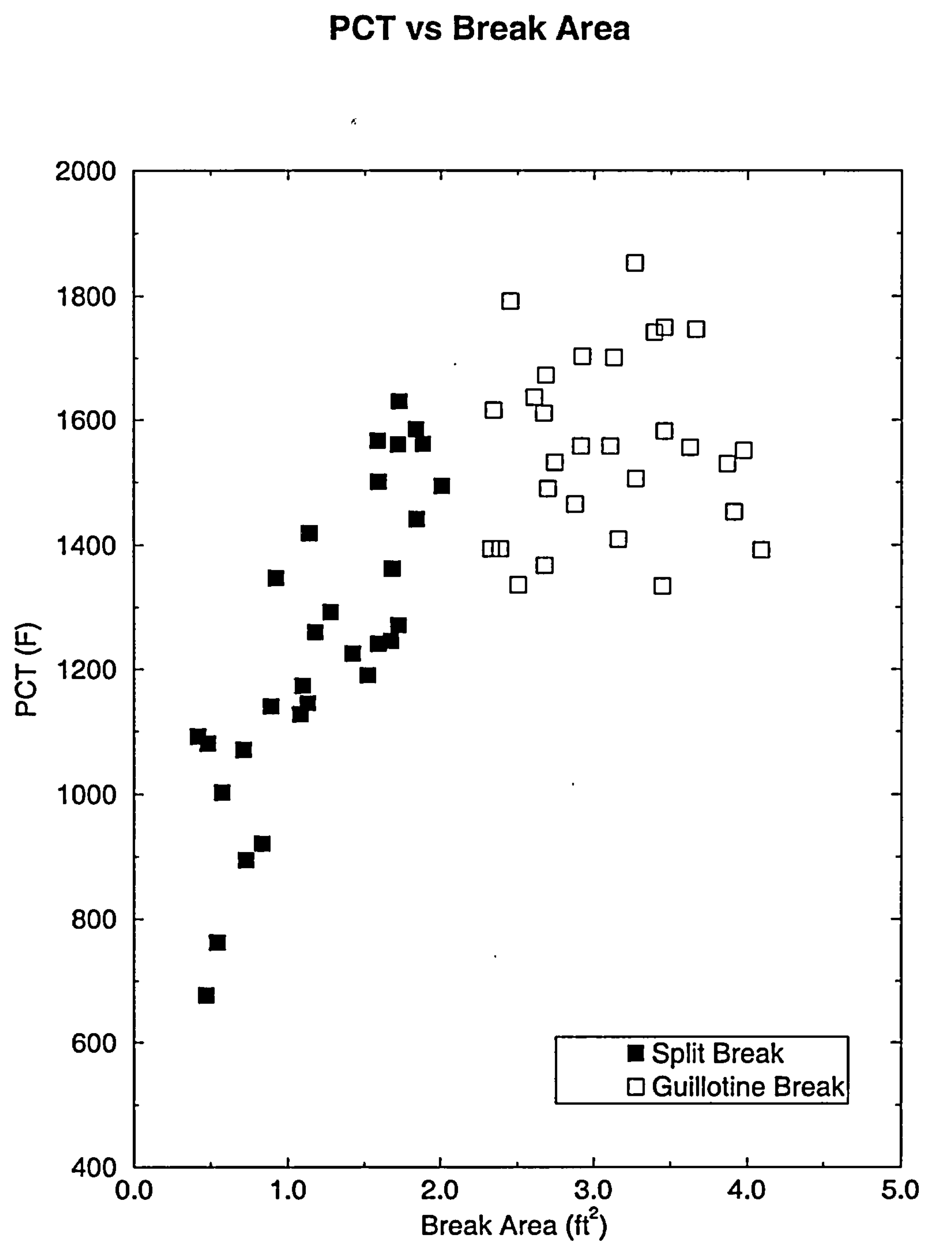

Figure 7.2-6: NAPS Unit 1 PCT versus Break Size per Side Scatter Plot

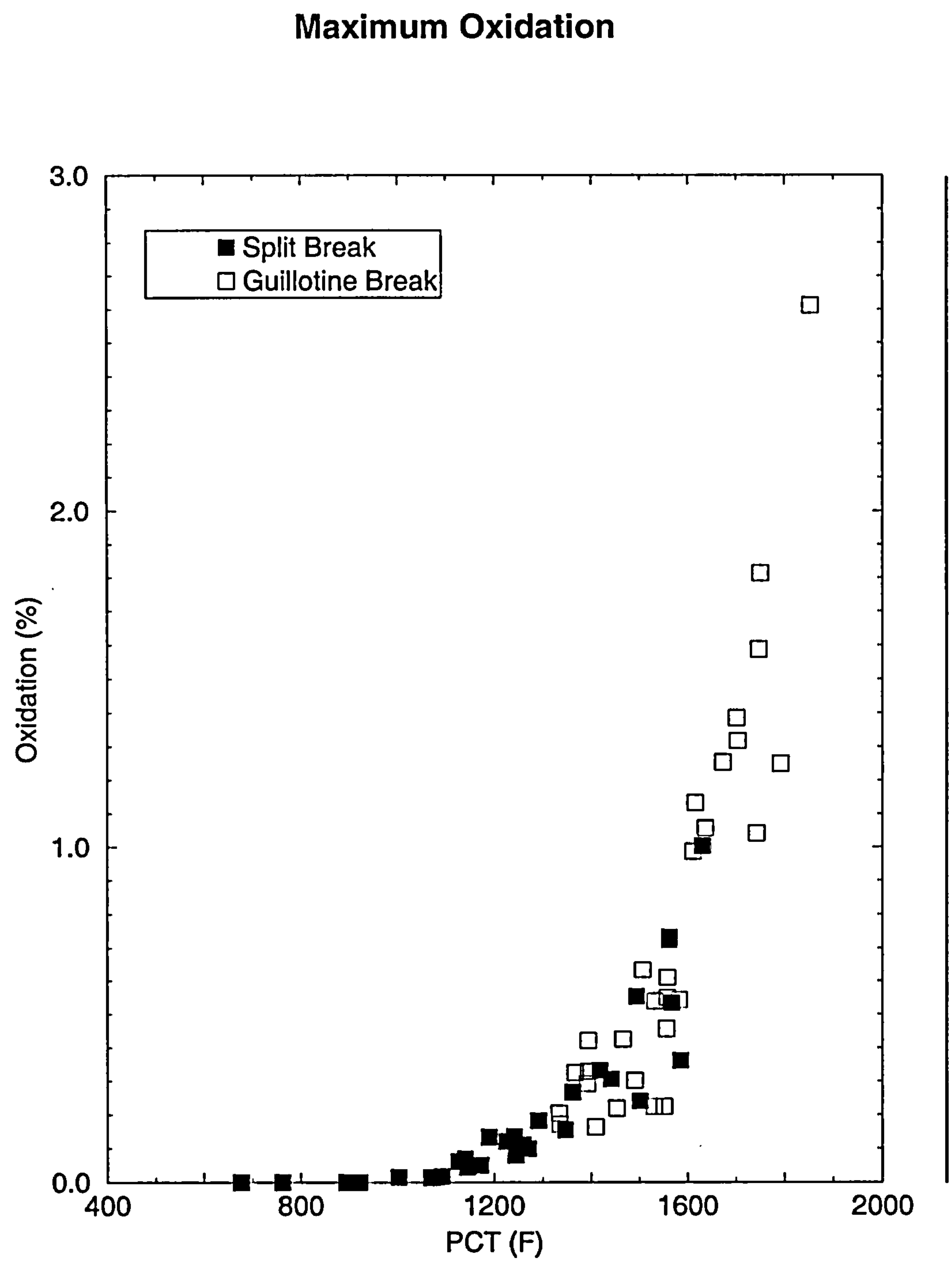

Figure 7.2-7: NAPS Unit 1 Maximum Oxidation versus PCT Scatter Plot

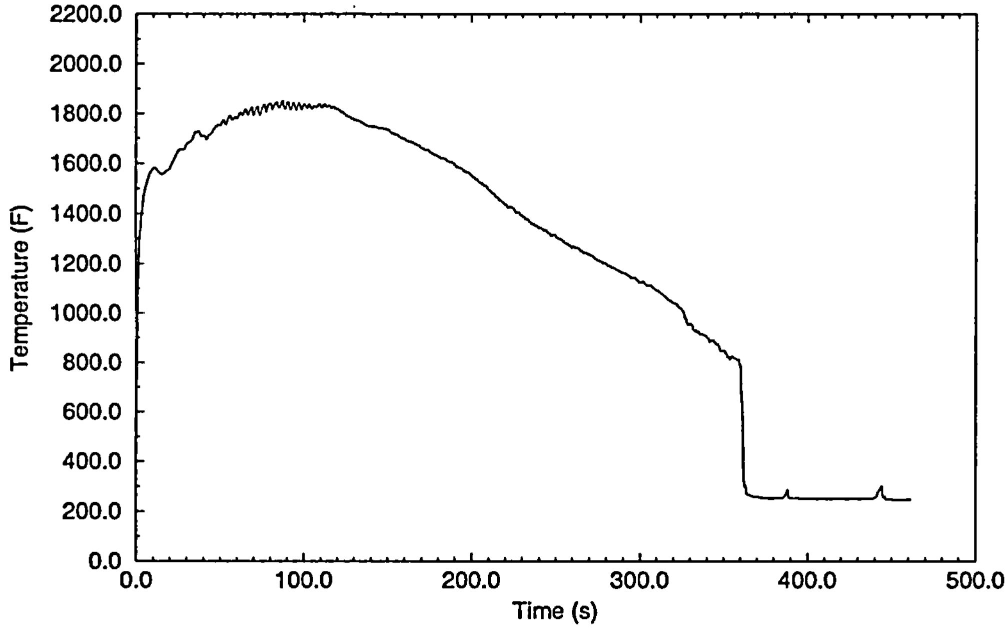

Figure 7.2-8: NAPS Unit 1 Peak Cladding Temperature for the Limiting Break (elevation independent)

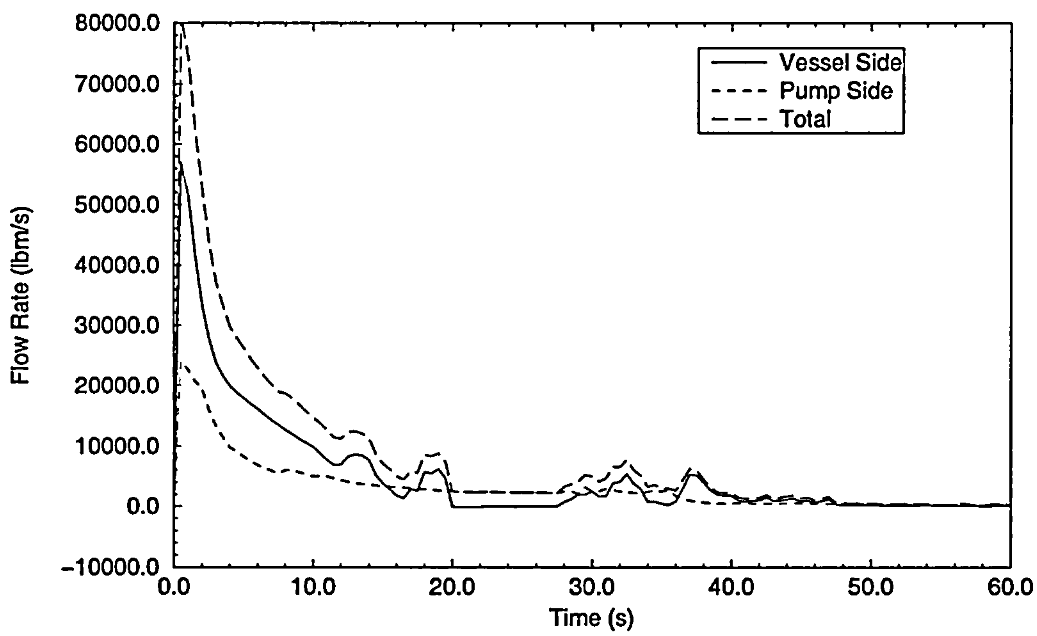

Figure 7.2-9: NAPS Unit 1 Break Flow for the Limiting Break

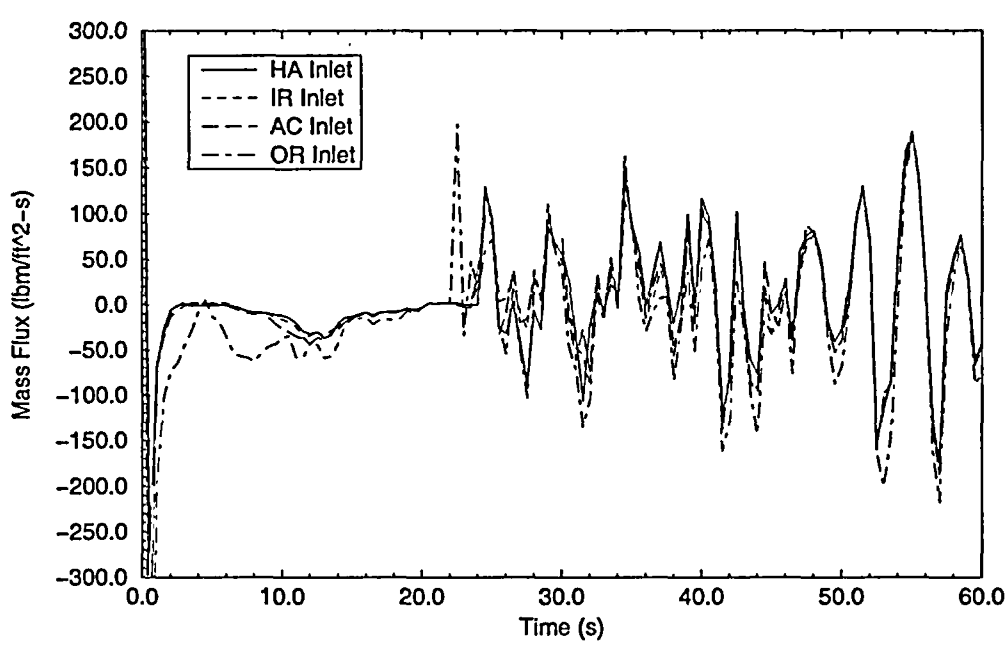

Figure 7.2-10: NAPS Unit 1 Early Core Inlet Mass Flux for the Limiting Break

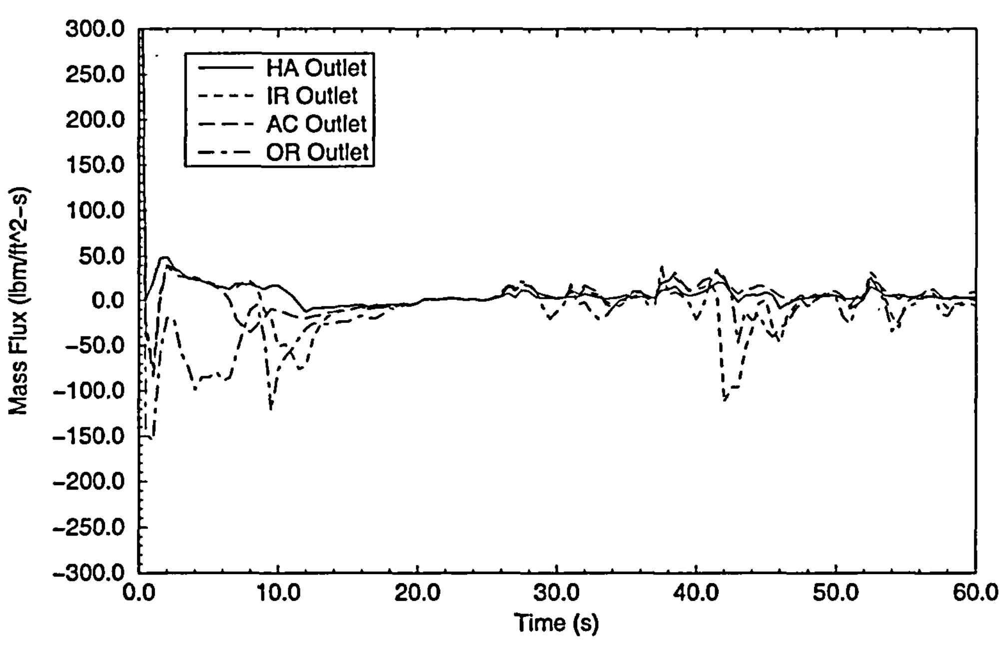

Figure 7.2-11: NAPS Unit 1 Core Outlet Mass Flux for the Limiting Break

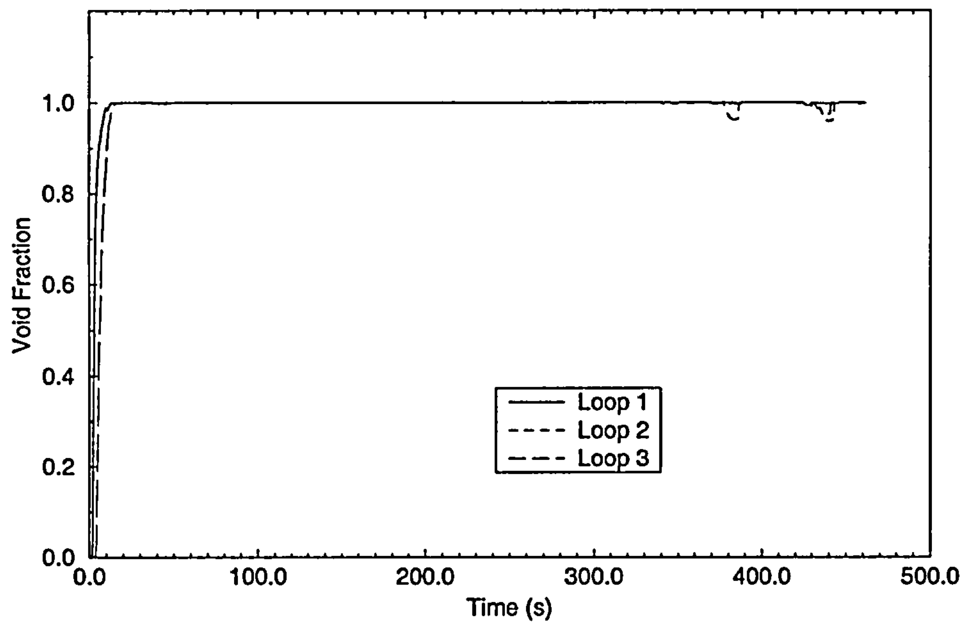

Figure 7.2-12: NAPS Unit 1 Void Fraction at RCS Pumps for the Limiting Break

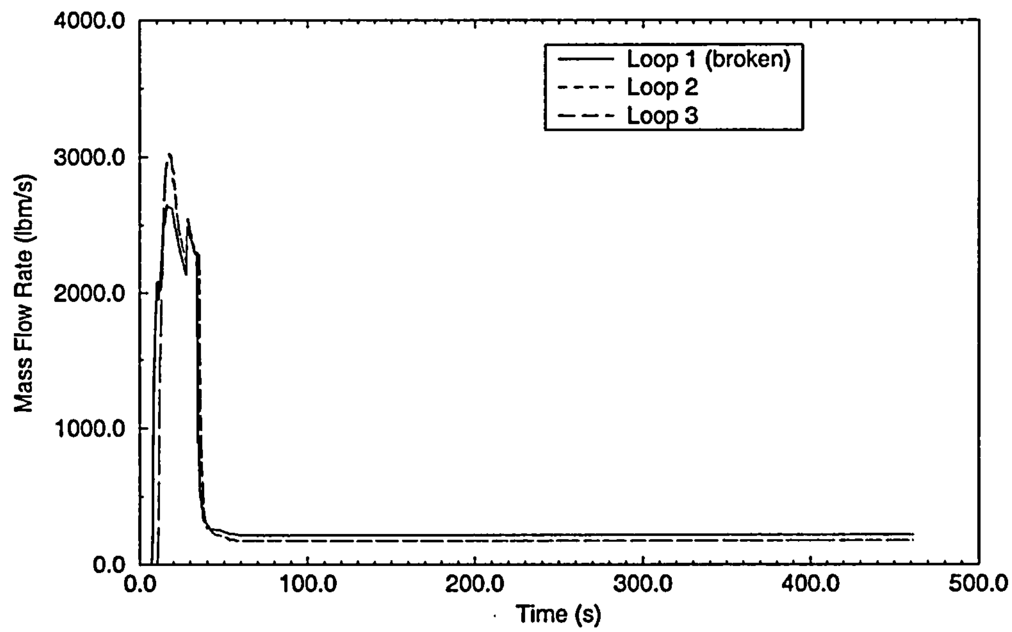

Figure 7.2-13: NAPS Unit 1 ECCS Flows (includes Accumulator, HHSI and LHSI) for the Limiting Break

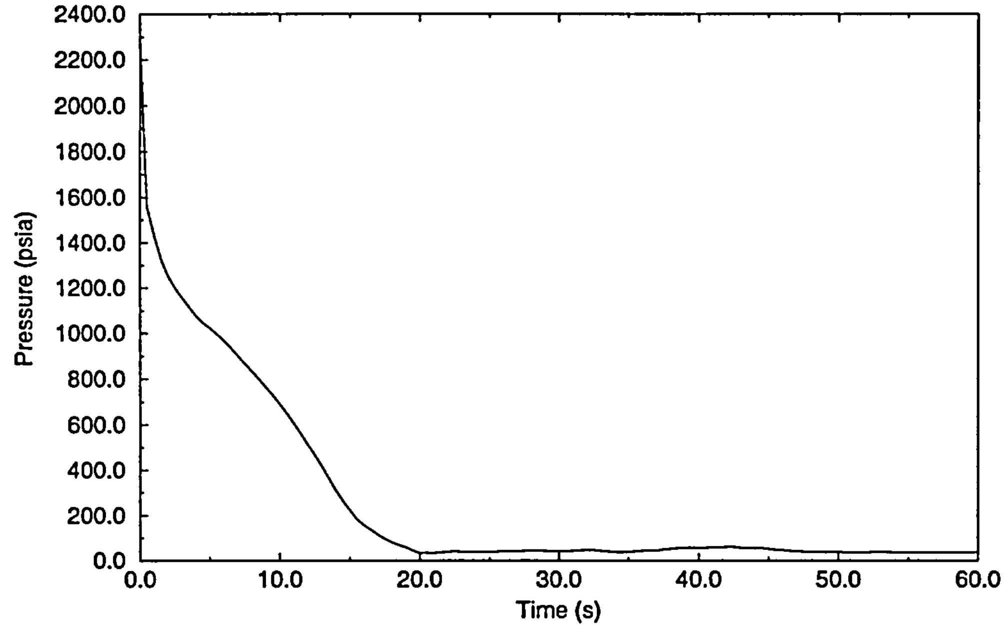

Figure 7.2-14: NAPS Unit 1 System (Upper Plenum) Pressure for the Limiting Break

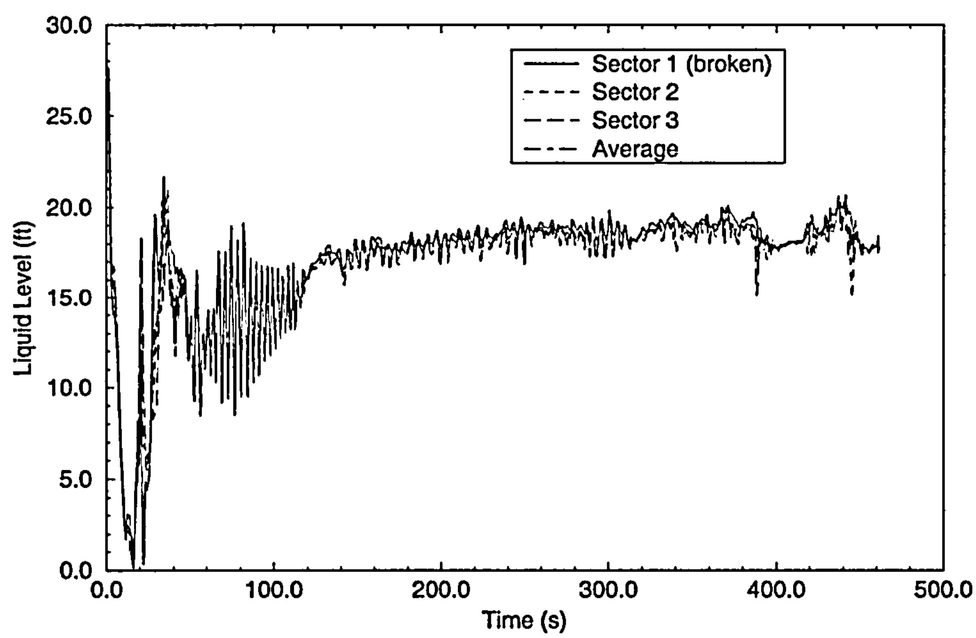

Figure 7.2-15: NAPS Unit 1 Collapsed Liquid Level in the Downcomer for the Limiting Break

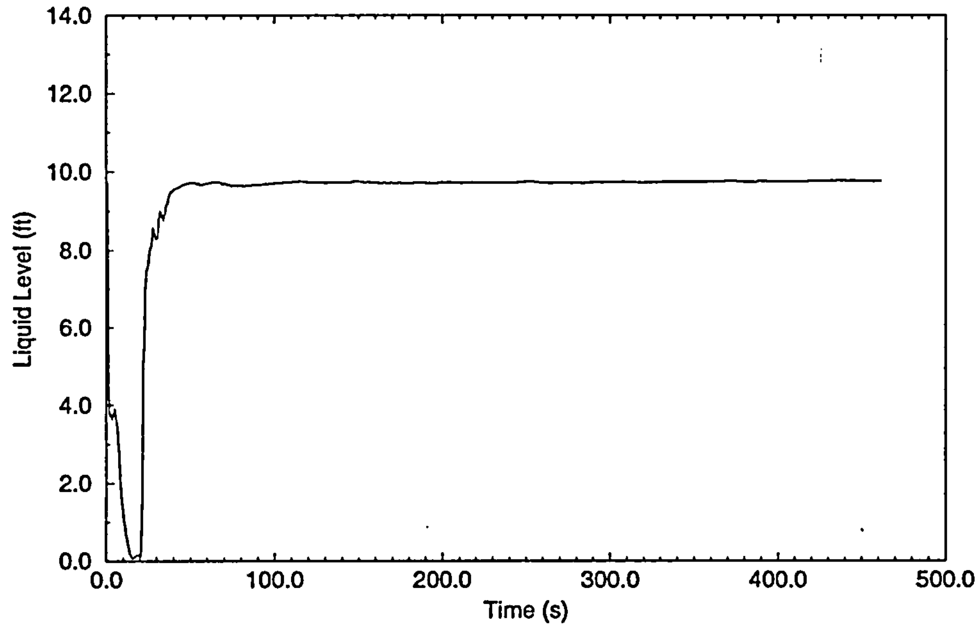

Figure 7.2-16: NAPS Unit 1 Collapsed Liquid Level in the Lower Vessel for the Limiting Break

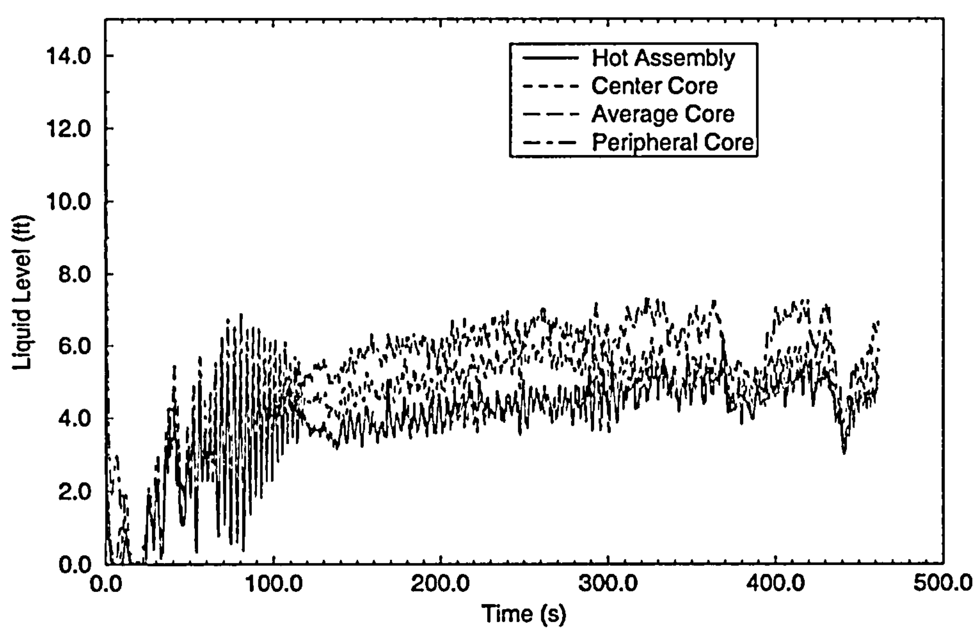

Figure 7.2-17: NAPS Unit 1 Collapsed Liquid Level in the Core for the Limiting Break

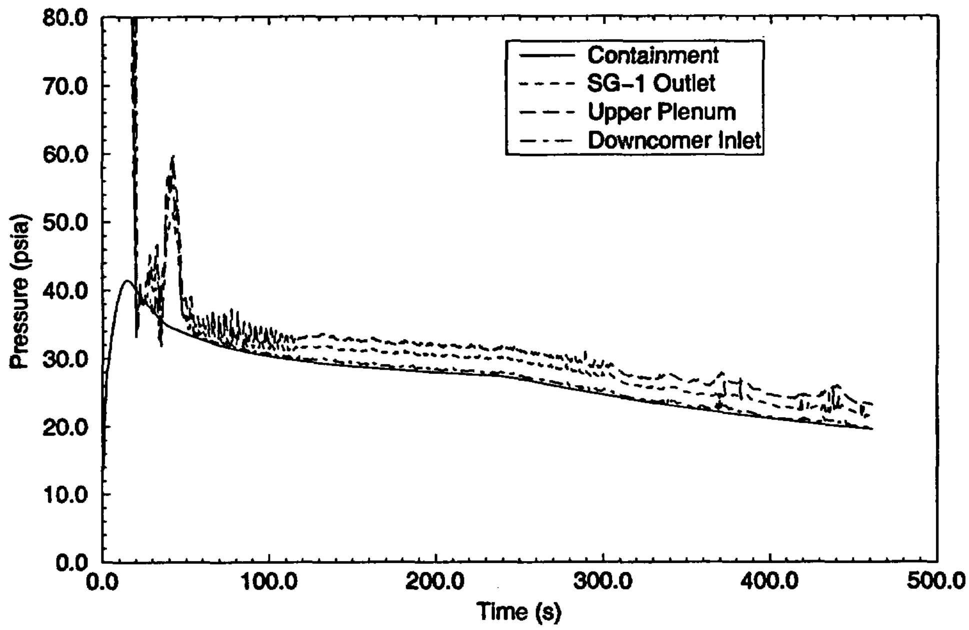

Figure 7.2-18: NAPS Unit 1 Containment and Loop Pressures for the Limiting Break