ATTACHMENT I

INSTRUCTIONS FOR IMPLEMENTING

SUPPLEMENT NO. 7 TO PROPOSED CHANGE NO. 145

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IMPLEMENTATION INSTRUCTIONS

1. Replace Section 4.0 "Small Break Analysis" of Appendix A to "Yankee Nuclear Power Station Core XIII Performance Analysis" with the corresponding Section 4.0 attached in its entirety (including all tables and figures).

4.0 SMALL BREAK ANALYSIS

4.1 Introduction

Modifications to the ECCS (Section 2.0) and to the low flow film boiling correlation used by Yankee (Section 3.2) were made to assure that the consequences of the previously identified most limiting small break LOCA (2.25 in I.D. thermal sleeve) are within the limits specified in 10CFR50.46. As previously discussed, the unique break postulated to occur is a complete severance in a small length of ECCS piping (1 to 2 feet) immediately downstream of the check valve which is nearest to one of the RCS cold leg injection points. This bre location results in reactor coolant (RCS) blowdown through a 2.25 in. I.D. thermal sleeve and ECCS spillage through a 3.438 in. I.D. ECCS line to containment.

The revised ECCS assures that the consequences of this most improbable event and other small breaks are acceptable by providing separate HPSI through each of the ECCS injection trains to the four RCS cold legs. Sufficient injection to the three intact cold legs is assured by supplying resistance in each of the separate HPSI lines to yield a HPSI header pressure in excess of 1000 psia when spilling through the ruptured ECCS line prior to injection to the intact loops. This is accomplished using throttle valves in each of the four lines connecting the HPSI header to the LPSI injection lines (refer to Section 2.0).

To confirm that the combination of modified low flow film boiling heat transfer and the revised ECCS provide the margin necessary to limit the consequences of small break LOCA events within 10CFR50.46 criteria, a complete small break LOCA spectrum analysis was performed. Sections 4.2 through 4.4 provide the analysis of the 2.25 inch ID thermal sleeve, 4.0 inch ID, 5.0 inch ID, 7.5 inch ID and 10 inch ID small breaks.

4.2 Method of Analysis

The transient depressurization of the RCS was calculated using the NRC approved RELAP4-EM digital computer code as modified by the Exxon Nuclear Company (RELAP4-EM/003 11/07/75 95ENC20) and Yankee (refer to Section 3.2). For rod heatup calculations, the approved TOODEE2 Version ENC13 as modified by Yankee (refer to Section 3.2) digital computer code was used.

The reactor coolant system was nodalized into control volumes interconnected by flowpaths as shown in Figure 4-1. The broken loop was modeled explicitly while the intact loops were lumped together. This model is identical to the nodalization used in the Core XII analysis excepting:

(1) changes in the ECCS portion of the model necessary to represent the modified ECCS and

(2) changes in the ECCS model necessary to accurately reproduce both the results of the most recent LPSI and HPSI pump tests and the 1972 accumulator flow tests. Figure 4-2 provides the Core XII model for comparison.

(3) changes to the input HPSI fill curves to reflect recent HPSI pump tests. The results of these tests are provided in Figure 4.3. For conservatism and to allow for future potential measurement uncertainties, the minimum

HPSI performance curve (i.e., Pump No. 3 from 790 psid to 160 psid, and Pump No. 1 from 160 psid to runout conditions) was reduced by 7.5% both in flow and head. This revised performance curve is also included in Figure 4-3.

As stated above, the only actual change in the model is in the ECCS modeling. However, a minor change in secondary system modeling was required due to RELAP restrictions. The change is in the modeling of the feedwater flow to the steam generators. In the Core XII analysis, feedwater flow to the steam generators was modeled as a time dependent fill junction. It was found in preparing the current small break model that due to separation of the HPSI pumps from the LPSI pumps (Core XII LPSI and HPSI pumps were additive and treated as a single fill junction) that a total of six (6) fill junctions would be required if the primary system model were to be retained intact. Since RELAP is restricted to a maximum of five (5) fill junctions, it was decided to modify the feedwater modeling since this was the most readily accomplishable change. Thus, feedwater input to the steam generator is modeled as a time dependent volume (Volume 26) connected to each of the two steam generator secondary nodes (Volumes 16 and 17) with time dependent valves in each junction. The change was developed to assure that the feedwater flow, which is minimal since it is ramped from full flow to zero flow in two seconds, remained consistent with the Core XII analysis and subsequently was confirmed in the analysis.

The peak clad temperature analysis was performed using the TOODEE2 digital computer code as modified by Yankee (refer to Section 3.2). Figure 4-4 provides the 17 axial node model employed to simulate the peak rod.

Initial fuel rod temperatures were obtained utilizing RELAP4-EM/HOT Channel as modified by Yankee (refer to Section 3.2) with a corresponding axial nodalization. Time dependent fluid conditions required as TOODEE2 input were obtained from the blowdown results.

4.3 Results

The following figures illustrate the key parameters for the various small breaks analyzed for Core XIII at BOC Conditions:

Figures 4-5.1 through 4-5.8	2.25 inch ID	12.85 kw/ft
Figures 4-6.1 through 4-6.8	4.00 inch ID	12.85 kw/ft
Figures 4-7.1 through 4-7.8	5.00 inch ID	12.85 kw/ft
Figures 4-8.1 through 4-8.8	7.50 inch ID	12.85 kw/ft
Figures 4-9.1 through 4-9.8	10.00 inch ID	12.85 kw/ft

Table 4-1 provides a summary of the sequence of events for the above breaks and Table 4-2 provides a summary of the results.

4.4 Conclusions

The effects of the revised ECCS and modified low flow film boiling correlation yield small break LOCA transients whose consequences are well within the limits specified in 10CFR50.46.

TABLE 4-1

YANKEE ROWE CORE XIII SMALL BREAK ANALYSIS

TIME SEQUENCE OF EVENTS

	Event Time, Seconds				
Break Size Equivalent, ID:	2.25"	4.0"	5.0"	7.5"	10.0"
Event					
Pipe Rupture	0.0	0.0	0.0	0.0	0.0
Loss of Offsite Power	0.0	0.0	0.0	0.0	0.0
Safety Injection Signal	10.5	6.2	6.0	5.6	4.9
PCT Occurs	12.6	209.8	117.6	72.8	5.4
HPSI and LPSI Flow Begins	20.0	20.0	20.0	20.0	20.0
ECCS Flow to Intact Cold Legs Begins	48.0	24.8	20.0	20.0	20.0
Core Recovery Occurs	616.4	218.5	126.8	76.0	56.0

TABLE 4-2

YANKEE ROWE CORE XIII SMALL BREAK LOCA ANALYSIS
SUMMARY OF RESULTS*

Parameter	Break Size Equivalent Internal Diameter, Inches				
	2.25	4.0	5.0	7.5	10.0
Peak Clad Temperature ^{o}F	1133.5	1793.4	1522.4	1398.4	1625.3
Peak Clad Temperature Location, ft.	4.29	3.79	3.79	3.79	3.79
Maximum Local Zr/H_2O Reaction, %	.13	0.70	.24	.17	.20
Maximum Local Zr/H_2O Reaction Location ft.	4.29	4.04	3.79	3.79	3.79
Percent of Total Core Zr/H_2O Reaction, %	<1	<1	<1	<1	<1

*CALCULATIONS PERFORMED AT THE FOLLOWING CONDITIONS:

Power Level, MWt	618
Peak Linear Heat Generator Rate	12.85
Total Peaking Factor	2.76
Accumulator Water, FT^3	700
Cold Leg Temperature, ^{o}F	519

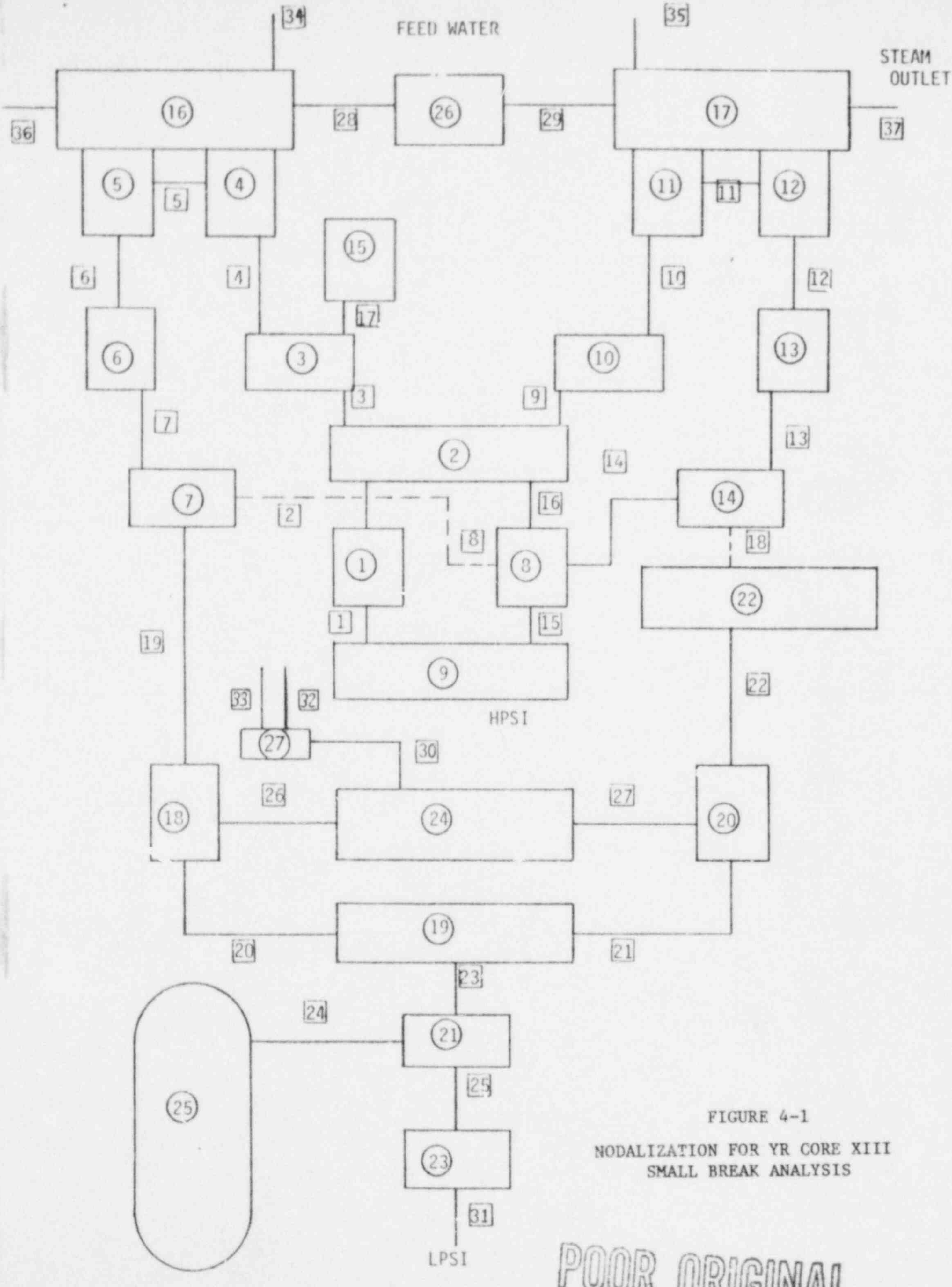


FIGURE 4-1

NODALIZATION FOR YR CORE XIII
SMALL BREAK ANALYSIS

POOR ORIGINAL

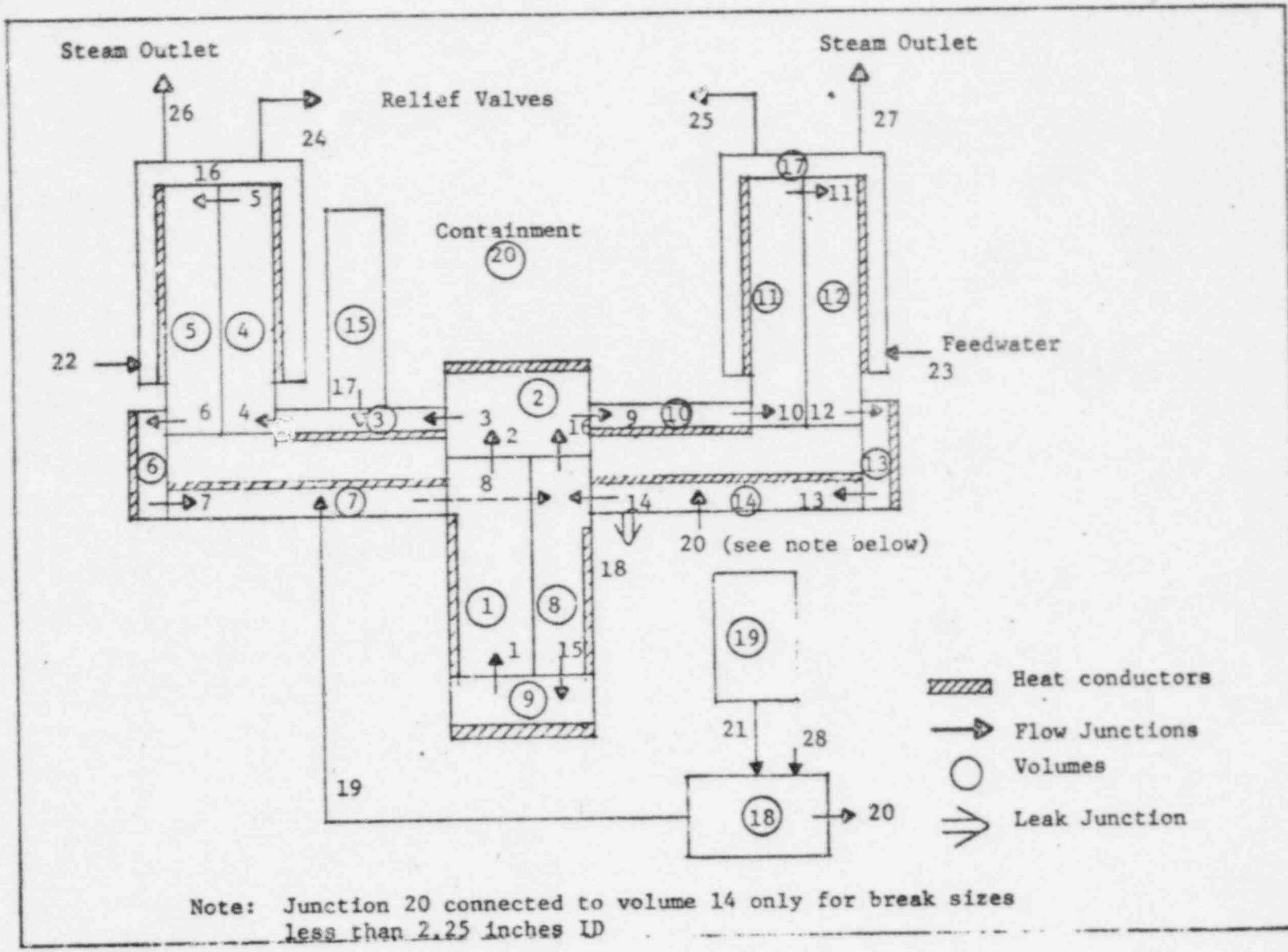


Figure 4-2 Small Break Nodalization for YR Core XII LOCA Analysis

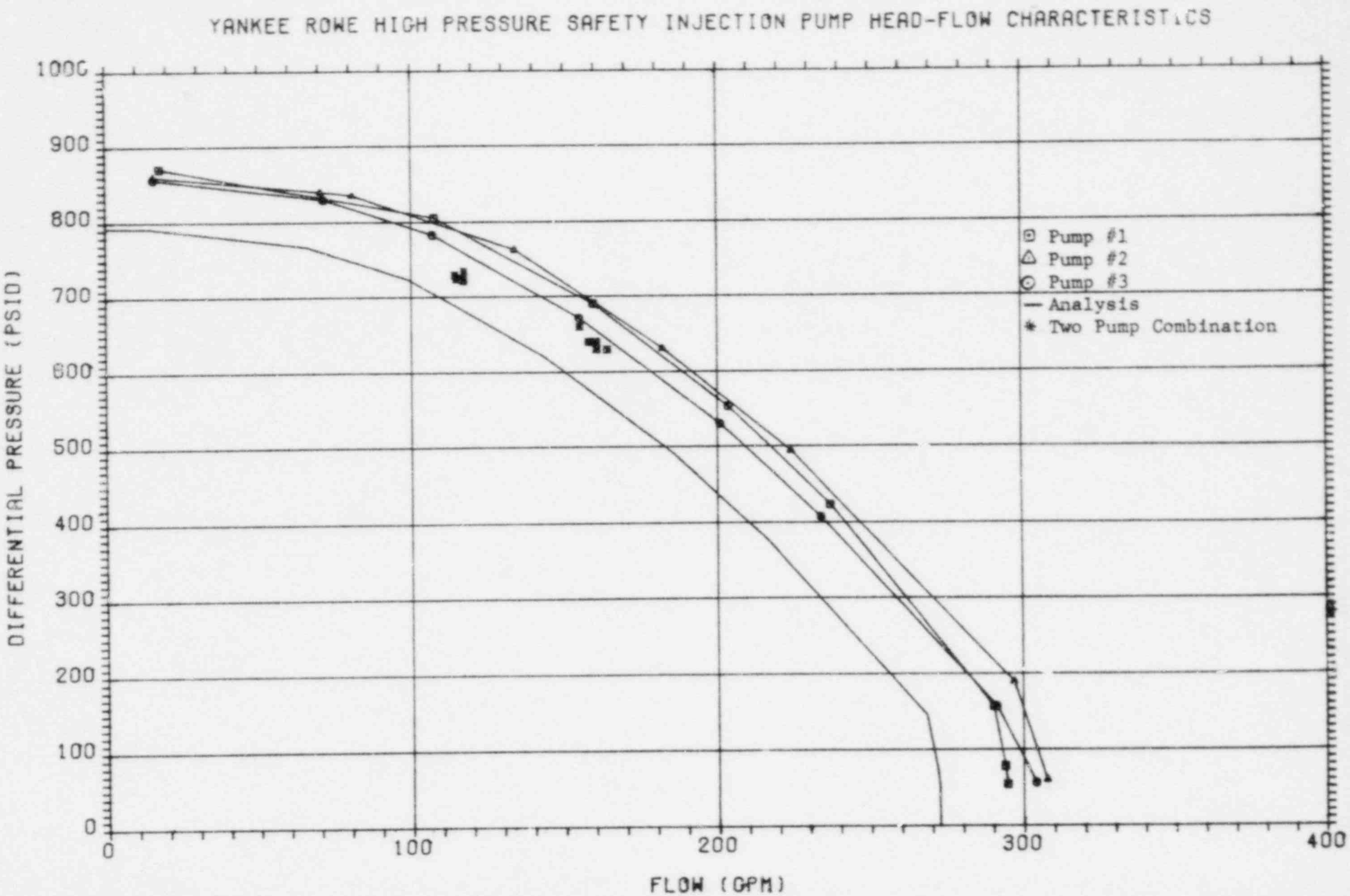
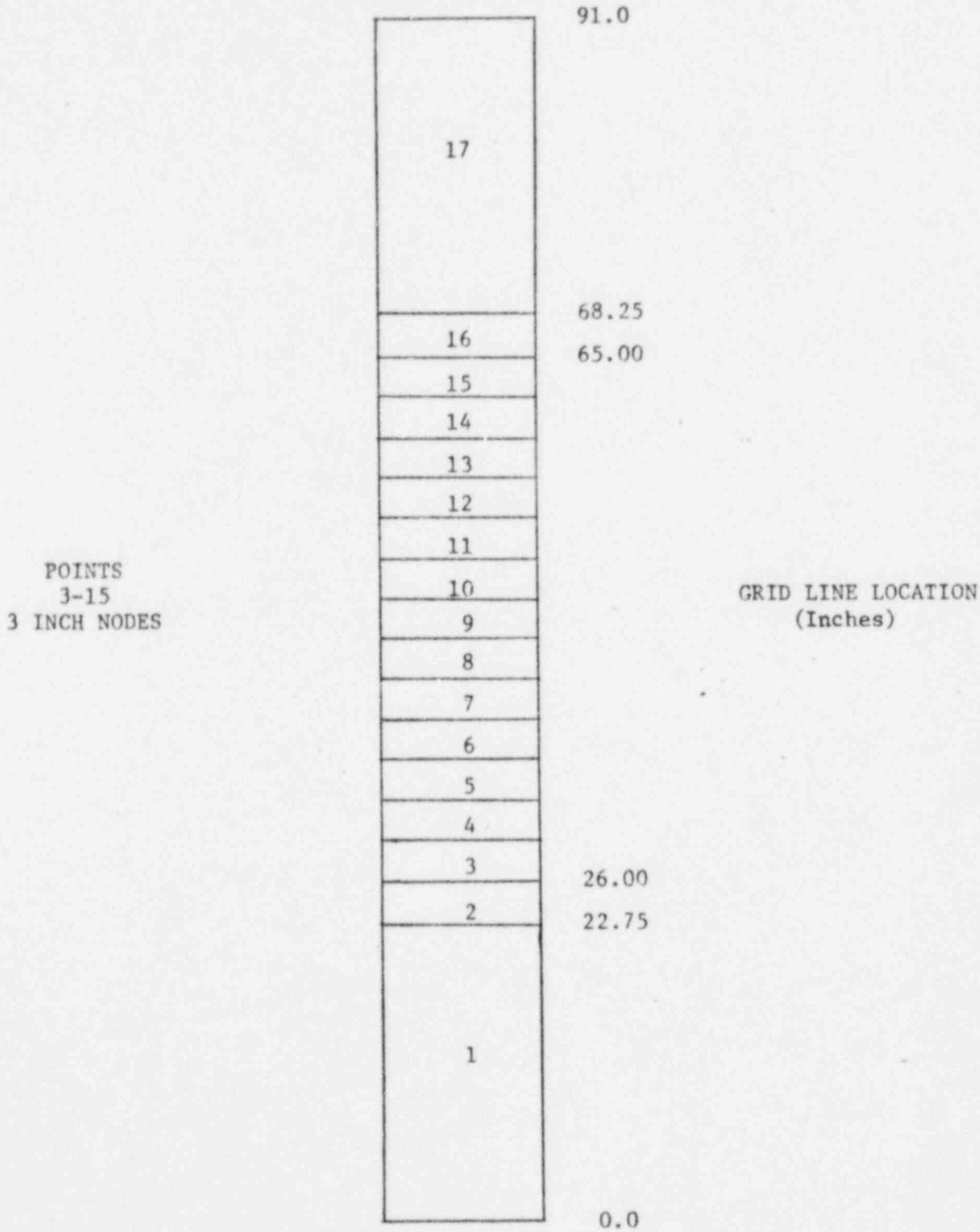


FIGURE 4-3

HPSI PERFORMANCE CURVES

FIGURE 4- 4

TOODEE2 HOT ROD NODALIZATION



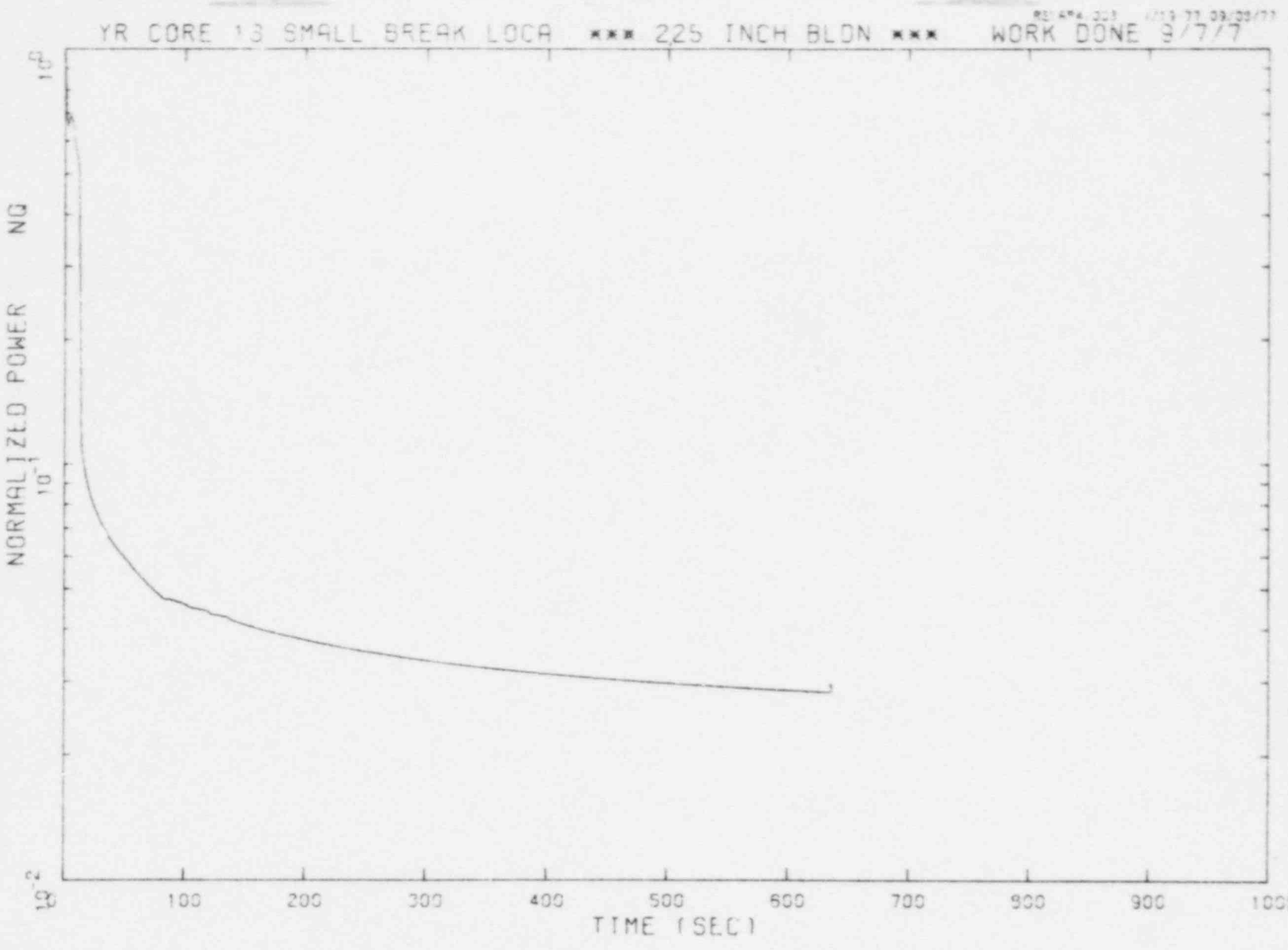


Figure 4-5.1
Normalized Power vs. Time for 2.25
Inch ID Small Break

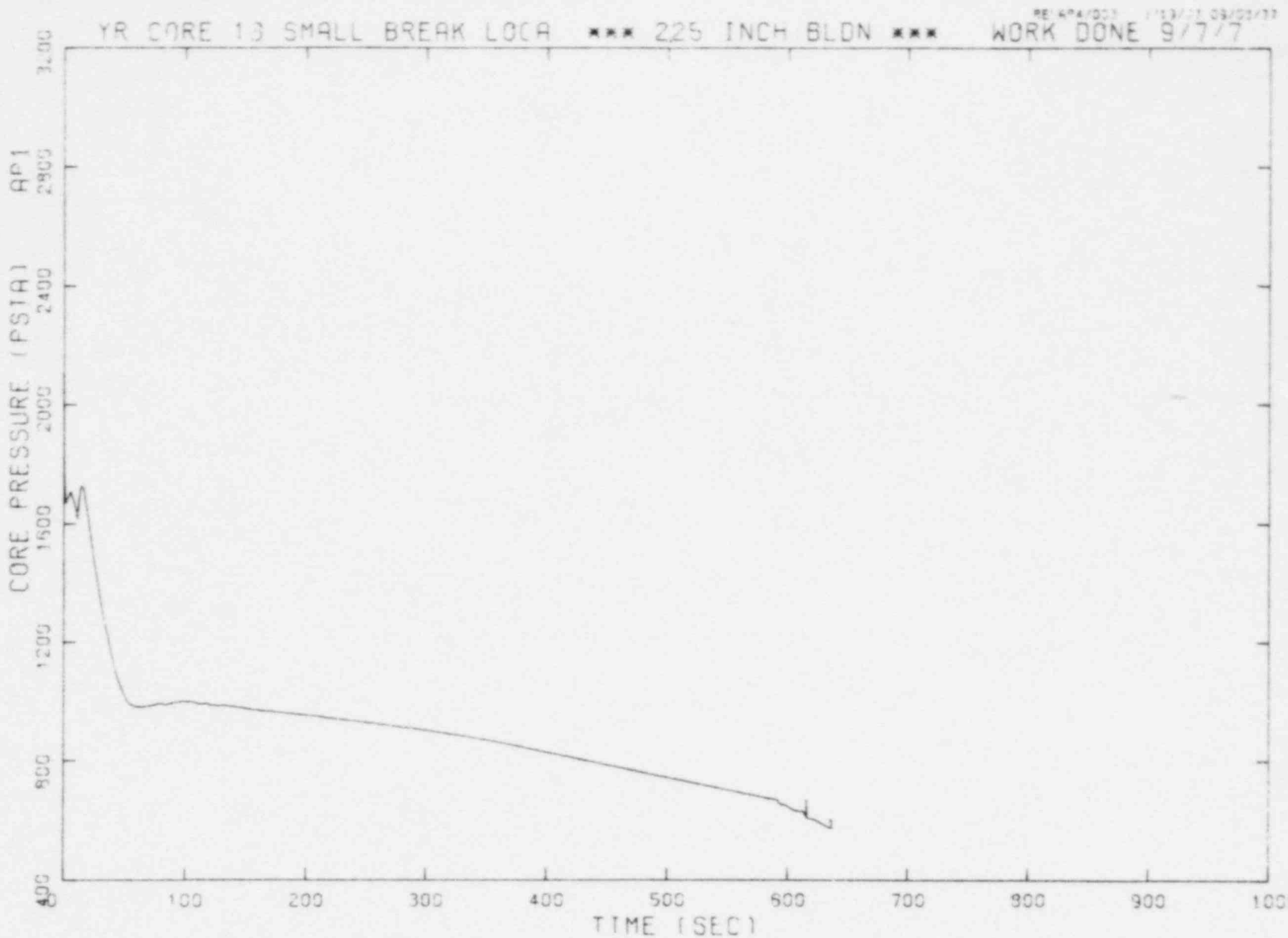


Figure 4.5-2
Core Pressure vs. Time for 2.25
Inch ID Small Break

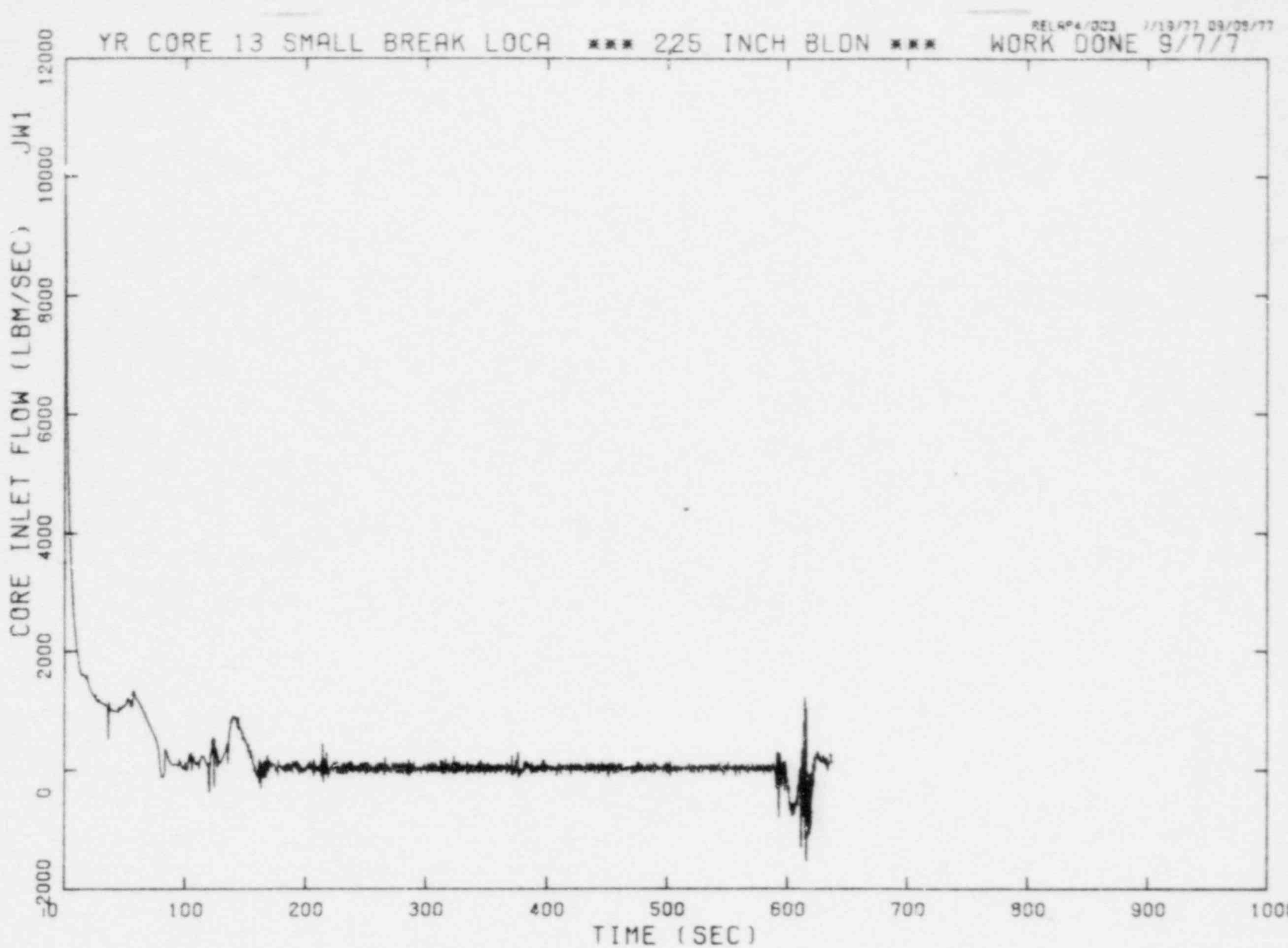


Figure 4-5.3
Inlet Flow vs. Time for 2.25 Inch
ID Small Break

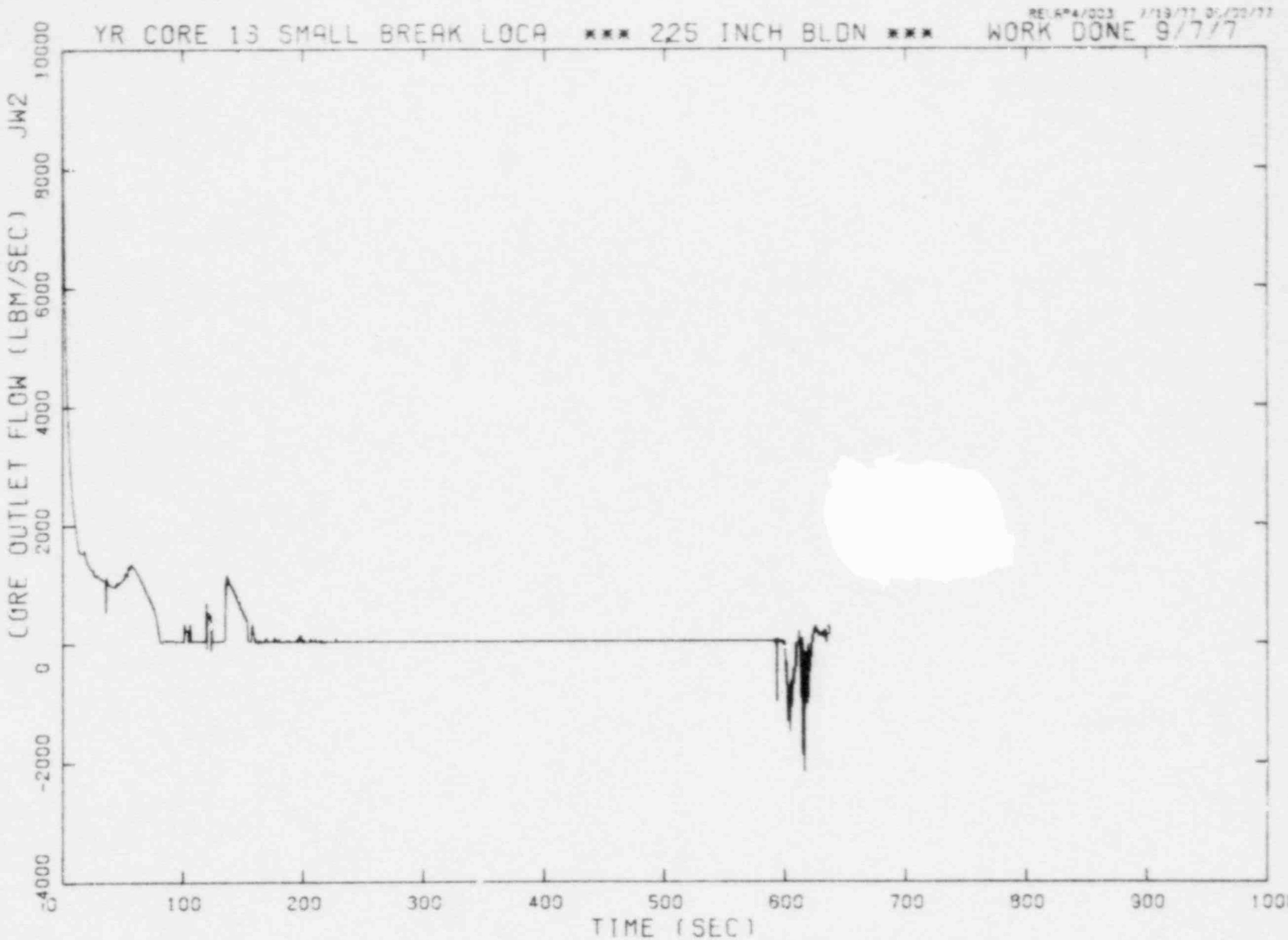
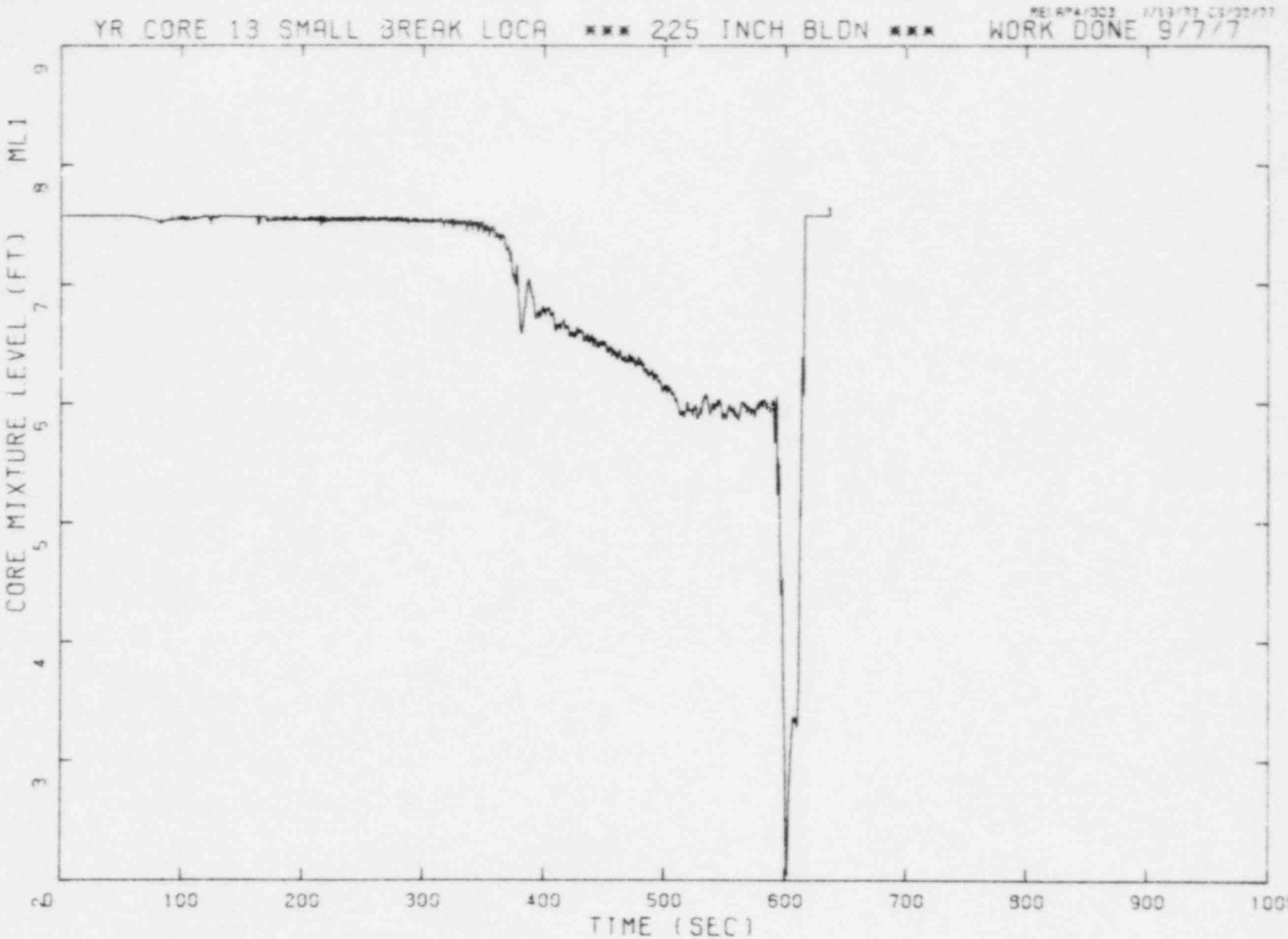


Figure 4-5.4
Core Outlet Flow vs. Time for 2.25 Inch ID Small Break



POOR ORIGINAL

Figure 4-5.5
Core Mixture Level vs. Time for 2.25
Inch ID Small Break

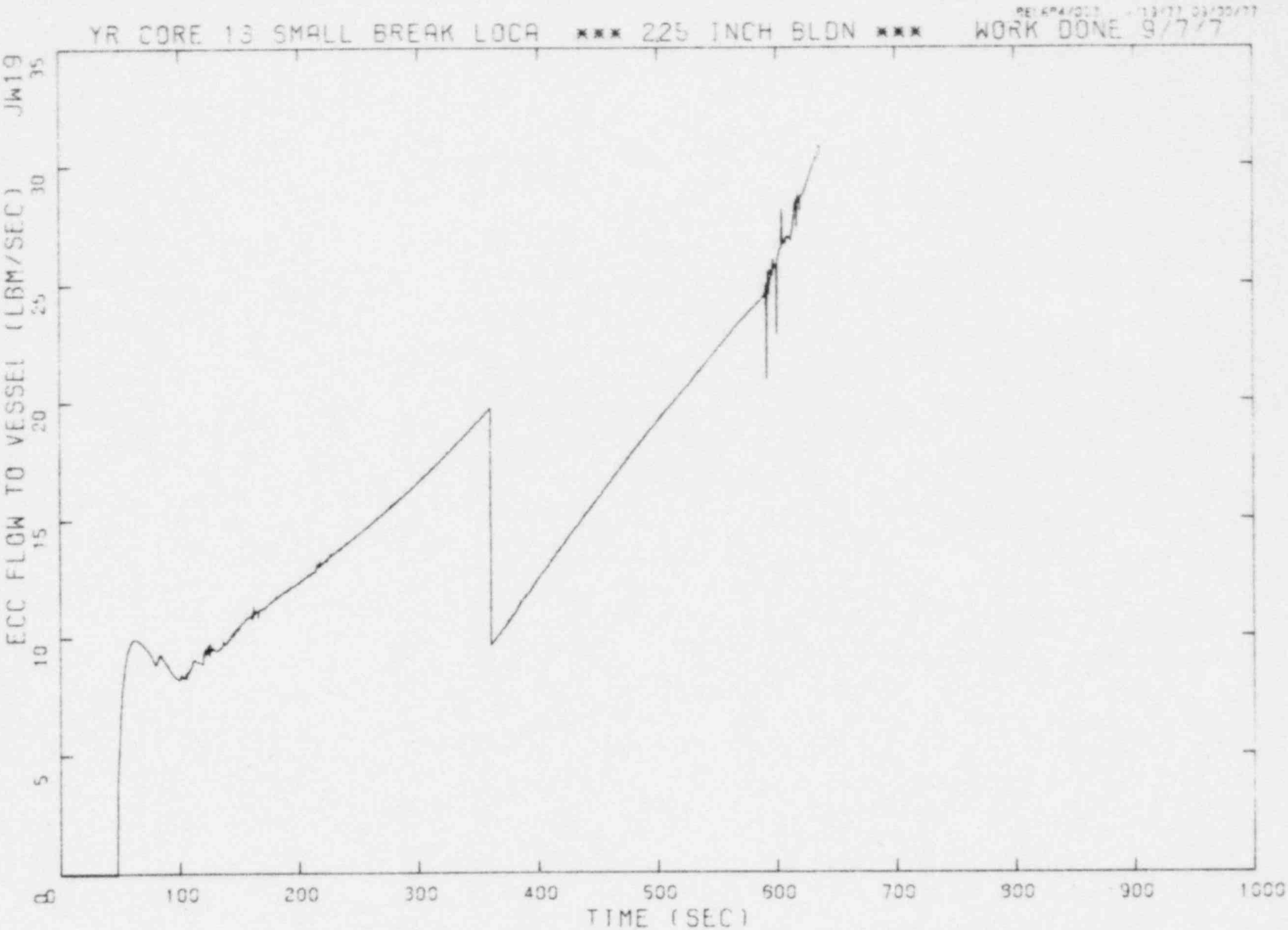


Figure 4-5.6
ECCS Flow to Core vs. Time for
2.25 Inch ID Small Break

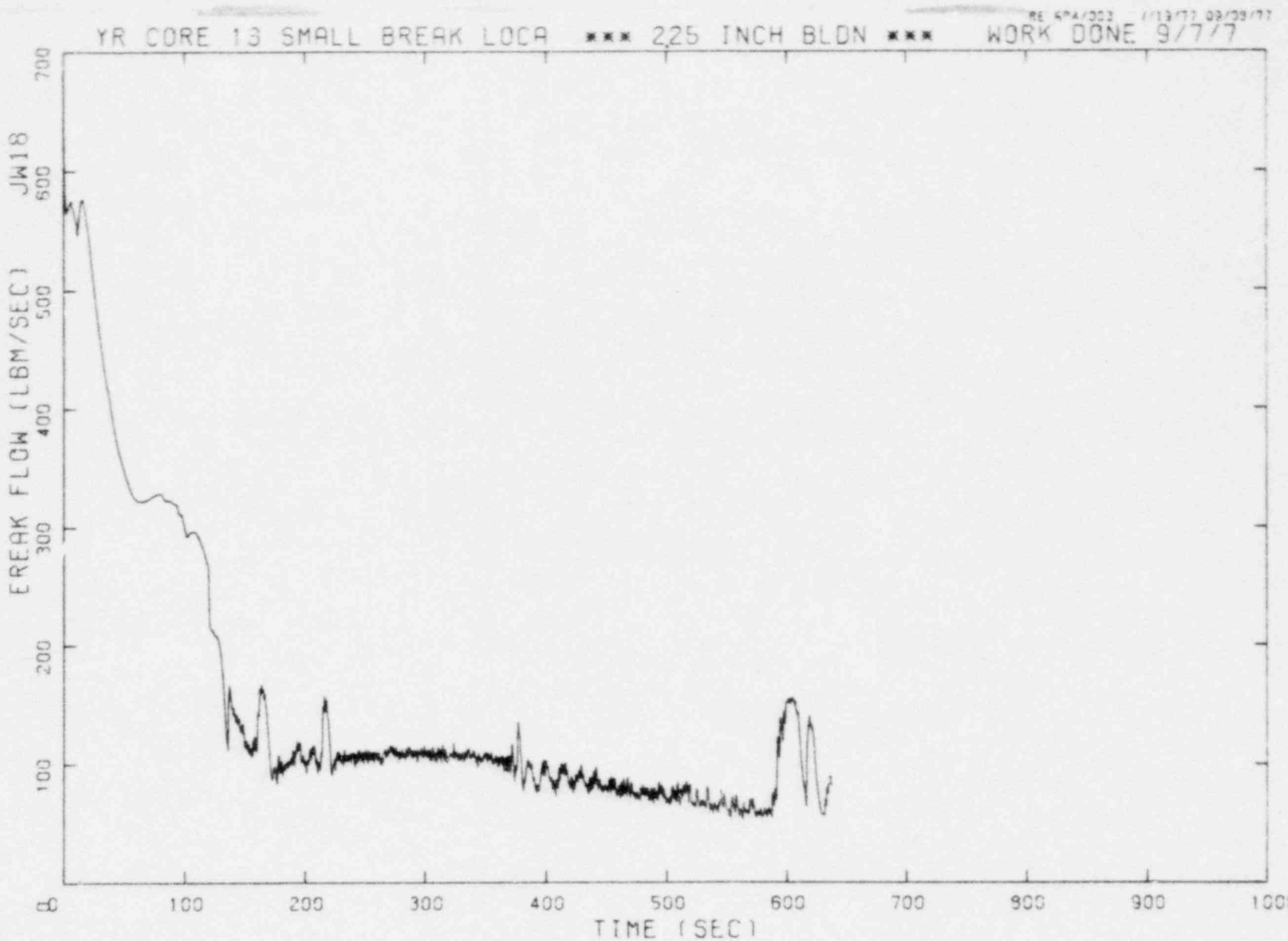


Figure 4-5.7
Cold Leg Break Flow vs. Time for
2.25 Inch ID Small Break

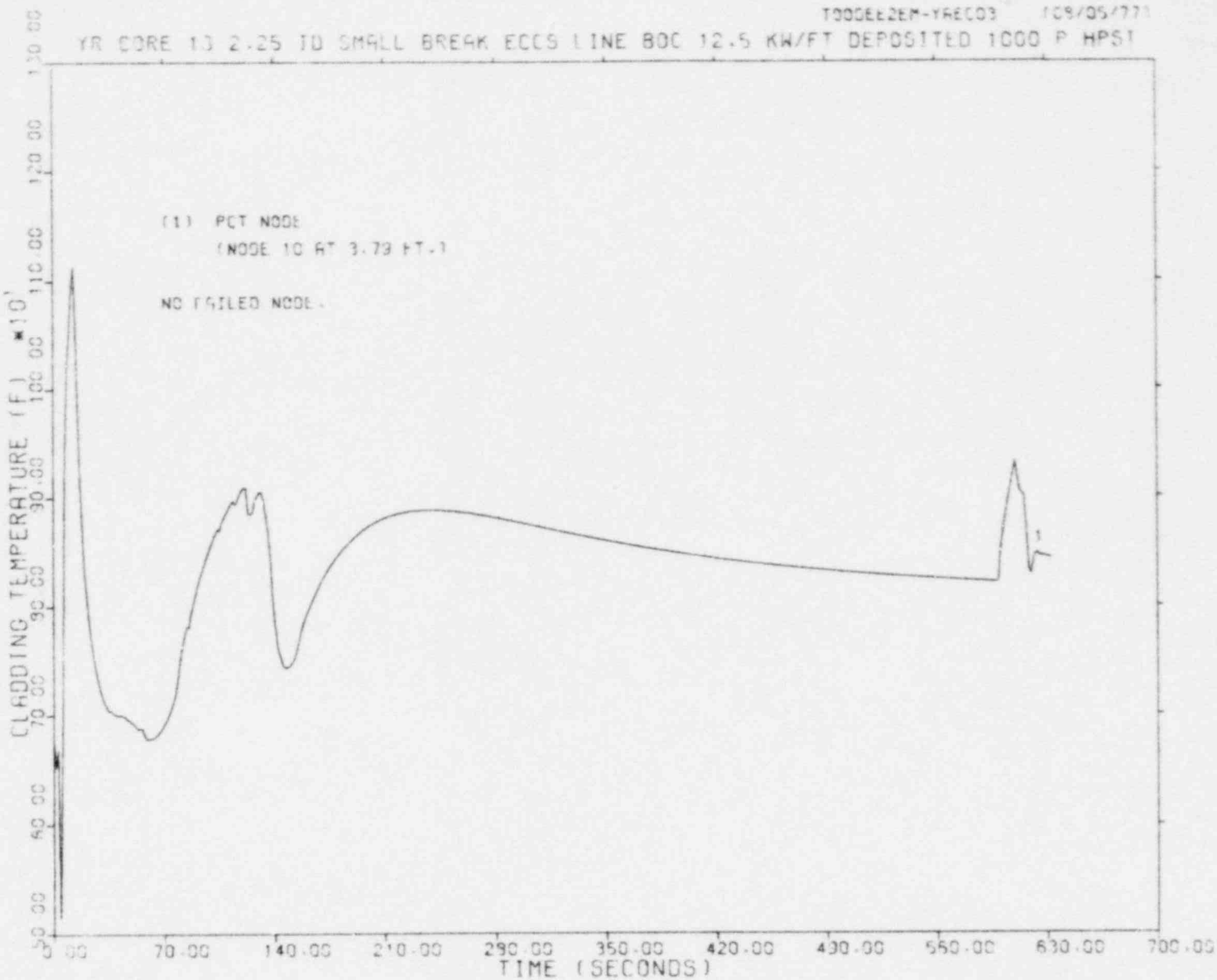


Figure 4-5.8
Peak Clad Temperature vs. Time for
2.25 Inch ID Small Break

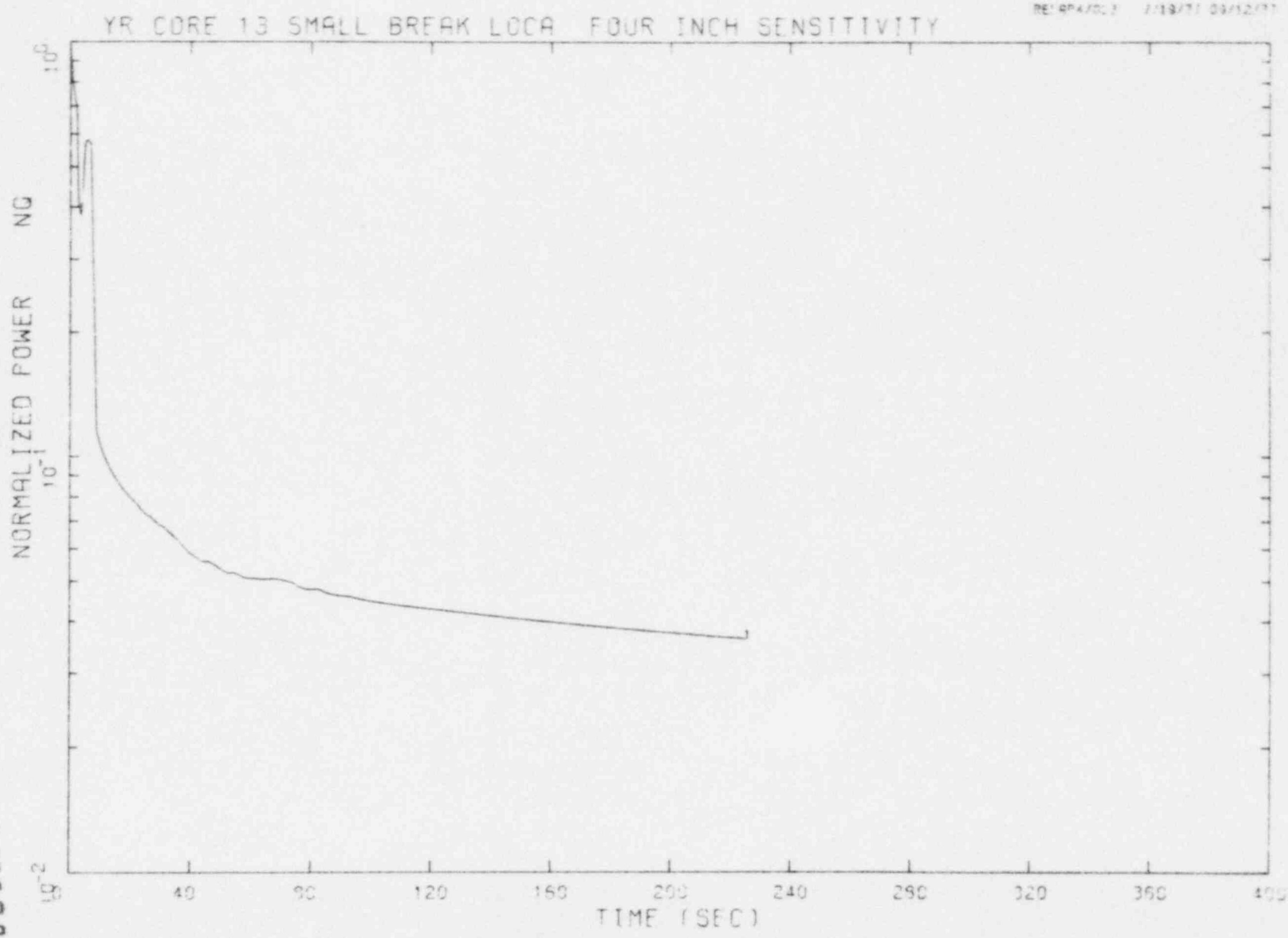


Figure 4-6.1
Normalized Power vs. Time for 4.00
Inch ID Small Break

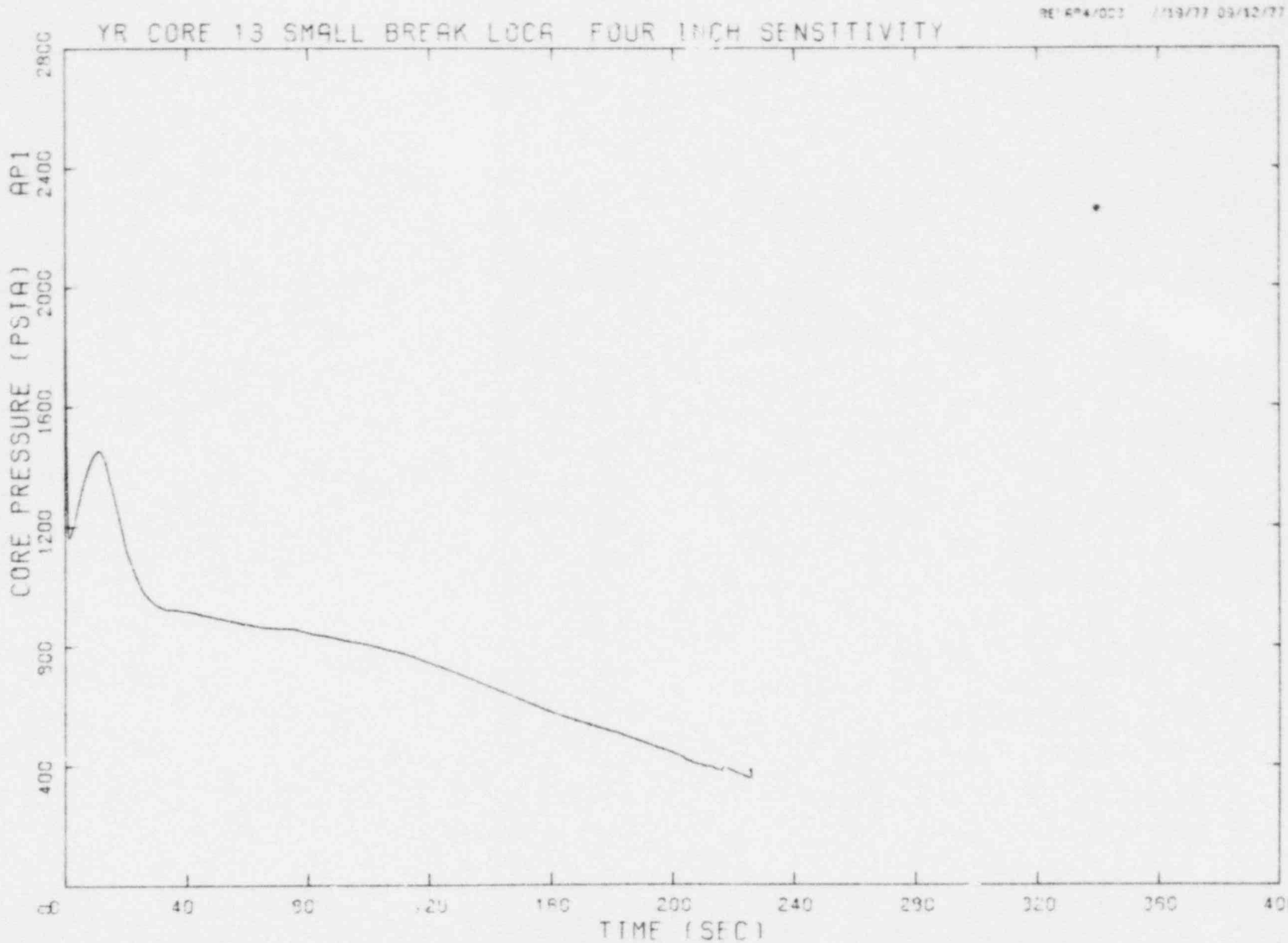


Figure 4-6.2
Core Pressure vs. Time for 4.00
Inch ID Small Break

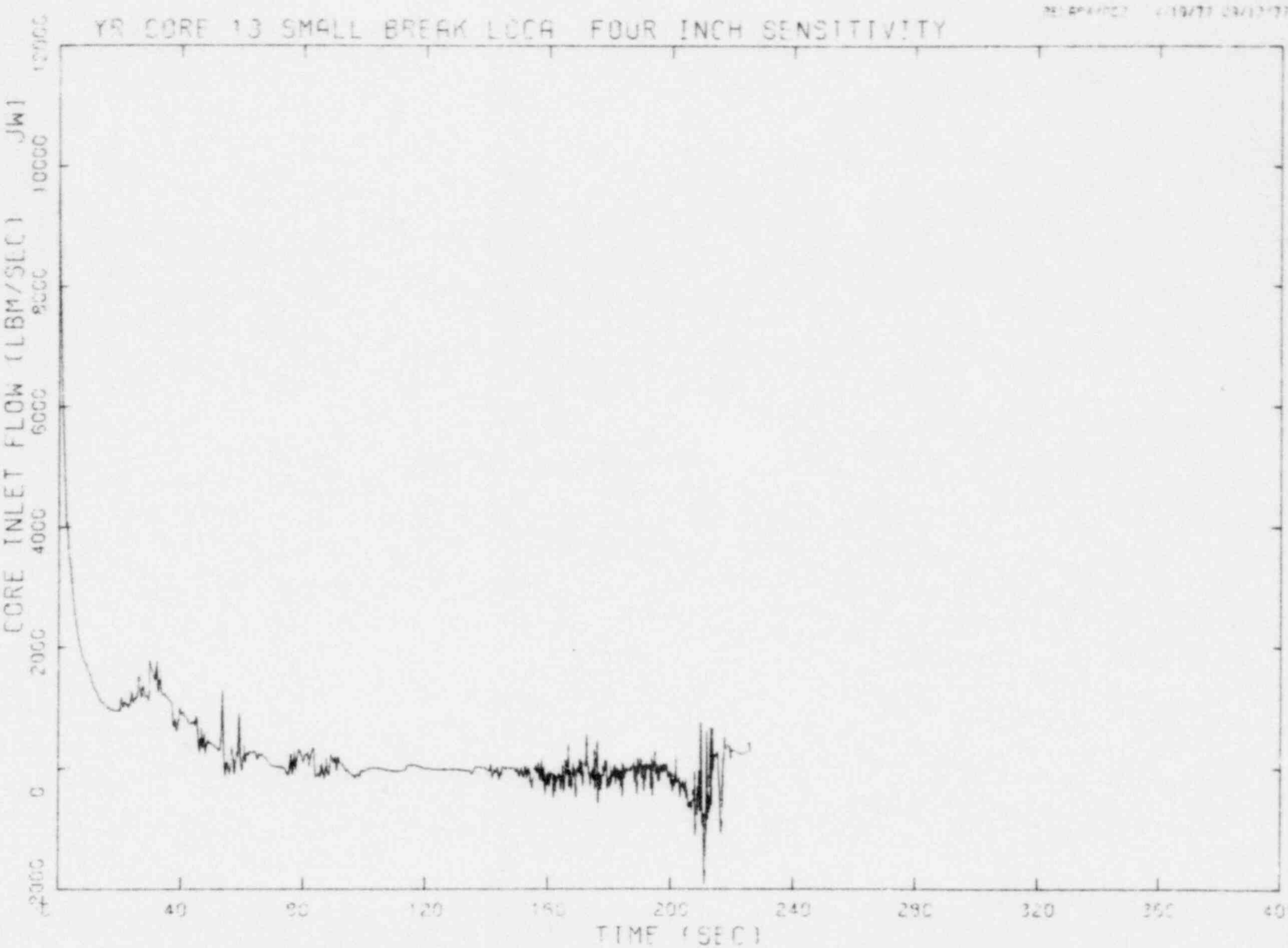


Figure 4-6.3
Inlet Flow vs.Time for 4.00 Inch
ID Small Break

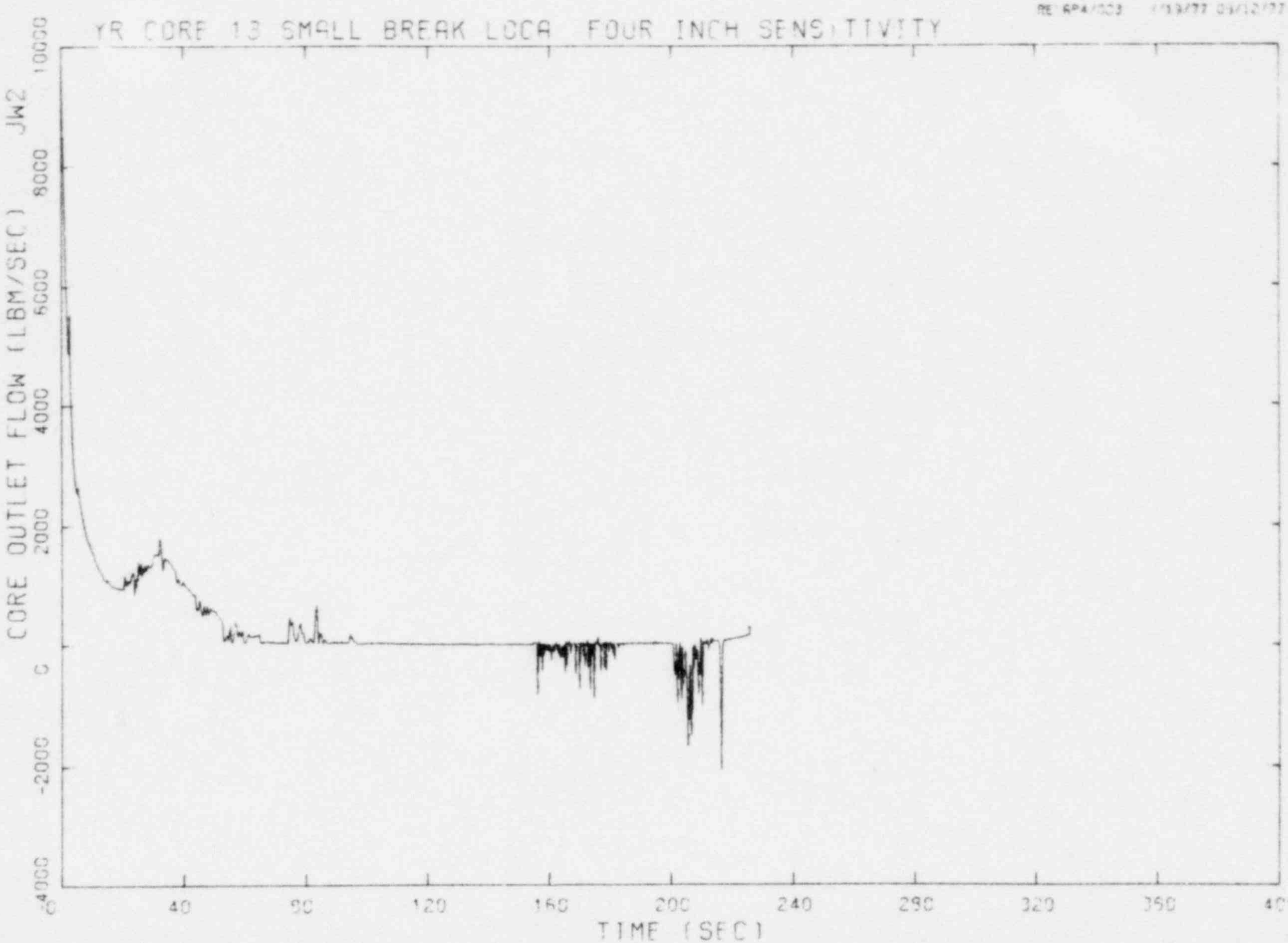


Figure 4-6.4
Core Outlet Flow vs. Time for 4.00
Inch ID Small Break

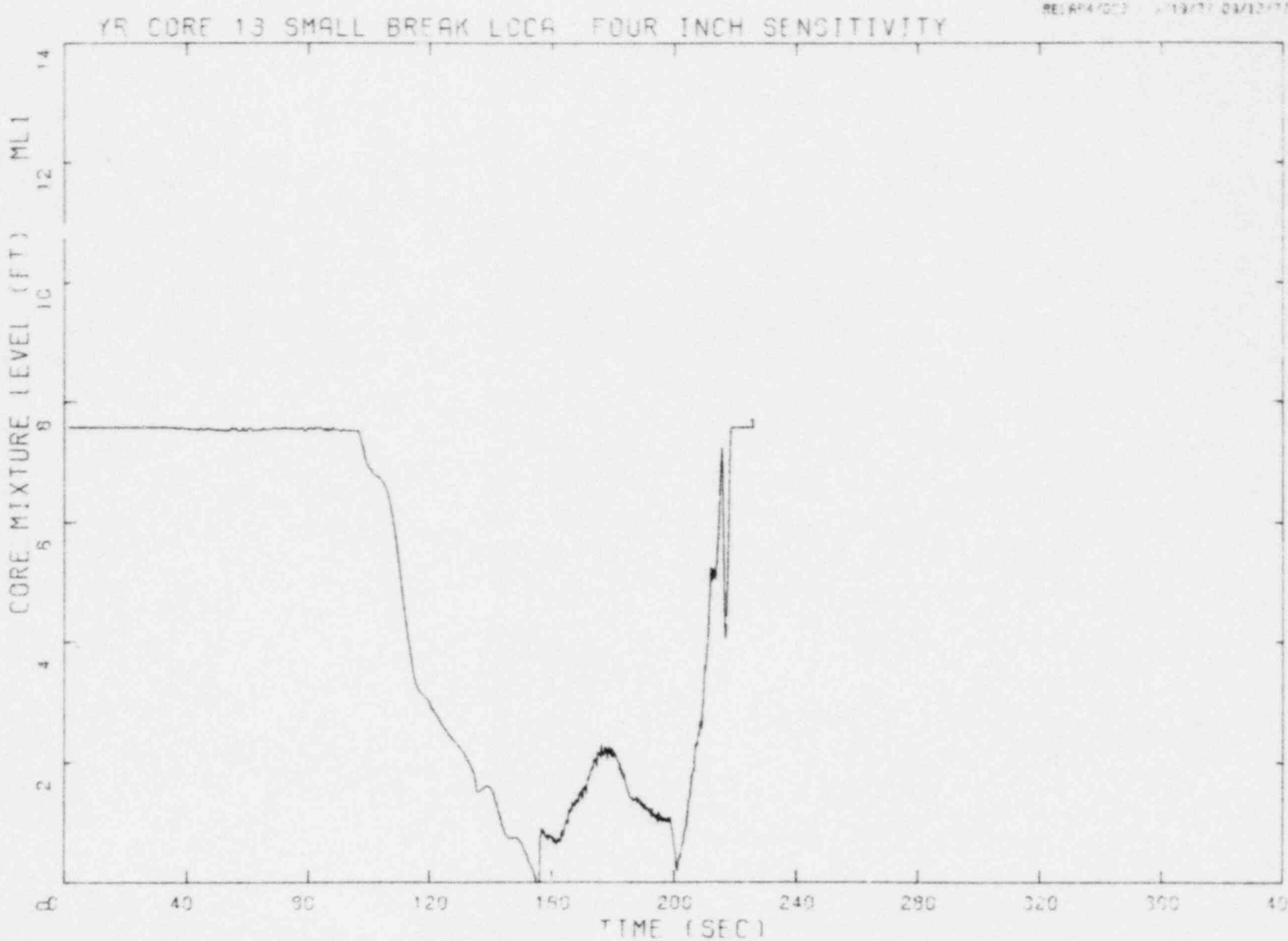


Figure 4-6.5
Core Mixture Level vs. Time for
4.00 Inch ID Small Break

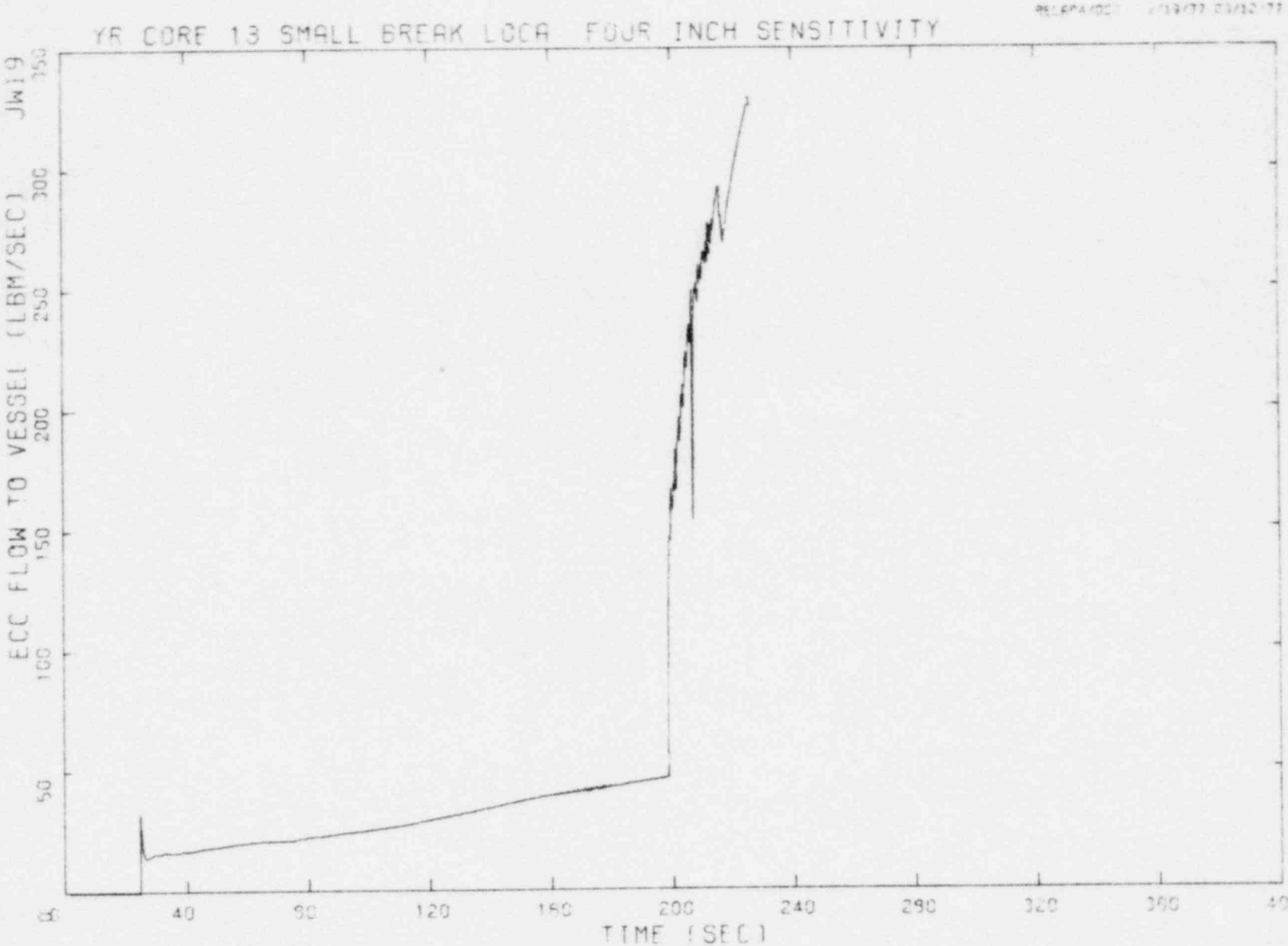


Figure 4-6.6
ECCS Flow to Core vs. Time for
4.00 Inch ID Small Break

POOR ORIGINAL

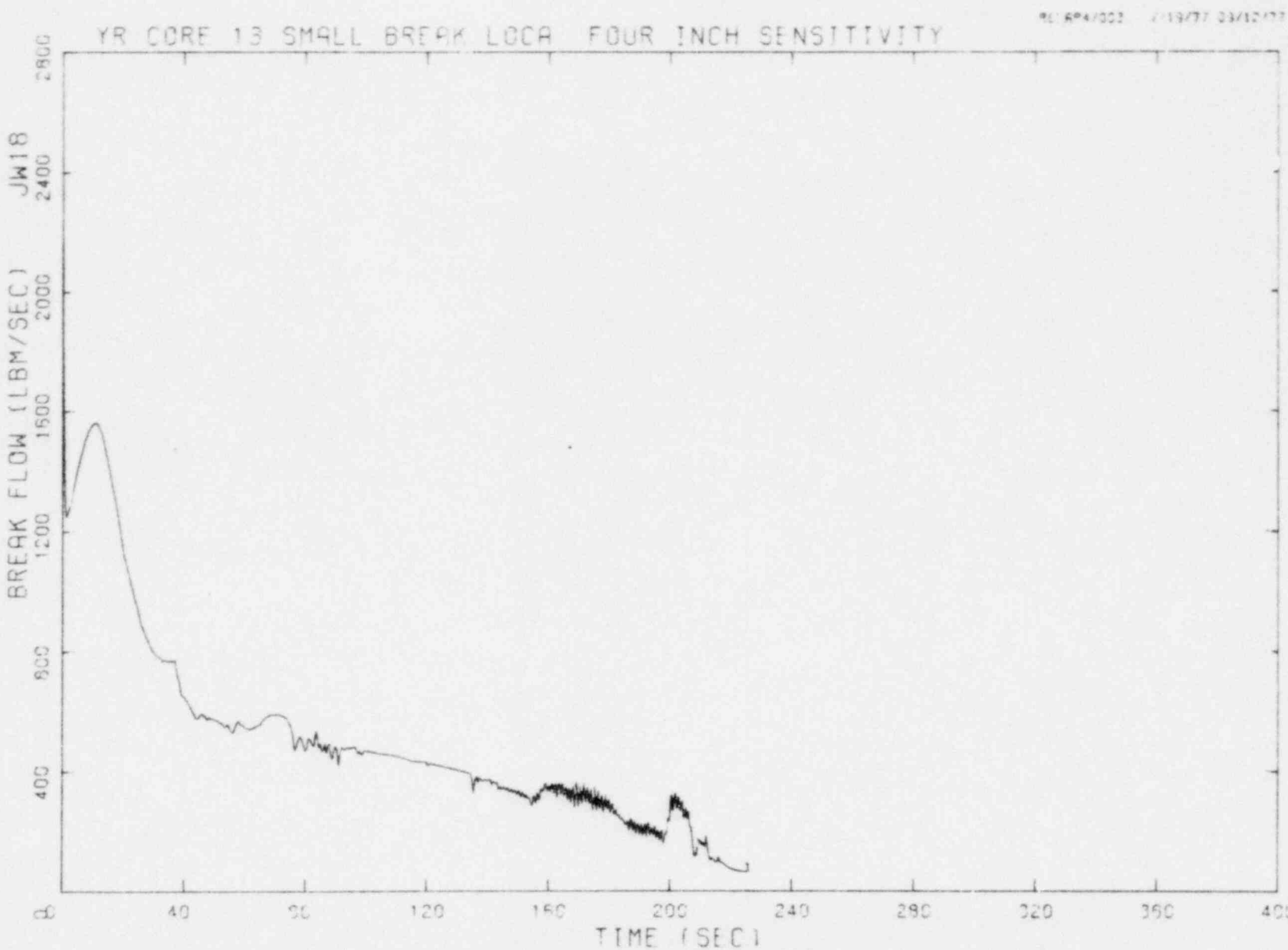


Figure 4-6.7
Cold Leg Break Flow vs. Time for
4.00 Inch ID Small Break

POOR ORIGINAL

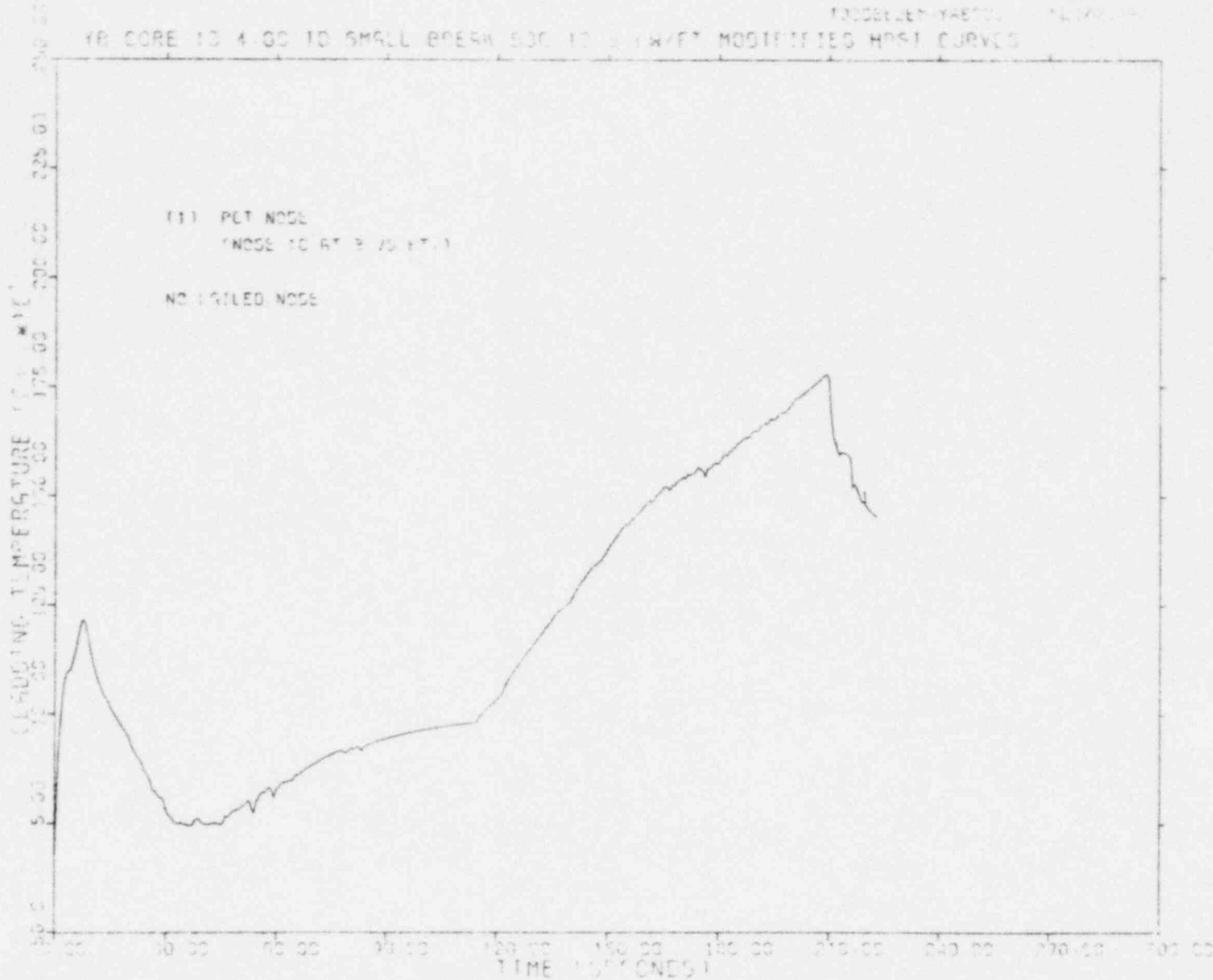


Figure 4-6.8
Peak Clad Temperature vs. Time

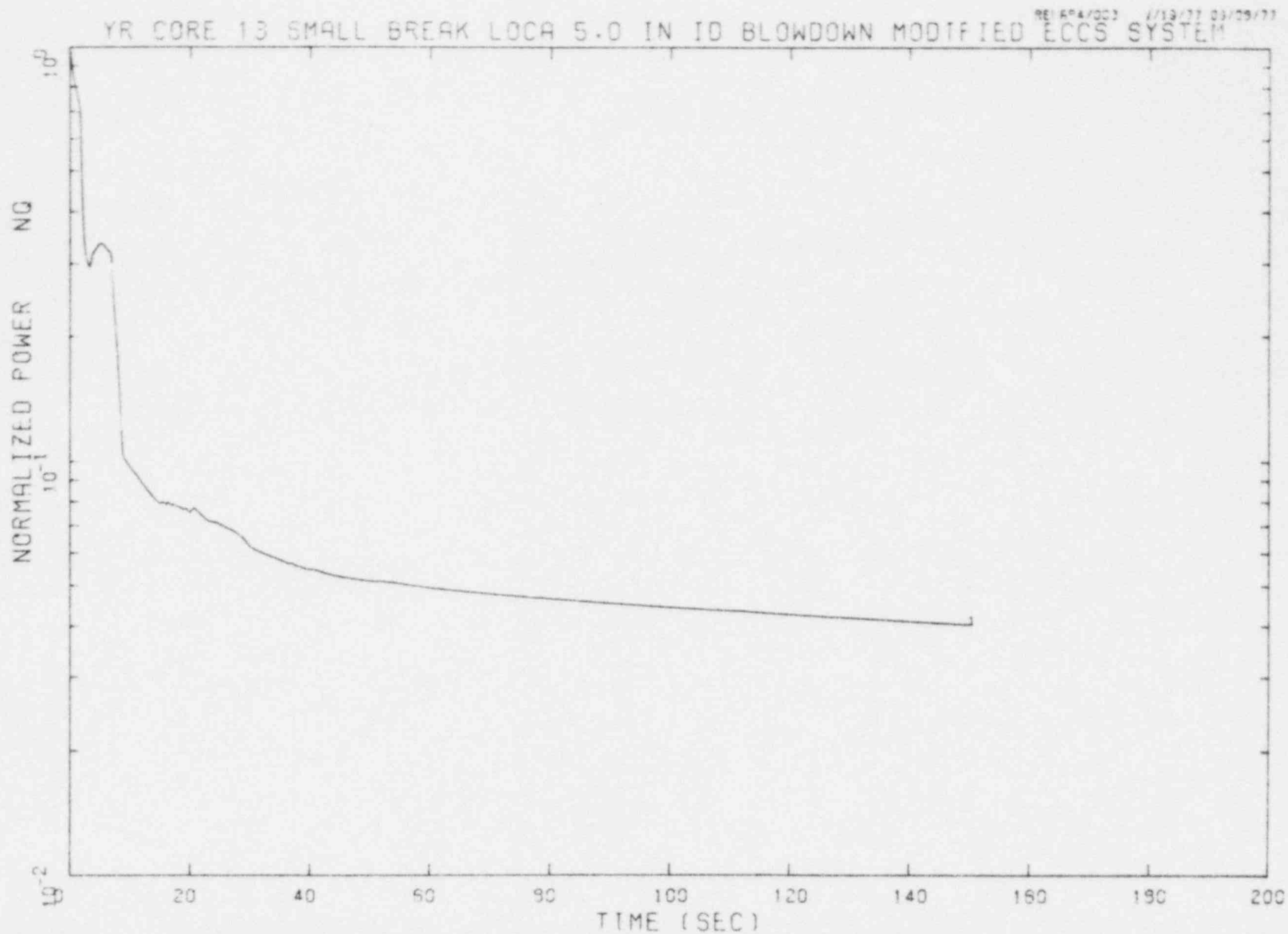


Figure 4-7.1
Normalized Power vs. Time for 5.00 Inch ID Small Break

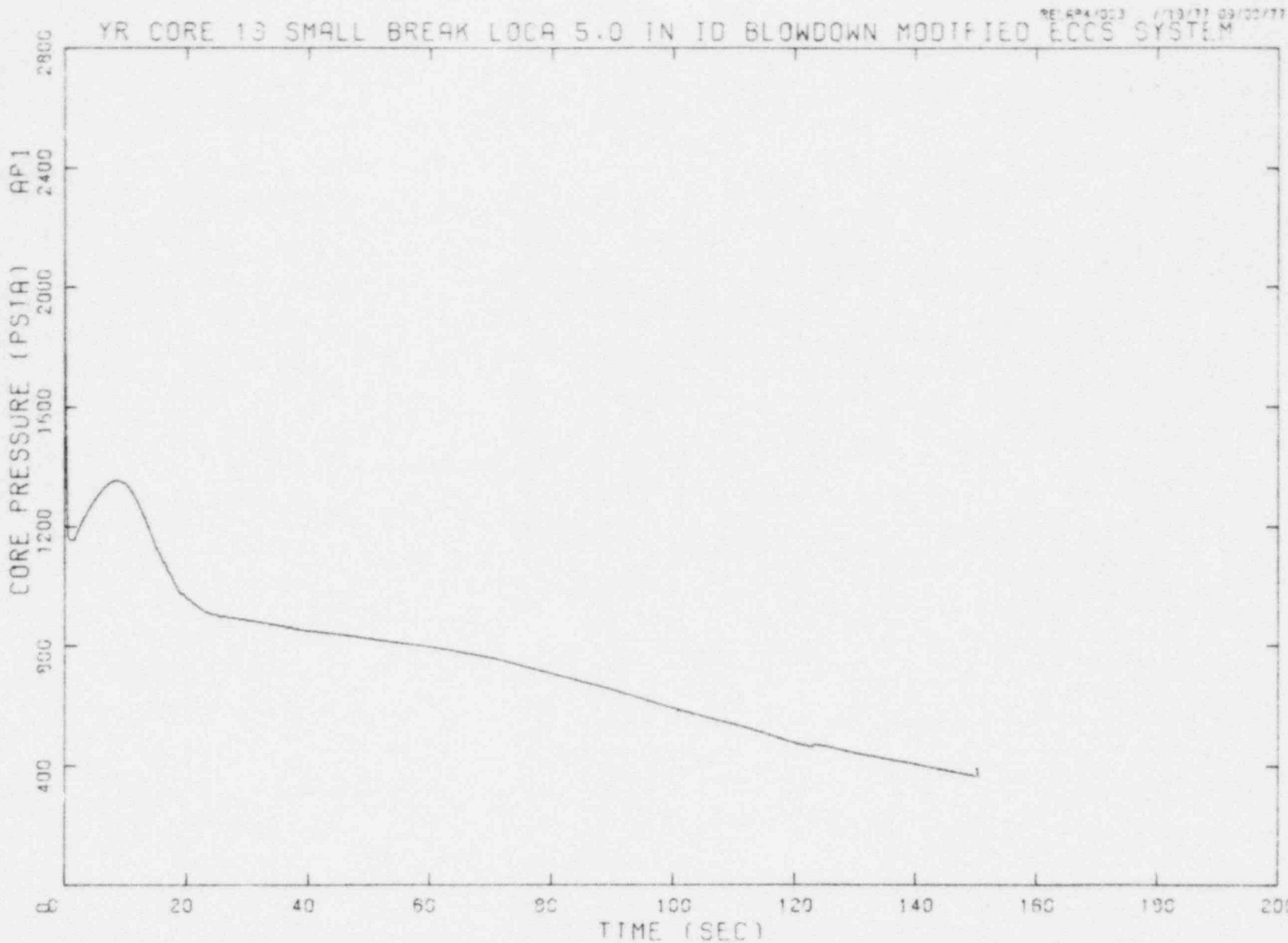


Figure 4-7.2
Core Pressure vs. Time for 5.00
Inch ID Small Break

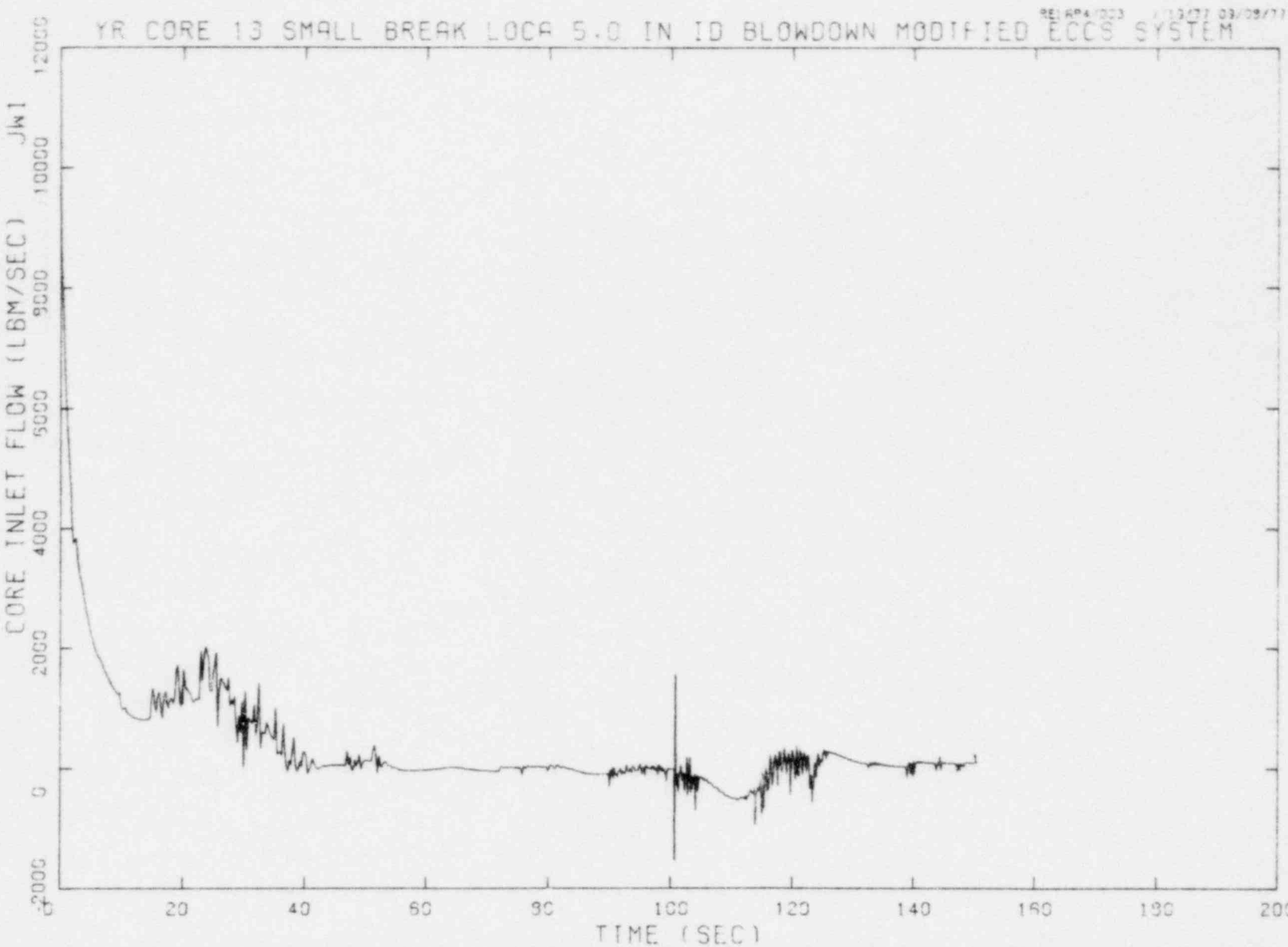


Figure 4-7.3
Inlet Flow vs. Time for 5.00 Inch
ID Small Break

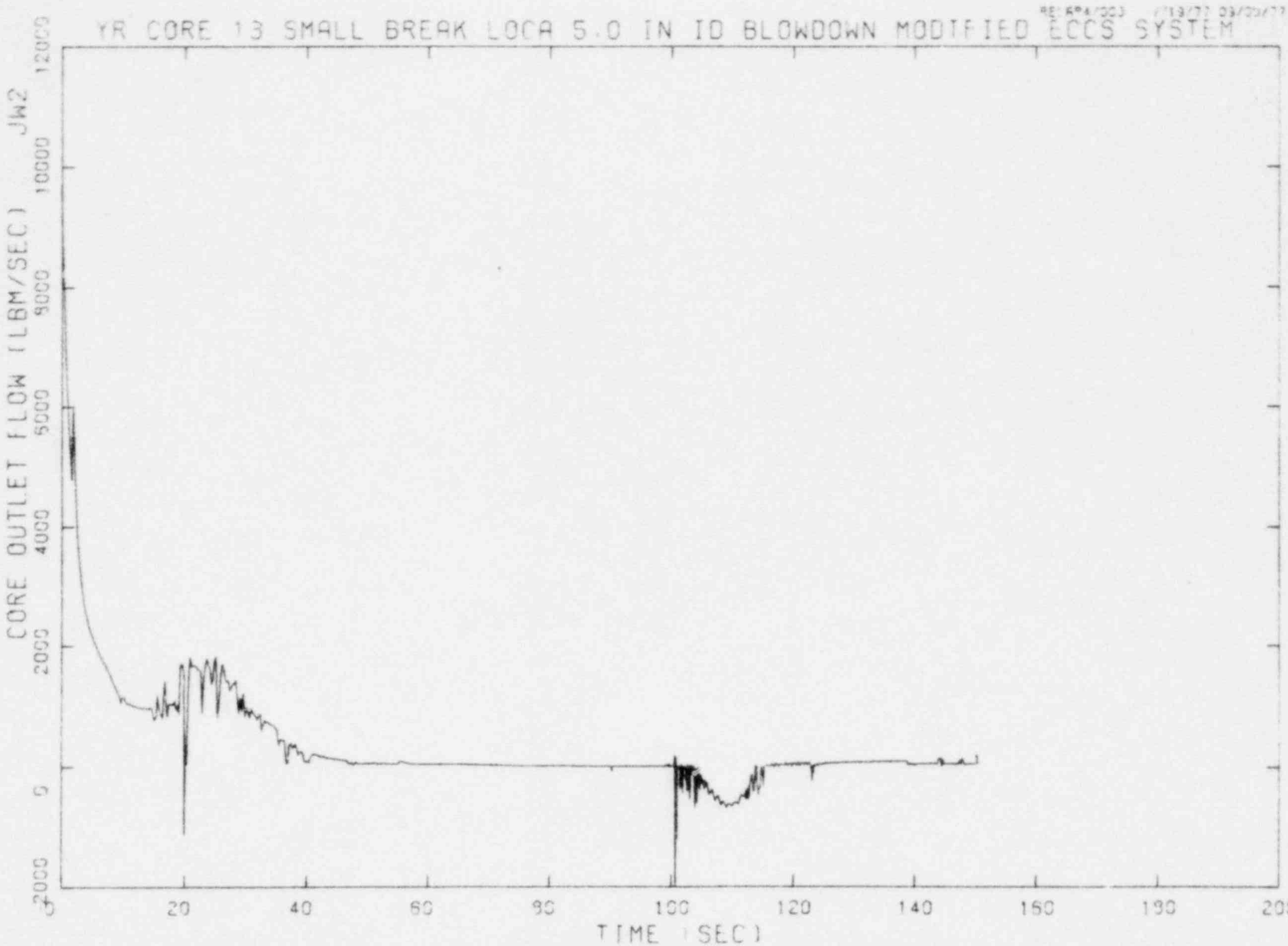


Figure 4-7.4
Core Outlet Flow vs. Time for 5.00
Inch ID Small Break

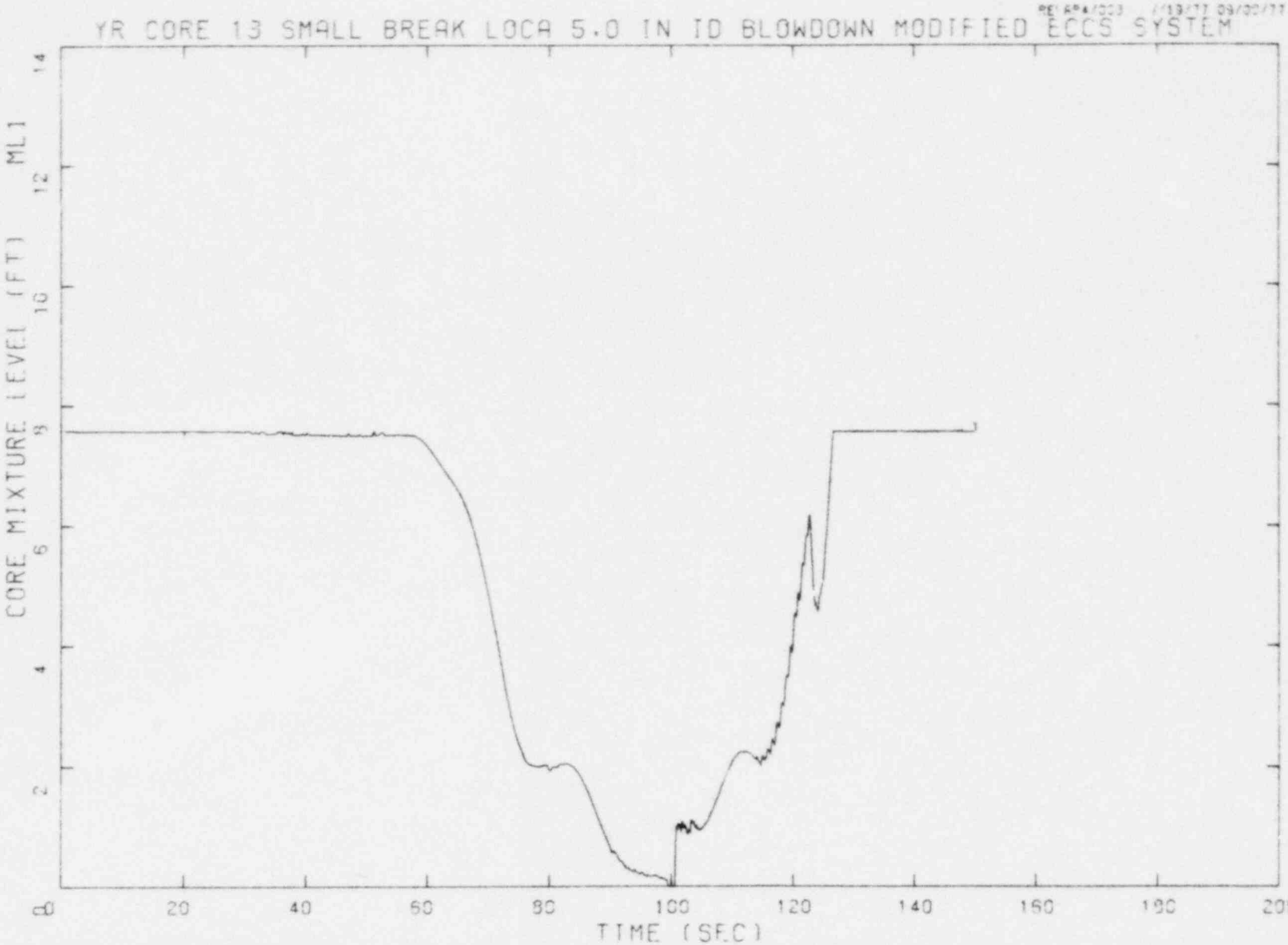


Figure 4-7.5
Core Mixture Level vs. Time for
5.00 Inch ID Small Break

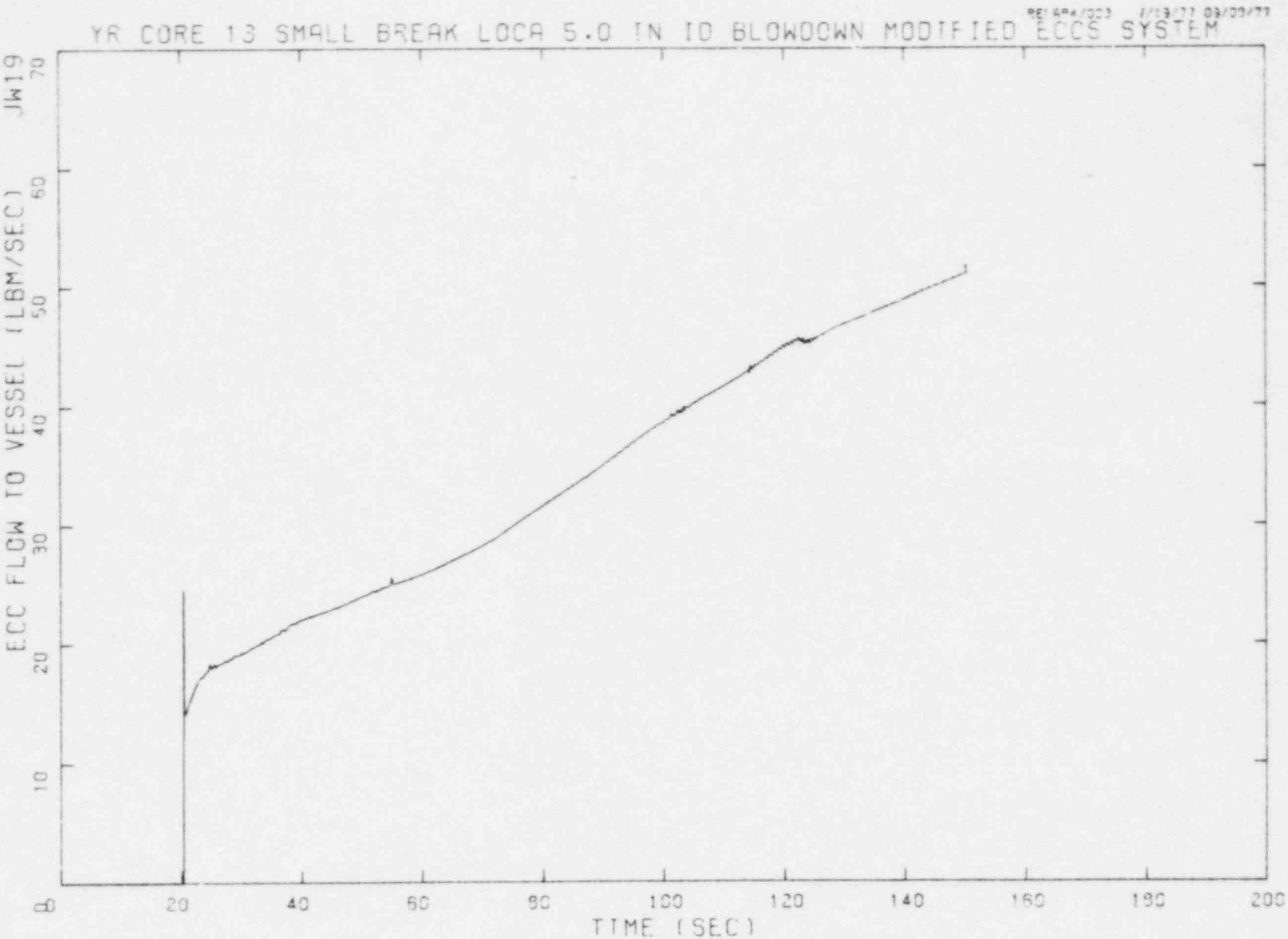


Figure 4-7.6
ECCS Flow to Core vs. Time for
5.00 Inch ID Small Break

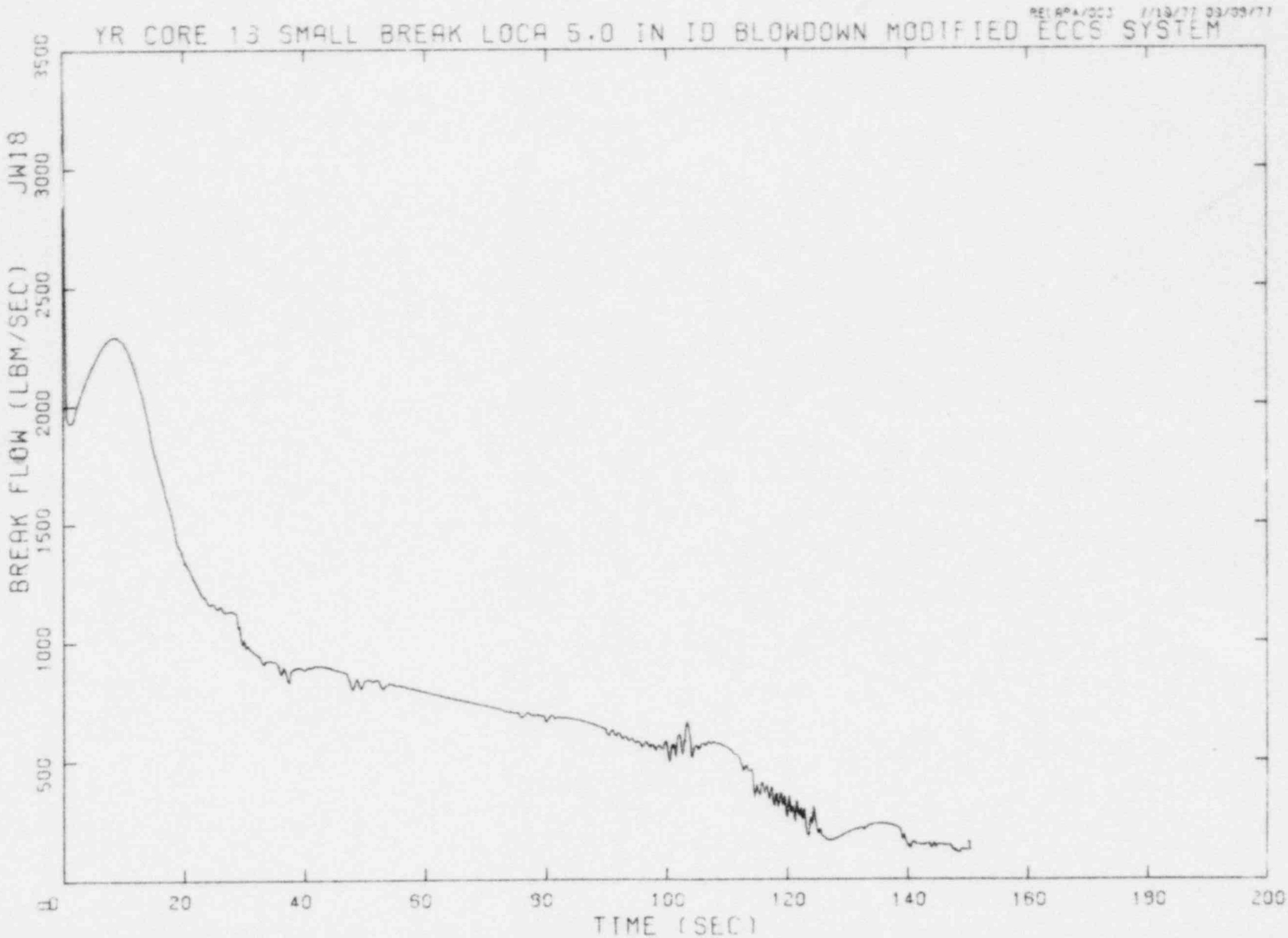


Figure 4-7.7
Cold Leg Break Flow vs. Time for
5.00 Inch ID Small Break

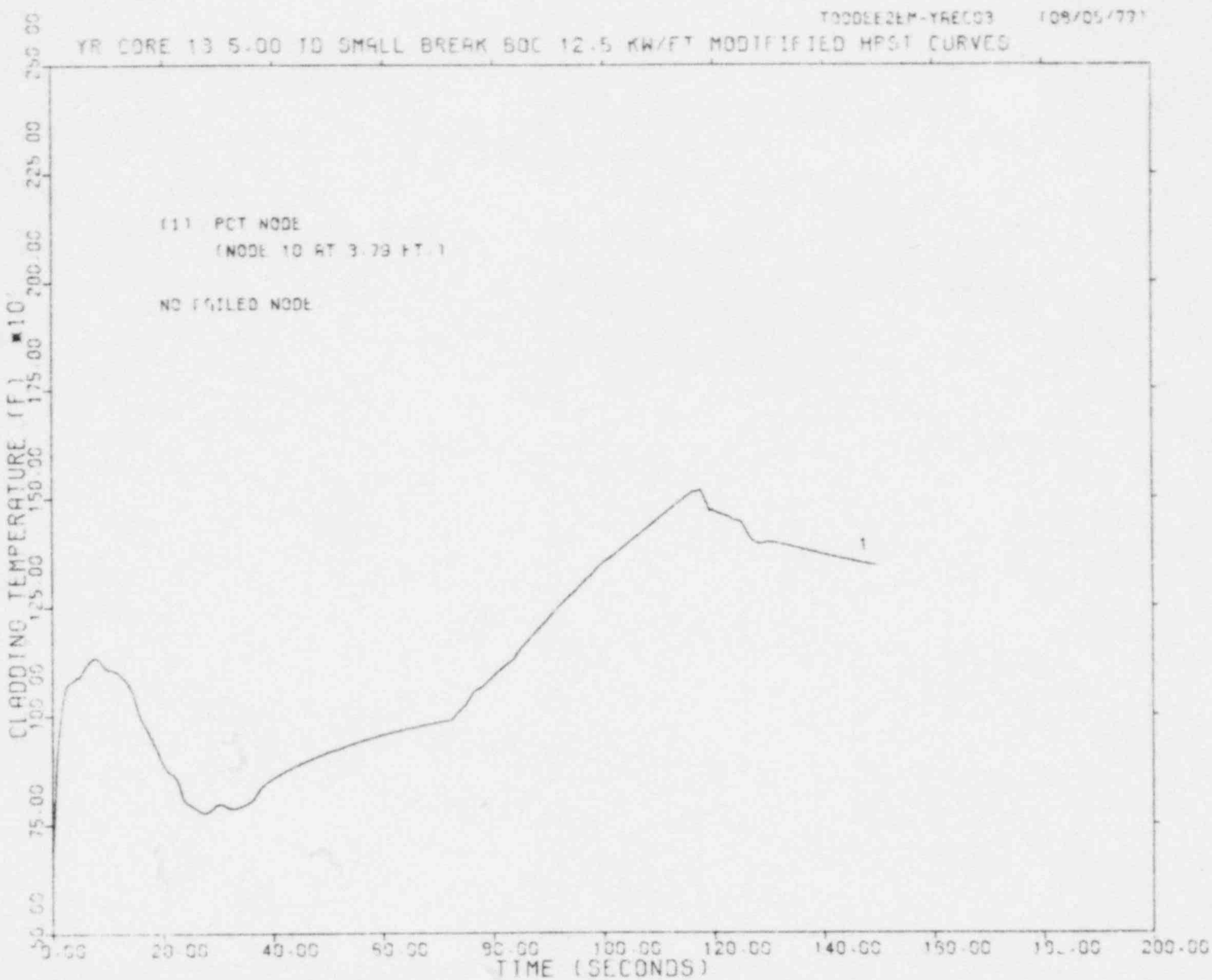


Figure 4-7.8
Peak Clad Temperature vs. Time for
5.00 Inch ID Small Brak

POOR ORIGINAL

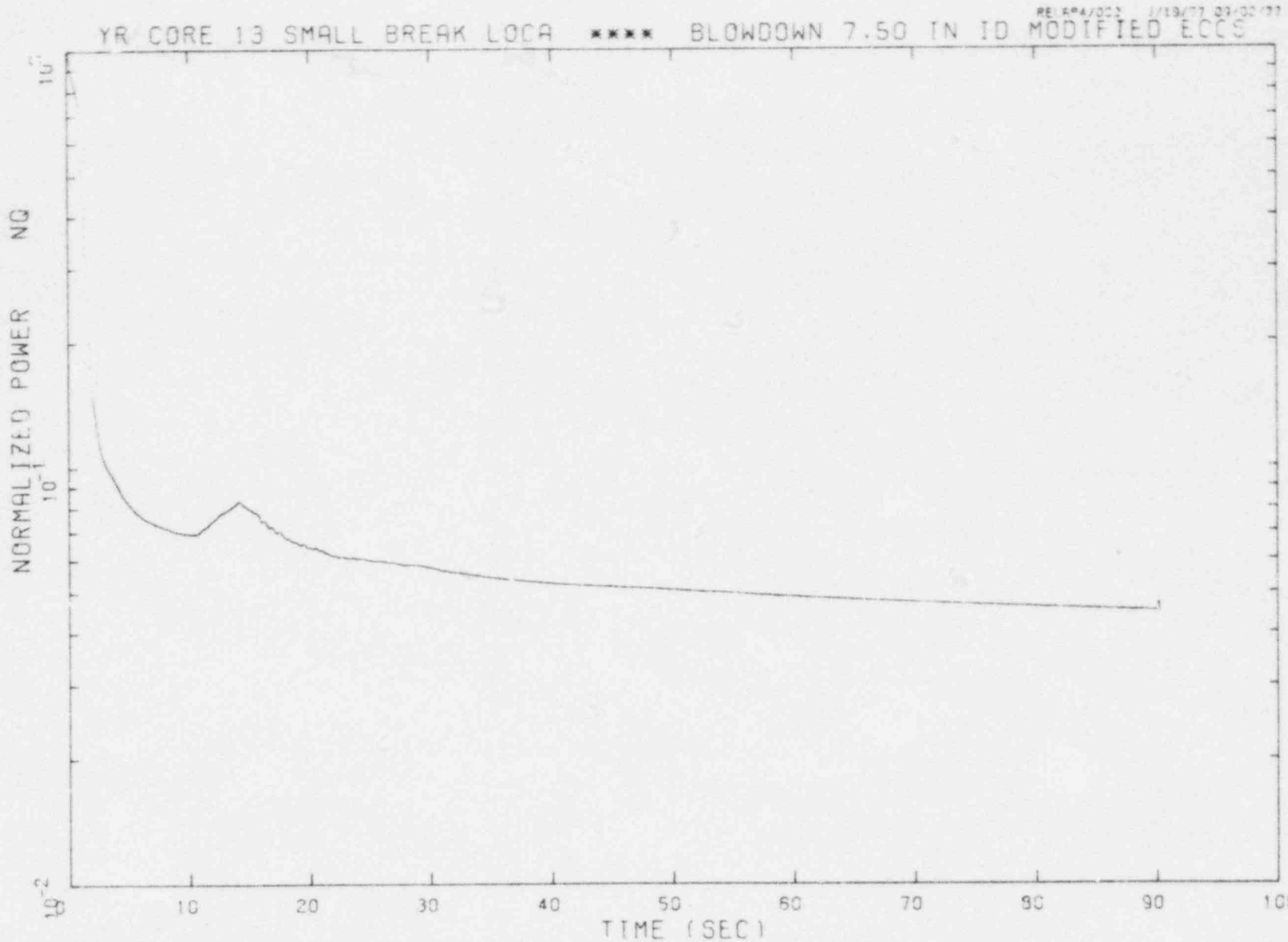


Figure 4-8.1
Normalized Power vs. Time for 7.50 Inch ID Small Break

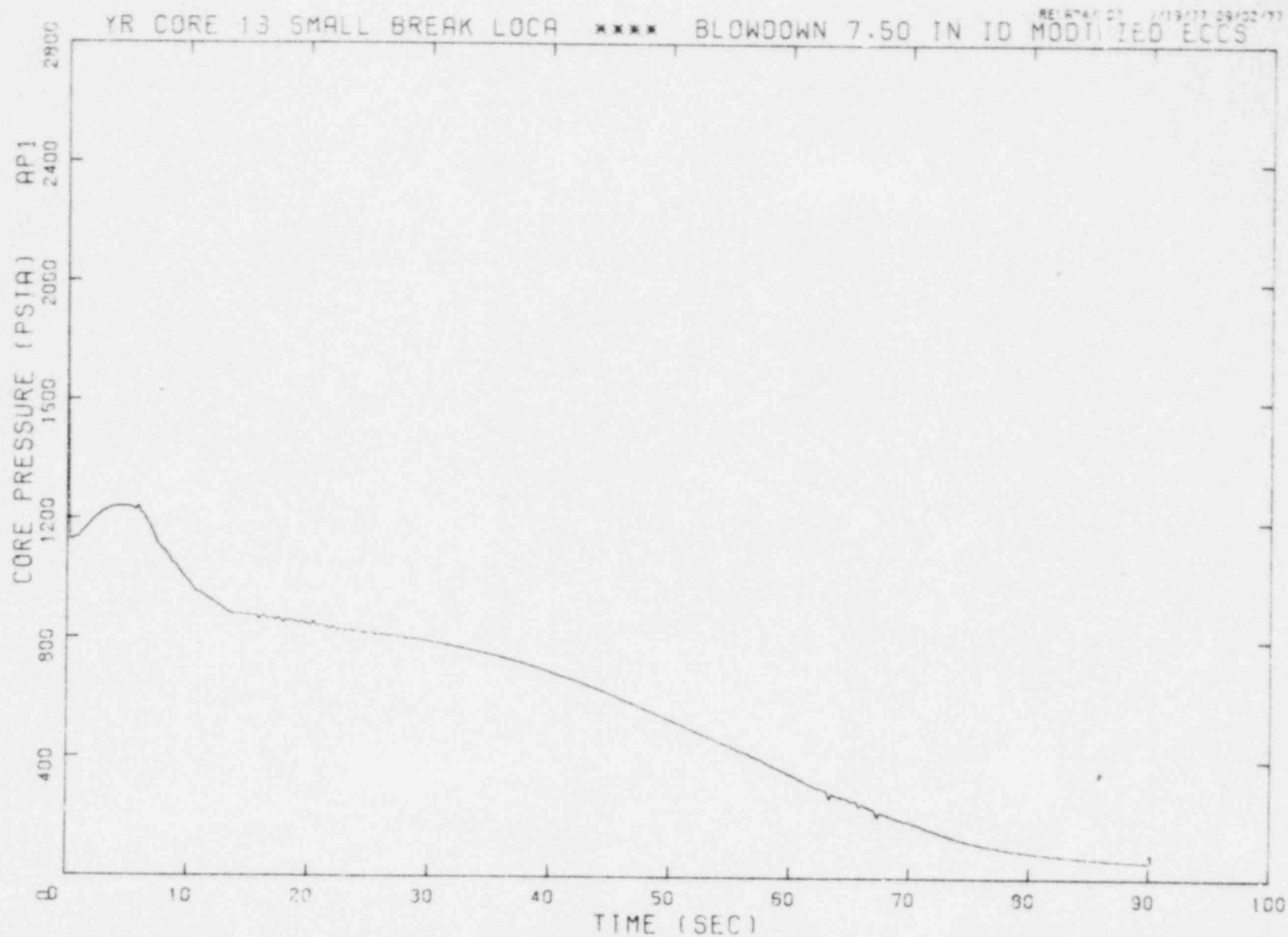


Figure 4-8.2
Core Pressure vs. Time for 7.50
Inch ID Small Break

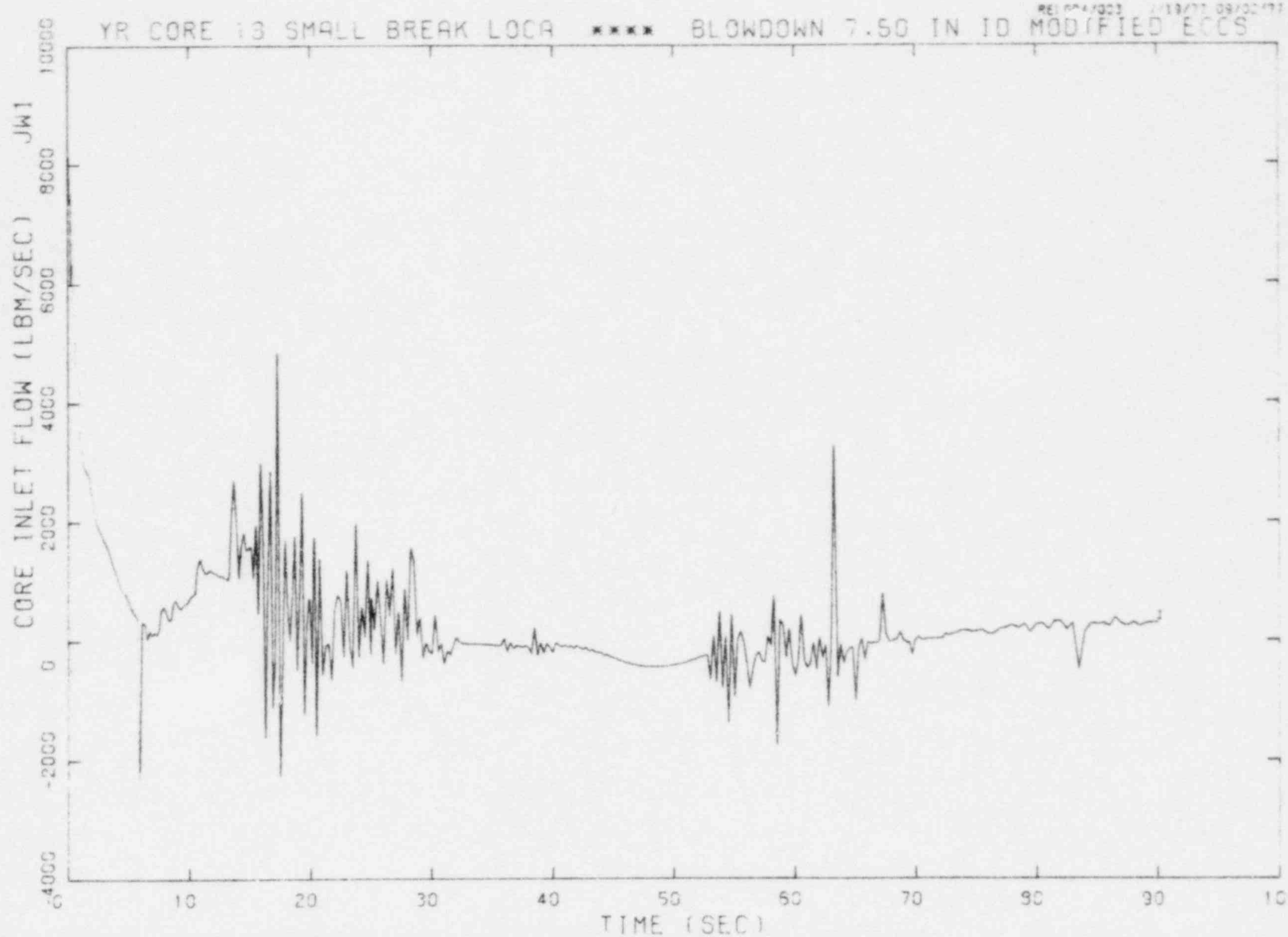


Figure 4-8.3
Inlet Flow vs. Time for 7.50 Inch
ID Small Break

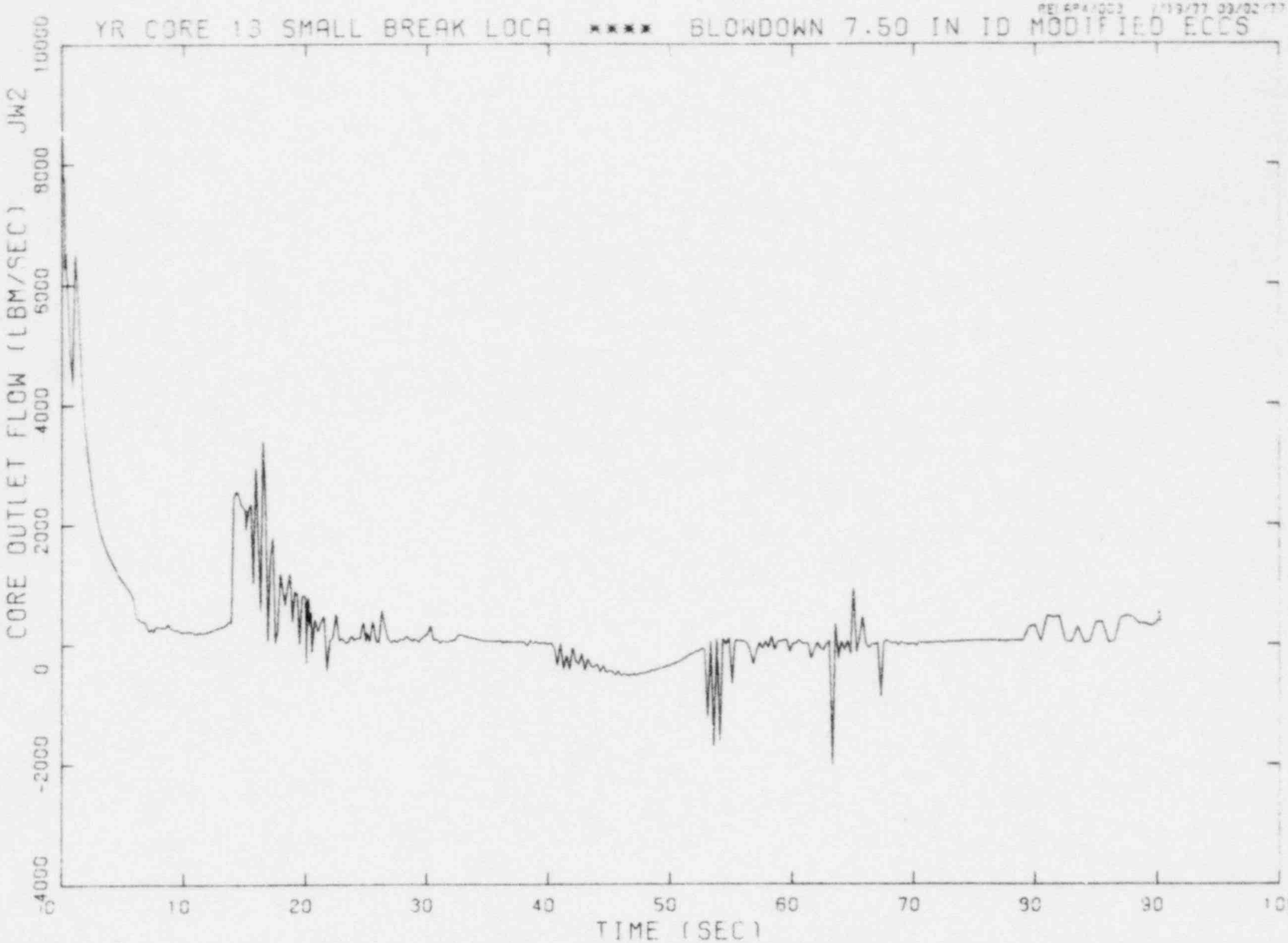


Figure 4-8.4
Core Outlet Flow vs. Time for 7.50
Inch ID Small Break

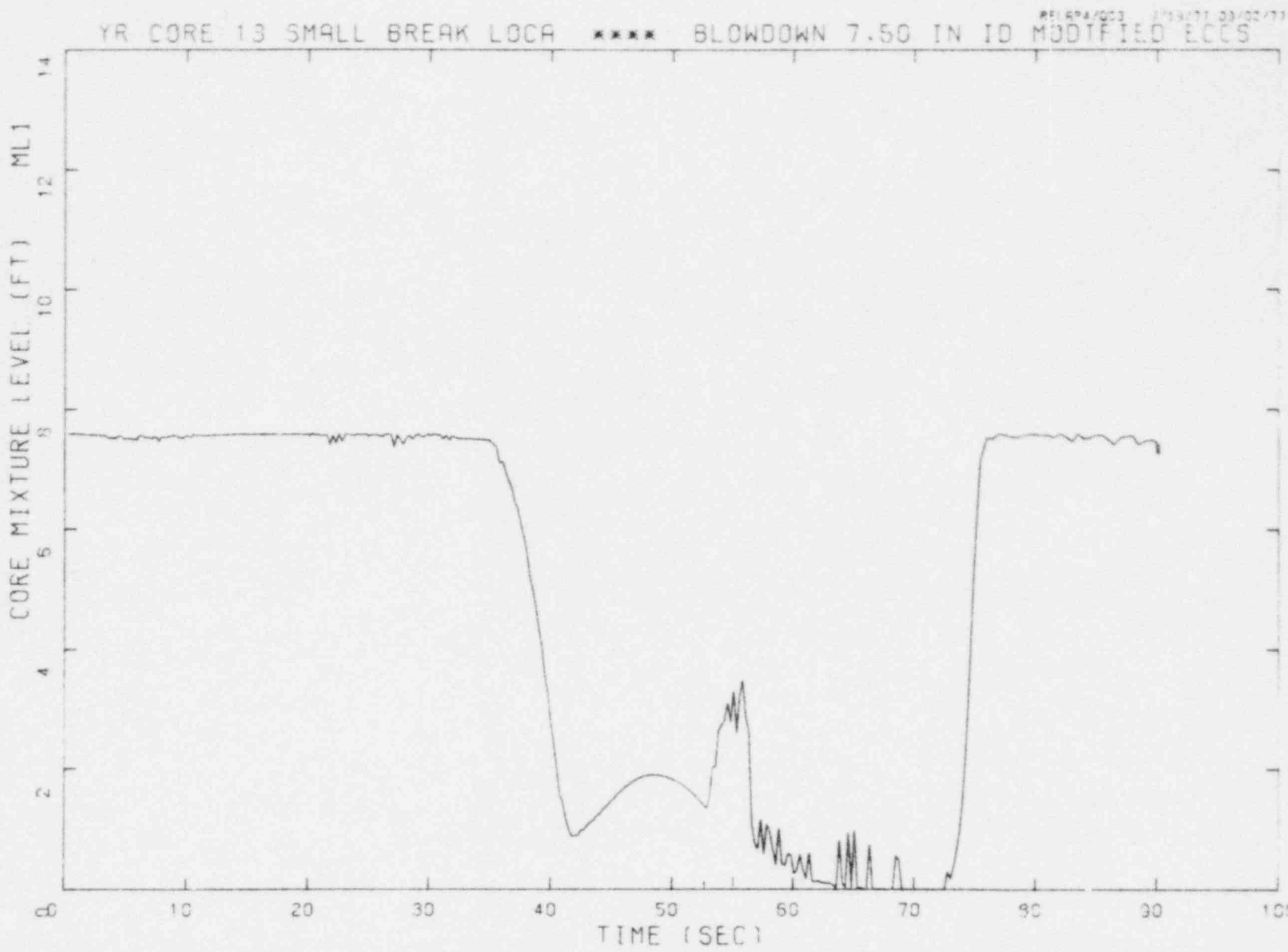


Figure 4-8.5
Core Mixture Level vs. Time for
7.50 Inch Small Break

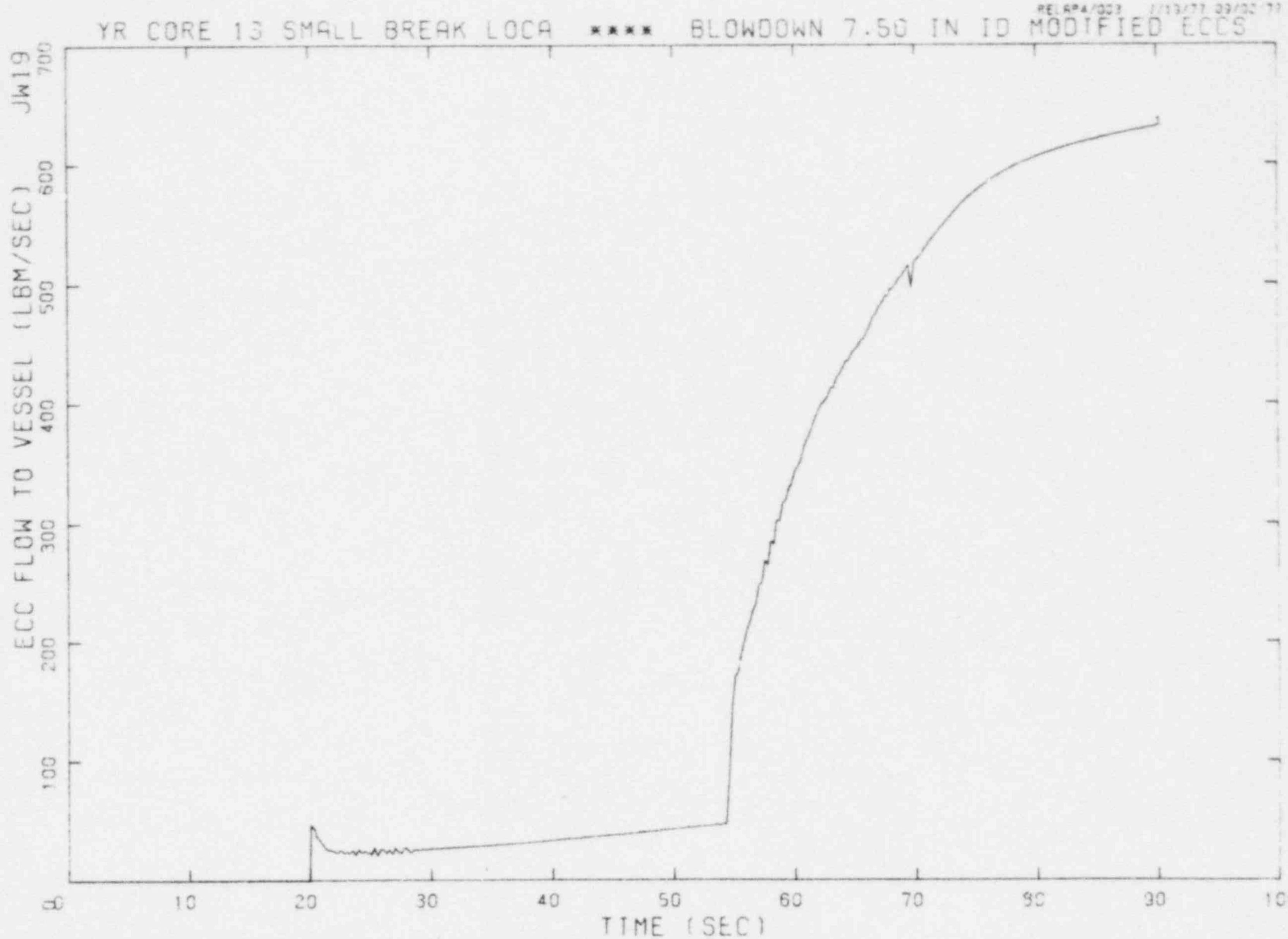


Figure 4-8.6
ECCS Flow to Core vs. Time for
7.50 Inch ID Small Break

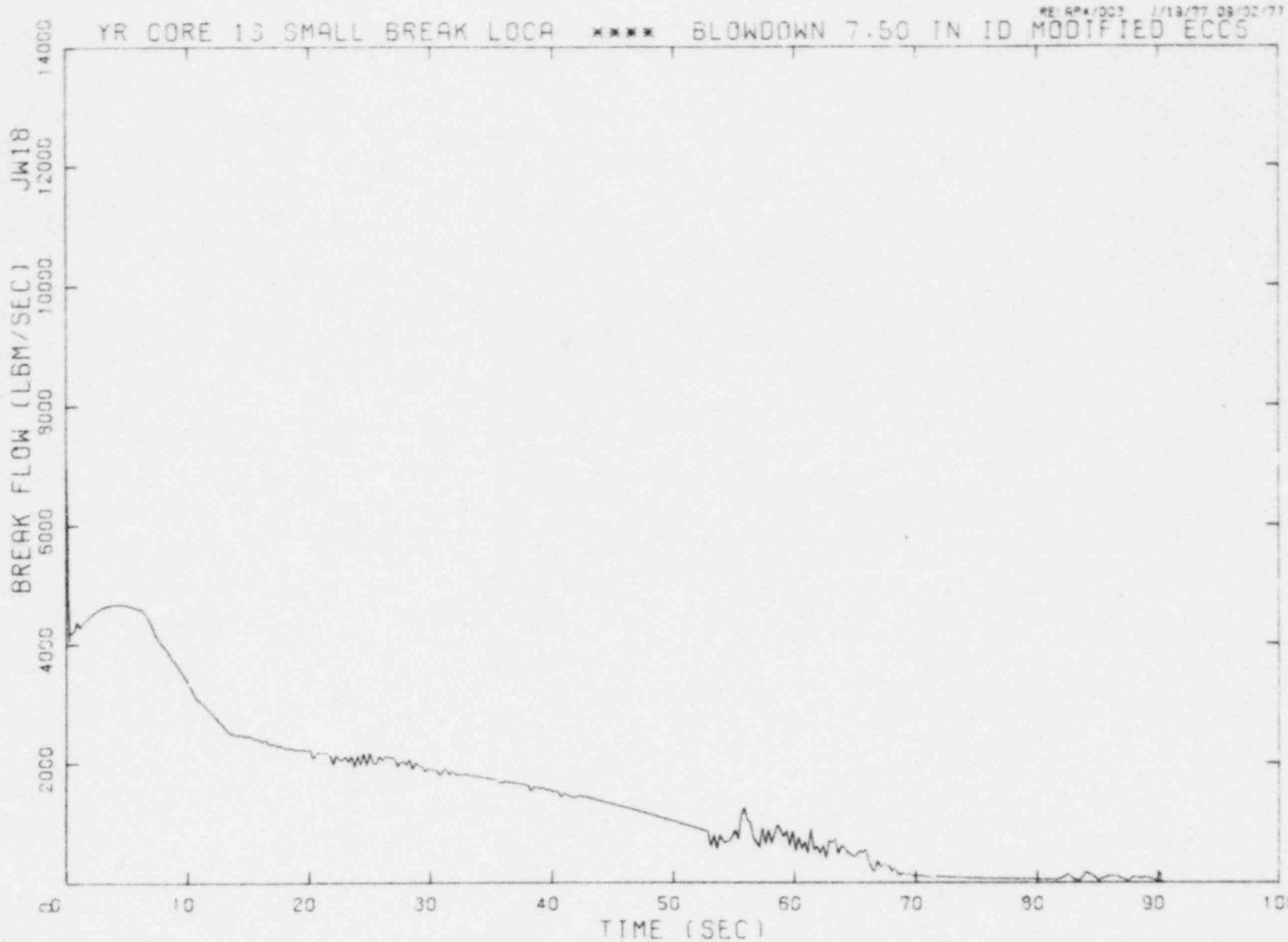
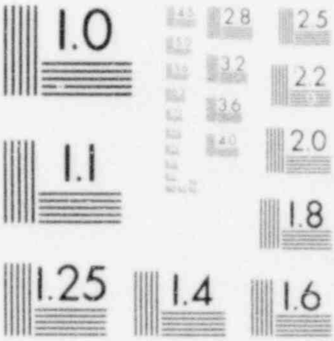


Figure 4-8.7
Cold Leg Break Flow vs. Time for
7.50 Inch ID Small Break

IMAGE EVALUATION
TEST TARGET (MT-3)



6"

MICROCOPY RESOLUTION TEST CHART

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

MICROCOPY RESOLUTION TEST CHART

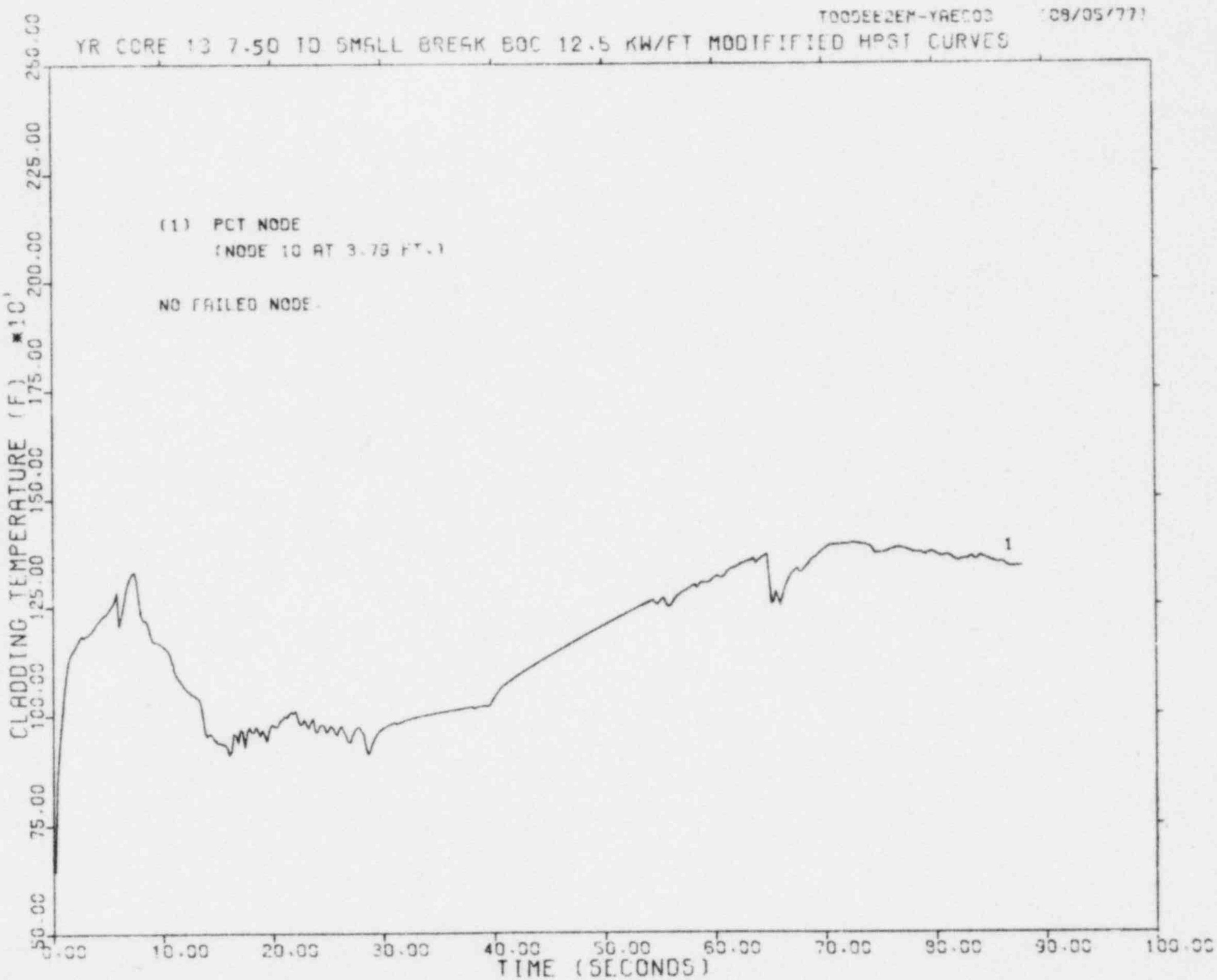


Figure 4-8.8
Peak Clad Temperature vs. Time for 7.50 Inch ID Small Break

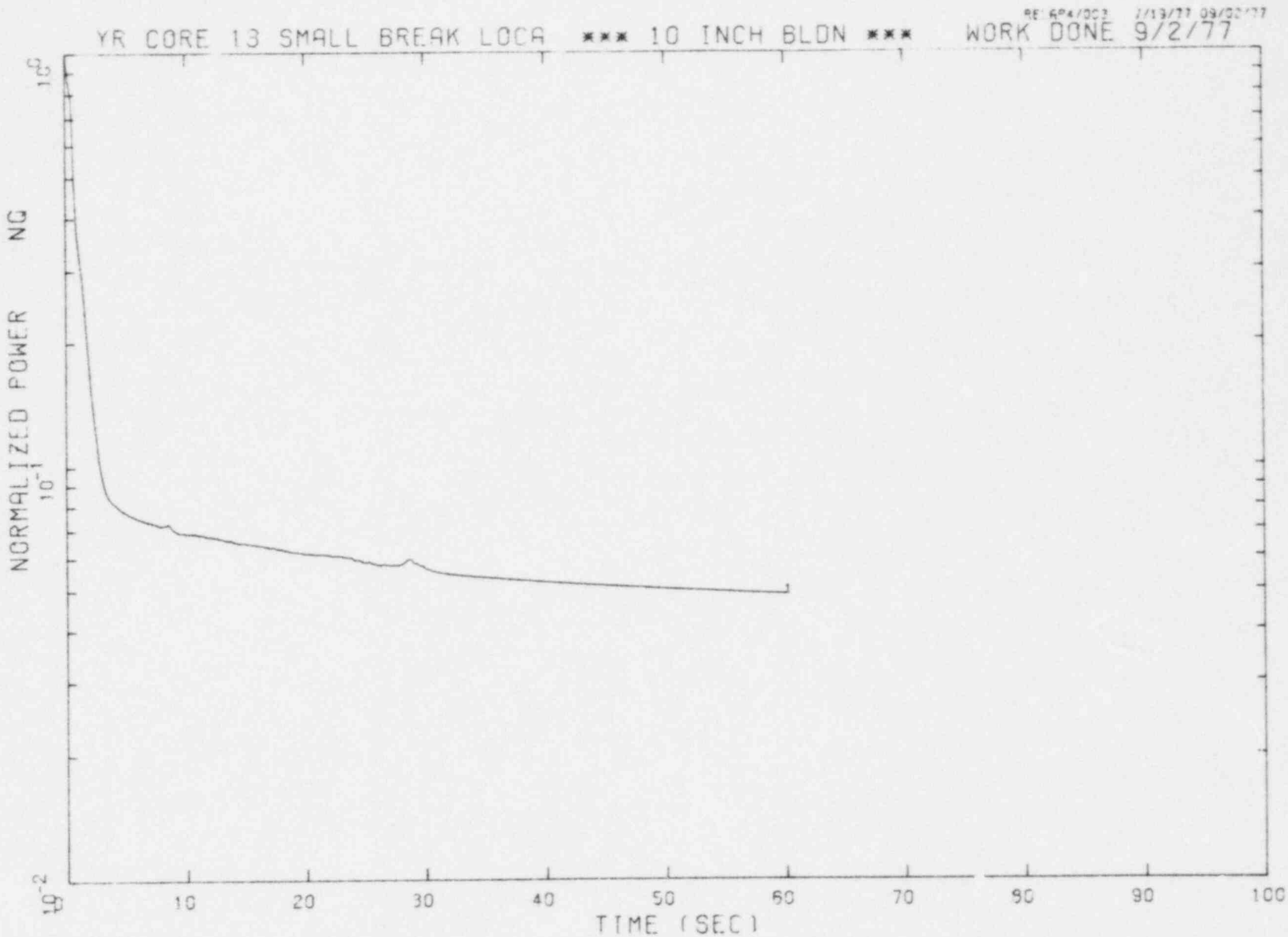


Figure 4-9.1
Normalized Power vs. Time for 10.00
Inch ID Small Break

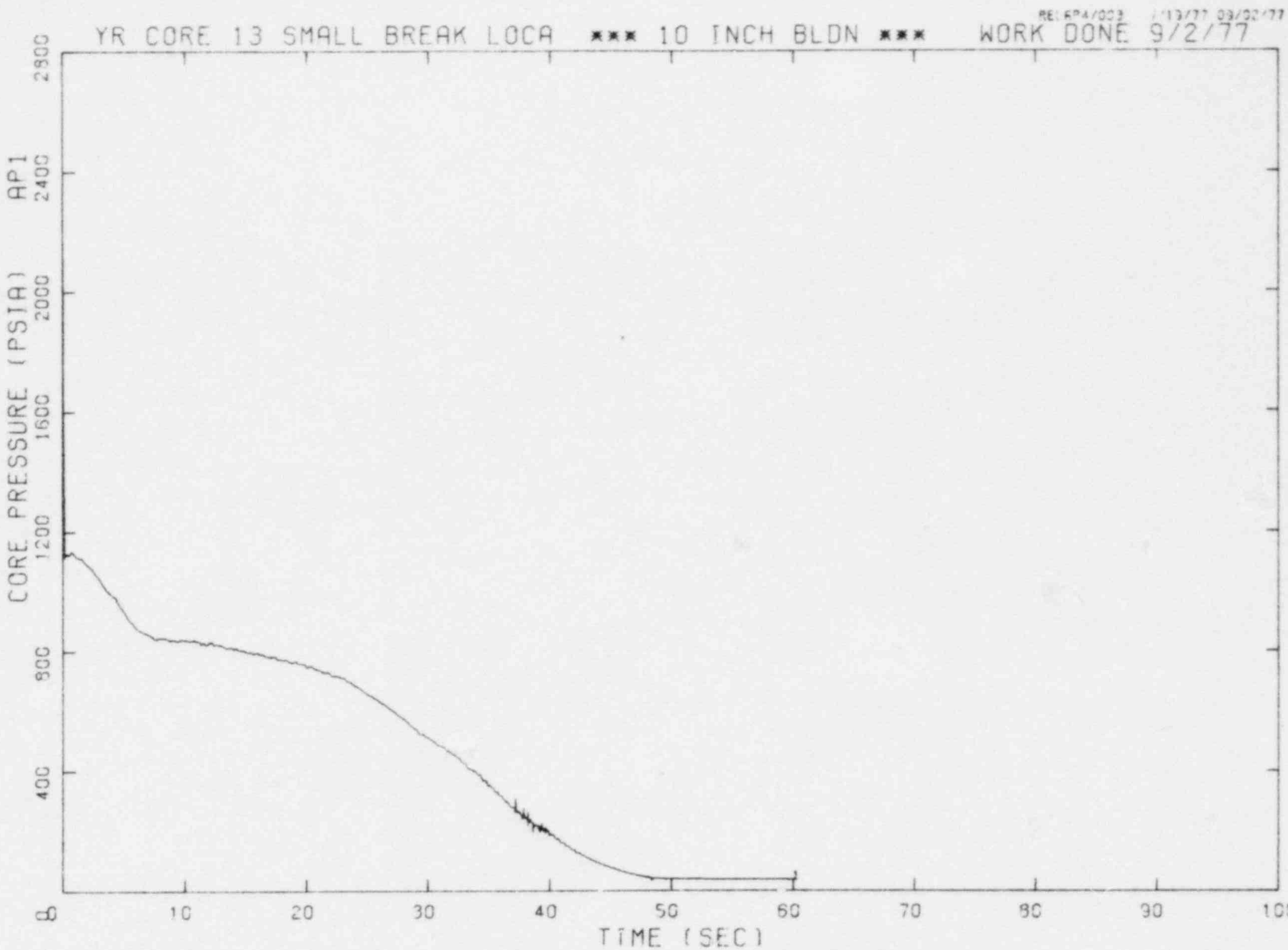


Figure 4-9.2
Core Pressure vs. Time for 10.00
Inch ID Small Break

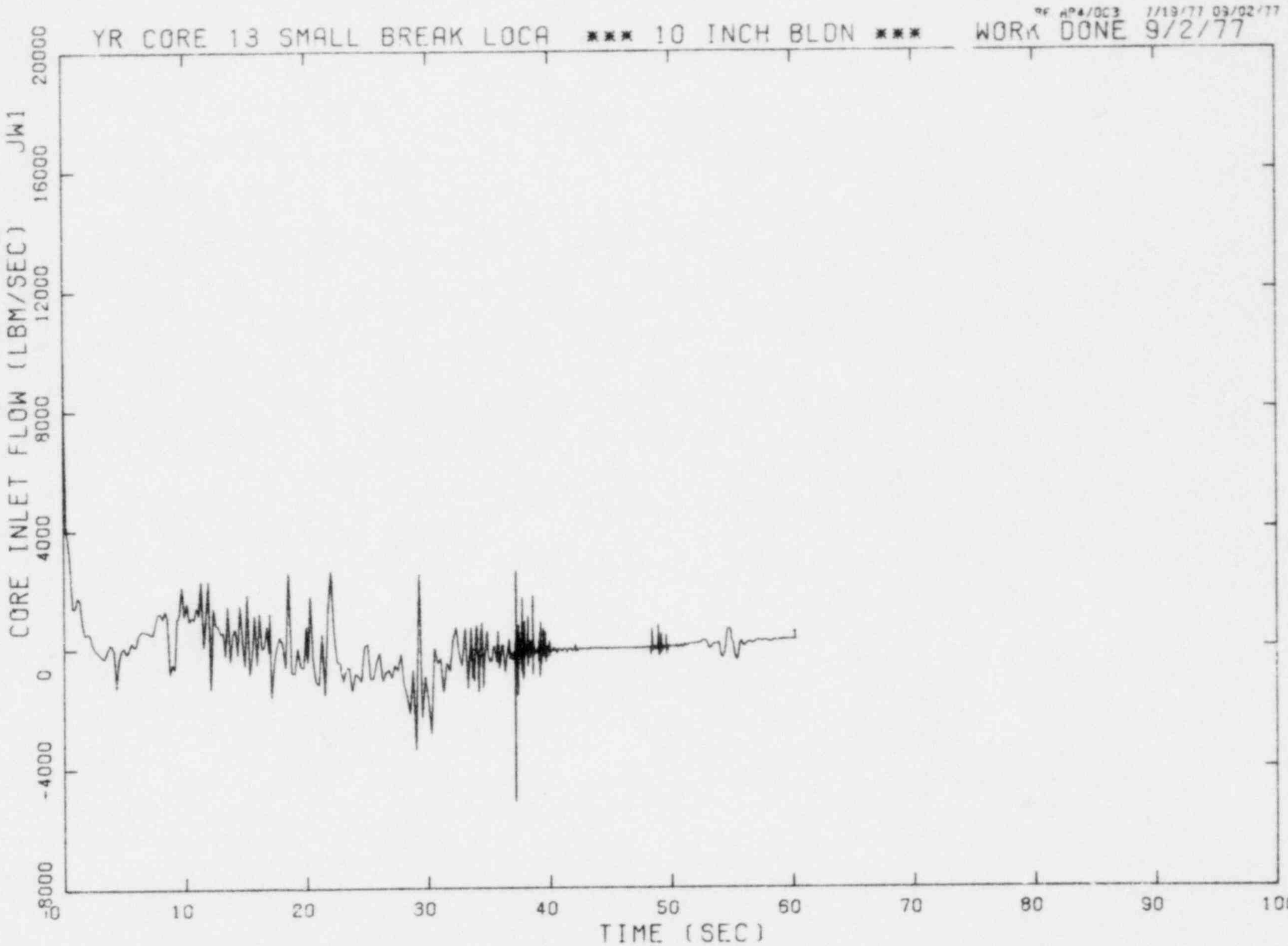


Figure 4-9.3
Inlet Flow vs. Time for 10.00 Inch
ID Small Break

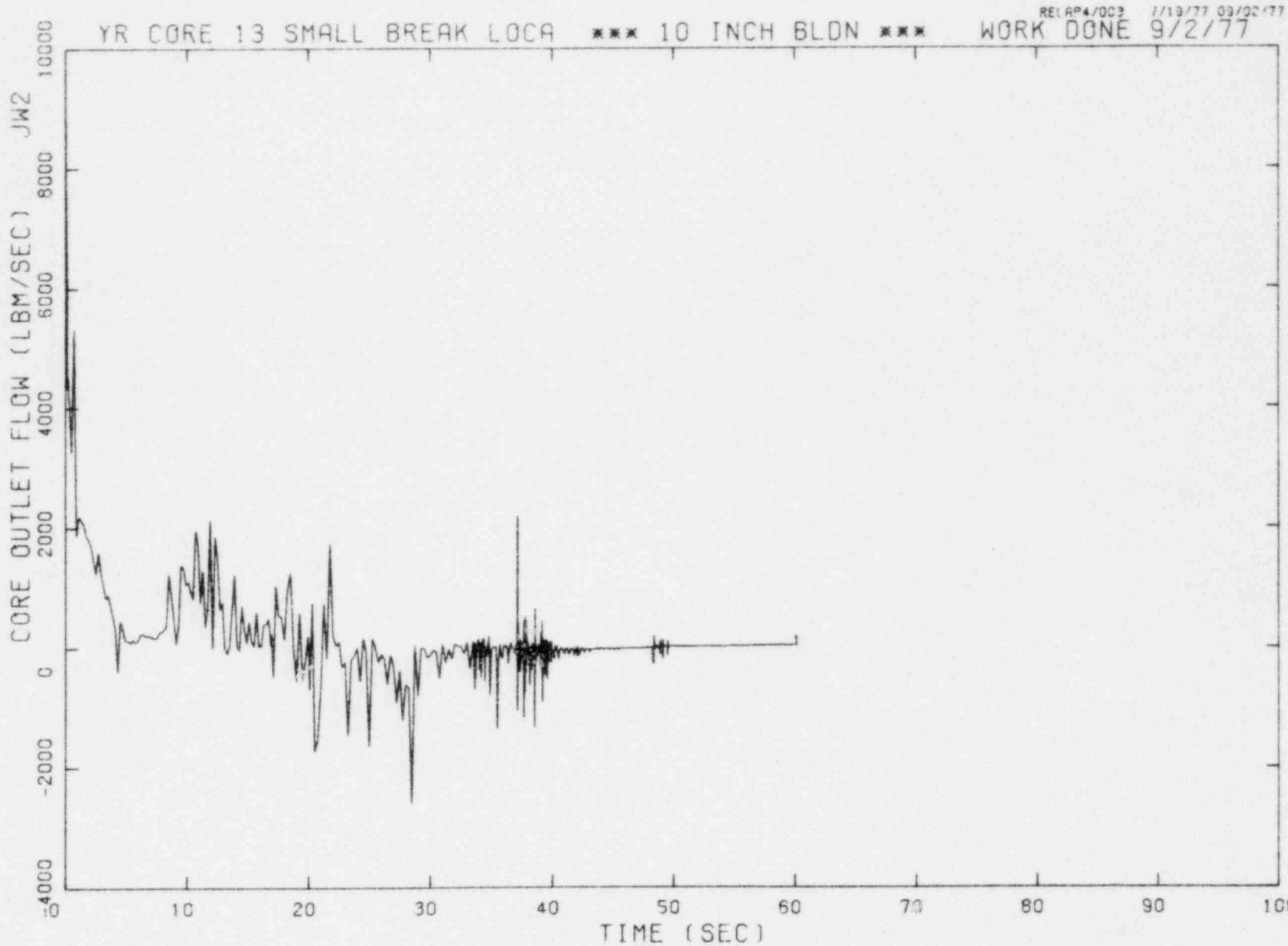


Figure 4-9.4
Core Outlet Flow vs. Time for 10.00
Inch ID Small Break

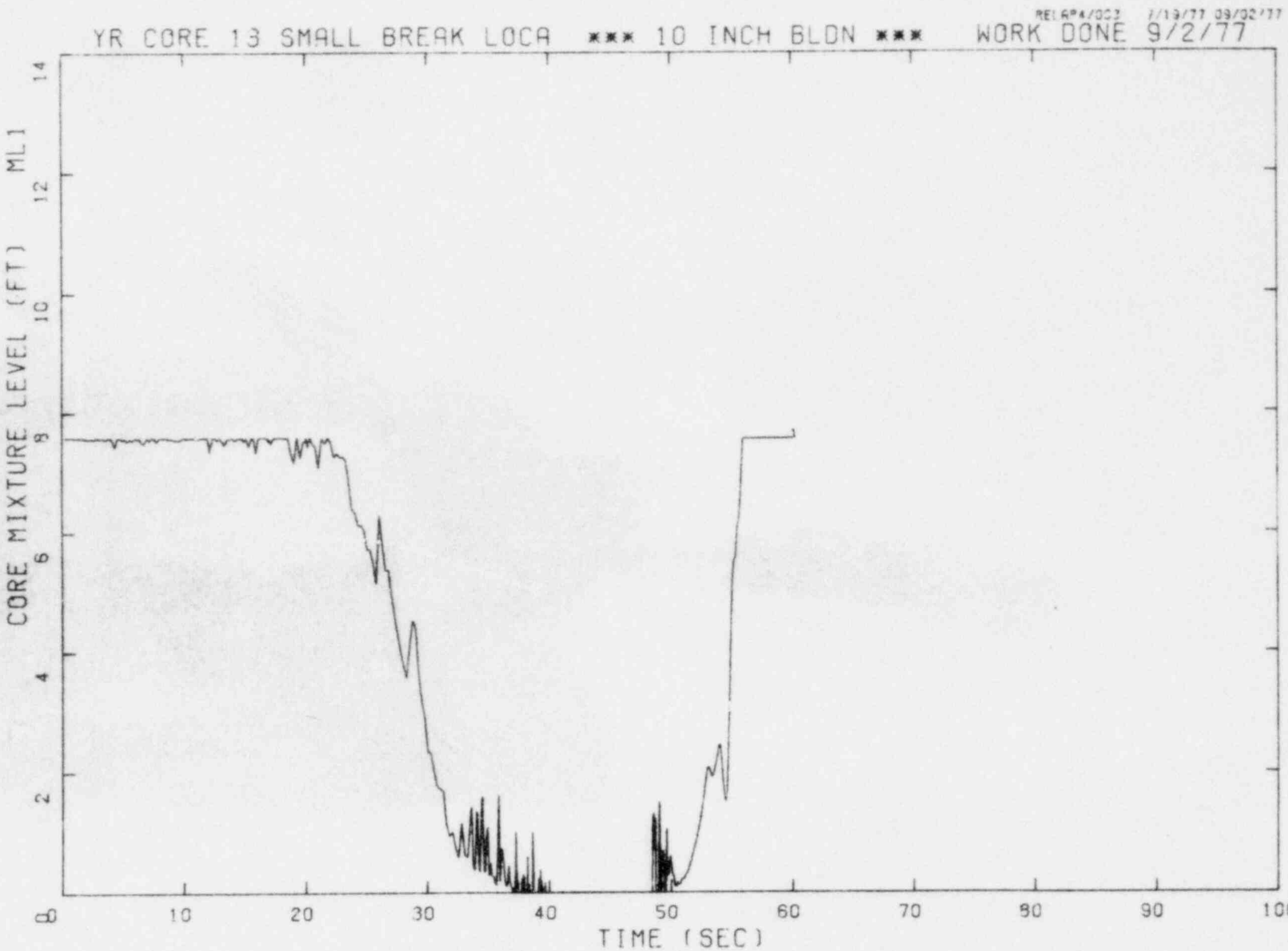


Figure 4-9.5
Core Mixture Level vs. Time for
10.00 Inch ID Small Break

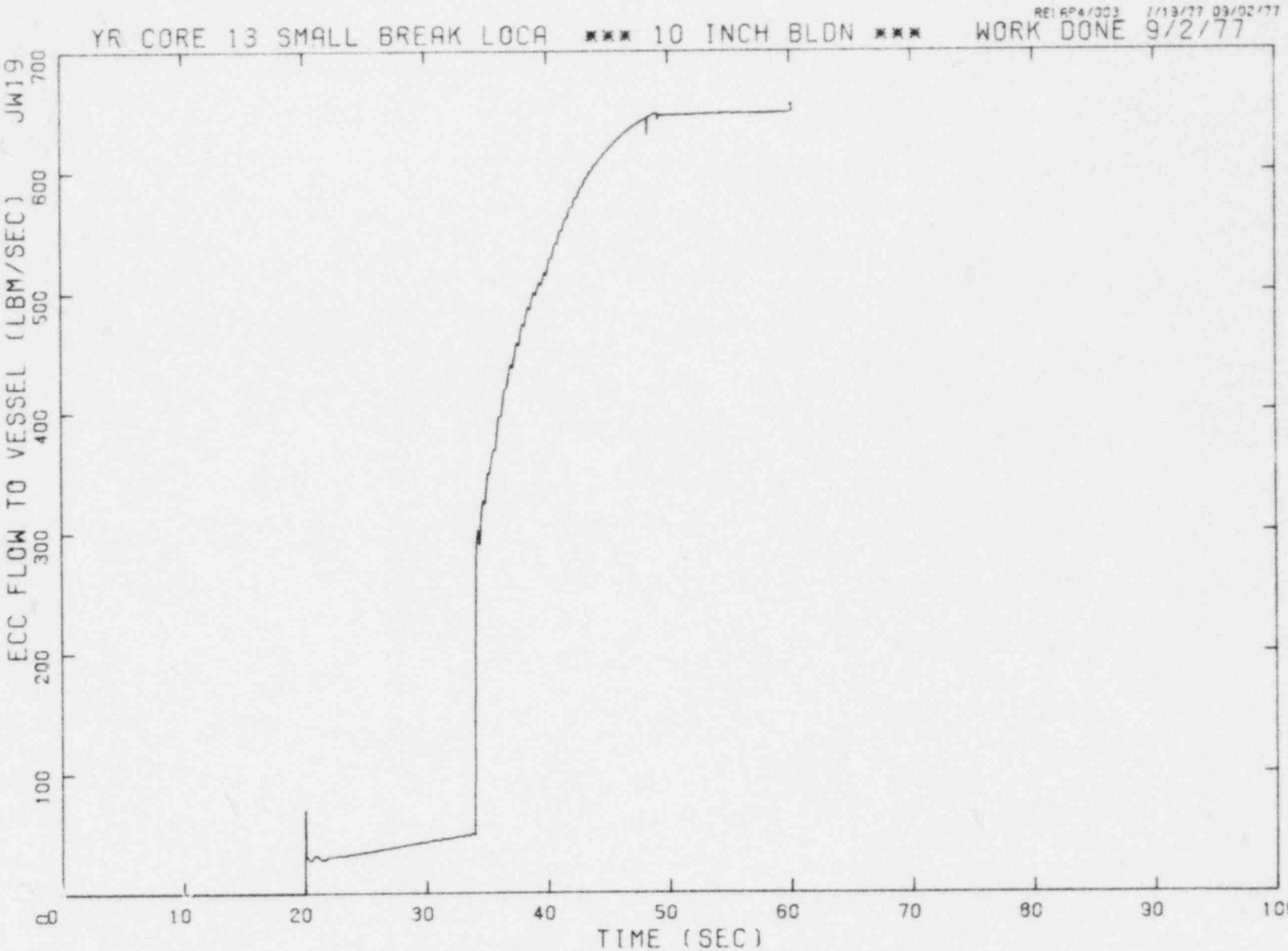


Figure 4-9.6
ECCS Flow to Core vs. Time for
10.00 Inch ID Small Break

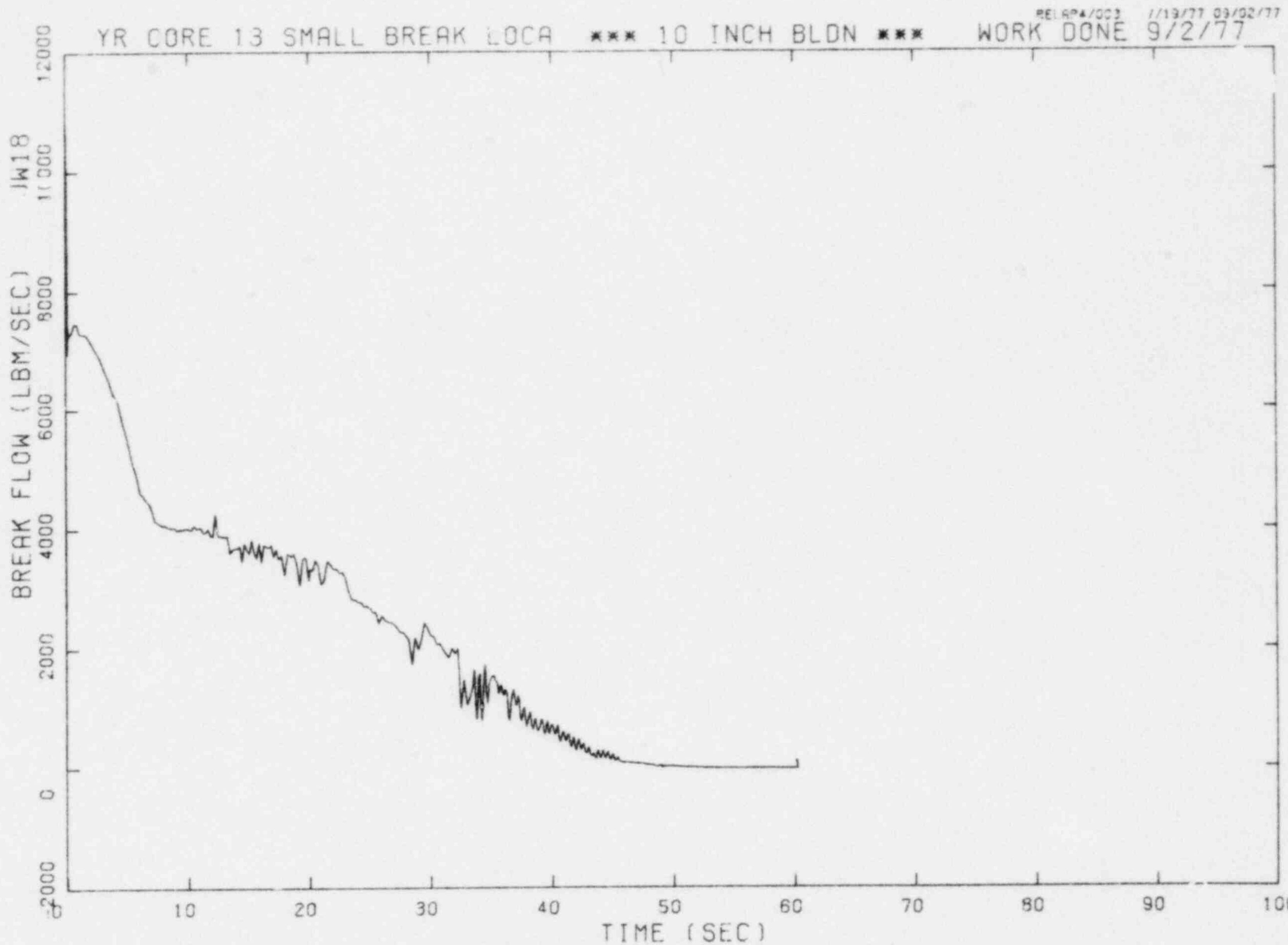


Figure 4-9.7
Cold Leg Break Flow vs. Time for
10.00 Inch ID Small Break

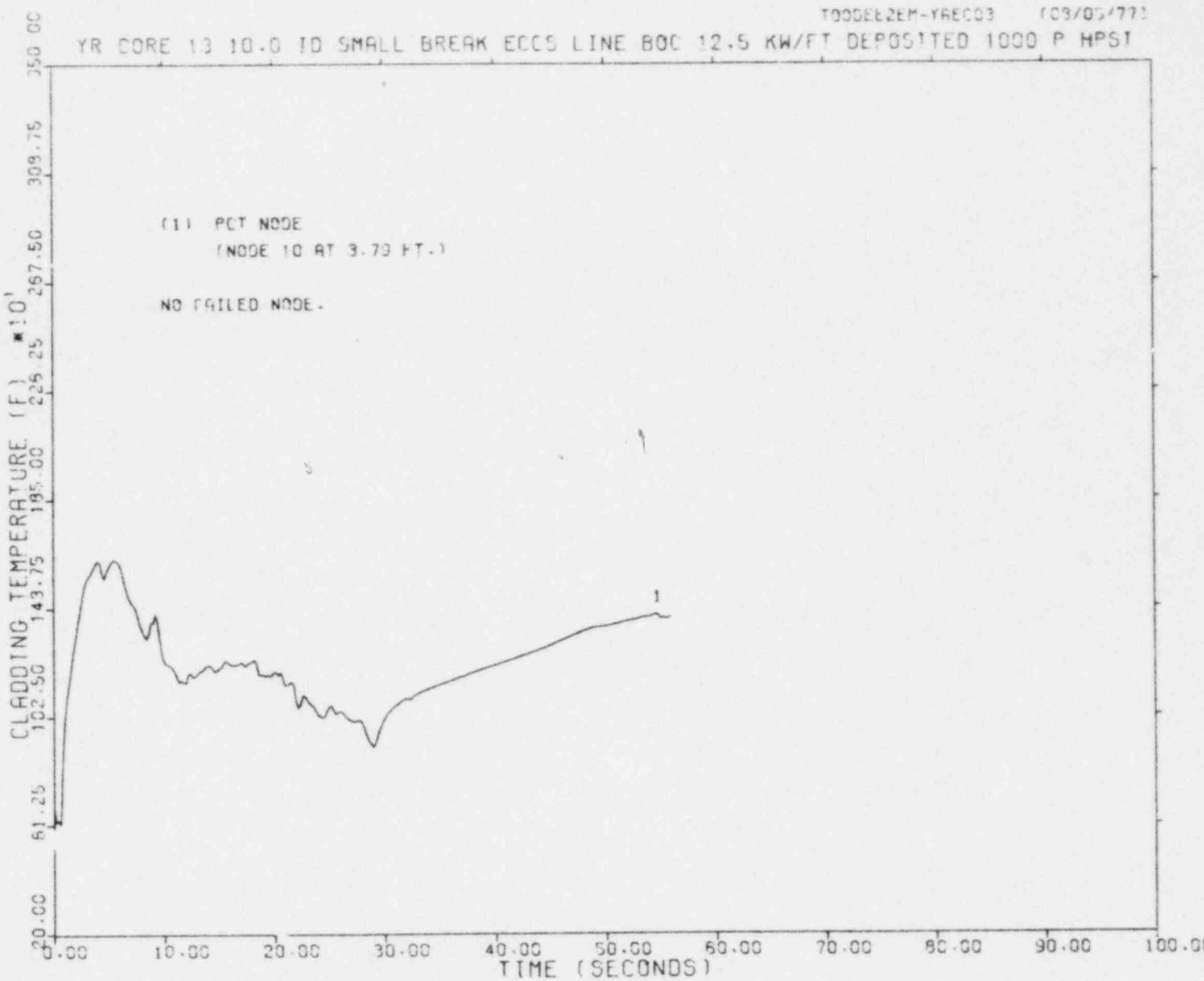


Figure 4-9.8
Peak Clad Temperature vs. Time for
10.00 Inch ID Small Break