VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

July 18, 2003

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

Serial No. 03-407
NLOS/ETS
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
REALISTIC LARGE BREAK LOSS OF COOLANT ACCIDENT (LBLOCA) ANALYSIS RESULTS FOR THE PROPOSED TECHNICAL SPECIFICATIONS CHANGES AND EXEMPTION REQUEST FOR USE OF FRAMATOME ANP ADVANCED MARK-BW FUEL

In a March 28, 2002 letter (Serial No. 02-167), Virginia Electric and Power Company (Dominion) requested an amendment to Facility Operating License Numbers NPF-4 and NPF-7 and associated exemptions from 10 CFR 50.44 and 10 CFR 50.46 for North Anna Power Station Units 1 and 2. The amendments and exemptions will permit North Anna Units 1 and 2 to use Framatome ANP Advanced Mark-BW fuel. This fuel design has been evaluated by Framatome and Dominion for compatibility with the resident Westinghouse fuel and for compliance with fuel design limits. Subsequent to the March 28, 2002 letter, Dominion submitted supplements on REFLOD3B (July 25, 2002, Serial No. 02-167B), small break LOCA (August 2, 2002, Serial No. 02-167C), and large break LOCA (August 16, 2002, Serial No. 02-167D). Based on further discussions with the NRC, Dominion withdrew the LBLOCA and REFLOD3B submittals (November 15, 2002, Serial No. 02-167E) and agreed to submit a RLBLOCA analysis, and a revised small break LOCA (SBLOCA) analysis. Dominion submitted a supplement that provided the RLBLOCA analysis results for North Anna Unit 2 (May 6, 2003, Serial No. 03-313). In addition, Dominion submitted the revised SBLOCA analysis results for North Anna Units 1 and 2 (May 27, 2003, Serial No. 03-245).

Attachment 1 to this letter provides the RLBLOCA results for Advanced Mark-BW fuel in North Anna Unit 1. The RLBLOCA information is presented in the form of changed pages to the proprietary and non-proprietary supplements provided in our May 6, 2003 letter (specifically, report Section 7.0). Although marked as proprietary for inclusion into the May 6, 2003 proprietary version, the attached pages contain no proprietary information. For completeness, the LOCA Summary in Section 7.4 incorporates the conclusions for the RLBLOCA Unit 1 analysis and those developed in our May 27, 2003 letter for SBLOCA. Please note that the submittal of the RLBLOCA results for North Anna Unit 1 is the final submittal planned for this license amendment.

A001

To support the use of Framatome Advanced Mark-BW fuel in North Anna Unit 2, Cycle 17, we respectfully request the NRC to complete their review and approval of the license amendment and exemptions by September 30, 2003. We appreciate your consideration of our technical and schedular requests. If you have any questions or require additional information, please contact us.

Very truly yours,

Eugene S. Grecheck
Vice President - Nuclear Support Services

Commitments made in this letter: None

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SN: 03-407
Docket Nos.: 50-338/339
Subject: Proposed TS Change & Exempt. Request –
LBLOCA Analysis Results
To Use 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 Eugene S. Grecheck, who is Vice President - Nuclear Support Services, of Virginia Electric and Power Company. He has affirmed before me that he 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 his knowledge and belief.

Acknowledged before me this 18th day of July, 2003.

My Commission Expires: March 31, 2004.

Maggie McClure
Notary Public

(SEAL)

Realistic Large Break LOCA Analysis Results – Unit 1

Non-Proprietary Version

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 (1,992 °F) was number 28. It is characterized in Tables 7.2-6 and Table 7.2-7. The maximum oxidation (3.8 %) and total oxidation (0.04 %) 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 30. The nominal PCT is 1,497 °F. This result can be used to quantify the relative conservatism in the limiting PCT case result. In this analysis, it is 495 °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 RLBLOCA analyses show that the limiting NAPS Unit 1 case has a PCT of 1,992 °F. The limiting PCT for Unit 2 is 2,032 °F. Maximum oxidation thickness and hydrogen generation for both units are well within regulatory requirements. Discussions in Sections 7.2.5 and 7.2.6 demonstrate compliance with the coolable geometry and long-term cooling 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)	1.07
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	1,992 °F
Time	95.3 seconds
Elevation	~9.6 ft
Metal-Water Reaction	
% Oxidation Maximum	3.8 %
% Total Oxidation	0.04 %
Total Hydrogen	0.62 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
Start of Intact Loop Accumulator Injection	11
End of Bypass	21
Start of HHSI	28
Start of LHSI	28
Beginning of Core Recovery (Beginning of Reflood)	30
Broken Loop Accumulator Empties	38
Intact Loop Accumulators Empty	40, 40
PCT Occurs (1,992 °F)	95.3

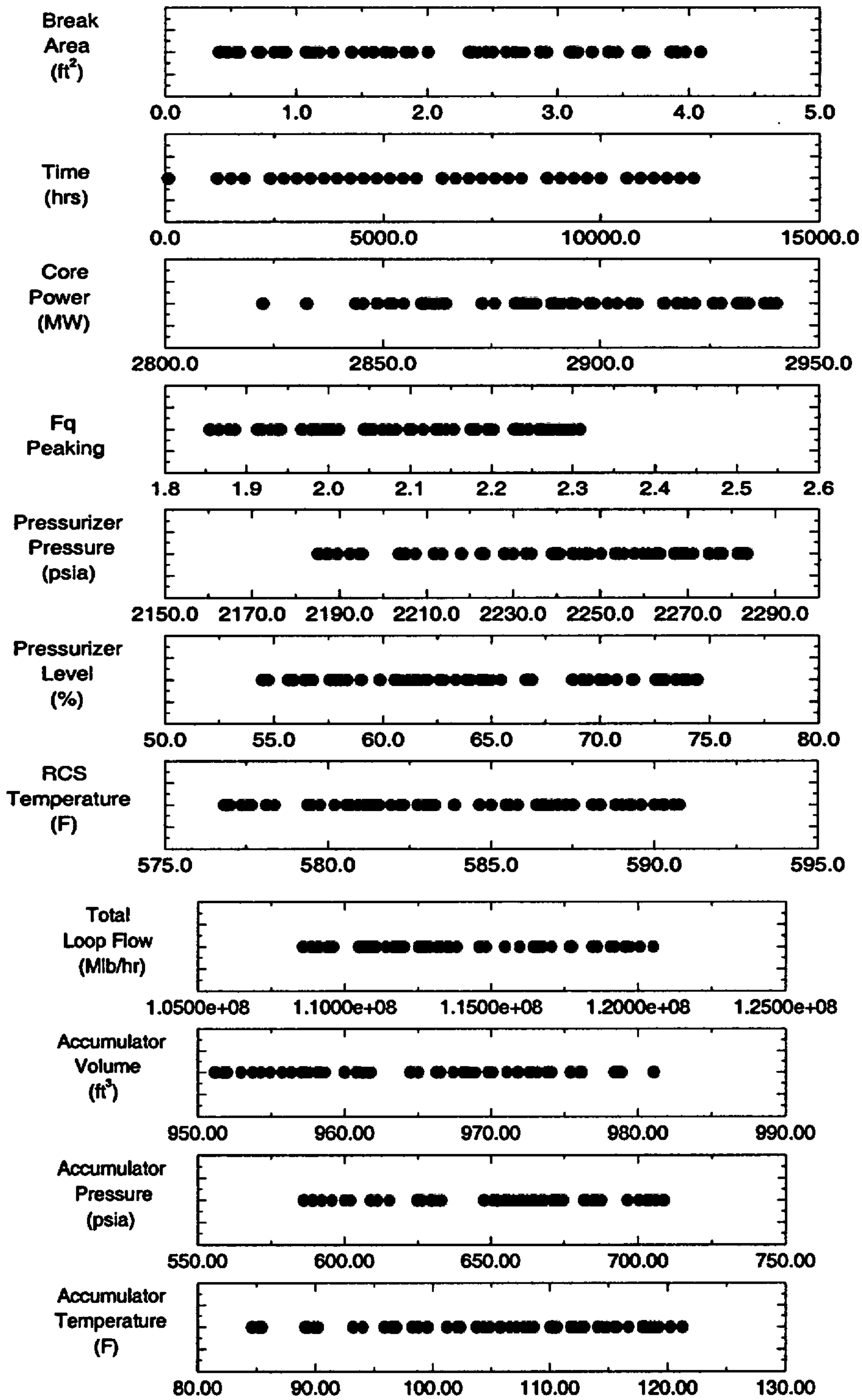

Figure 7.2-4: NAPS Unit 1 Scatter Plots of Operational Parameters

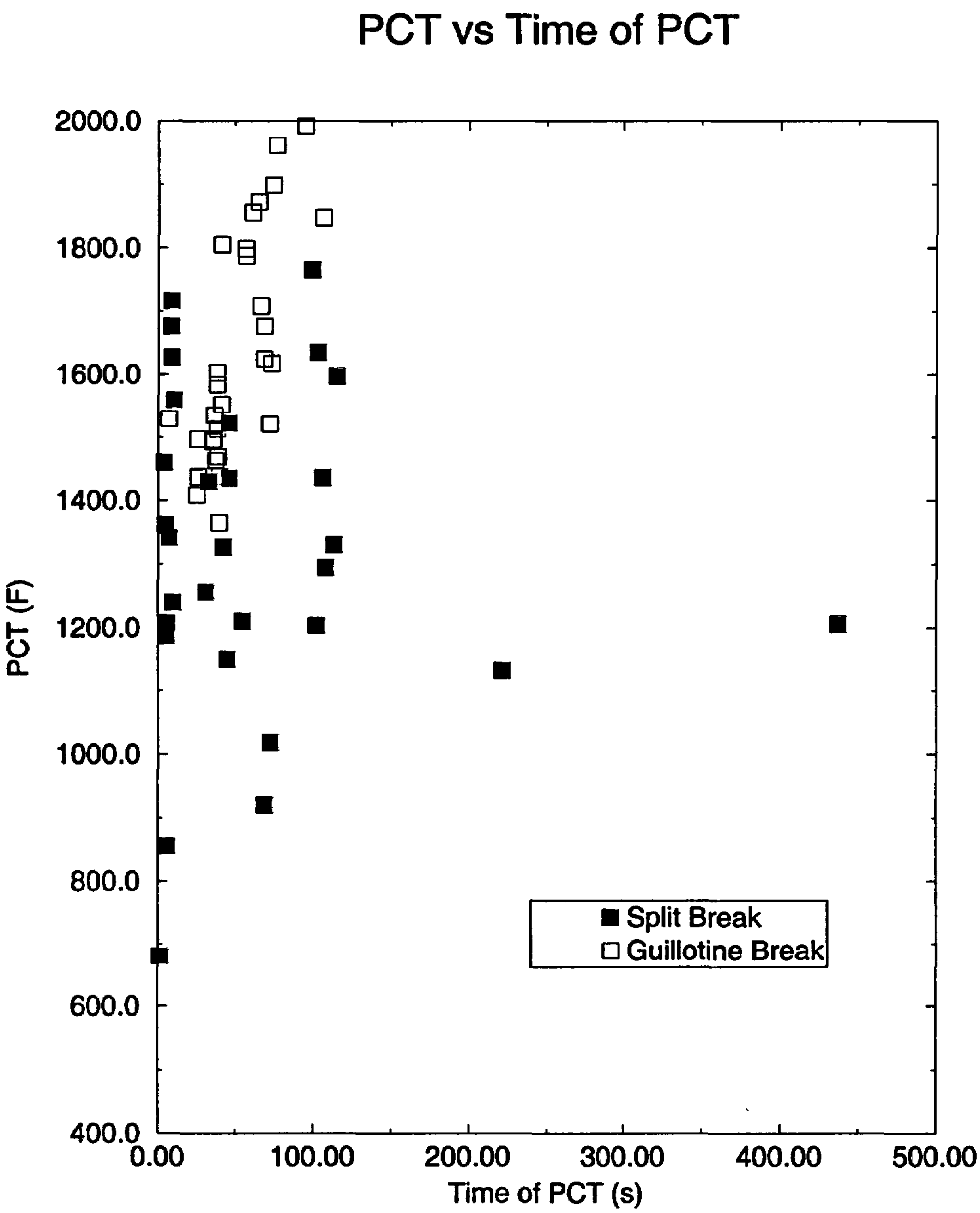

Figure 7.2-5: NAPS Unit 1 PCT versus PCT Time Scatter Plot

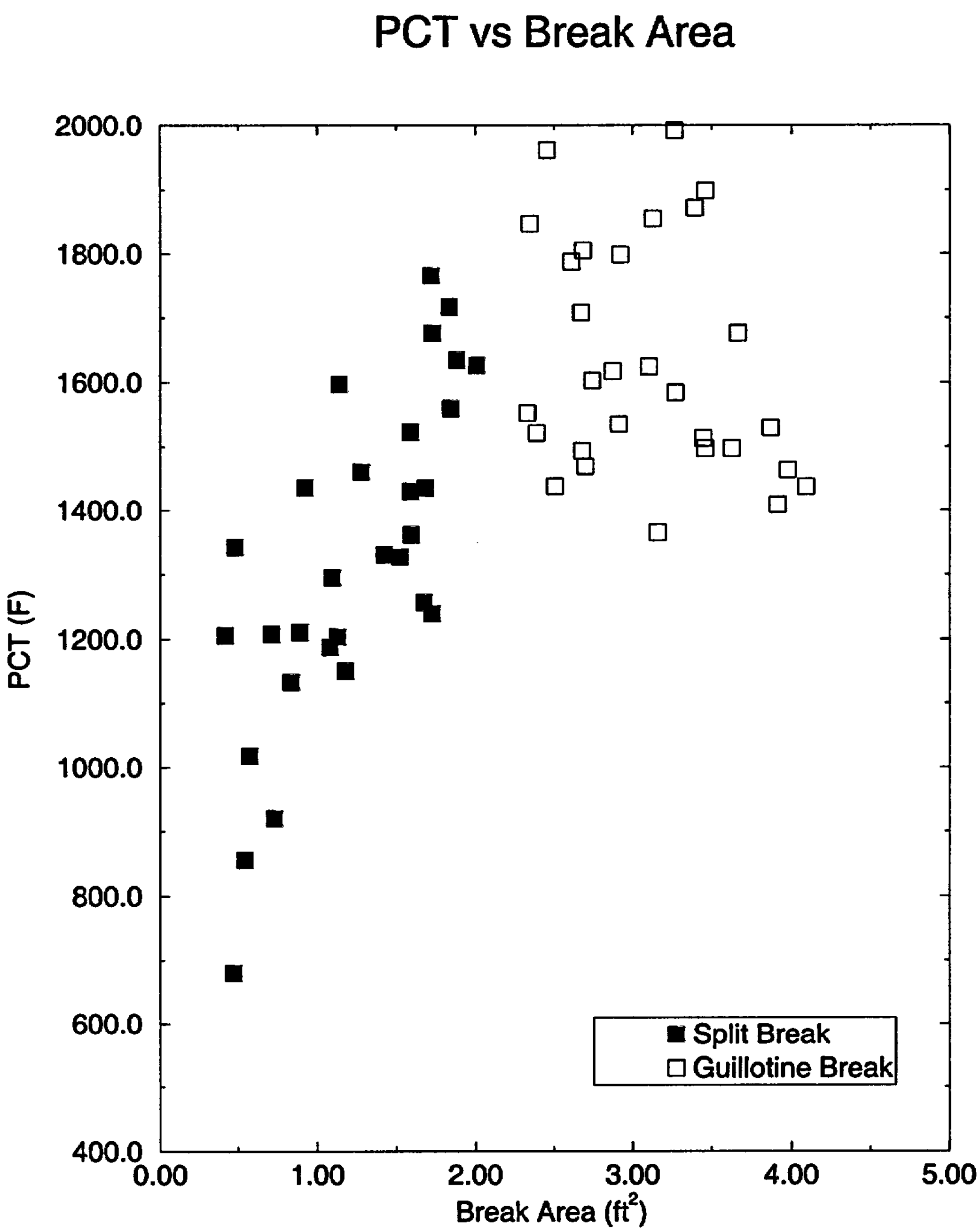

Figure 7.2-6: NAPS Unit 1 PCT versus Break Size per Side Scatter Plot

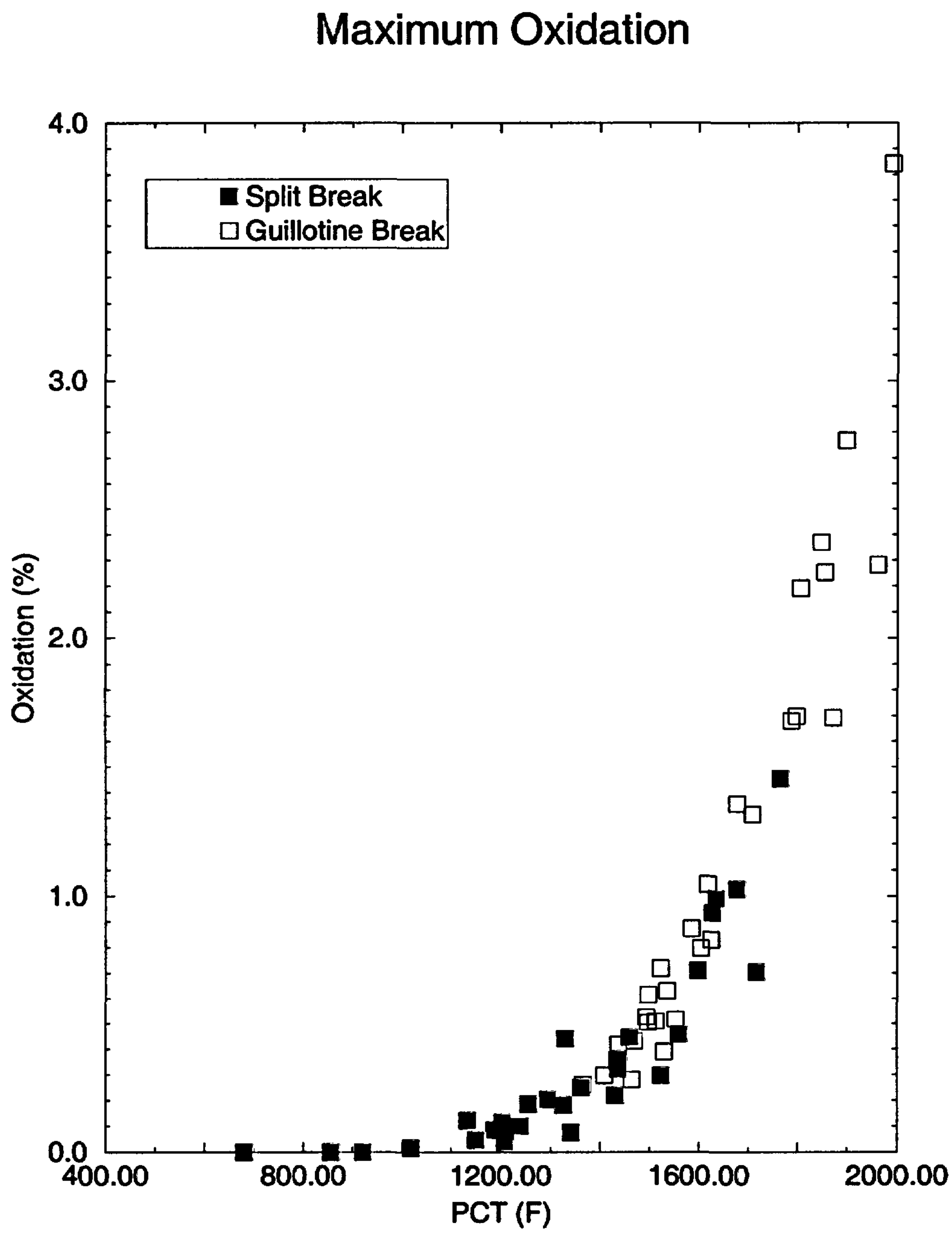

Figure 7.2-7: NAPS Unit 1 Maximum Oxidation versus PCT Scatter Plot

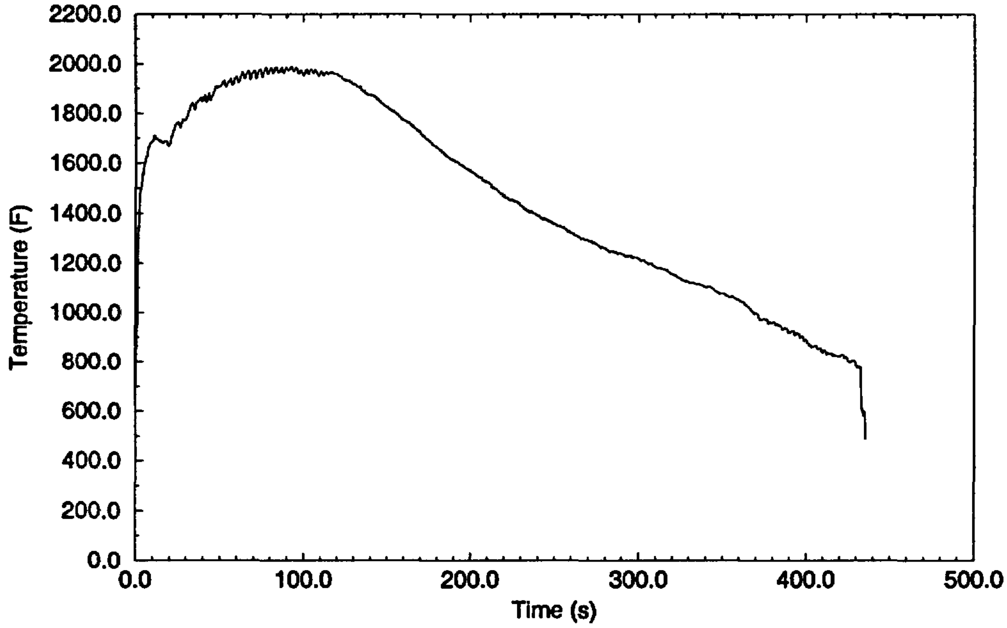

Figure 7.2-8: NAPS Unit 1 Peak Cladding Temperature for the Limiting Break (elevation independent)

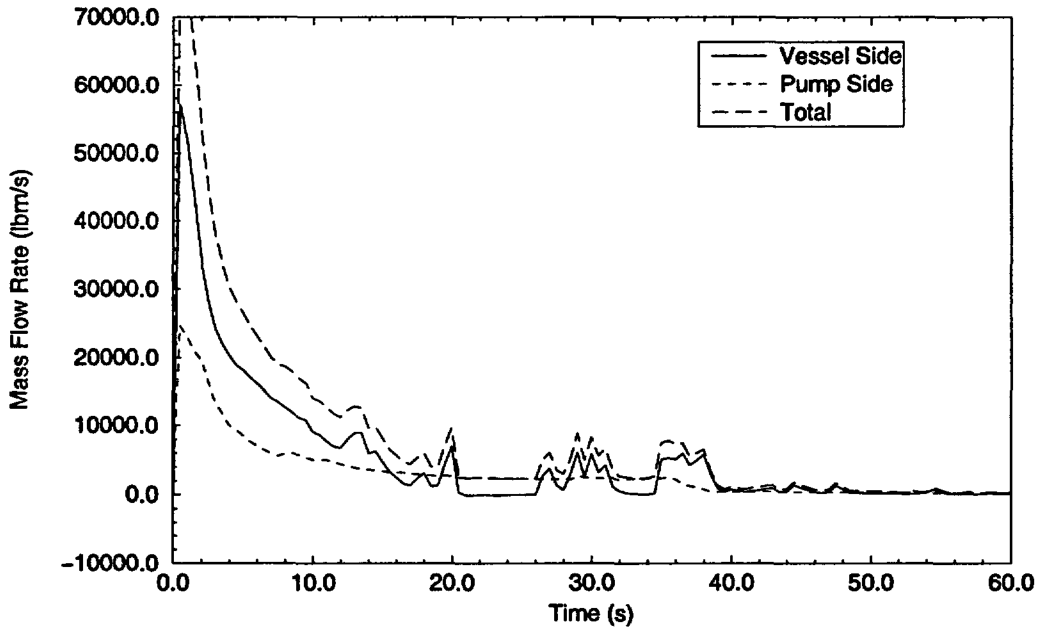

Figure 7.2-9: NAPS Unit 1 Break Flow for the Limiting Break

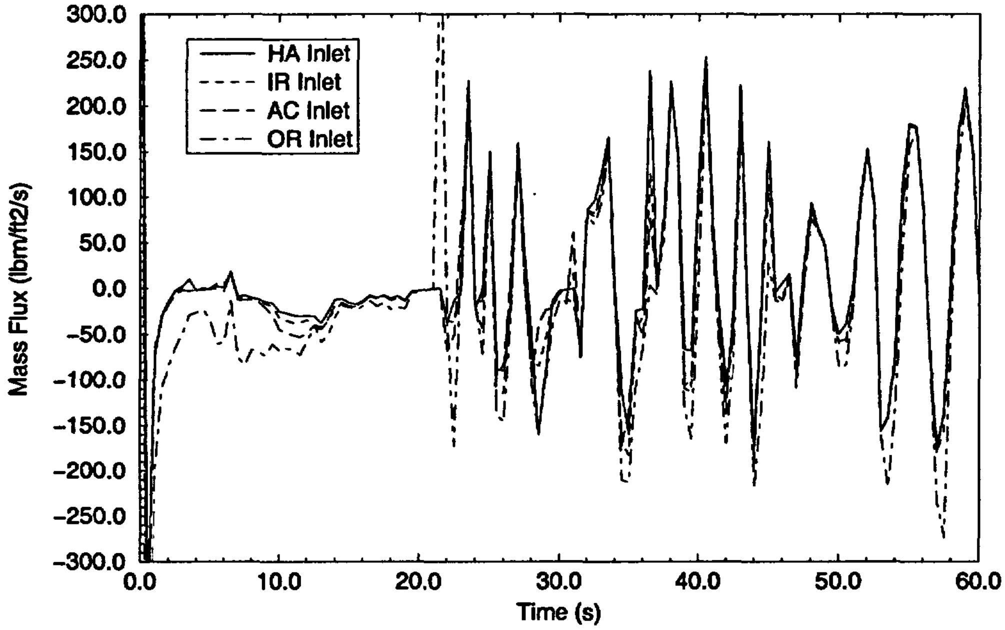

Figure 7.2-10: NAPS Unit 1 Early Core Inlet Mass Flux for the Limiting Break

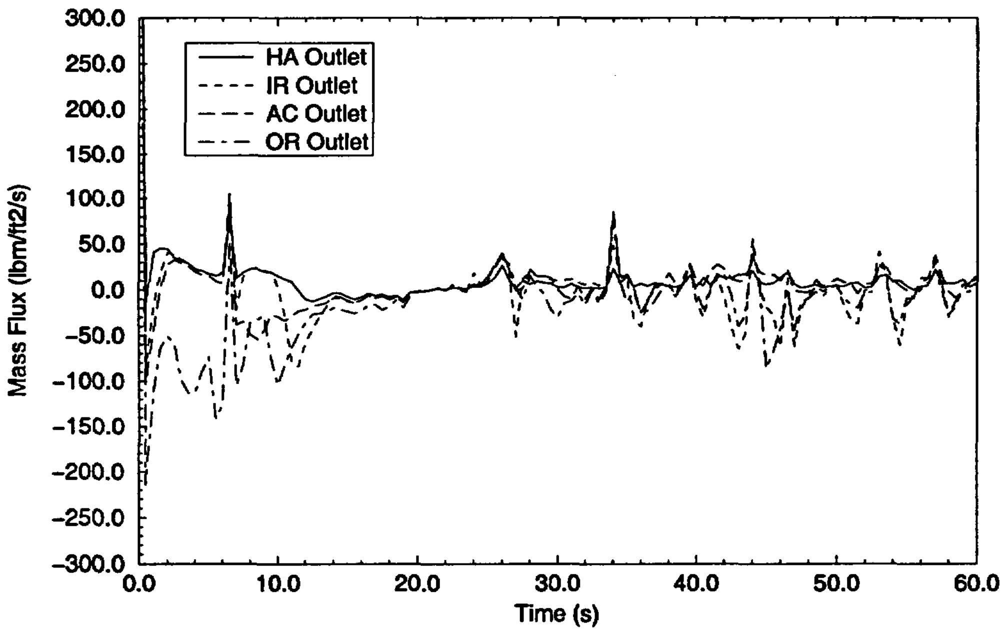

Figure 7.2-11: NAPS Unit 1 Core Outlet Mass Flux for the Limiting Break

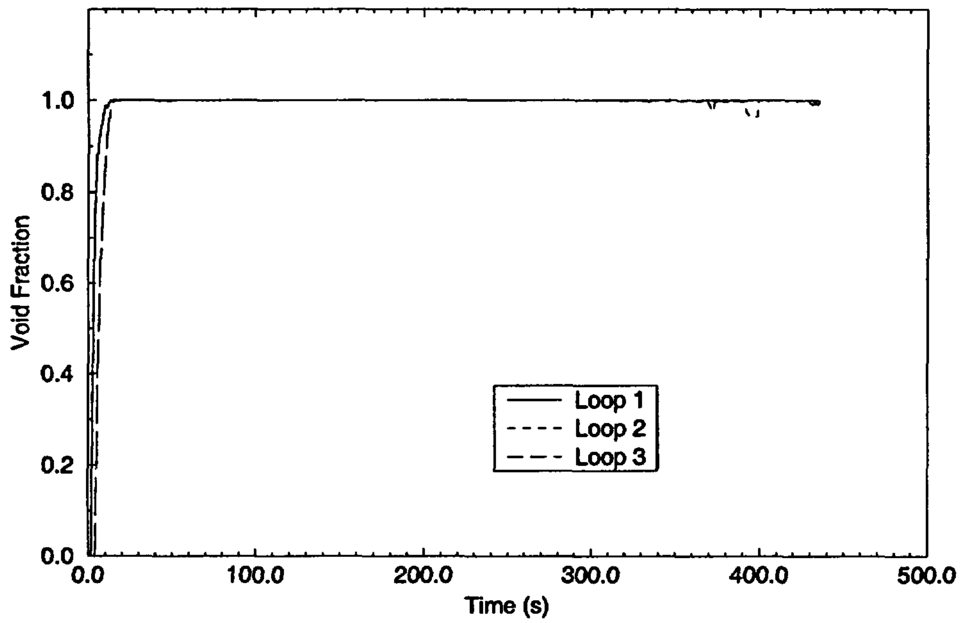

Figure 7.2-12: NAPS Unit 1 Void Fraction at RCS Pumps for the Limiting Break

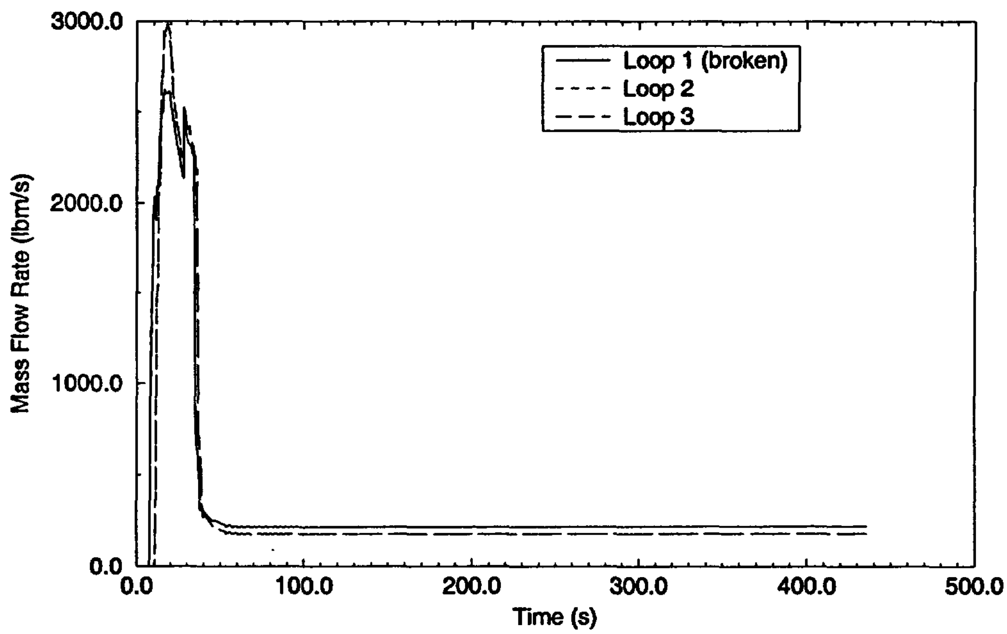

Figure 7.2-13: NAPS Unit 1 ECCS Flows (includes Accumulator, HHSI and LHSI) for the Limiting Break

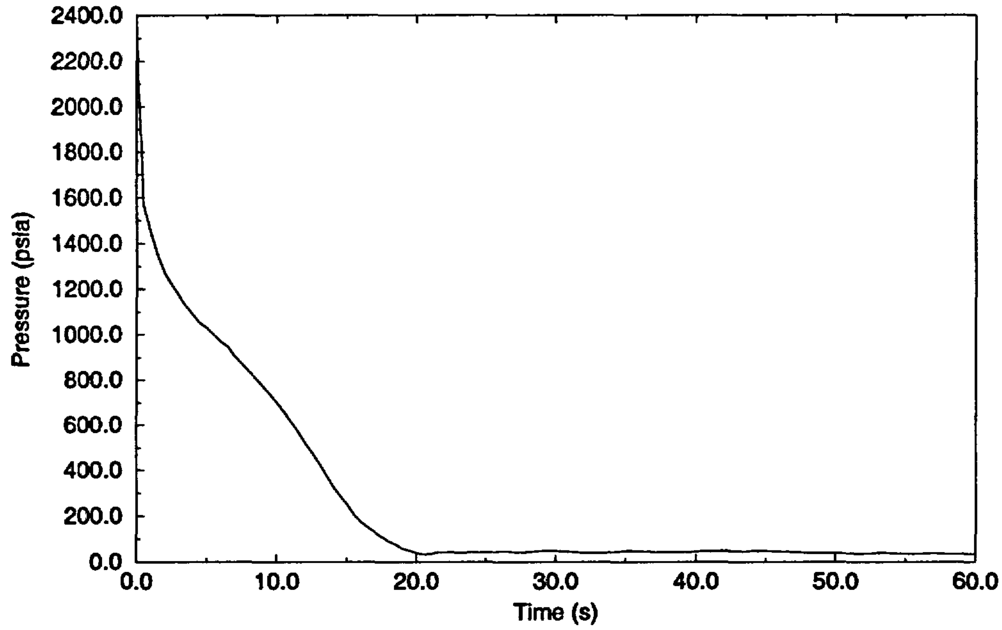

Figure 7.2-14: NAPS Unit 1 System (Upper Plenum) Pressure for the Limiting Break

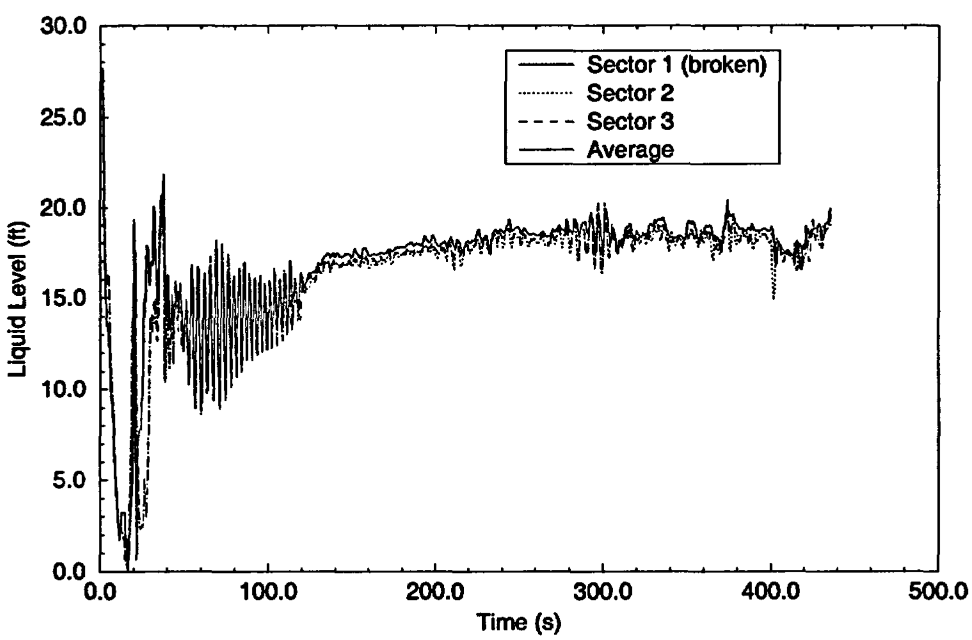

Figure 7.2-15: NAPS Unit 1 Collapsed Liquid Level in the Downcomer for the Limiting Break

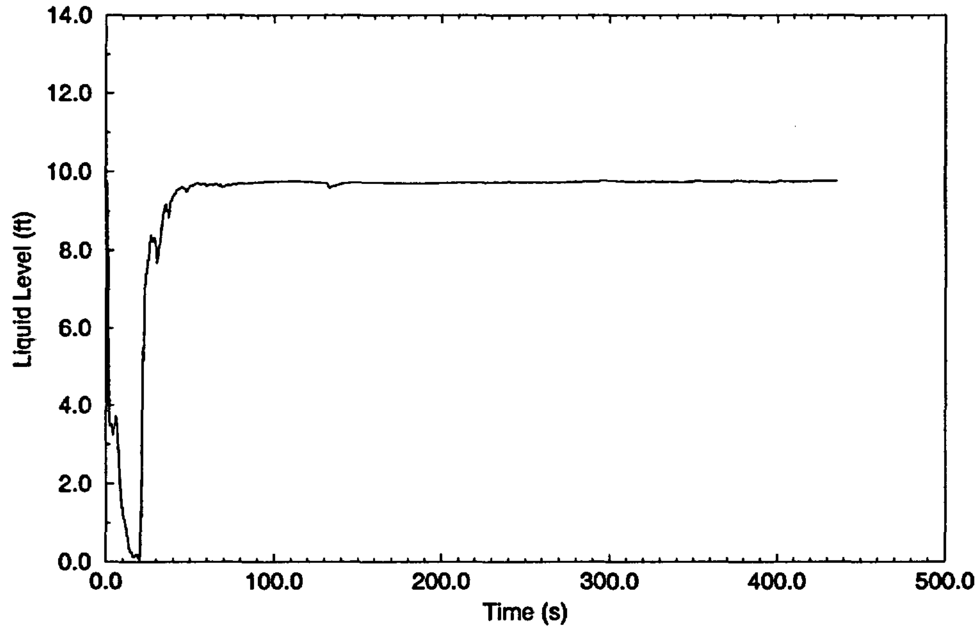

Figure 7.2-16: NAPS Unit 1 Collapsed Liquid Level in the Lower Vessel for the Limiting Break

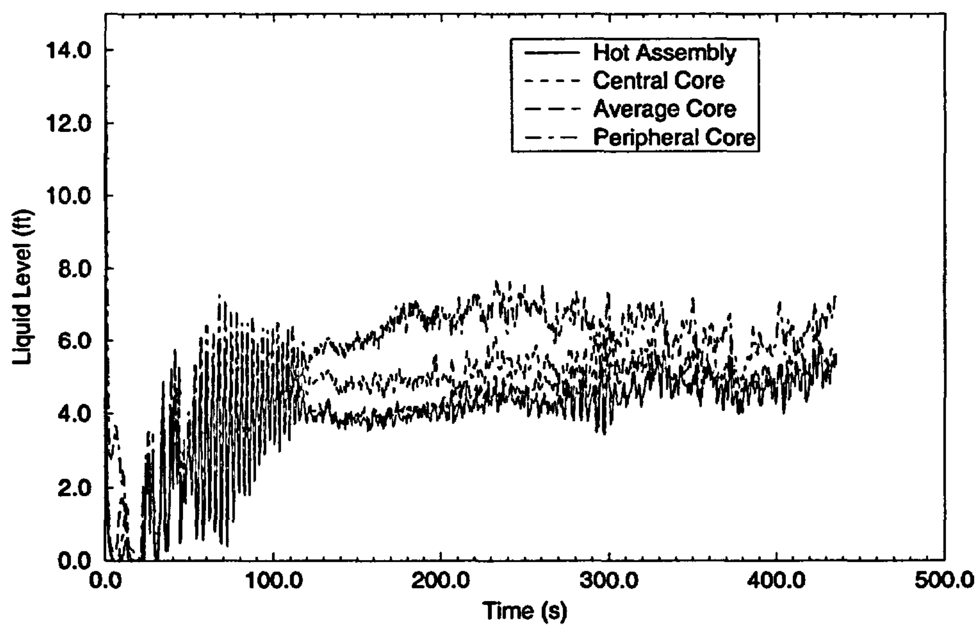

Figure 7.2-17: NAPS Unit 1 Collapsed Liquid Level in the Core for the Limiting Break

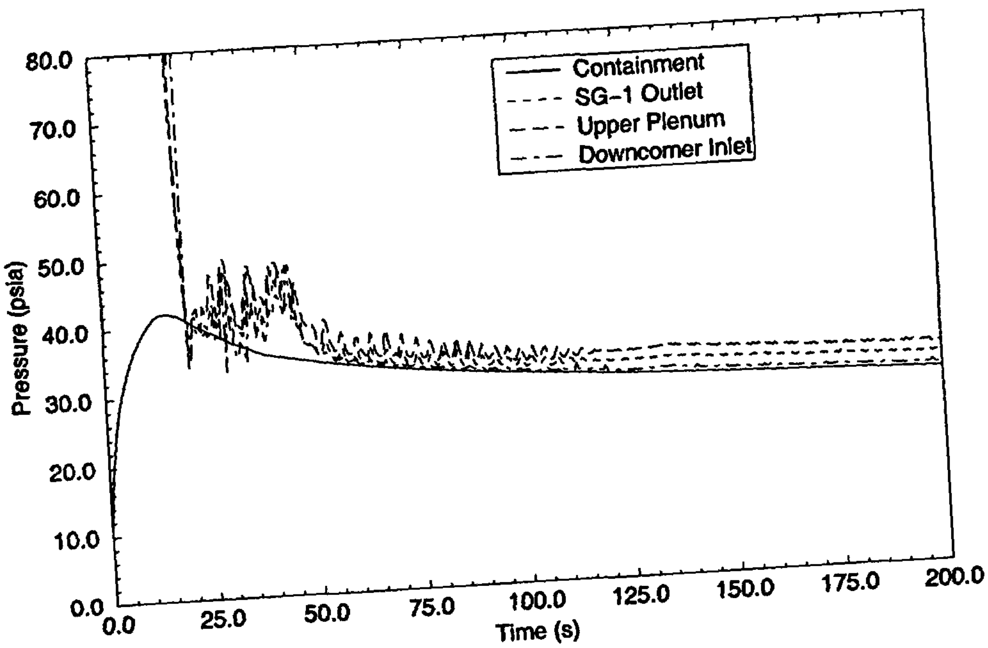

Figure 7.2-18: NAPS Unit 1 Containment and Loop Pressures for the Limiting Break

7.4 LOCA Summary

10CFR50.46 specifies that the ECCS for a commercial nuclear power plant must meet five criteria. The calculations and evaluations documented in this chapter demonstrate that the two NAPS units meet the required licensing criteria when operated with Advanced Mark-BW fuel. LOCA calculations performed in concurrence with approved evaluation models (Reference 7-1 through 7-3) demonstrate compliance for breaks up to and including the double-ended severance of the largest primary coolant pipe. The co-residence of Advanced Mark-BW fuel and NAIF assemblies in the same fuel cycle is concluded to be of minimal consequence and does not cause the calculated clad temperature of either assembly to approach the limits of 10CFR50.46.

Specifically, this report, in conjunction with Dominion's LOCA evaluations for NAIF, concludes that when the North Anna units are operated with Advanced Mark-BW fuel:

1. The calculated PCT for the limiting PCT case is less than <u>2,200 °F</u>.
2. The maximum calculated local clad oxidation is less than <u>17 percent</u>.
3. The maximum amount of core-wide oxidation does not exceed <u>1 percent of the fuel cladding</u>.
4. The cladding remains <u>amenable to cooling</u>.
5. <u>Long-term cooling is established and maintained</u> after the LOCA.

Large break studies were performed for both units using the FANP RLBLOCA evaluation model (References 7-1 and 7-2). Tables 7.2-6 through 7.2-11 show the RLBLOCA results. The RLBLOCA analyses applied no K_Z restraint on axial peaking, that is, K_Z is set equal to one for all core elevations. The results of demonstrate LBLOCA compliance with the five criteria of 10CFR50.46. The mixed core was evaluated and no significant impact on either NAIF or Advanced Mark-BW fuel was identified.

Small break LOCA analyses were also performed for both NAPS units using the FANP deterministic EM (Reference 7-3, Volume II). Compliance with the five criteria of 10CFR50.46 was again demonstrated. The mixed core was evaluated with no significant impact on either fuel assembly design. SBLOCA analysis results are presented in Tables 7.3-8 through 7.3-19. The local power is axially restricted by the K_Z curve in Figure 7.3-3.

Both large and small break LOCA analyses conclude that current NAPS UFSAR analyses remain valid for application to NAIF.