ARKANSAS POWER & LIGHT COMPANY

ARKANSAS NUCLEAR ONE

STEAM ELECTRIC STATION

UNIT TWO

STARTUP REPORT

TO THE

U.S. NUCLEAR REGULATORY COMMISSION

LICENSE NUMBER NFP-6

DOCKET NUMBER 50-368

SUPPLEMENT 2

PERIOD ENDING JANUARY 29, 1980

8003110 600

FORWARD

This Startup Report for Arkansas Nuclear One Unit 2 covers the period from November 1, 1979, until January 29, 1980. It is being submitted in accordance with Unit 2 Technical Specification 6.9.1.1 and Regulatory Guide 1.16, "Reporting of Operating Information - Appendix "A" Technical Specifications." The latter requires a startup report to be submitted within 90 days following completion of the startup test program or within 9 months following initial criticality, whichever is earliest, and a subsequent report every 90 days until the startup test program is completed.

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6.3 50% THRU 100% POWER PLATEAU

INTRODUCTION

Upon completion of an inspection of the reactor core plus a short duration maintenance outage, the reactor was returned to criticality on December 1, 1979, in preparation for escalation to 100% power. Following the outage, short versions of Hot Functional Testing and Low Power Physics Testing were performed to ensure proper re-assembly of the core. During escalation, testing was performed at various plateaus to collect additional baseline data for the T_{hot} anomaly. In addition, scheduled start up testing resumed at the 50% power plateau.

Sections 6.3.1 through 6.3.30 provide a detailed description of the tests performed during the ascension to and while at 100% power. A description and summary of the testing performed to verify proper reactor reassembly following the T_H anomaly inspection outage is given in Attachment A. An update on the T_{hot} anomaly, (as described previously in Supplement 1 of this Startup report), is presented in Attachment B.

6.3.1 NUCLEAR AND THERMAL POWER CALIBRATION TESTS

6.3.1.1 Purpose

The purpose of this test was to adjust the Excore Linear Power Calibrate potentiometers and the CPC addressable constants (KCAL) and TPC) relating to the core power level to agree with the COLSS secondary calorimetric power.

6.3.1.2 Test Method

The Nuclear and Thermal Power Calibration Test was performed at the 50%, 80%, and 100% power plateaus as part of the power ascension test sequence. Calibration checks were also performed at 65%, 70%, 90% and 95% with wider acceptance criteria to monitor for non-linearities. For each safety channel, the input to PHICAL (calibrated neutron flux power) and BDT (static thermal power) were recorded and compared to the COLSS secondary calorimetric power. Adjustment of the Excore Linear Power Calibrate potentiometers, and/or the addressable CPC constants KCAL or TPC was necessary if the High Linear Power, PHICAL or BDT readings varied from the COLSS secondary calorimetric power by more than ±0.2% of Rated Thermal Power, (for 65%, 70%, 90% and 95% the criteria was ±2.0%.)

For each safety channel (one at a time) the following adjustments were performed as necessary:

A. The Excore Linear Power Calibrate potentiometer was adjusted so that the input to the High Linear Power Bistable, as monitored by an external DVM at the PPS cabinet, equaled the following value:

$$\text{DVM Reading} = \% \frac{\text{Power X 5 Volts}}{100} \pm .005\text{V}$$

B. The CPC addressable constants KCAL and TPC were adjusted as follows:

$$\text{KCAL (NEW)} = \% \frac{\text{Power X KCAL (OLD)}}{\text{PHICAL (OLD}}$$

$$\text{TPC (NEW)} = \% \frac{\text{Power X TPC (OLD)}}{\text{BDT (OLD)}}$$

After the initial adjustments were performed, readings from all four channels for High Linear Power, PHICAL, and BDT were taken and compared to the COLSS secondary calorimetric power. If any of the readings varied from the COLSS secondary calorimetric by more than ±0.2% of Rated Thermal Power, the adjustments were repeated until the ±0.2% criteria were met.

6.3.1.3 Test Results

This test was performed three times at 50% power, seven times at 80% power, two times at 100% power and one time each at 65%, 70%, 90% and 95% power. These test runs are summarized in Table 6.3.1.1 and are briefly described below.

	Comments
50% Power:	
Run #1	This test was performed prior to further increase in the power escalation to verify the accuracy of the COLSS calorimetric following an extended outage.
Run #2	This test was performed at non-equilibrium xenon conditions after the 80% Loss of Flow Trip Test to verify the accuracy of the COLSS calorimetric.
Run #3	This test was performed at equilibrium xenon conditions. Minor adjustments were required to meet the acceptance criteria.
65% Power:	This test was performed at non-equilibrium conditions during the ascension to 80% power. No adjustments were required.
70% Power	This test was performed during the fuel preconditioning hold at 70% preceding the ascension to 80% power. No adjustments were required.

	Comments
80% Power:	
Run #1	This test was the initial Nuclear and Thermal Power Calibration performed at 80% power. No adjustments were required to meet the non-equilibrium xenon conditions acceptance criteria.
Run #2	This test was performed at equilibrium xenon conditions and minor adjustments were required.
Run #3	This test was repeated at equilibrium xenon conditions after placing all CPC channels in "CEAC INOP" for testing.
Run #4	This test was performed at non-equilibrium xenon conditions following the return to 80% after a condenser outage.
Run #5	This test was performed at non-equilibrium xenon conditions following the return to 80% power after the 80% "Loss of Flow Trip Test". During the shutdown the CPC Channel B Cold Leg temperature transmitter was recalibrated and adjustments were required.
Run #6	This test was repeated at equilibrium xenon conditions after removing the "CEAC INOP" function. Adjustments were made for all channels.
Run #7	This test was performed at non-equilibrium xenon conditions at the completion of the post 80% testing during the escalation to 100%. No adjustments were required.

Comments

90% Power:	This test was performed during the fuel preconditioning hold at 90% preceding the ascension to 95% power. No adjustments were required.
95% Power:	This test was performed during the fuel preconditioning hold at 95% preceding the ascension to 100% power. Adjustments were performed to all channels for PHICAL, TPC and Neutron Power to affect as close agreement as possible with COLSS Secondary Calorimetric prior to increasing to full rated power.
100% Power:	
Run #1	This test was performed at non-equilibrium xenon conditions upon the initial achievement of 100% power. No adjustments were required.
Run #2	This test was performed at equilibrium xenon conditions. Minor adjustments were made.

6.3.1.4 Conclusions

At the 50%, 80% and 100% power plateaus, the Excore Linear Power Calibrate potentiometers and the CPC addressable constants KCAL and TPC were adjusted such that the High Linear Power, PHICAL, and BDT readings for all safety channels agreed with the COLSS secondary calorimetric power to within ±0.2% of Rated Thermal Power.

TABLE 6.3.1.1

RESULTS OF NUCLEAR AND THERMAL POWER CALIBRATION TESTS

DATE/TIME PERFORMED	SECONDARY CALORIMETRIC (%)	SAFETY CHANNEL	Variation from Calorimetric before Adjustments			Variation from Calorimetric after adjustments		
			HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)	HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)
12-17-79 (1) 0215	51.02	A	.42	- .47	.20	- .06	- .02	- .11
		B	.30	.35	- .06	- .04	- .02	- .04
		C	.28	.13	.20	0	- .01	- .01
		D	.28	- .17	.54	- .02	- .10	.04
12-19-79 (2) 0455	64.48	A	.55	1.97	-1.02	NO ADJUSTMENTS NEEDED		
		B	.54	0.96	-1.73			
		C	.53	1.04	-0.93			
		D	.53	1.20	-1.96			
12-19-79 (2) 2225	77.83	A	2.09	3.05	- .43	- .17	- .22	- .76
		B	2.13	2.23	-1.20	- .21	- .42	- .43
		C	2.15	2.05	-0.72	- .09	- .41	- .80
		D	2.15	2.13	-1.75	- .21	- .36	- .23
12-23-79 (3) 0225	79.26	A	- .34	- .21	-1.28	.07	.09	.14
		B	- .42	-1.30	-2.52	.07	.06	.08
		C	- .31	-0.30	- .08	.02	- .03	- .03
		D	- .44	-0.24	-2.73	0	- .05	- .19
12-24-79 (3) 0317	79.31	A	+ .01	-1.18	.12	.07	.04	.08
		B	0	.01	- .06	.06	.12	- .08
		C	- .03	- .02	- .03	.03	- .07	- .03
		D	- .04	.02	- .02	.02	.01	0
12-29-79 (2) 2030	77.05	A	1.67	1.35	- .50	1.76	1.60	-0.37
		B	1.63	2.14	0.61	1.88	0.41	1.47
		C	1.64	1.34	-0.56	1.83	1.57	-0.38
		D	1.60	1.25	0.04	1.77	1.47	0.14

TABLE 6.3.1.1 (cont)

RESULTS OF NUCLEAR AND THERMAL POWER CALIBRATION TESTS

DATE/TIME PERFORMED	SECONDARY CALORIMETRIC (%)	SAFETY CHANNEL	Variation from Calorimetric before Adjustments			Variation from Calorimetric after adjustments		
			HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)	HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)
1-1-80 (2) 1540	77.26	A	- .36	.56	- .05	-1.63	- .22	- .61
		B	- .38	-2.17	-2.06	- .74	- .91	- .74
		C	- .42	.42	- .19	-1.67	- .27	-1.01
		D	- .54	.38	.05	-1.73	.38	- .47
1-3-80 (3)	79.16	A	- .42	1.16	- .05	.08	.08	- .14
		B	- .46	.44	- .012	.16	.07	.2
		C	- .64	.95	- .13	.16	.06	.10
		D	- .76	.82	- .037	.12	.12	.12
1-8-80 (2) 1800	51.48	A	-3.12	-1.87	- .58	.09	-1.79	- .94
		B	-2.96	-1.88	-1.21	.09	-1.90	-1.36
		C	-2.60	-1.38	- .90	.09	- .92	- .75
		D	-2.46	-1.35	- .18	.09	- .51	- .16
1-10-80 (3) 2130	52.21	A	.61	-1.73	-1.09	.2	.1	0
		B	.63	-1.95	-1.72	.2	.18	.11
		C	.31	-1.65	-1.18	.2	.14	.14
		D	.33	-1.60	- .33	.2	.14	.01
1-14-80 (2) 0540	63.80	A	1.24	.90	1.20	NO ADJUSTMENTS NECESSARY		
		B	1.34	1.40	1.60			
		C	1.44	1.20	1.20			
		D	1.56	1.40	.90			

TABLE 6.3.1.1 (cont)

RESULTS OF NUCLEAR AND THERMAL POWER CALIBRATION TESTS

DATE/TIME PERFORMED	SECONDARY CALORIMETRIC (%)	SAFETY CHANNEL	Variation from Calorimetric before Adjustments			Variation from Calorimetric after adjustments		
			HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)	HIGH LINEAR POWER (%)	PHICAL (%)	BDT (%)
1-19-80 1115	75.20	A	-4.58	-4.06	-2.01	NO ADJUSTMENTS REQUIRED (FOR INFORMATION ONLY)		
		B	-4.42	-4.35	-2.95			
		C	-4.32	-3.97	-2.12			
		D	-4.30	-4.03	-1.31			
1-22-80 (2) 1300	90.29	A	1.55	- .42	- .43	NO ADJUSTMENTS NECESSARY		
		B	1.01	- .32	.21			
		C	1.17	- .54	1.1			
		D	1.13	- .45	.39			
1-23-80 (2) 0600	95.10	A	1.64	- .39	- .69	- .23	.03	- .06
		B	1.09	- .41	- .57	- .23	- .05	- .20
		C	1.29	- .71	.5	- .19	.02	.05
		D	1.71	- .27	- .08	- .23	- .17	.06
1-23-80 (2) 1400	99.15	A	.21	.15	- .69	NO ADJUSTMENTS NECESSARY		
		B	.19	.38	- .71			
		C	.21	.24	- .28			
		D	.19	- .12	- .09			
1-24-80 (3) 1109	99.22	A	.68	.63	.16	- .14	.01	.01
		B	.62	.71	- .66	- .12	- .01	- .03
		C	.64	.54	.42	- .10	0	.08
		D	.64	.34	.07	- .18	- .05	- .12

NOTES:

(1) Test Conducted at Non-Equilibrium Xenon, acceptance criteria $\pm$.2%

(2) Test conducted at Non-Equ librium Xenon, acceptance criteria $\pm$2%

(3) Test conducted at Equilibrium Xenon conditions, acceptance criteria + 2%

6.3.2 NSS CALORIMETRIC TESTS

6.3.2.1 Purpose

The purpose of this test was to:

A. Determine core thermal power by means of a secondary plant heat balance;

B. Verify the COLSS core thermal power calculations;

C. Verify that OP 2103.16 (Heat Balance Calculation) will provide a satisfactory indication of core power.

6.3.2.2 Test Method

Plant parameters were maintained essentially constant while steam generator data and reactor power information was collected over a three-hour period. This data along with the energy input and loss terms measured during the RCS Heat Loss was used to calculate the core thermal output.

The calculated core thermal power was compared to the COLSS secondary calorimetric power (BSCAL) to verify the accuracy of the algorithm. It was also compared to the COLSS primary calorimetric power (BDELT) and adjustments were made as necessary to the ΔT Power Gain Factor (in the BDELT algorithm) to provide agreement between BDELT and BSCAL. OP 2103.16 (Heat Balance Calculation) was completed concurrently and compared to the calculated core thermal power to verify its accuracy.

6.3.2.3 Test Results

This test was performed a total of five times between the 50% and 100% plateaus. The result of these tests are shown in Table 6.3.2.1. Adjustments were required and performed satisfactorily at 70% and 100% while no adjustments were required at 80% power.

6.3.2.4 Conclusions

The plant computer secondary calorimetric was found to be within the acceptable limits. Also, OP 2103.16 (Heat Balance Calculation) was found to provide acceptable results.

TABLE 6.3.2.1

RESULTS OF NSSS CALORIMETRIC

DATE PERFORMED	CALCULATED CORE THERMAL POWER	BSCAL (BEFORE TO BDELT)	BDELT ADJUSTMENT	RESULTS OF OP 2103.16	CALCULATED VALUE FOR ΔT POWER GAIN	BSCAL (AFTER TO BDELT)	BDELT ADJUSTMENT
12-19-79	67.42	67.45	65.95	N/A	1.0223	67.36	67.43
12-19-79	77.83	77.74	77.75	N/A	N/A	N/A	N/A
12-23-79	79.31	79.37	79.47	79.23	N/A	N/A	N/A
1-22-80	90.29	90.29	89.89	N/A	N/A	N/A	N/A
1-24-80	99.90	99.75	99.31	99.37	1.00636	99.81	99.71

6.3.3 RCS CALORIMETRIC FLOW MEASUREMENT

6.3.3.1 Purpose

The purpose of this test was to determine the reactor coolant flow rate based upon the computer secondary plant calorimetric and to provide guidance for adjustment of the CPC and COLSS flow algorithm constants if necessary.

1) The measured RCS mass flow rate is less than 144.5×10^6 lbm/hr, but greater than 120.4×10^6 lbm/hr;

2) The COLSS calculated volumetric flow is adjusted to be less than but within 0.2% (of design flow) of the measured RCS volumetric flow;

3) The CPC flows are adjusted to be less than the COLSS mass flow but within 0.5% (of design flow) of the measured RCS mass flow.

4) The thermal power adjustment coefficients, BADJ, must fall within an acceptance level of $\pm 0.5\%$ for 30%, 50%, 80% and 100% plateau.

6.3.3.2 Test Method

Calculation of the reactor coolant mass flow rate is based upon secondary plant calorimetric power. Over a period of approximately an hour, during which time plant conditions are maintained essentially constant, RCS data is recorded from both the CPC's and the plant computer. Following this collection period, the data is averaged to obtain representative values for core parameters. The average enthalpy rise of the reactor coolant is then determined and is used with secondary calorimetric power to calculate the mass flow of the reactor coolant.

The calculated coolant mass flow rate is compared to CPC and COLSS values for RCS flow. If necessary, new values are calculated for the constants in the CPC and COLSS algorithms to provide the agreement specified in the acceptance criteria. New values are also calculated for the CPC thermal power scaling constants and for the COLSS ΔT Power Gain and Bias terms. These values are entered and their adequacy verified by remeasuring RCS flow as above and comparing CPC and COLSS calculated values to the measured flow.

6.3.3.3 Test Results

This test was performed a total of three times at the 100% plateau. The first run was sucessfully performed with the exception of proper adjustment of COLSS flow. During the second attempt, plant conditions were not stable enough to allow proper verification of the changes made following the first run.

The third test run was performed satisfactorily. During the initial flow measurement the average core thermal power was 99.66% (COLSS secondary plant calorimetric power). The average enthalpy rise of the reactor coolant across the core as determined from CPC data was 72.00 btu/lbm. Hence, the reactor coolant mass flow rate was calculated to be 1.3295×10^8 lbm/hr. This translates to 110.4% of the base mass flow rate (120.4×10^6 lbm/hr). By comparison, all four CPC channels indicated approximately 108.5% base flow and COLSS indicated approximately 109.9% of base flow.

New values were calculated for the COLSS flow bias constants, for the CPC flow constants (FC1), for the CPC thermal power scaling constants (TPC), and for the COLSS ΔT Power Gain and Bias terms. These were entered into COLSS and the CPC's and the flow was remeasured as before to verify the adequacy of the new constants.

6.3.3.4 Conclusions

The calculated RCS Flow was within acceptable limits.

6.3.4 SDBCS CAPACITY CHECKS

6.3.4.1 Purpose

The purpose of this procedure was twofold:

1) Develop calibration curves of steam flow vs. controller output for one 13% turbine bypass valve, the 5% turbine bypass valve and one 13% upstream atmospheric dump valve for use in CESEC verification.

2) Verify that the capacity of the atmospheric dump valves upstream of the MSIV's is less than assumed for the most severe excess heat removal accident ($1.69 \times 10^6 \frac{lbm}{hr}$) as described by the FSAR, Section 15.1.10.2.1.

6.3.4.2 Test Method

To develop the calibration curve for 2CV-0306 (13% turbine bypass), reactor power and turbine power were reduced to 35%. Holding steam flow to the turbine constant, reactor power was increased while dumping excess steam through 2CV-0306. Conditions were stabilized at each 10% of controller output and steam flow vs. controller output data was taken. With 2CV-0306 controller output at 100%, reactor power was stabilized. Bypass valve 2CV-0303 was opened at 10% increments while closing 2CV-0306 to hold steam pressure constant. A curve of steam flow vs. controller output was developed for 2CV-0303 by using incremental changes in 2CV-0306.

The calibration curve of 2CV-1001 was developed by holding reactor and turbine constant and opening 2CV-1001 in 10% increments. Steam pressure was held constant by closing 2CV-0306 and 2CV-0303. Steam flow through 2CV-1001 was calculated using calibration curves of 2CV-0303, 2CV-0306 and the incremental changes in valve positions.

Capacity checks on 2CV-1001 and 2CV-1051 were performed by measuring the controller outputs of 2CV-0306 and 2CV-0303 with the respective atmospheric dumps at 100% open.

6.3.4.3 Test Results

The calibration curves for 2CV-0306 and 2CV-0303 (Figure 6.3.4.1 and 6.3.4.2) were developed with their respective controllers in automatic mode. This caused controller output to be somewhat unstable. Controller output was determined by averaging the output as read from the computer trend groups.

The calibration curve for 2CV-1001 (Figure 6.3.4.3) was developed with the controllers for 2CV-0306 and 2CV-0303 in manual mode, producing more stable output.

The calibration curves are for information only, to be used in CESEC verification.

The capacities of the valves are tabulated below:

VALVE	CAPACITY ($10^6 \frac{lbm}{hr}$)
2CV-0306	1.24
2CV-0303	0.69
2CV-1001	0.94
2CV-1051	<1.69

6.3.4.4 Conclusions

The capacity of each upstream atmospheric dump was found to meet the requirements of the FSAR, Section 15.1.10.2.1. Calibration curves for 2CV-0306, 2CV-0303 and 2CV-1001 were developed satisfactorily.

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FIGURE 6.3.4.1

FLOW THROUGH 2CV-0305 VS VALVE POSITION

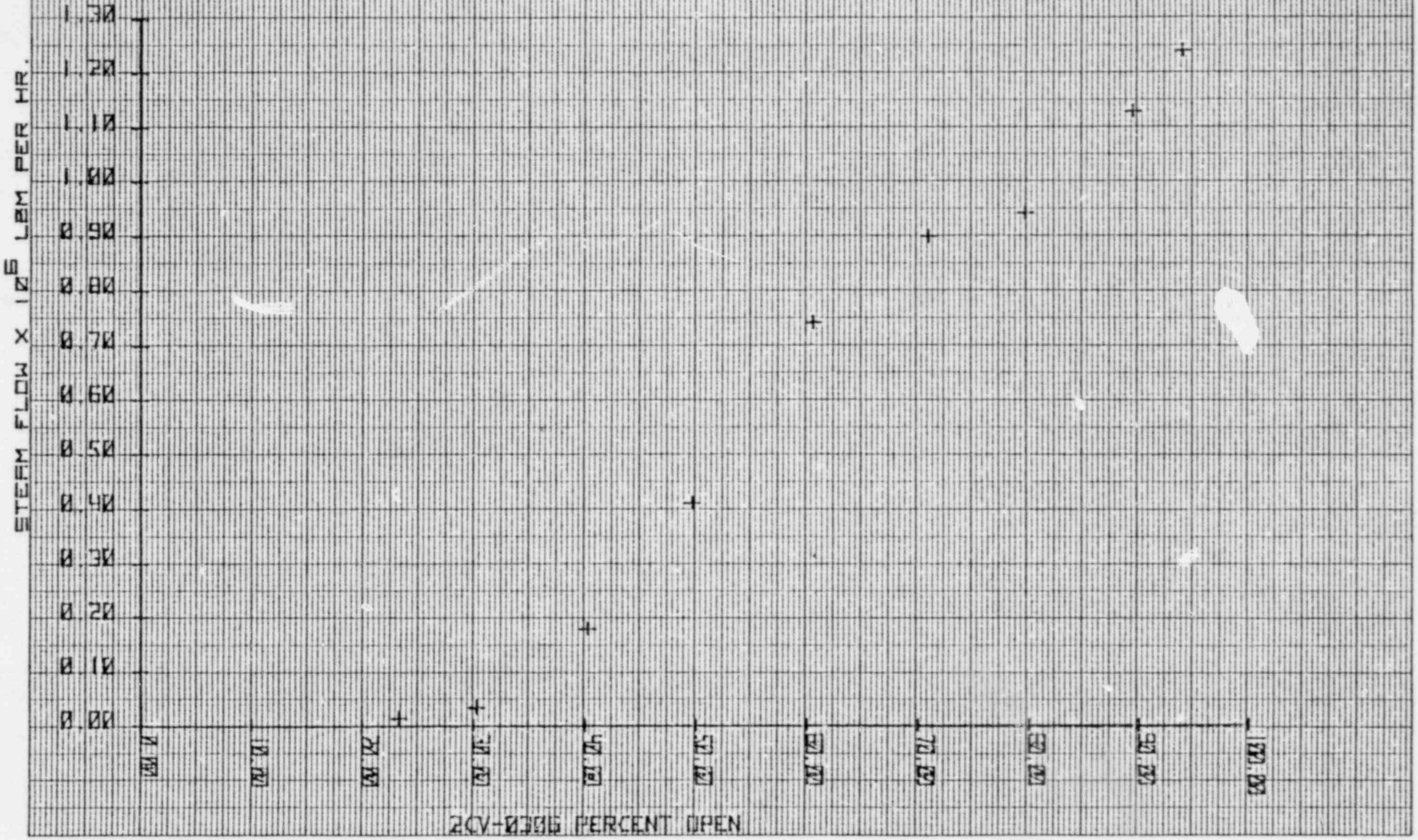


FIGURE 6.3.4.2

FLOW THROUGH 2CV-0303 VS VALVE POSITION

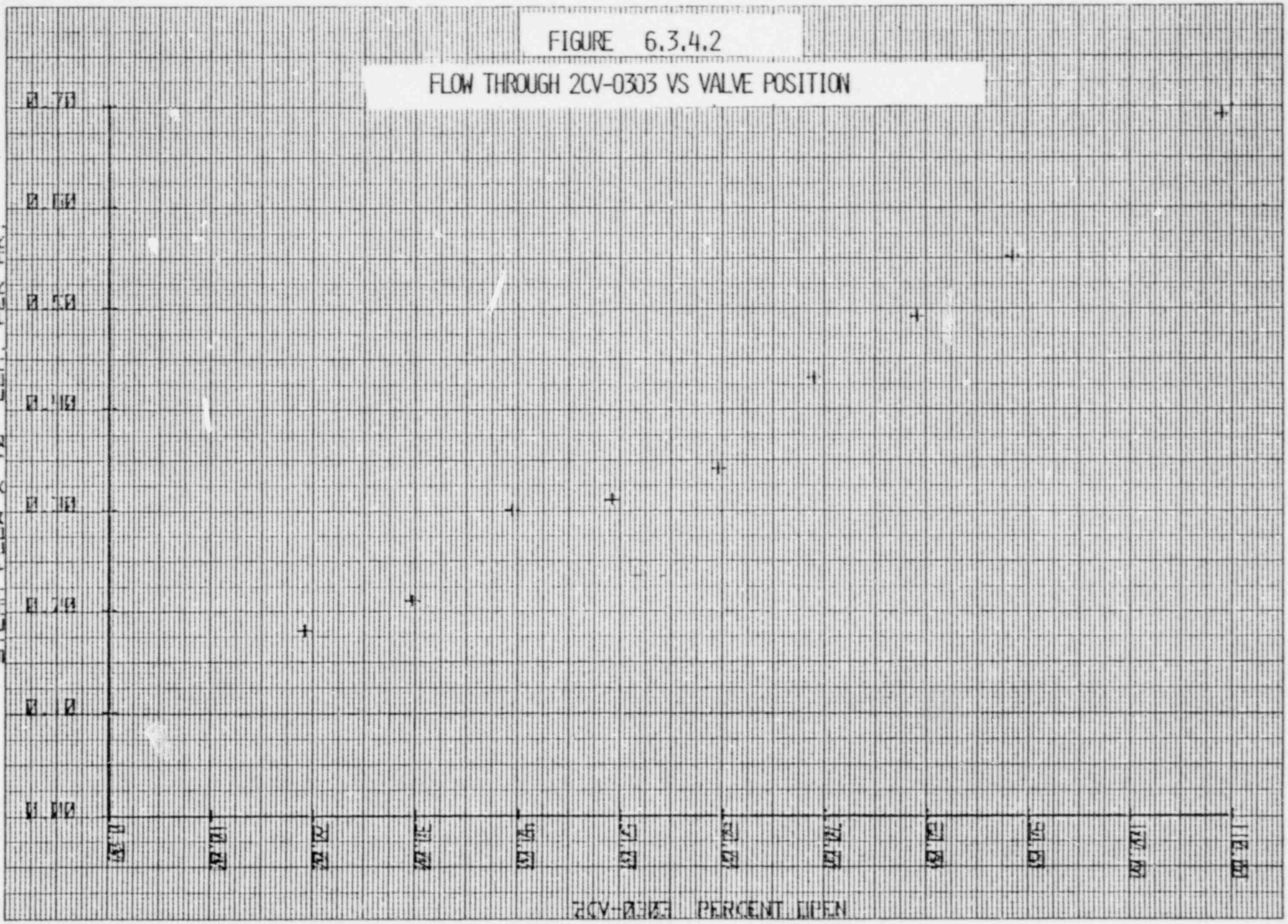
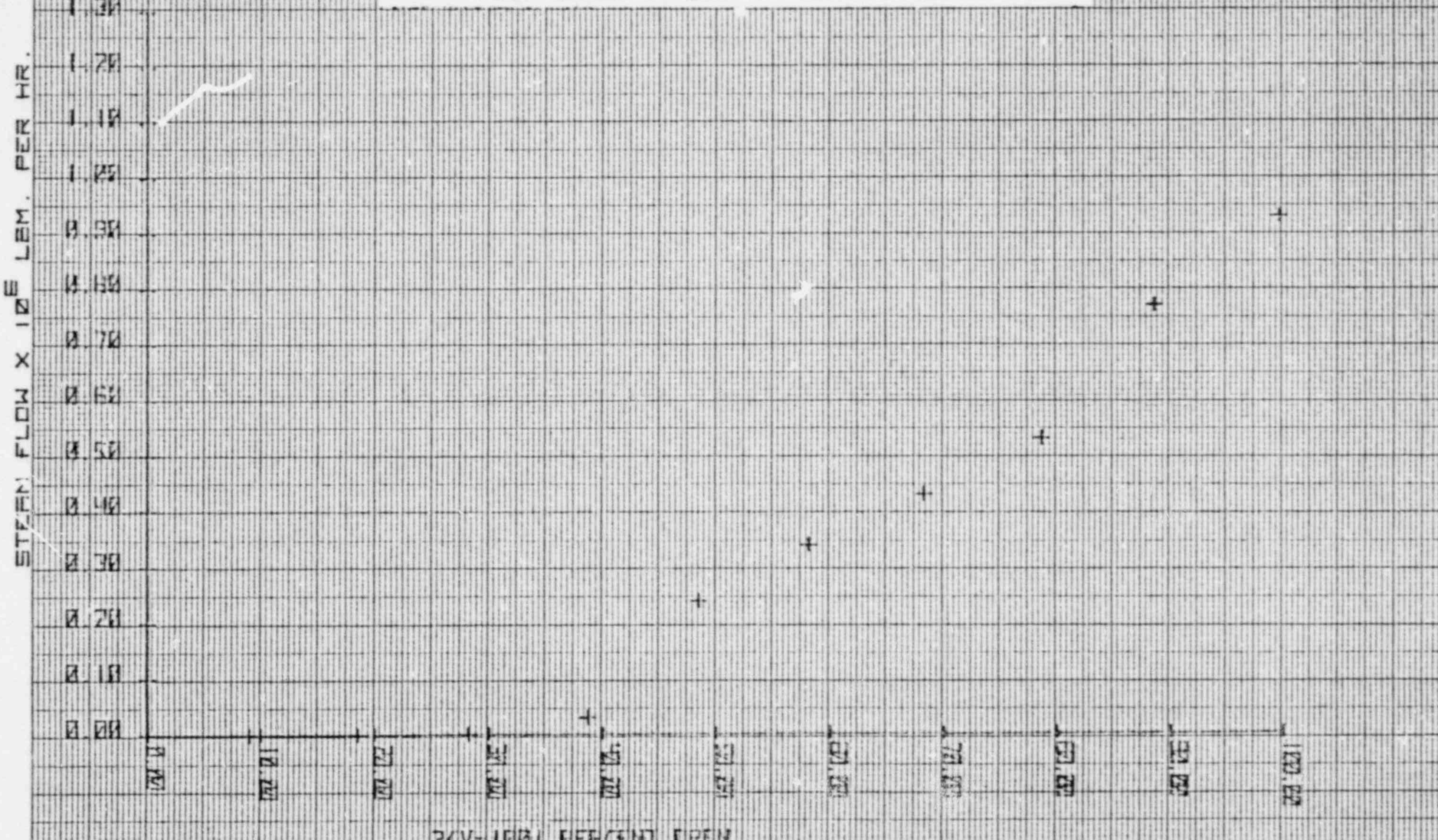


FIGURE 6.3.4.3

FLOW THROUGH 2CV-1001 VS VALVE POSITION



6.3.5 PROCESS VARIABLE INTERCOMPARISON TESTS

6.3.5.1 Purpose

The purpose of this test was to compare Process Instrumentation readings obtained from the Plant Computer, Plant Protection System, Core Protection Calculators, and various console meters to verify proper agreement between systems.

6.3.5.2 Test Method

After establishing steady state RCS conditions at the 80% and 100% power plateaus, (not necessarily equilibrium Xenon), data was recorded for the following process variables:

1. RCS cold leg temperature,
2. RCS hot leg temperature,
3. RCP differential pressure,
4. RCP speeds,
5. RCS pressure,
6. Pressurizer level,
7. Steam Generator levels, and
8. Steam Generator pressures.

Common process variable readings for each system were then intercompared against preset acceptance criteria to assure the accuracy of process loop calibrations and system signal processing.

Acceptance criteria for the channel 4 RTD's in the RCS hot legs was revised to account for flow stratification effects.

6.3.5.3 Test Results

All intercomparisons were within allowed tolerance at the 80% and 100% power plateaus except as follows:

80% Plateau

T4715A	Cold Leg "C" Temperature-Computer
2PD-6176A	RCP "B" Differential Pressure-Process

100% Plateau

2TI-4716	Cold Leg "D" Temperature-Process
2TI-4605-3NB	Cold Leg "C" Temperature-Process
T4715A	Cold Leg "C" Temperature-Computer
T4635-1	Hot Leg "A" Temperature-Computer
T4610-2	Hot Leg "A" Temperature-Computer
2PD-6176A	RCP "B" Differential Pressure-Process
L1031-1	SG "A" Level-Computer
2LI-1131-3N	SG "B" Level-Process

6.3.5.4 Conclusions

Those instruments found out of tolerance as listed in "Test Results" above will be recalibrated. Retesting of these instruments will be done on next ascension to 100% power.

6.3.6 CHEMISTRY AND RADIOCHEMISTRY TESTS

6.3.6.1 Purpose

The purpose of this test was to conduct chemistry tests with the intent of establishing baseline corrosion data and activity buildup with power level. As a result of this, procedures for sample collection analysis were verified. Also, this test was used to verify the calibration of the process radiation monitor, including a repeat of the 50% power plateau data (see Supplement 1, Section 6.2.6.4 of this Startup Report).

6.3.6.2 Test Method

A. Primary System

Sample and analysis procedures were performed using the CE Chemistry Manual (CENPD-28) as a guide. Three sets of RCS chemistry analyses were performed at the 80% and 100% power plateaus. The analyses included the following tests:

a. pH

b. Conductivity

c. Cl

d. F^-

e. Dissolved Oxygen

f. Suspended Solids

g. Boron

h. Lithium

i. Dissolved Hydrogen

j. Gamma Spectroscopic Analysis (gas)

k. Degassed Gross Beta

l. Crud Activity

m. Tritium

n. Iodine Ratio

o. Iodine Dose Equivalent

p. Gamma Spectroscopic Analysis (liquid)

q. Total Gas (primary coolant)

B. Secondary System

Sampling and analysis procedures were performed using CENPD-28 as a guide. Five sets of secondary chemistry analyses were performed at the 80% and 100% power plateaus. Each set of analyses included the following tests:

a. pH

b. Conductivity

c. Cation Conductivity

d. Dissolved Oxygen

e. Hydrazine

f. Ammonia

g. Silica

h. Sodium

i. Iron

j. Copper

C. Process Radiation Monitor

A sample was taken downstream of the Process Radiation Monitor. Laboratory results of the Gross Gamma Coolant Analysis were compared to the Process Radiation Monitor Analysis for verification of proper Process Radiation Monitor function.

In addition, comparisons at different power levels were made to verify that increases in RCS activity, as determined by laboratory analysis are accompanied by increases in the Process Radiation Monitor readings.

6.3.6.3 Test Results

The required radiochemistry and secondary samples were obtained and analyzed. The process radiation monitor readings were within the required band of laboratory analysis results at the 50% and 80% plateaus. This agreement was not achieved at 100% power. Both the 80% and 100% readings indicated that increases in RCS activity, as determined by laboratory analysis, were accompanied by increases in the Process Radiation Monitor. Baseline activities for the 80% and 100% plateaus were established.

6.3.6.4 Conclusions

It was demonstrated that primary and secondary sampling and analysis can be performed in accordance with Technical Specifications and CENPD-28. Baseline activities for the RCS were recorded. The Process Radiation Monitor calibration has been verified at the 50% and 80% power plateaus. This calibration has not been verified at the 100% power plateau, however, when equilibrium conditions are achieved upon return to the 100% plateau, additional data will be taken.

6.3.7 CORE PEFORMANCE RECORD TESTS

6.3.7.1 Purpose

The purpose of this test was to record core performance data from incore detectors, and to specify the acceptance criteria for comparison of the measured results with predicted core operating parameters. The test was performed at the 80% and 100% power plateaus.

6.3.7.2 Test Method

A. While the reactor was being maintained at steady state power, with equilibrium Xenon, incore detector data was collected for analysis.

B. The measured results were then compared to predicted values in the following manner:

   a. The comparison of the measured power distribution with the predicted radial power distribution is a root mean squared statistical comparison of the relative radial power density distribution for each of the 177 fuel assemblies.

   b. The comparison of the measured axial power distribution with the predicted axial power distribution is a root mean squared statistical comparison of the relative axial power distribution for each of the 100 axial nodes.

   c. The measured values of total planar radial peaking factor (Fxy), total integrated radial peaking factor (Fr), core average axial peak (Fz), and core 3-D power peak (Fq), were compared to predicted values.

6.3.7.3 Test Results

Results of the statistical comparisons and peaking factors are summarized in Tables 6.3.7.1 and 6.3.7.2.

6.3.7.4 Conclusions

All acceptance criteria have been met for the comparisons beteeen predicted values and measured results. As shown in Tables 6.3.7.1 and 6.3.7.2, the predictions were acceptable for determining core operating parameters.

TABLE 6.3.7.1

	Measured Results (RMS) 80%	100%	Acceptance Criteria (RMS)
Power Density Distribution	1.0030	1.0194	≤5
Axial Power Distribution	2.7630	2.1508	≤5

TABLE 6.3.7.2

80%

	Measured	Predicted	% Difference	Acceptance Criteria
Fxy	1.4203	1.4028	1.248	≤10%
Fr	1.4148	1.4028	0.855	≤10%
Fz	1.2656	1.2540	0.925	≤10%
Fq	1.800	1.759	2.331	≤10%

100%

	Measured	Predicted	% Difference	Acceptance Criteria
Fxy	1.4371	1.393	3.16	<10%
Fr	1.4187	1.393	1.84	<10%
Fz	1.25186	1.2378	1.18	<10%
Fq	1.78551	1.7243	3.55	<10%

6.3.8 CPC/COLSS VERIFICATION TESTS

6.3.8.1 Purpose

The CPC/COLSS Verification Tests were performed to:

a) Verify that the CPC/COLSS DNBR and LPD calculations are correct.

b) Evaluate the effect of process input noise on the CPC/COLSS system.

6.3.8.2 Test Method

The process input noise was measured at the 80% and 100% power plateaus, with ARO and equilibrium xenon. Plant computer reports containing information on the CEA's, CPC's and COLSS were obtained for use in the verification of the CPC/COLSS DNBR and LPD calculations. The CPC/COLSS data was compared to the results of the CEDIPS* computer code and incore detector analysis results.

6.3.8.3 Test Results

The process noise data was recorded for the 80% and 100% power plateaus. The data required at both power levels for verification of CPC/COLSS and LPD calculations was collected and compared to the results of the CEDIPS* compouter code. All data was transmitted to CE-Windsor for review.

6.3.8.4 Conclusions

The CPC output parameters were compared to the CEDIPS* code and found to be acceptable at both 80% and 100% power. The following reviews by CE-Windsor are still in progress:

a) COLSS DNBR and LPD related calculations for all power plateaus, and

b) the effect of process input noise on the CPC/COLSS system.

*CEDIPS is a FORTRAN program for statistical analysis of effects of process inputs upon the CPC system.

6.3.9 VARIABLE T_{AVG} TESTS

6.3.9.1 Purpose

The objective of this test was to determine the Isothermal Temperature Coefficient (ITC) and Power Coefficient.

6.3.9.2 Test Method

At the 80% power plateau, two methods were used to determine the Isothemal Temperature Coefficient; one method was performed with no CEA movement and the other was performed with center CEA movement. The method used to determine the Power Coefficient utilized center CEA movement. These two approaches are described in more detail below:

A. No CEA Movement

With the reactor at steady state and equilibrium or near equilibrium xenon and CEA group 6 at 120 inches withdrawn, a small step change in the turbine control valve position is made and then adjusted to establish a new coolant inlet temperature. This change produces a small turbine load-reactor mismatch. The temperature change results in a reactivity feedback and a resultant power change. The power change produces an opposite reactivity feedback and the reactor settles out at a new power and temperature condition. The cycle is then reversed by making a small change in the turbine control valve position in the opposite direction. The ITC is calculated iteratively using the resultant power and temperature changes along with an assumed power coefficient. The Moderator Temperature Coefficient (MTC) is then calculated by subtracting the predicted Fuel Temperature Coefficient (FTC) from the measured Isothermal Temperature Coefficient.

B. With Center CEA Movement

a. Isothermal Temperature Coefficient

With the reactor at steady state and equilibrium xenon and CEA group 6 at 120 inches withdrawn, a small step change in the turbine control valve position is made and then adjusted to establish a new coolant inlet temperature. This change produces a small turbine load-reactor power mismatch. The temperature change results in a reactivity feedback. This reactivity is matched with equal and opposite reactivity by movement of the center CEA (holding reactor power constant).

The ITC is calculated iteratively knowing the power and temperature changes along with the center CEA integral worth curve and by using the test predictions as initial guesses for the Isothermal Temperature and Power Coefficients. The MTC is calculated as described previously.

b. Power Coefficient

A reactivity insertion is made using the center CEA resulting in a change in reactor power. Average coolant temperature is held constant by changing turbine load to match reactor power. The reactor settles out at a new power when the reactivity feedback due to change in power is equal and opposite to the CEA reactivity insertion. The Power Coefficient is calculated iteratively in a manner similar to the ITC calculation.

At the 100% power plateau, the Isothermal Temperature Coefficient was measured without center CEA movement with the reactor at all rods out steady state equilibrium or near equilibrium xenon and reactor power at approximately 96%. The Power Coefficient was not measured at the 100% power plateau.

6.3.9.3 Test Results

The Variable Tavg Test was performed at the 80% power plateau as part of the power ascension test program. During the ITC measurement with no CEA movement, T_{cold} was swung approximately ± 3°F about the programmed T_{cold} at 80% power.

The Isothermal Temperature Coefficient measured with center CEA movement was performed by withdrawing CEA 6-1 from 120" withdrawn (the group average position) to 128.2" withdrawn and noting the increase in T_{cold}. T_{cold} was then decreased by approximately twice the amount determined above by inserting CEA 6-1. T_{cold} was cycled four times during the performance of this measurement.

The Power Coefficient measurement with center CEA movement was performed by withdrawing CEA 6-1 from 120" withdrawn (the group 6 average position) to 128.2" withdrawn and noting the increase in reactor power. The reactor power was then decreased by approximately twice the amount determined above by inserting CEA 6-1. Reactor power was cycled four times during the performance of this measurement.

The final ITC and Power Coefficient values were the average value of the runs conducted. The measured values, test predictions, and acceptance criteria for the 80% power plateau are shown in Table 6.3.9.1.

It should be noted that the original 80% power physics test predictions for ITC, Power Coefficient and integral rod worth curve for CEA 6-1 were calculated at a core average burnup of 50 MWD/T as opposed to the actual core average burnup of approximately 2172 MWD/T. A new integral worth curve for CFA 6-1 was calculated at a core average burnup of 2000 MWD/T. Using the updated curve in the data reduction resulted in better agreement between the two ITC's (as measured by the two different methods) than at 50% power.

The 100% power plateau variable Tavg test was actually performed at approximately 96% power to avoid exceeding an indicated T_{cold} of 555.5°F or steady state power level in excess of 100%. The ITC measurement T_{cold} was swung approximately ±3°F about a base T_{cold} of 550°F and was cycled four times during the performance of this measurement. The final ITC was the average value of the runs conducted. The measured value, test predictions, and acceptance criteria for the 100% power plateau are shown in Table 6.3.9.1.

It should be noted that the original 100% power physics test predictions for the ITC and power coefficient were calculated at a core average burnup of 1000 MWD/T as opposed to the actual core average burnup of approximately 2623 MWD/T. This burnup difference did not seriously compromise the acceptance criteria and no adjustments to the test predictions were performed.

6.3.9.4 Conclusions

The measured values for the Isothermal Temperature Coefficient and Power Coefficient compared well with the predicted values. Agreement between measurement and prediction was well within the uncertainties associated with each parameter. Table 6.3.9.1 summarizes the results of the 20%, 50%, 80% and 100% power plateau Variable Tavg tests.

TABLE 6.3.9.1

VARIABLE T_{AVG} TEST RESULTS

PARAMETER	20% PLATEAU	50% PLATEAU	80% PLATEAU	100% PLATEAU
CORE AVERAGE BURNUP(MWD/T)	162	858	2172	2623
RCS BORON CONCENTRATION (PPM)	828*	720*	642*	602
ISOTHERMAL TEMPERATURE COEFFICIENT ($X10^{-4}\Delta\rho/°F$)				
MEASURED (w/o center CEA movement)	-.2104	-.3770	-.4729	-.6140
(with center CEA movement)	-.2001	-.2852	-.5006	not measured
PREDICTED**	-.1590	-.4284	-.5616	-.6488
ACCEPTANCE CRITERIA	±0.5	±0.5	±0.5	±0.5
POWER COEFFICIENT ($X10^{-4}\Delta\rho$/% power)				
MEASURED	-1.1889	-1.0310	-.9504	not measured
PREDICTED	-1.17	-1.03	-.92	-.86
ACCEPTANCE CRITERIA	±0.2	±0.2	±0.2	N/A

* CEA Group 6 at 120" withdrawn

** Corrected for as-measured boron concentrations

6.3.10 UNIT LOAD TRANSIENT TEST

6.3.10.1 Purpose

The purpose of this test was to:

Demonstrate the following systems operate satisfactorily in the automatic mode to maintain plant parameters within acceptable limits during steady state power operations, and during transient conditions, including plant trips.

a. Reactor Regulating System (RRS)
b. Feedwater Control System (FWCS)
c. Steam Dump and Bypass Control System (SDBCS)
d. Megawatt Demand Setter (MDS)
e. Pressurizer Level Control System (PLCS)
f. Pressurizer Pressure Control System (PPCS)

6.3.10.2 Test Method

The specified sections of this test were performed at the indicated power plateaus.

The 50% power testing described herein represents testing not previously completed or described at 50% power (see Supplement 1 of this Startup Report, Sections 6.2.10.3.A and 6.2.10.3.D).

A. Automatic Steady State Operation; 50%, 80%, and 100% Power

The reactor was stabilized at the specified power and control systems verified to be in the automatic mode of operation. Strip chart recorders and computer trends were established as required by the test procedure and a 30 minute steady state run was performed.

Following the 30 minute run, the test data was collected, reduced and analyzed to determine the acceptability of the control systems operations. Control System setpoint adjustments were performed as necessary based on the results of the test data analysis. The above described process was performed until no further setpoint changes were required.

B. FWCS Tests; 80% and 100% Power

The reactor was stabilized at the specified power and the control systems verified to be in the automatic mode of operation. Steam Generator level transients were initiated by changing the setpoint at the master controller. Master Controller No. 1 controlled level in Steam Generator A. After each of the transients listed in Table 6.3.10.1, strip chart recorder traces and computer trends were analyzed and the FWCS setpoints adjusted as required. The transient was repeated until no further adjustments were required. The transients listed in Table 6.3.10.1 were completed first on FWCS #1 and then on FWCS #2.

C. RRS Tests; 80% Power

The reactor was stabilized at 80% power with CEA Group 6 between 113" and 135" withdrawn, the CEDMCS in manual sequential, all other control systems in automatic and the automatic withdrawal inhibit feature removed. Using RRS #1 (#2) for temperature control Tavg was decreased 4.5°F less than the Tref, The CEDMCS was placed in Automatic Sequential and the resultant transient recorded on strip chart recorders and computer trend groups. The CEDMCS was returned to the manual sequential mode, the results analyzed and the RRS setpoints adjusted as required. Tavg was then increased 4.5°F greater than Tref, the CEDMCS was placed in Automatic Sequential and the resultant transient recorded. The CEDMCS was returned to the manual sequential mode, the results were analyzed and RRS setpoints adjusted as required. Either or both transients were repeated as necessary until no further adjustments were necessary. Following completion of transients, the automatic withdrawal feature was inhibited.

D. MDS Tests; 50% and 80% Power

The reactor was stabilized at the specified power with CEA Group 6 between 113" and 135" withdrawn, the CEDMCS in manual sequential, the MDS in the Ready Mode and other control systems in automatic. The CEDMCS was then placed in auto sequential (at the 50% power plateau only). Turbine load was lowered by 20 MWe at less than 1/2% per minute from the turbine control panel. The MDS was placed in Operator Set Mode and turbine load was returned to its original value at 1% per minute.

This transient was recorded using strip chart recorders and computer trends. The test data was analyzed and the MDS setpoints adjusted as necessary. The transient was repeated until no further setpoint adjustments were necessary.

E. Plant Trips; 100% Power

Various plant parameters were monitored using strip chart recorders during performance of the scheduled plant trips.

6.3.10.3 Test Results

A. Steady State Test

Data from the various system parameters monitored during this test indicate that the control systems maintain steady state conditions when in the automatic mode of control.

B. FWCS Test

Brush pen recorder data and computer trend group data indicate that proper feedwater control was maintained. This data indicated that the level demanded by the FWCS #1 (#2) would be achieved in Steam Generator A (B) while the level in the remaining steam generator was relatively unaffected. During the transient a slight overshoot of the demanded setpoint was seen, with the level settling out in a fairly short period of time.

C. RRS Test

Analysis of test data revealed that the artificially created power defect was dampened quickly with little overshoot. Proper CEA motion was demanded by each RRS.

D. MDS Test

The MDS performed as designed. The demanded load was achieved at the desired rate with minimal oscillations.

6.3.10.4 Conclusions

A. Automatic Steady State Test

The ability of the FWCS, SDBCS, MDS, RRS, PLCS, and PPCS to maintain plant parameters within their control bands at steady state conditions has been demonstrated. No control system setpoint adjustments were necessary.

B. FWCS Test

The FWCS has been shown to operate as expected in the Automatic Control Mode. The ability of FWCS #1 and #2 to achieve demanded setpoints at various rates has been demonstrated. No FWCS setpoint adjustments were necessary.

C. RRS Test

Both RRS #1 and #2 operated satisfactorily to maintain Tavg within the Tref control band as designed. At 80% power, the RRS Tavg program and Tref transmitters were adjusted to reflect actual plant conditions.

D. MDS Test

The MDS has been shown to operate properly to control turbine load during both transient and steady state conditions.

E. Plant Trips

The required data was monitored for the planned plant trips.

TABLE 6.3.10.1

FWCS TESTS

	INITIAL STEAM GENERATOR LEVEL	FINAL STEAM GENERATOR LEVEL	RATE OF CHANGE
1)	70%	60%	10% per minute
	60%	70%	10% per minute
2)	70%	60%	1% per minute
	60%	70%	10% per minute
3)	70%	80%	10% per minute
	80%	70%	10% per minute
4)	70%	80%	1% per second
	80%	70%	10% per minute

6.3.11 SHAPE ANNEALING MATRIX AND BOUNDARY CONDITION MEASUREMENT TESTS

6.3.11.1 Purpose

The objective of this test was to measure the Shape Annealing Matrix (SAM) and to verify the Boundary Point Power Correlation (BPPC) constants for the CPC's. These constants are used in the CPC power distribution synthesis algorithm.

6.3.11.2 Test Method

The SAM coefficients and BPPCs are determined from a least squares analysis of the measured excore detector readings and corresponding axial power distribution determined from the incore detector signals. Since these values must be representative for rodded and unrodded cores throughout life, it is desirable to use as wide a range of core axial shapes as are available to establish their values. This is done by initiating an axial Xenon oscillation. Data is periodically gathered during the oscillations so that it will be representative of as wide a range of axial shapes as possible. Incore, excore and related data are recorded, and incore analysis is performed which relates the incore detector signals to power distribution and summarizes the necessary power distribution and excore detector data in a form and format which can be easily input to programs used to perform the least squares fitting. The incore analysis results include:

A. Excore detector fractional responses for each CPC;

B. Core peripheral power fractions for the upper, middle, and lower third of the core;

C. Core average power fractions for the upper, middle, and lower third of the core; and

D. Upper and lower core boundary average power.

The above output is used to determine a "best set" of SAM coefficients and BPPC constants by using least squares analysis. The results of these calculations are then used to adjust the power uncertainty factors (BERR1, BERR3) used by the CPC's in the LPD and DNBR calculations.

6.3.11.3 Test Results

No additional data was collected during this period. However, an error was discovered in the Plant Computer flux integration routine which required re-analysis of the previous data.

As a result of the error, the calculated burn-ups of the fixed incore detectors were slightly in error when the test was performed, resulting in erroneous flux level outputs from the detectors. Appropriate corrections were made to the original data and 118 new incore detector analysis cases were run. From these cases, new shap annealing matrices (SAM's) and new boundary point power correlation coefficients (BPPCC's) were calculated, as shown in Table 6.3.11.1. New values of the uncertainty factors BERR1 and BERR3 were also determined; these are also shown in Table 6.3.11.1.

6.3.11.4 Conclusions

Satisfactory SAM's, BPPCC's, and uncertainty factors have been obtained for all four CPC channels using corrected data. Combustion Engineering has reviewed this data and found it acceptable. The data in Table 6.3.11.1 has been entered into the CPC's.

TABLE 6.3.11.1

SHAPE ANNEALING MATRICES

SAM ELEMENT	ID	CPC A	CPC B	CPC C	CPC D
S_{11}	078	6.90646	6.47595	7.00111	4.84275
S_{12}	079	-1.04998	-0.19791	-1.50303	1.81810
S_{13}	080	-2.81050	-3.35249	-2.39350	-4.06252
S_{21}	081	-0.90103	1.07575	-0.58835	0.64198
S_{22}	082	4.82192	1.74088	4.48701	2.44015
S_{23}	083	-0.62382	0.97042	-0.54597	0.56958
S_{31}	084	-3.00849	-4.54620	-3.40516	-2.48616
S_{32}	085	-0.77259	1.46251	0.01473	-1.25990
S_{33}	086	6.43424	5.37673	5.93667	6.48966

POWER UNCERTAINTY FACTORS

BERR1	1.1665	1.1644	1.1582	1.1582
BERR3	1.2333	1.2311	1.2245	1.2245

BPPC COEFFICIENTS

1 = 0.01311

2 = 0.07022

3 = 0.01288

4 = 0.07644

6.3.12 80% LOSS OF FLOW TRIP

6.3.12.1 Purpose

The objective of this test was to measure plant response to a total loss of reactor coolant flow while at 80% power and to verify natural circulation. The results of this test will also be used for the purpose of CESEC verification.

6.3.12.2 Test Method

While operating at steady state 80% power level, total loss of flow was accomplished by simultaneously tripping all four reactor coolant pumps thus causing a CPC DNBR reactor trip. RCS parameters were monitored on the plant computer, brush recorders and a minicomputer throughout the transient and until full flow conditions were re-established. The above data was then used to calculate the decay heat power level and power-to-flow ratio.

6.3.12.3 Test Results

The reactor coolant pumps were secured and the reactor tripped on Low DNBR within 1 second. Natural circulation was verified by observing the trends of T_{hot} and T_{cold} and In-core Thermocouple data. The power-to-flow ratio was calculated over two different time periods and both met the acceptance criteria of less than 1.0. The first period (1210 to 1236) power-to-flow ratio was 0.288 and the second (1250 to 1308) was 0.250. Figures 6.3.12.1 through 6.3.12.24 display the results of various plant parameters versus time during the transient.

6.3.12.4 Conclusions

Following a complete loss of flow the RCS established natural circulation and met all acceptance criteria on parameters relating to the transient. In addition, data necessary for CESEC verification was obtained.

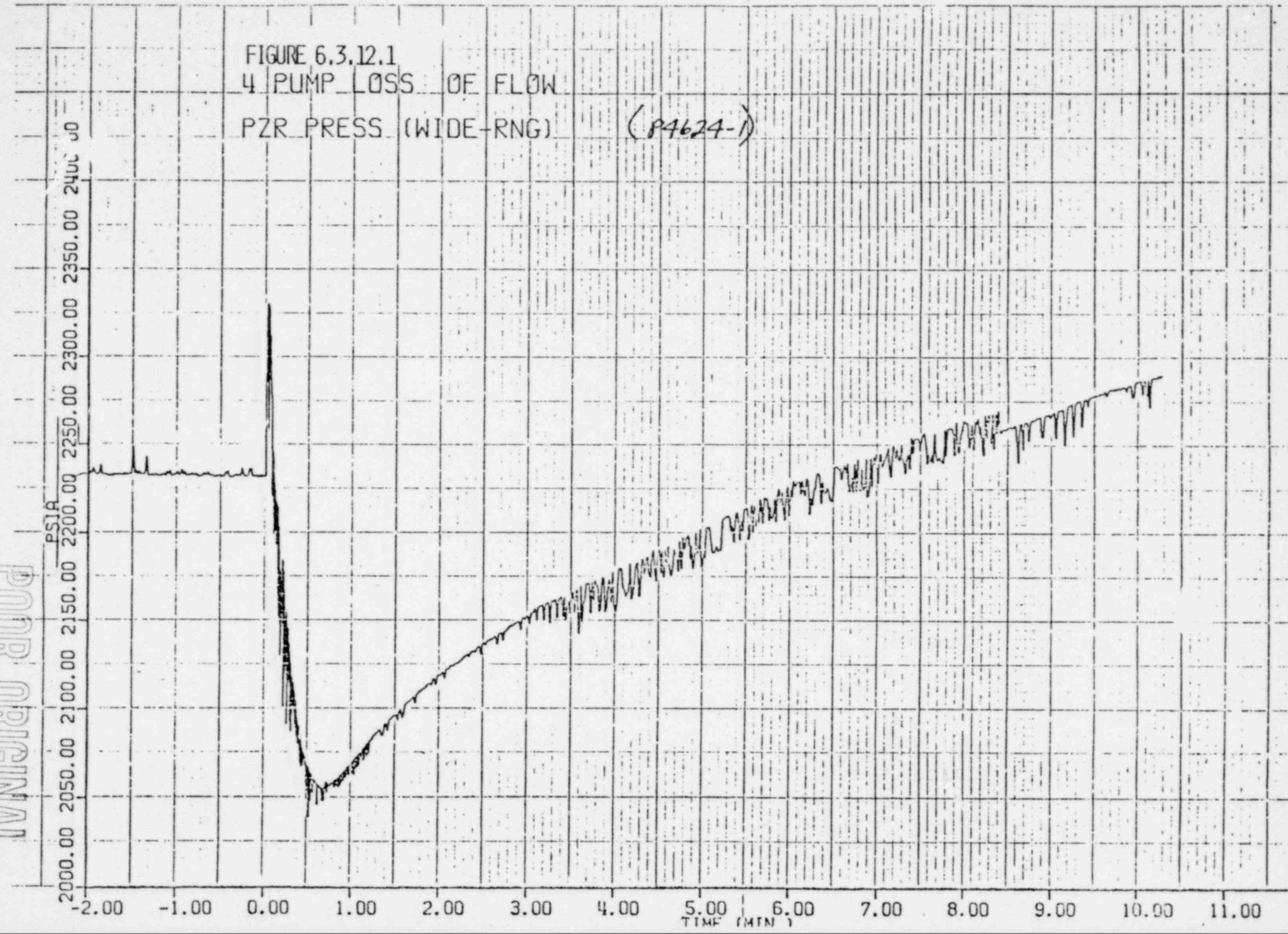
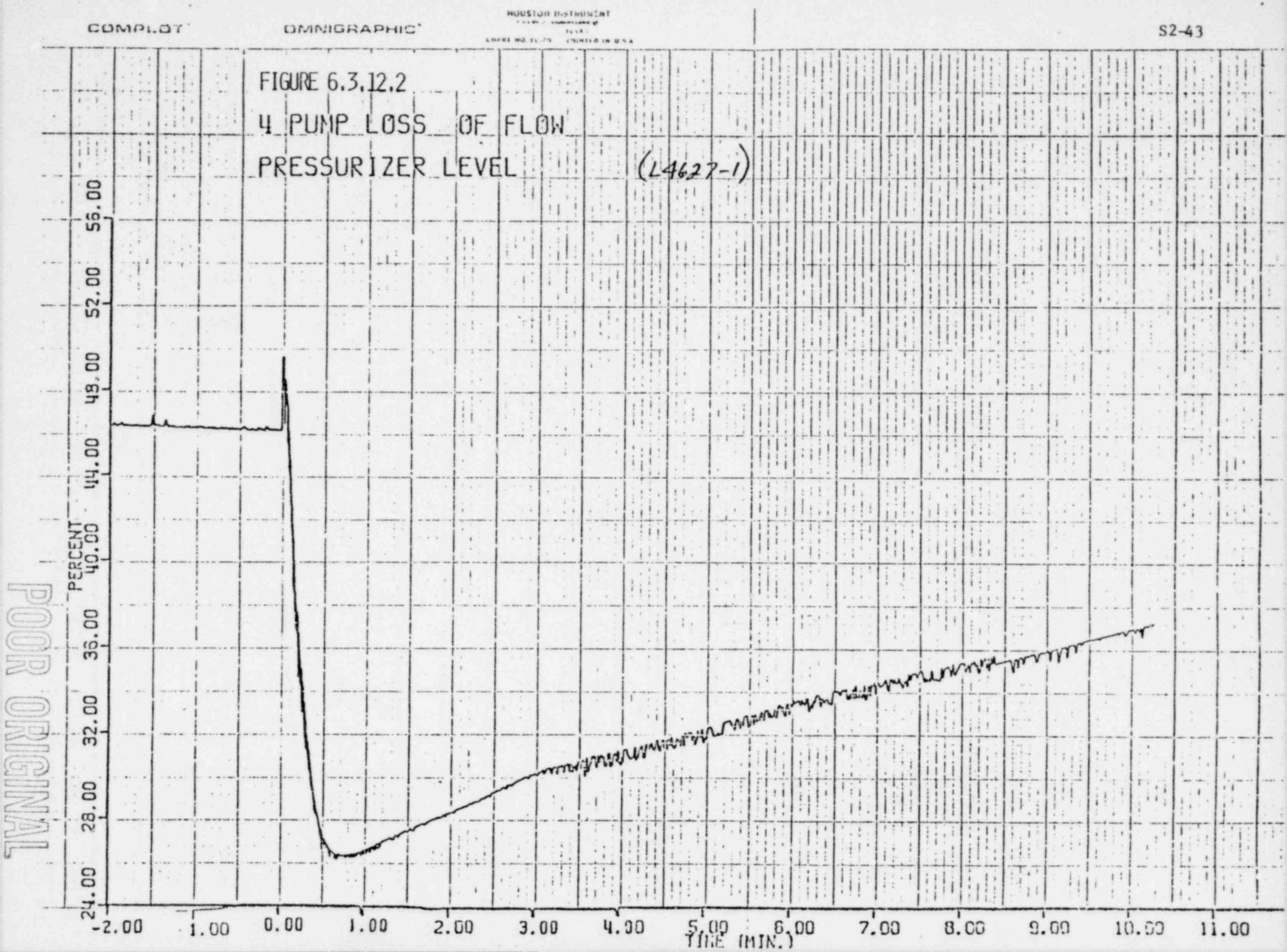
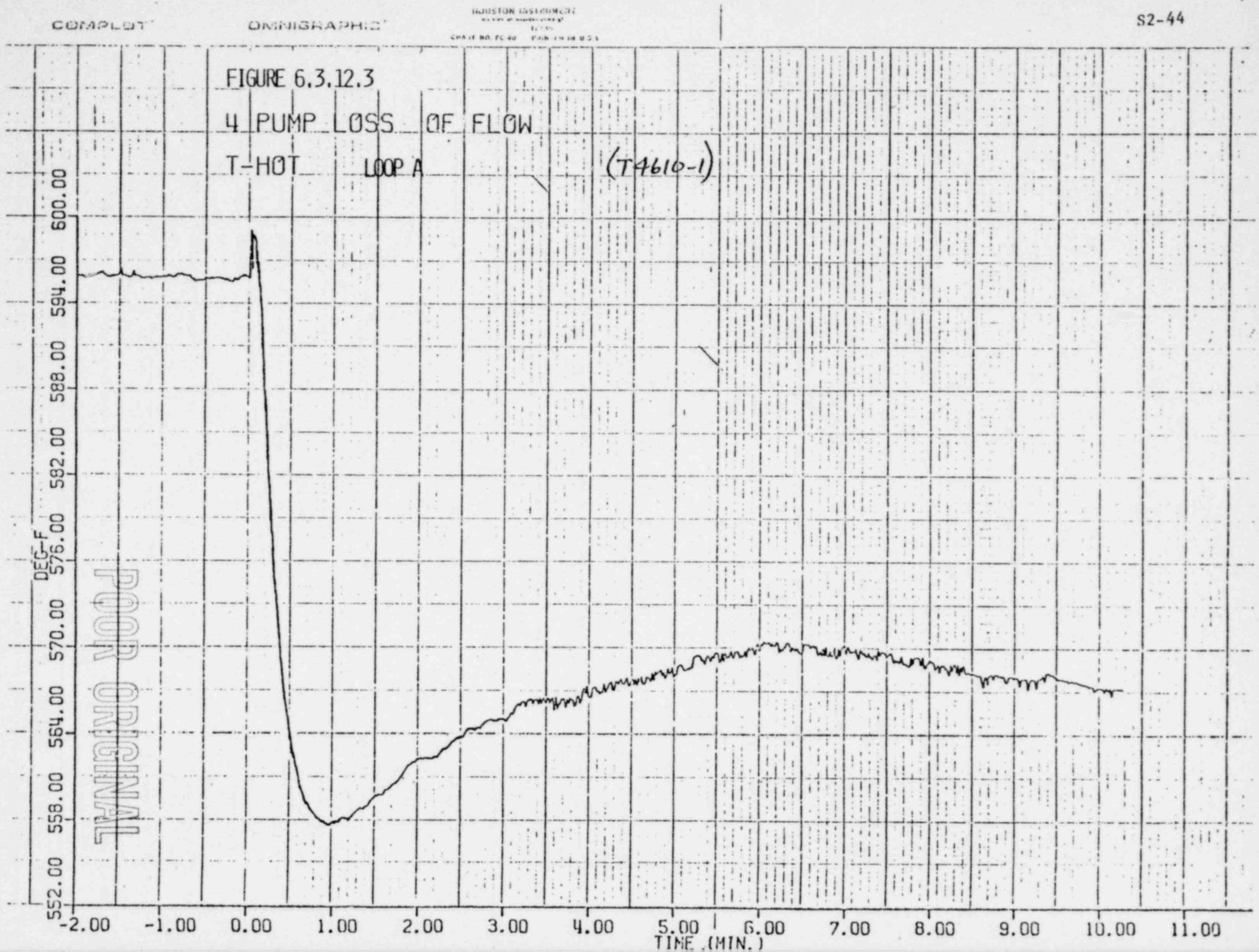


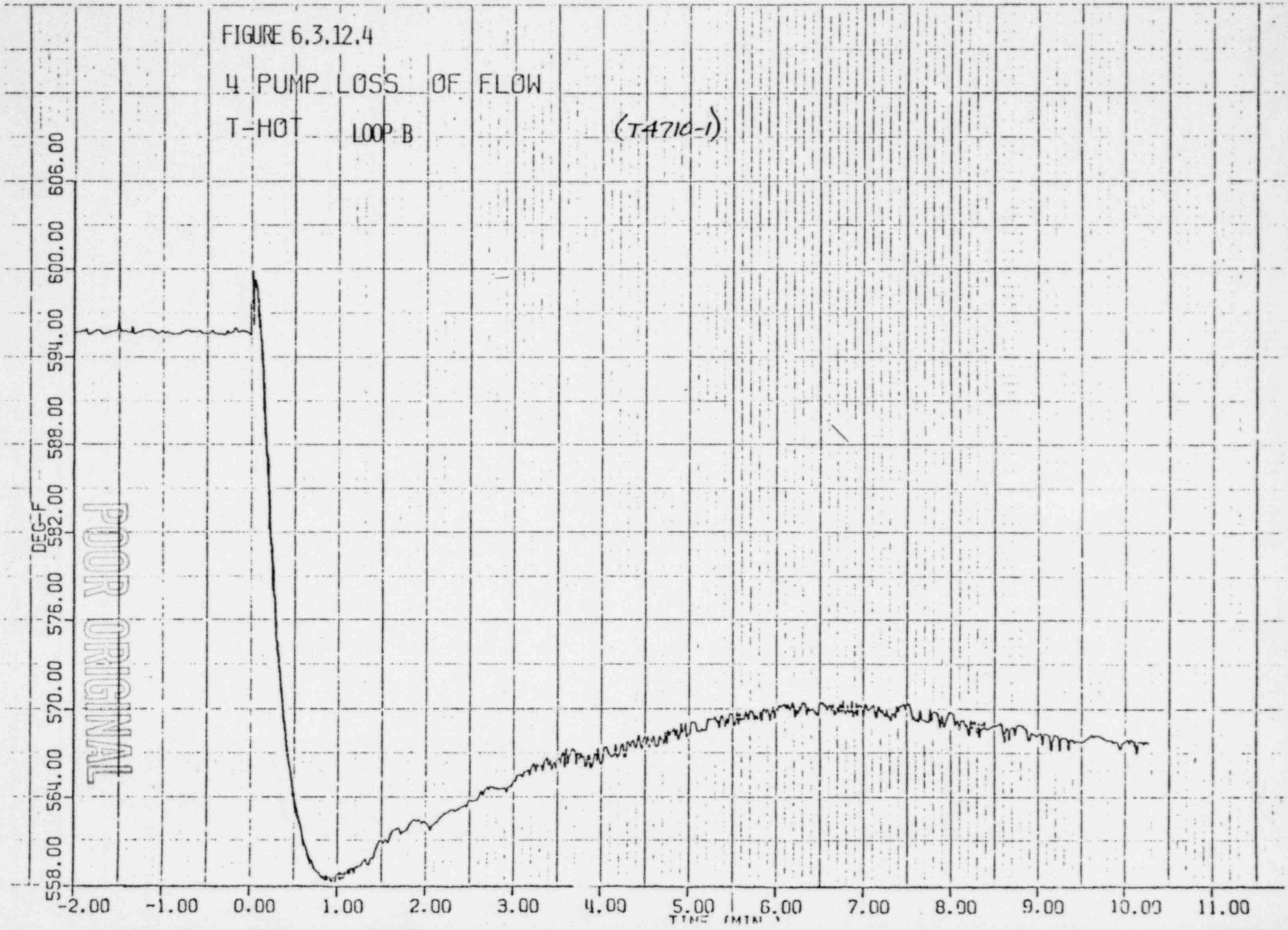
FIGURE 6.3.12.1
4 PUMP LOSS OF FLOW
PZR PRESS (WIDE-RNG)
(P4624-1)
PSIA
2000.00
2050.00
2100.00
2150.00
2200.00
2250.00
2300.00
2350.00
2400.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)

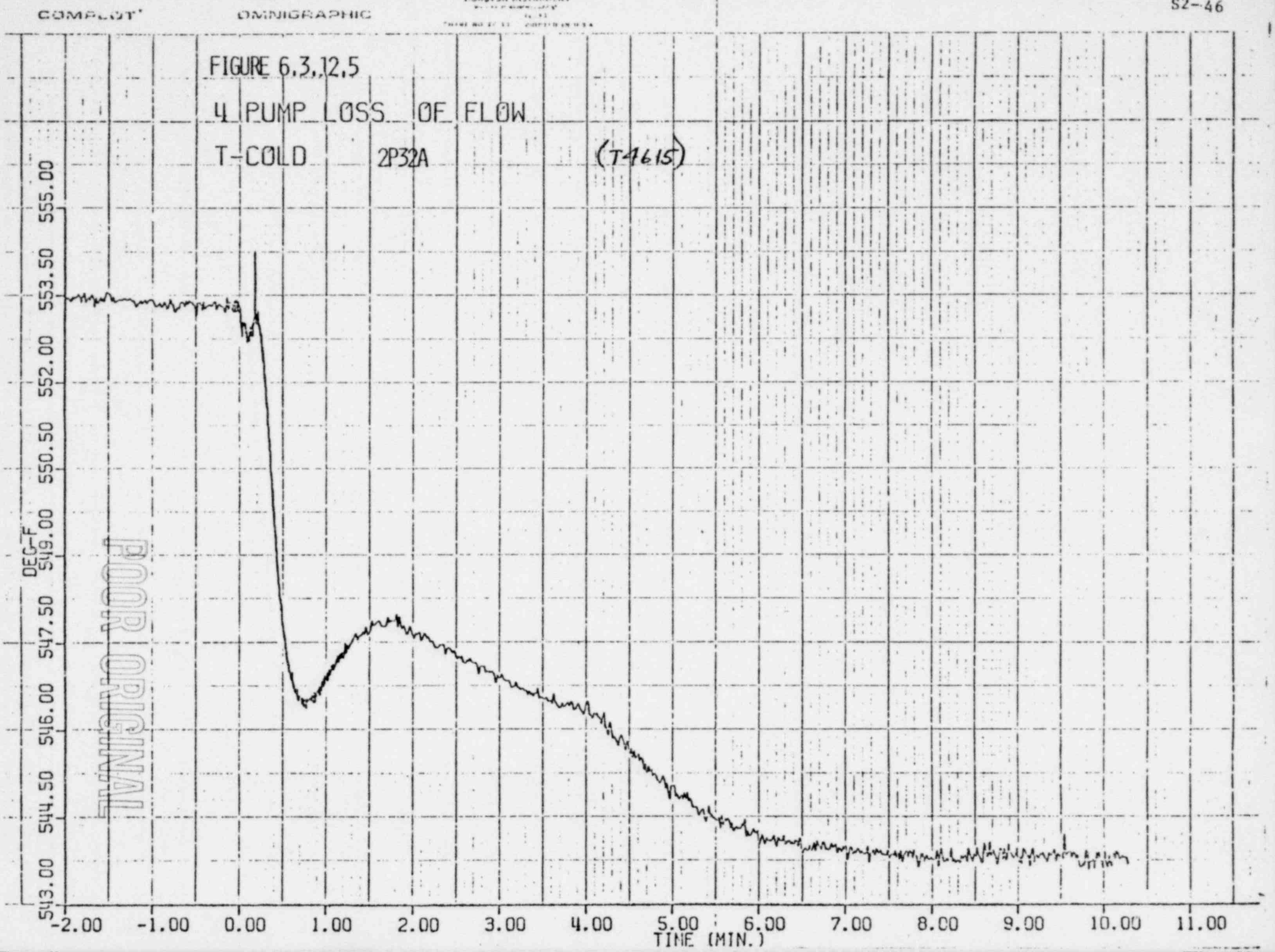
S2-43


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.12.2
4 PUMP LOSS OF FLOW
PRESSURIZER LEVEL
(L4627-1)
PERCENT
56.00
52.00
48.00
44.00
40.00
36.00
32.00
28.00
24.00
-2.00
1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL

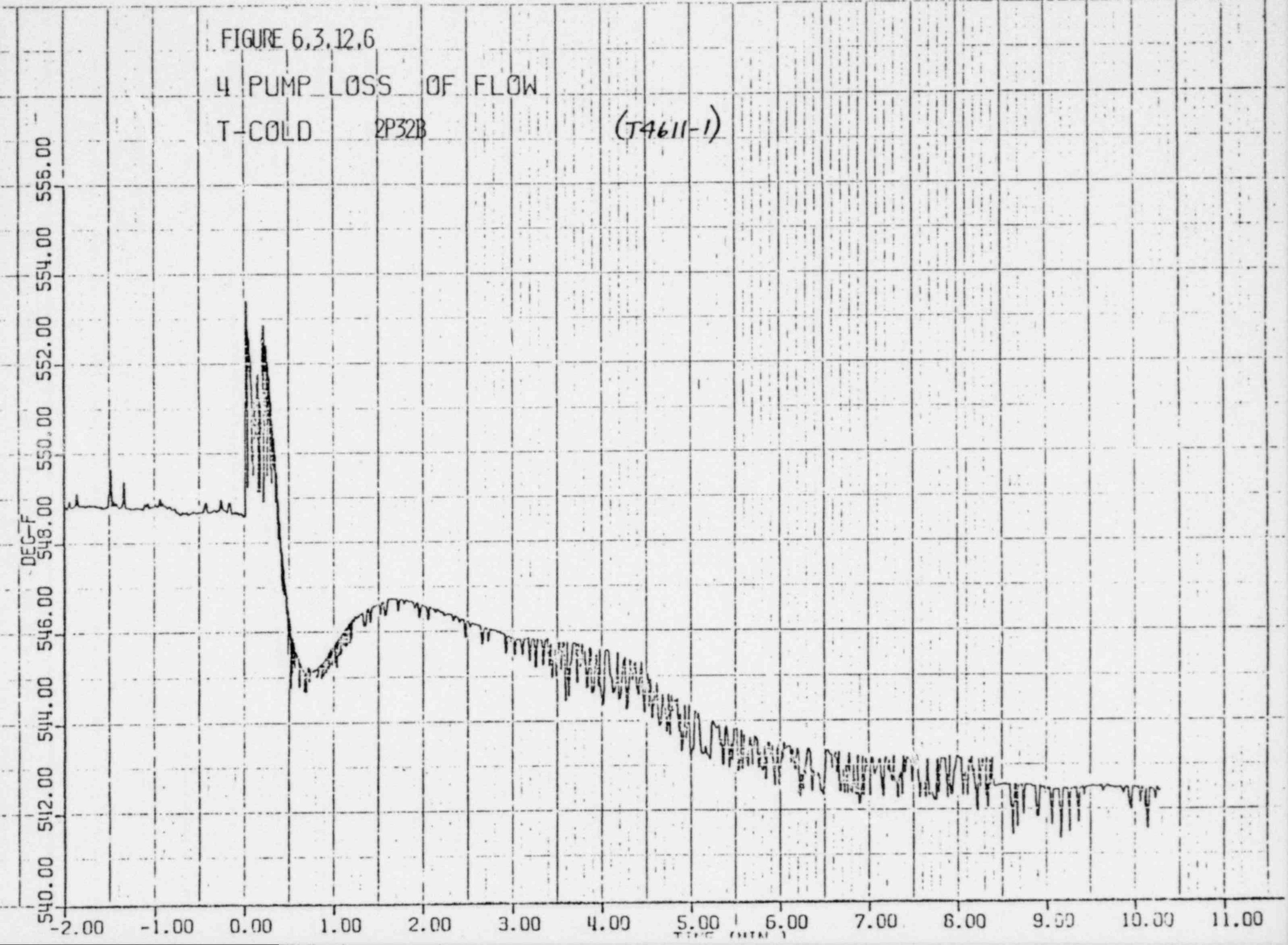

COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.12.3
4 PUMP LOSS OF FLOW
T-HOT
LOOP A
(T4610-1)
DEG-F
600.00
594.00
588.00
582.00
576.00
570.00
564.00
558.00
552.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL

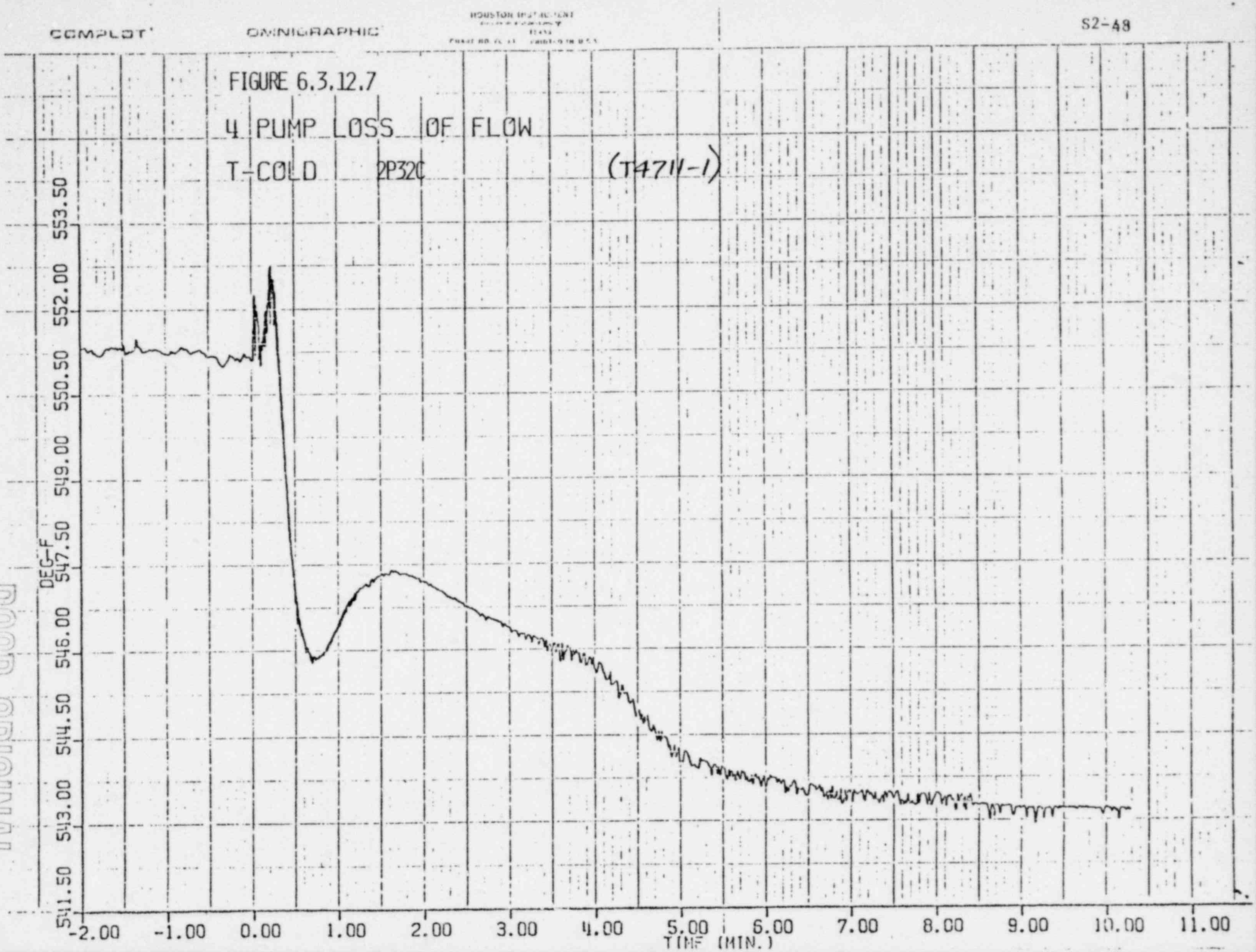
COMPLCT OMNIGRAPHIC

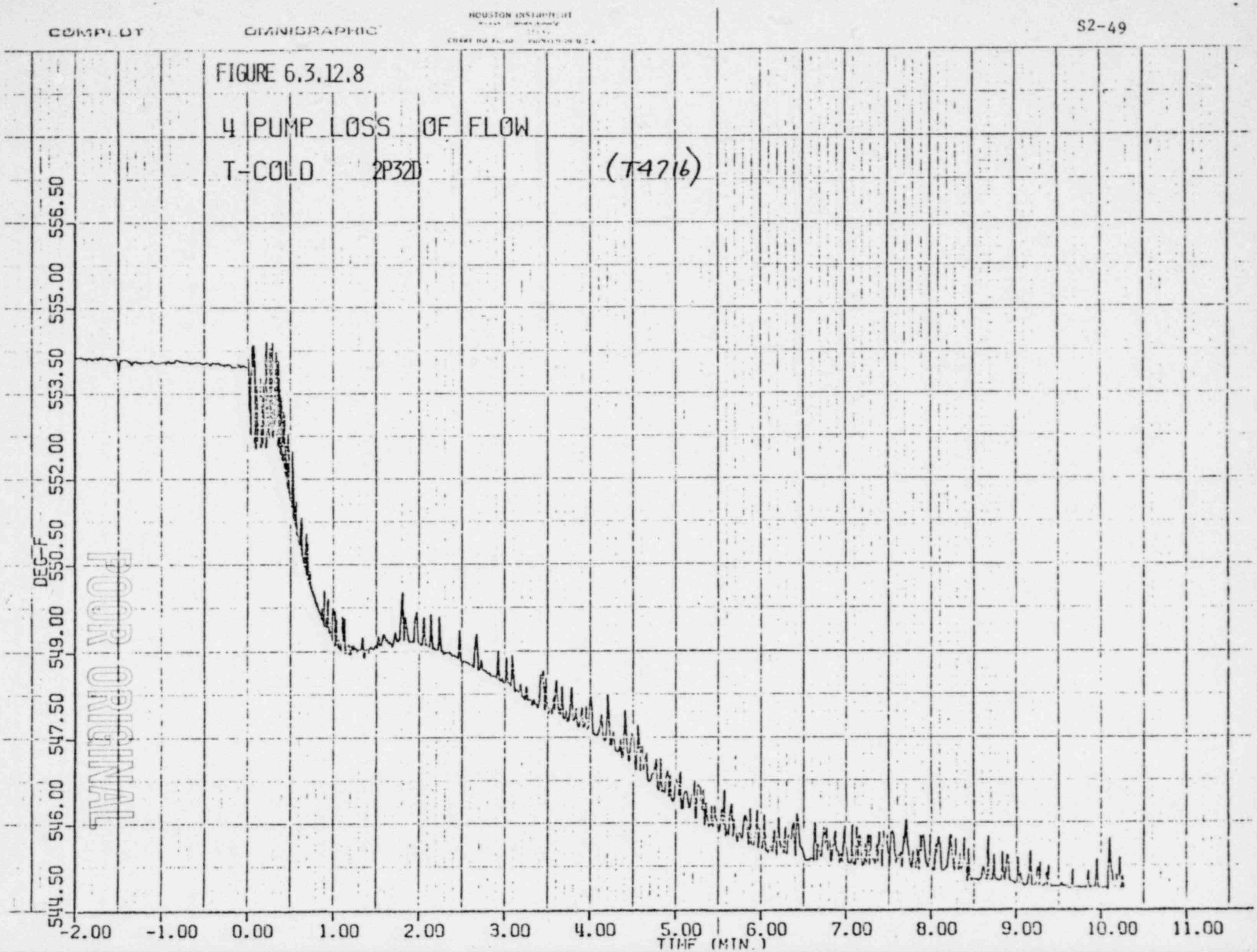


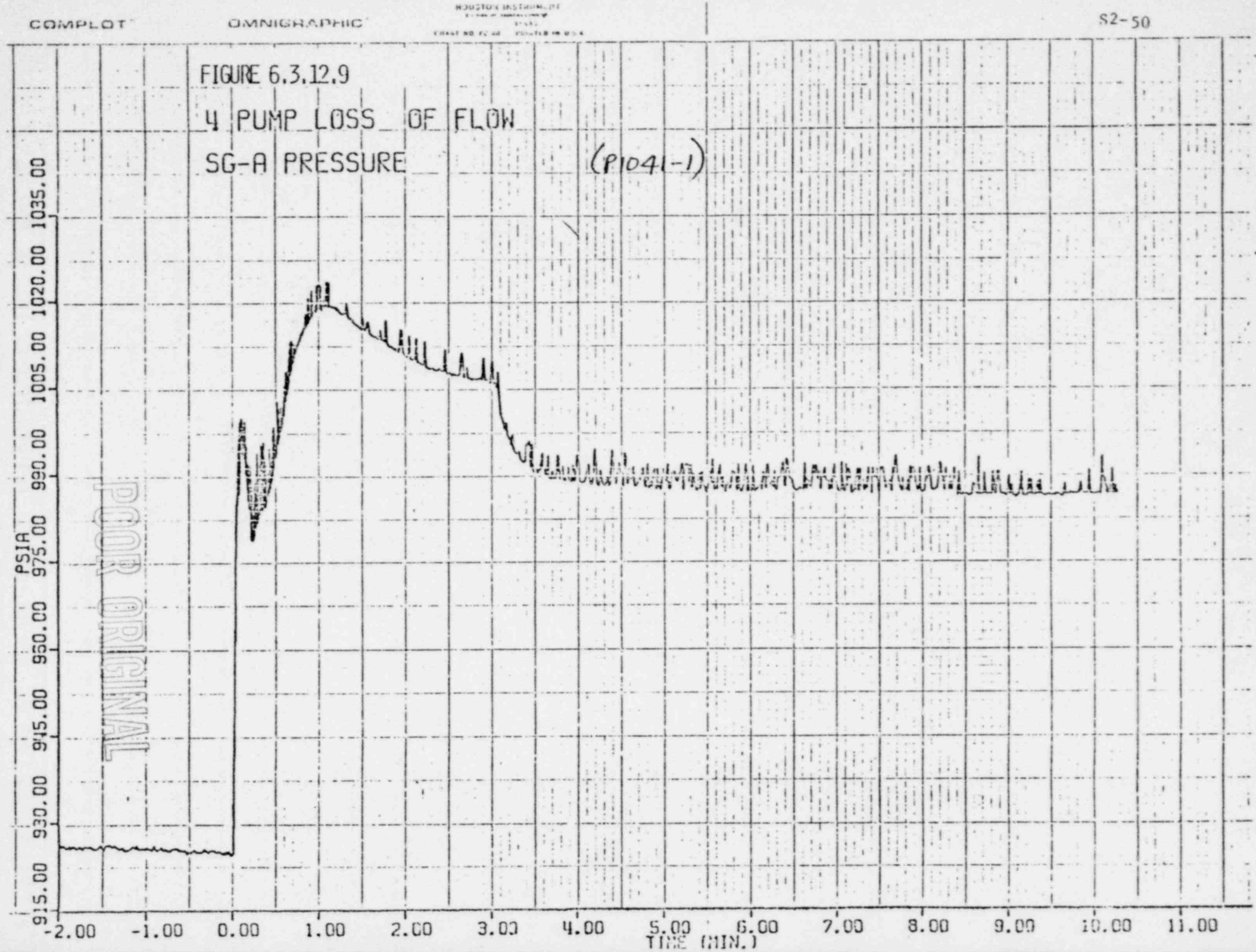

COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.5
4 PUMP LOSS OF FLOW
T-COLD 2P32A
(T4615)
555.00
553.50
552.00
550.50
549.00
547.50
546.00
544.50
543.00
DEG-F
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)

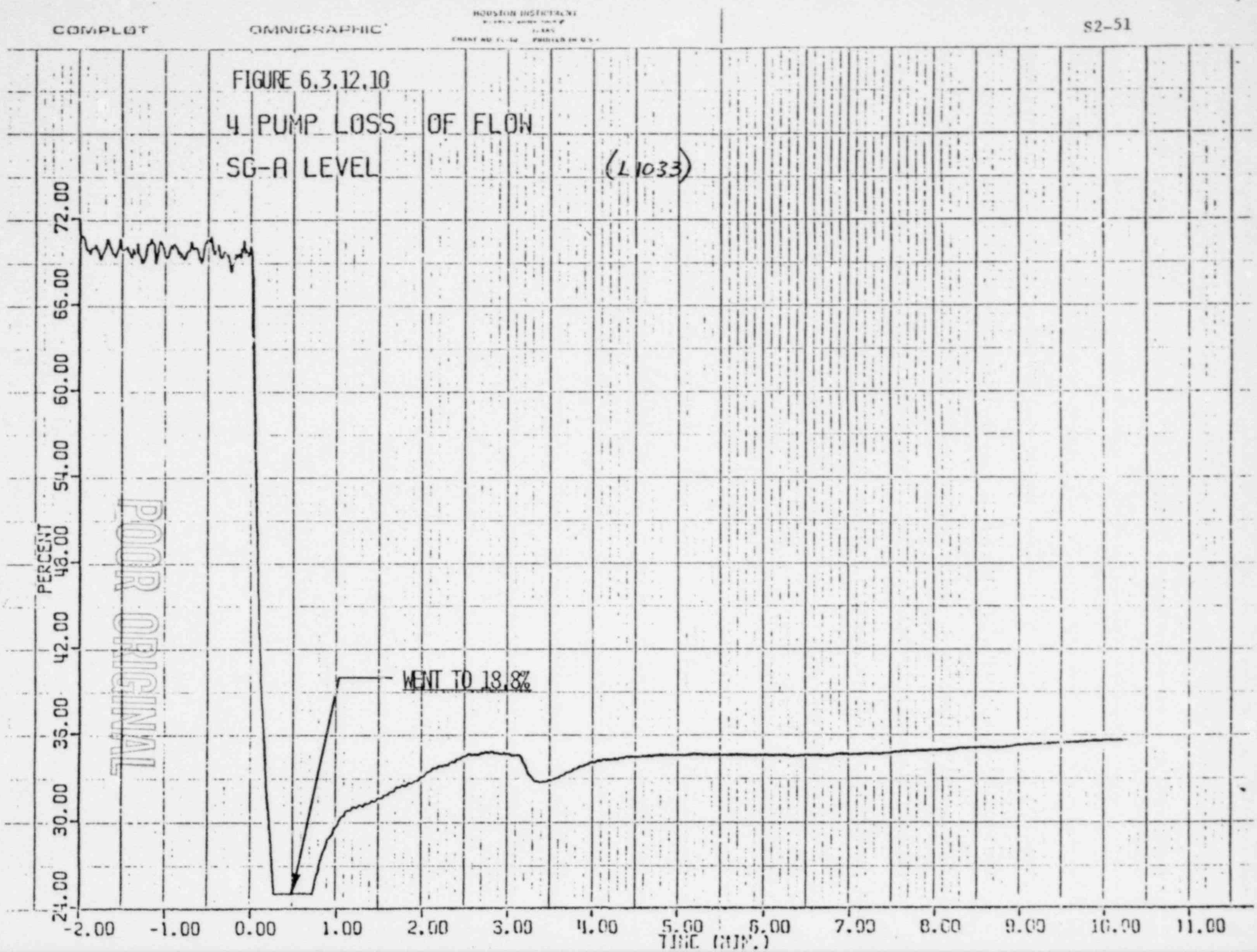
COMPLOT OMNIGRAPHIC

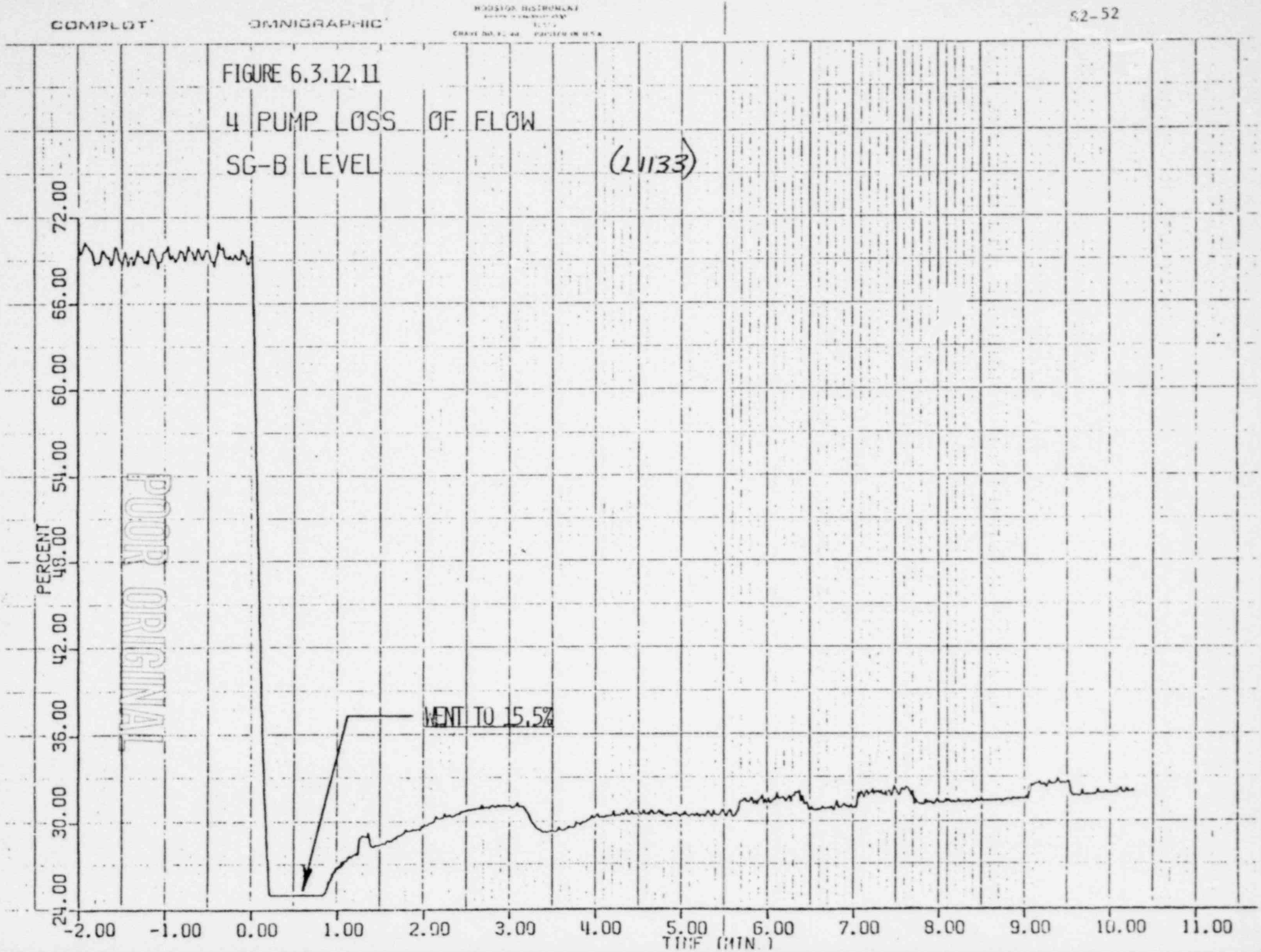



COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.7
4 PUMP LOSS OF FLOW
T-COLD 2P32C
(T4711-1)
DEG-F
553.50
552.00
550.50
549.00
547.50
546.00
544.50
543.00
541.50
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)

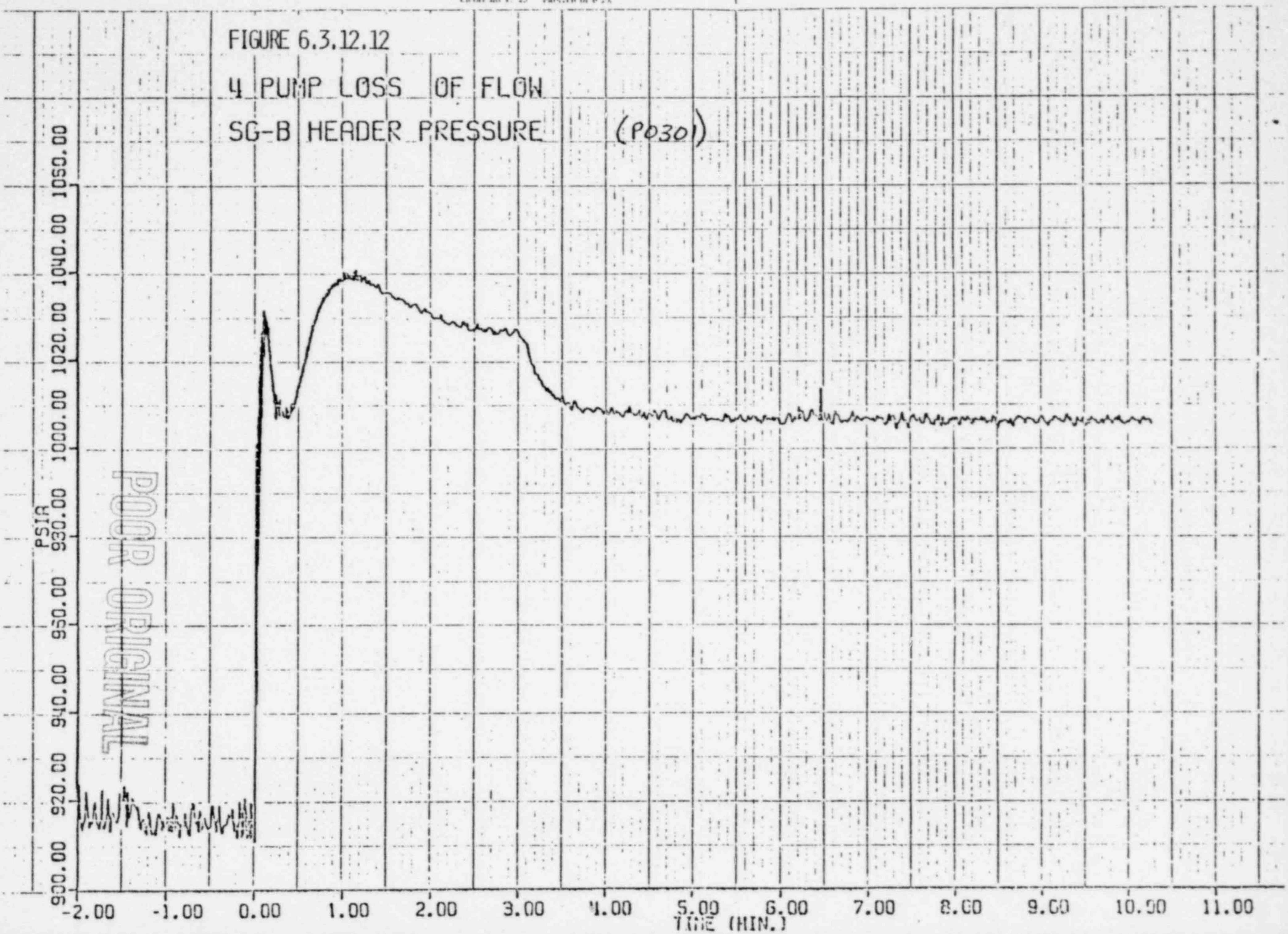

COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.12.8
4 PUMP LOSS OF FLOW
T-COLD 2P32D
(T4716)
DEG-F
556.50
555.00
553.50
552.00
550.50
549.00
547.50
546.00
544.50
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.9
4 PUMP LOSS OF FLOW
SG-A PRESSURE
(P1041-1)
PSIA
915.00
930.00
945.00
950.00
975.00
990.00
1005.00
1020.00
1035.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)


COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.10
4 PUMP LOSS OF FLOW
SG-A LEVEL
(L1033)
WENT TO 18.8%
PERCENT
72.00
66.00
60.00
54.00
48.00
42.00
36.00
30.00
24.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.11
4 PUMP LOSS OF FLOW
SG-B LEVEL
(L1133)
WENT TO 15.5%
PERCENT
72.00
66.00
60.00
54.00
48.00
42.00
36.00
30.00
24.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL

COMPLOT OMNIGRAPHIC HOUSTON INSTRUMENT



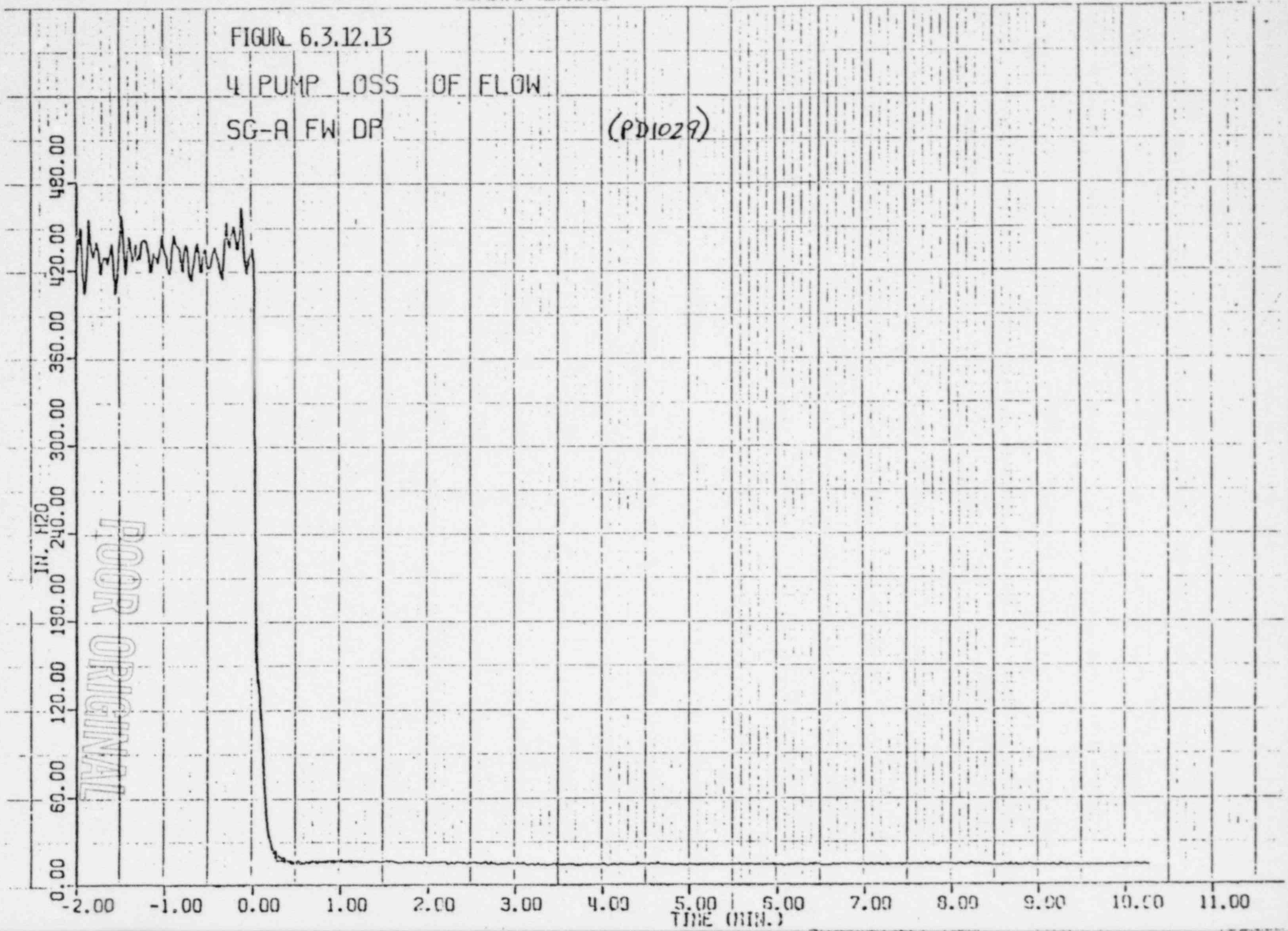
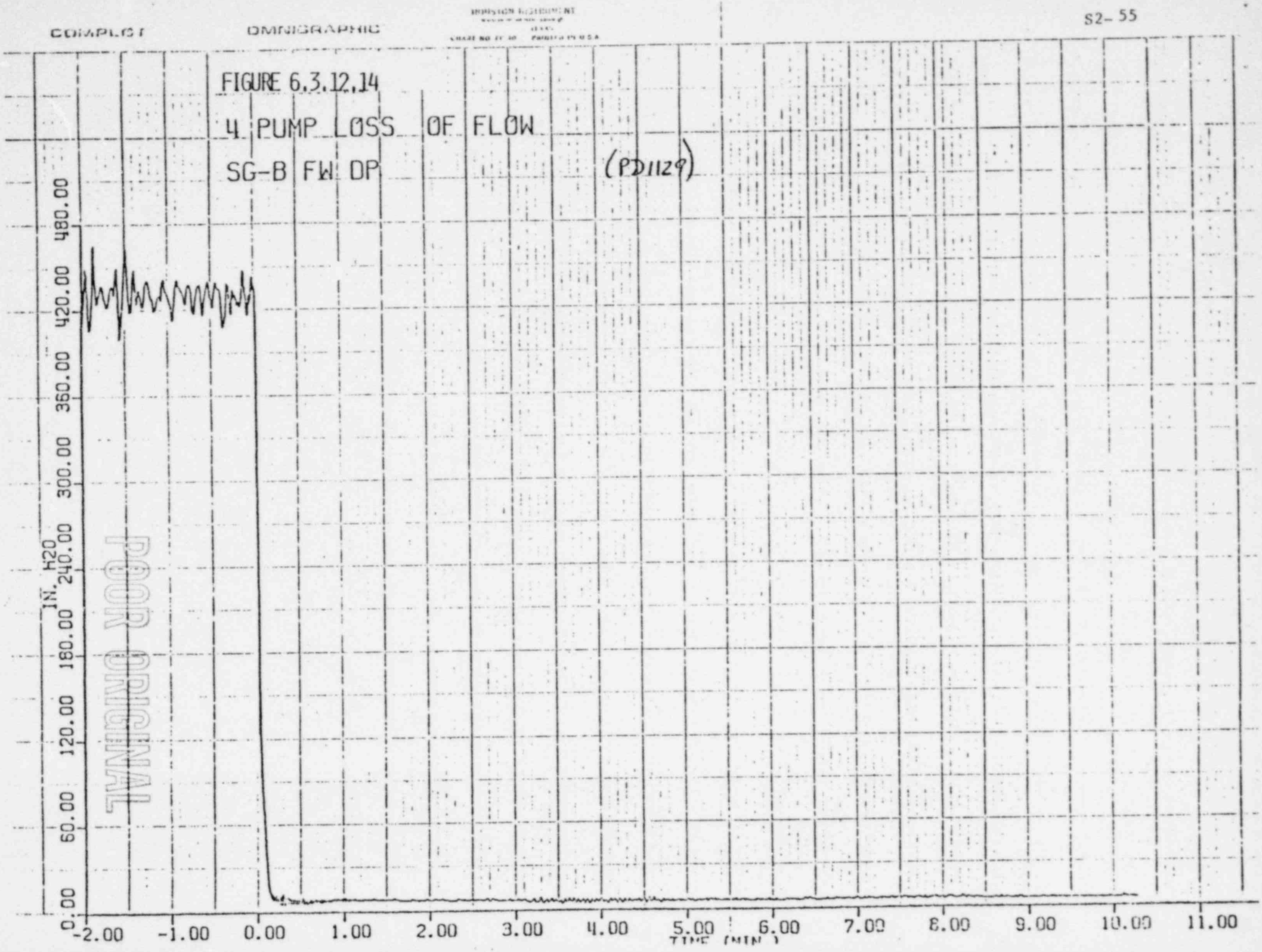
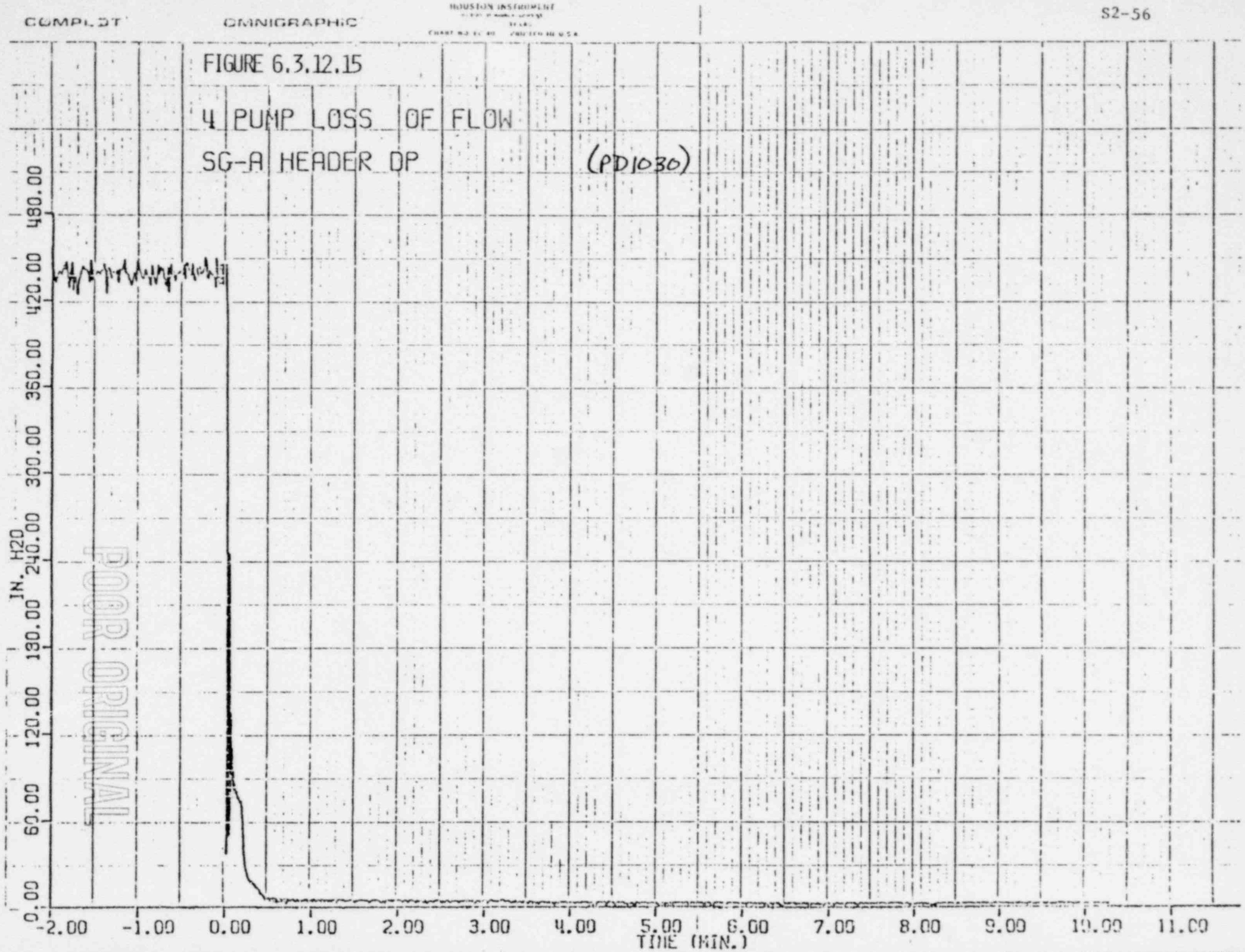
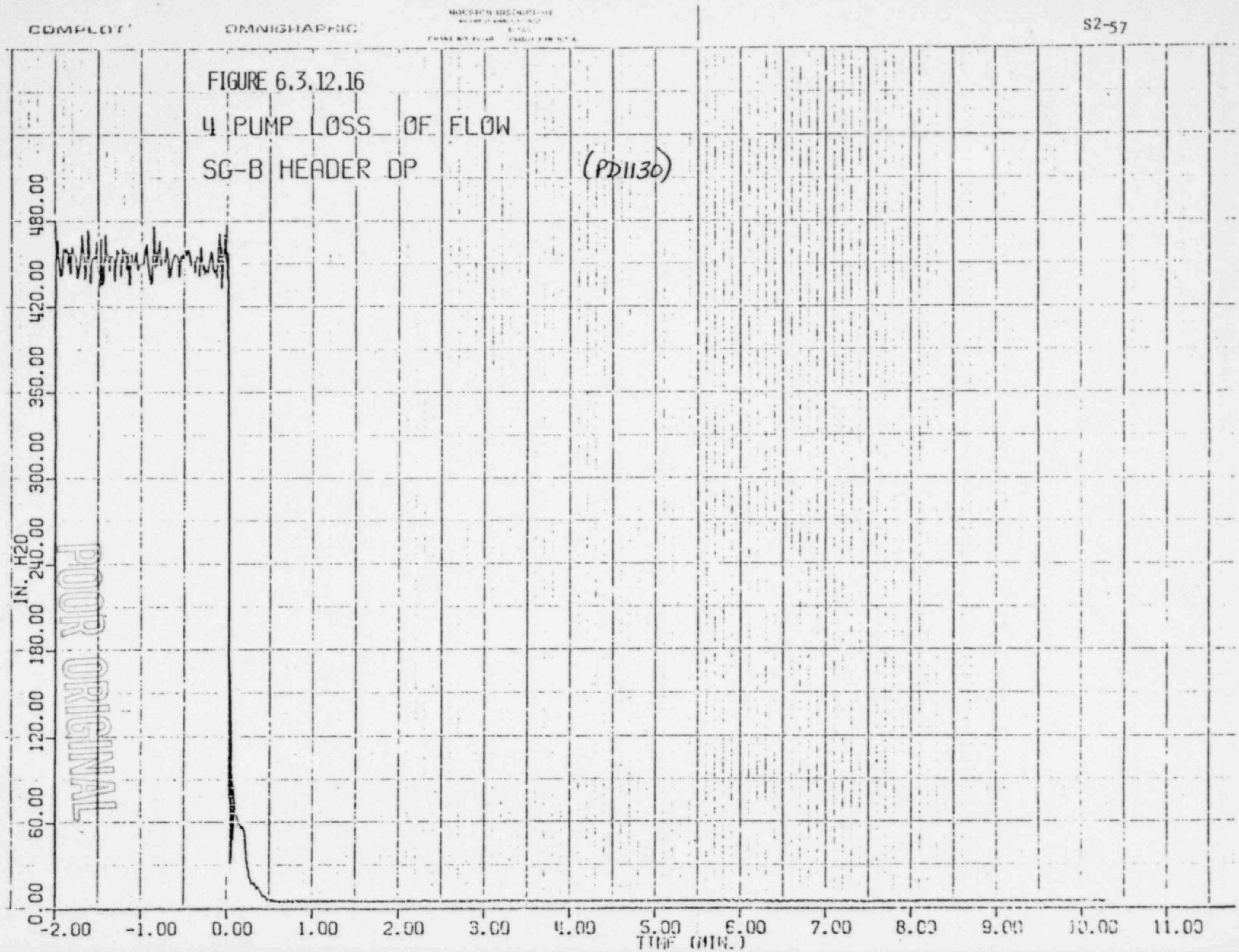


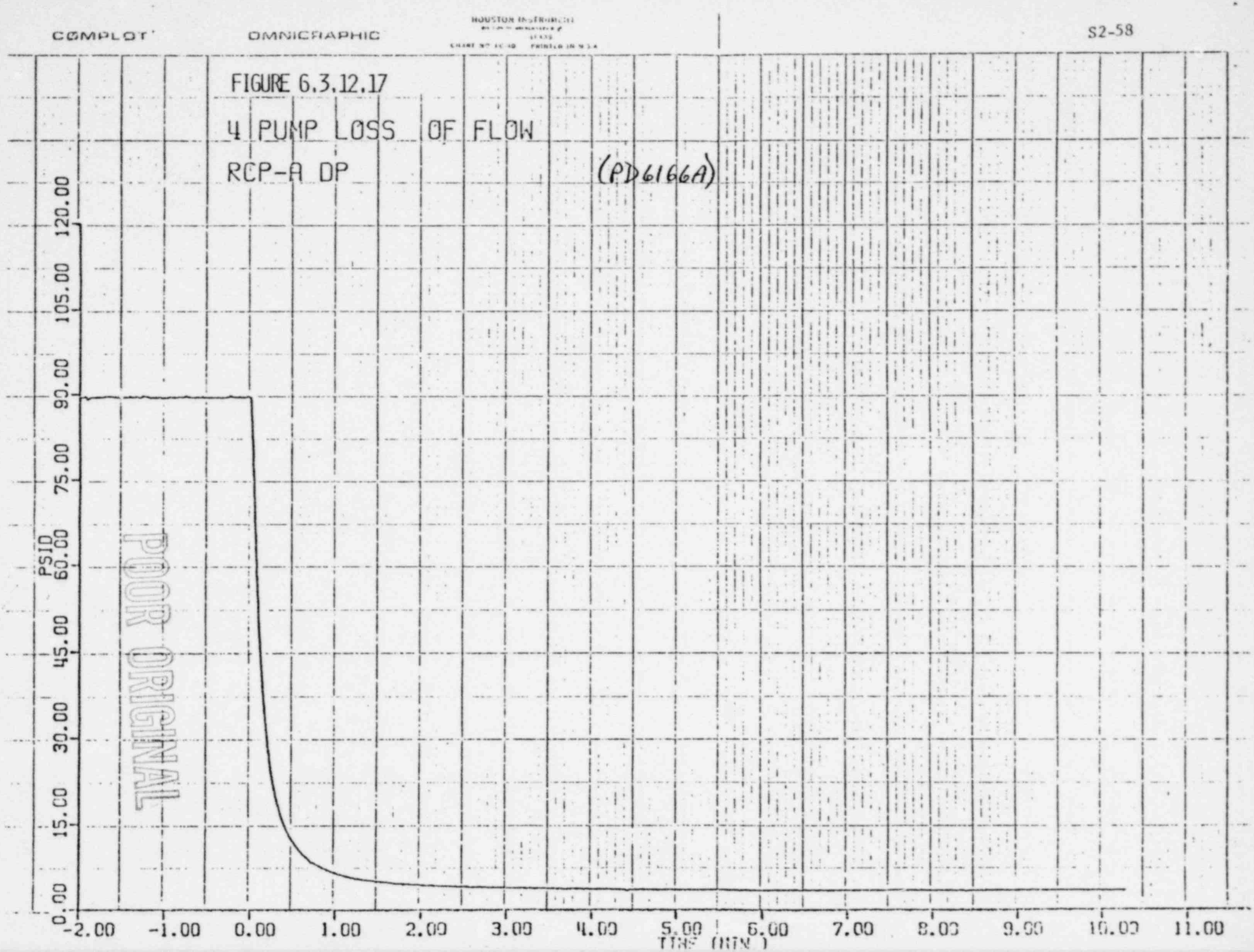
FIGURE 6.3.12.13
4 PUMP LOSS OF FLOW
SG-A FW DP
(PD1029)
IN. H2O
480.00
420.00
360.00
300.00
240.00
180.00
120.00
60.00
0.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL

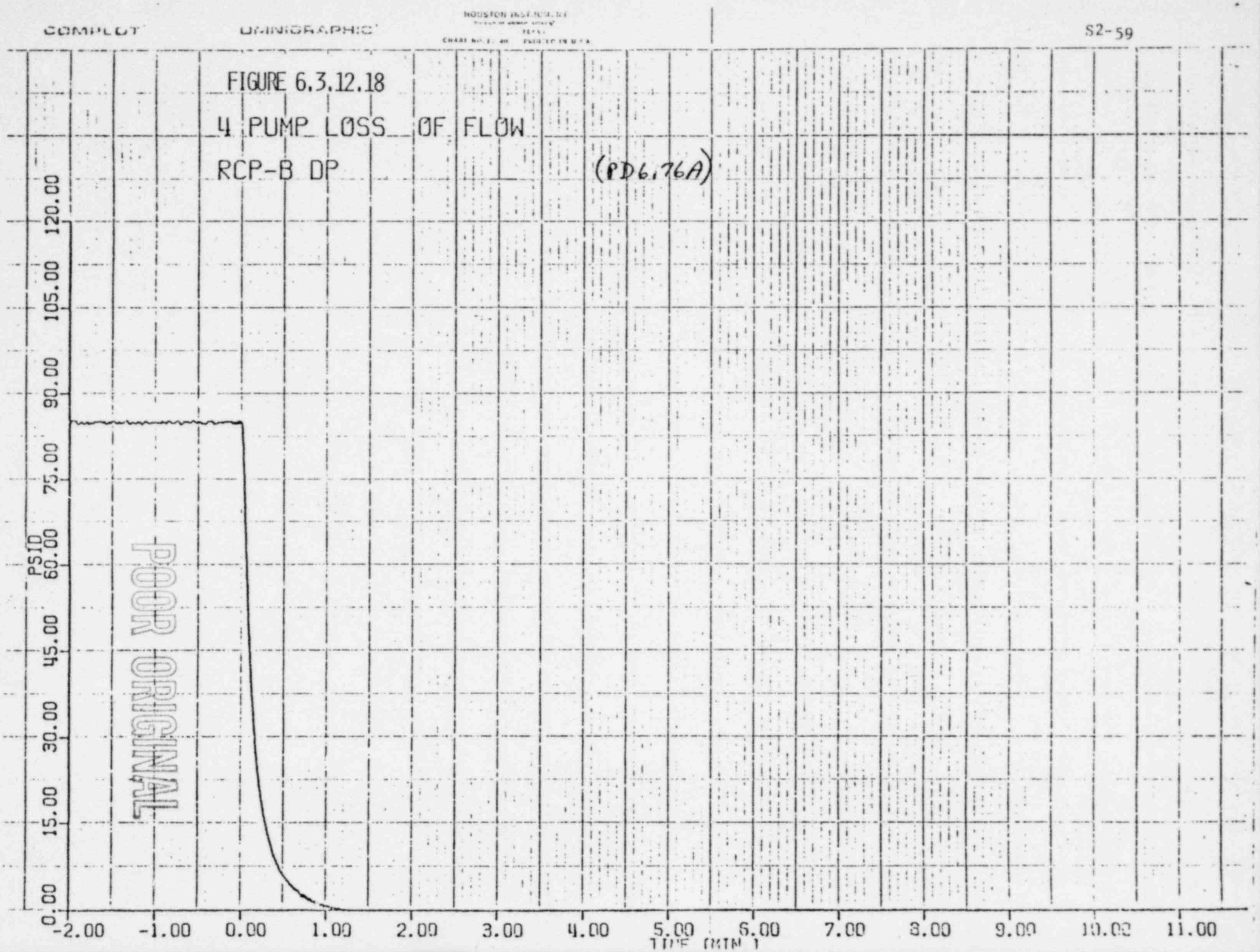


COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.14
4 PUMP LOSS OF FLOW
SG-B FW DP
(PD1129)
IN. H20
0.00
60.00
120.00
180.00
240.00
300.00
360.00
420.00
480.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL

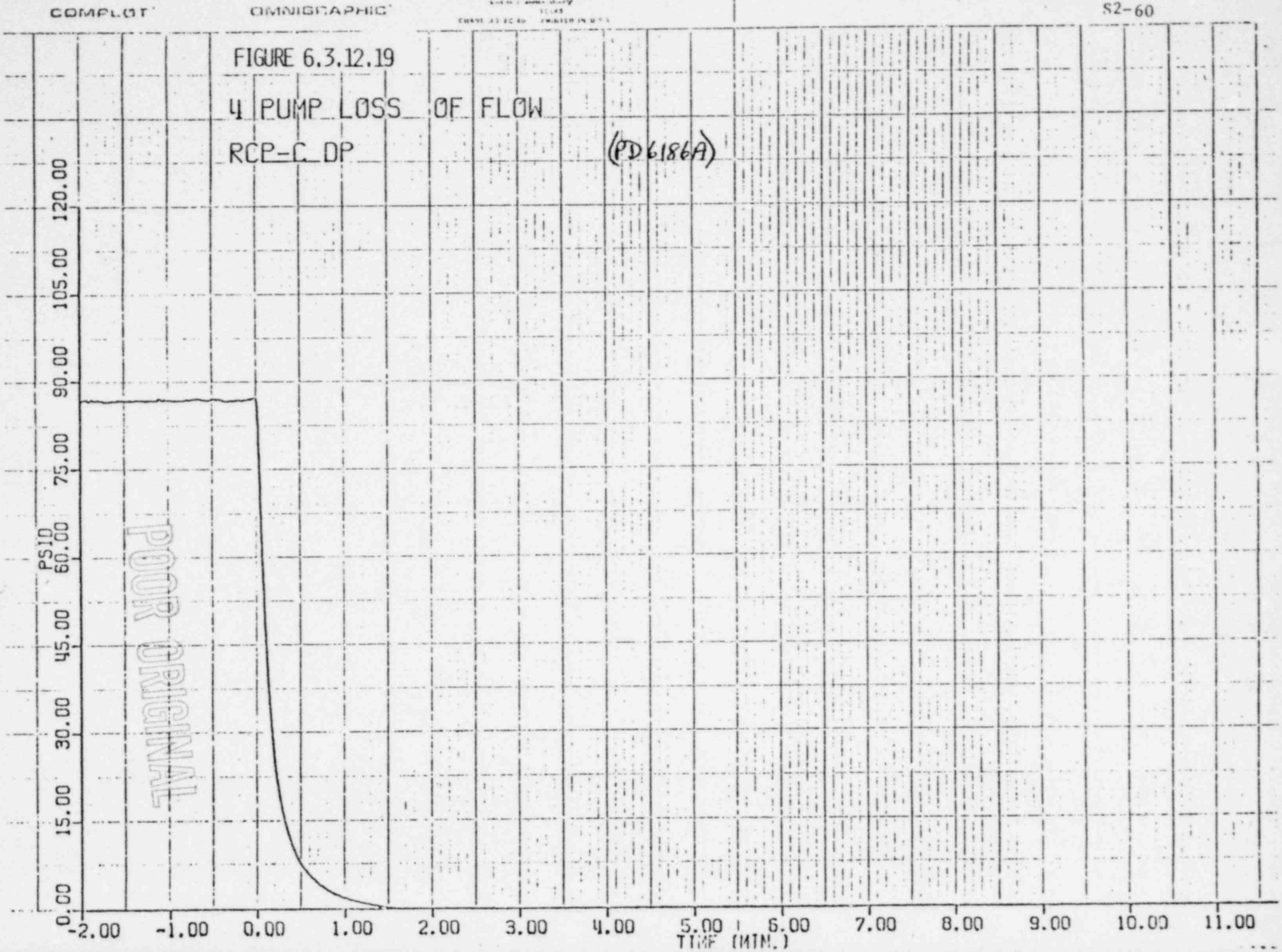

COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.15
4 PUMP LOSS OF FLOW
SG-A HEADER DP
(PD1030)
IN. H2O
480.00
420.00
360.00
300.00
240.00
180.00
120.00
60.00
0.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)

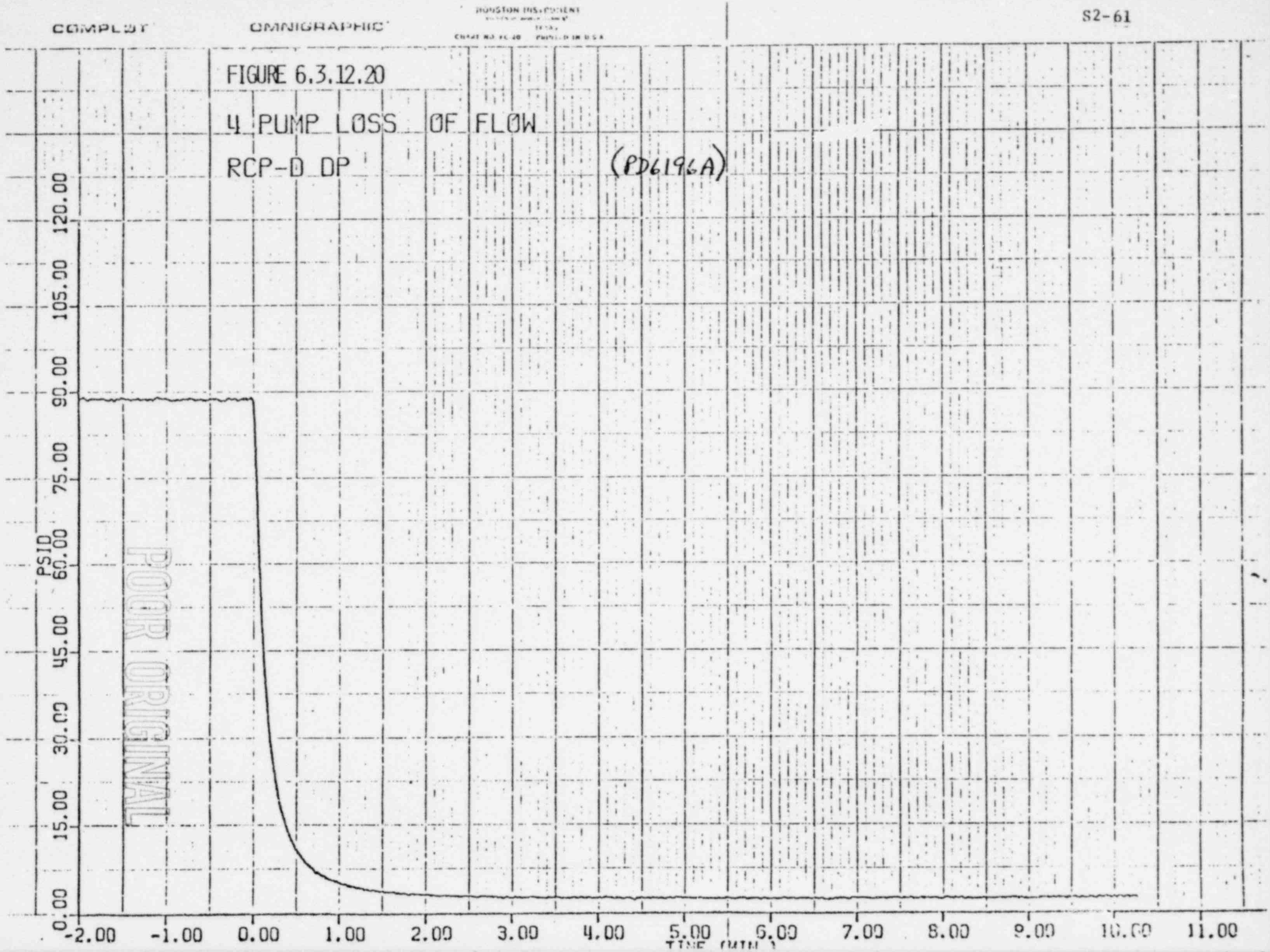

COMPLOT
OMNIGRAPHIC
FIGURE 6.3.12.16
4 PUMP LOSS OF FLOW
SG-B HEADER DP
(PD1130)
IN. H2O
480.00
420.00
360.00
300.00
240.00
180.00
120.00
60.00
0.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENTS
FIGURE 6.3.12.17
4 PUMP LOSS OF FLOW
RCP-A DP
(PD6166A)
PSID
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)
POOR ORIGINAL



COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.12.18
4 PUMP LOSS OF FLOW
RCP-B DP
(PD6.76A)
PSID
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
S2-60
FIGURE 6.3.12.19
4 PUMP LOSS OF FLOW
RCP-C DP
(PD6186A)
PSID
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.12.20
4 PUMP LOSS OF FLOW
RCP-D DP
(PD6196A)
PSID
120.00
105.00
90.00
75.00
60.00
45.00
30.00
15.00
0.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)
POOR ORIGINAL

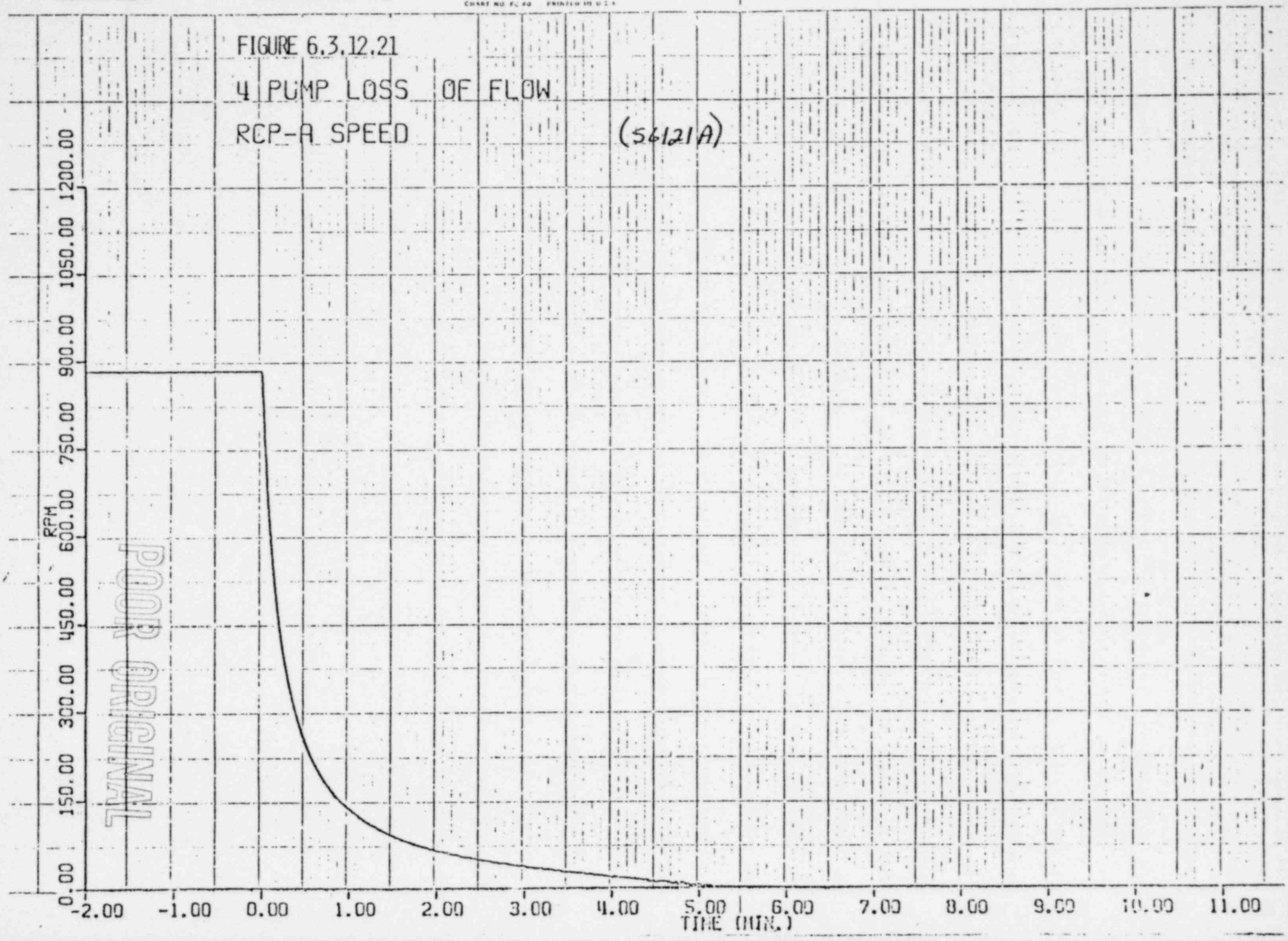
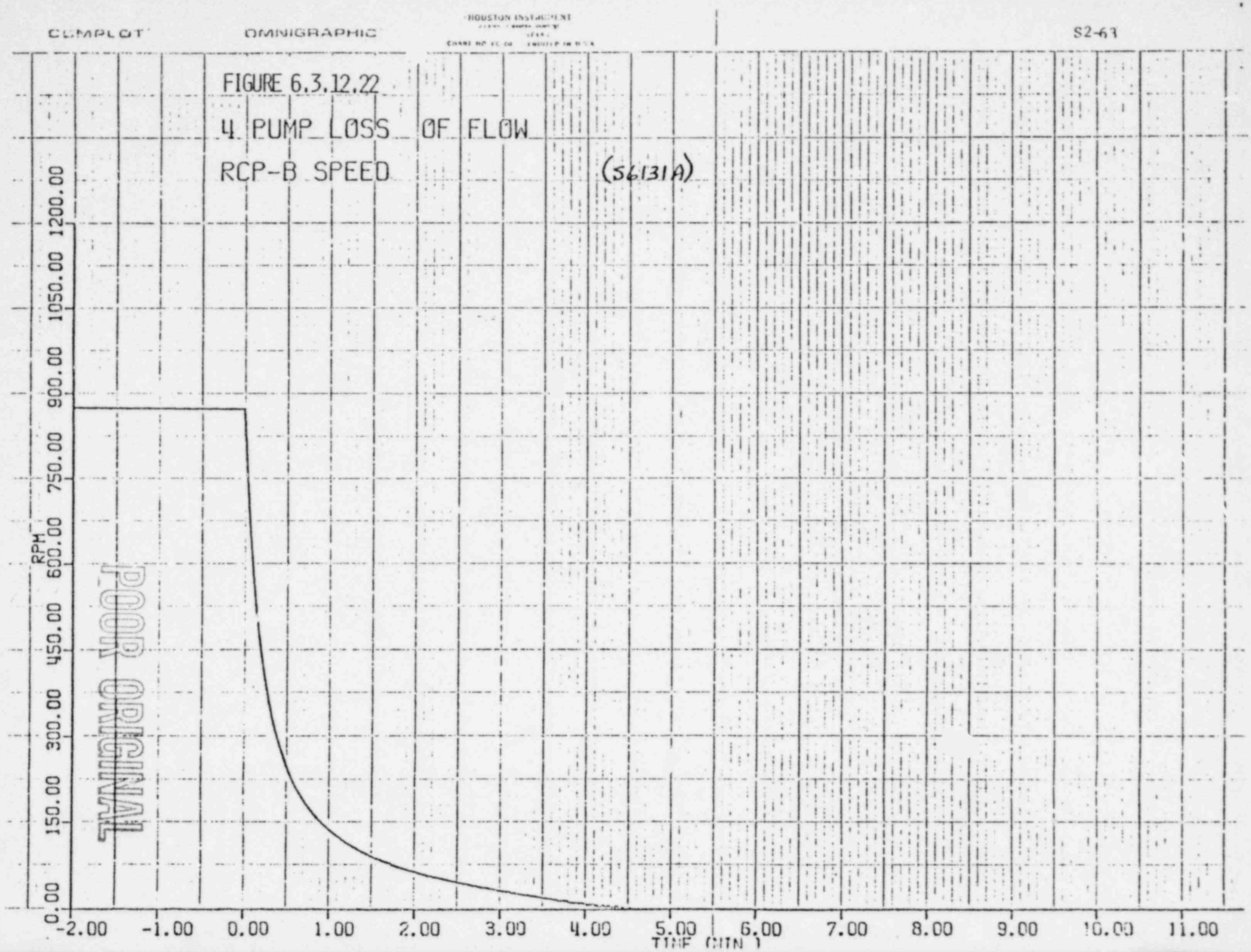
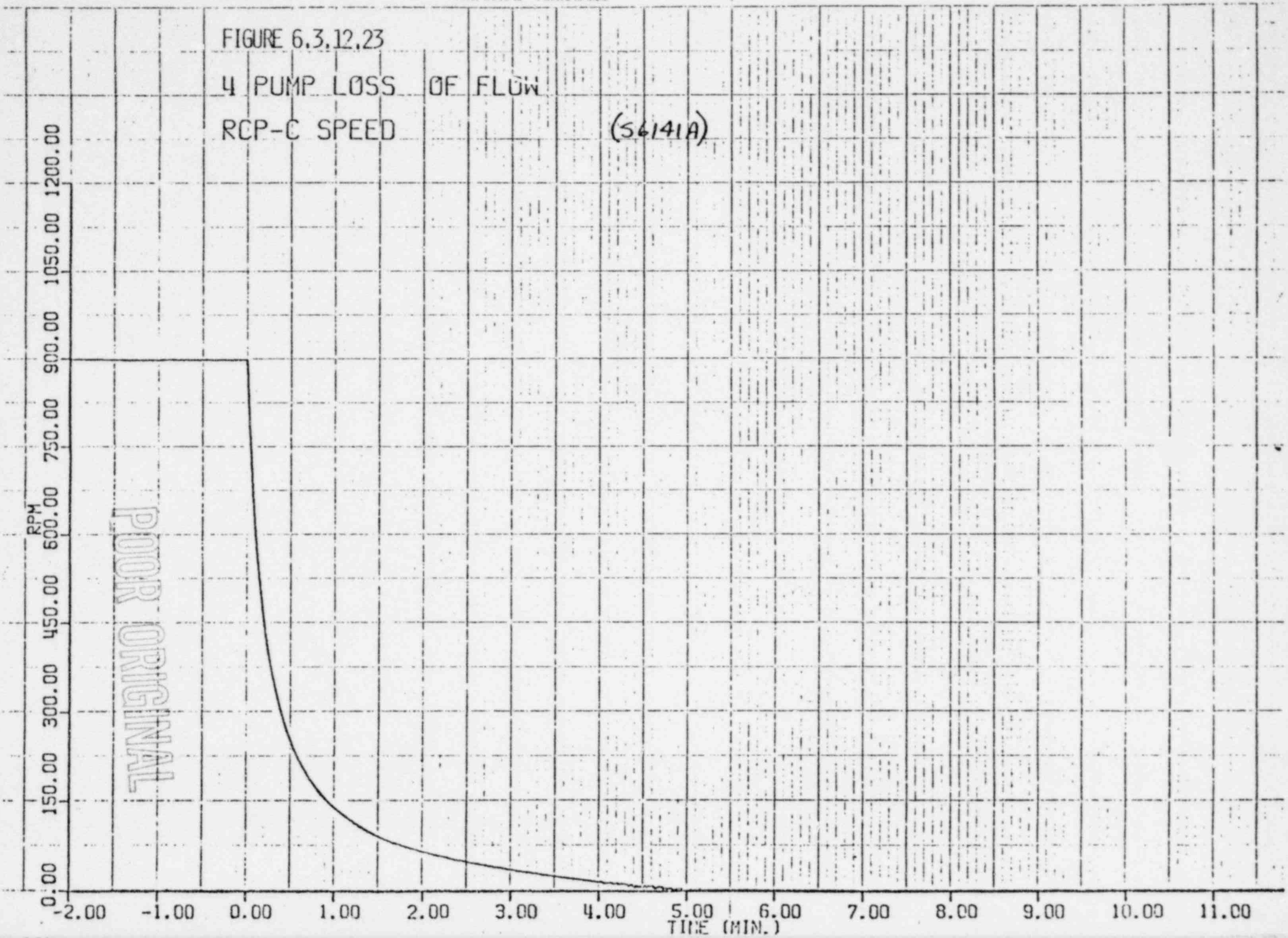


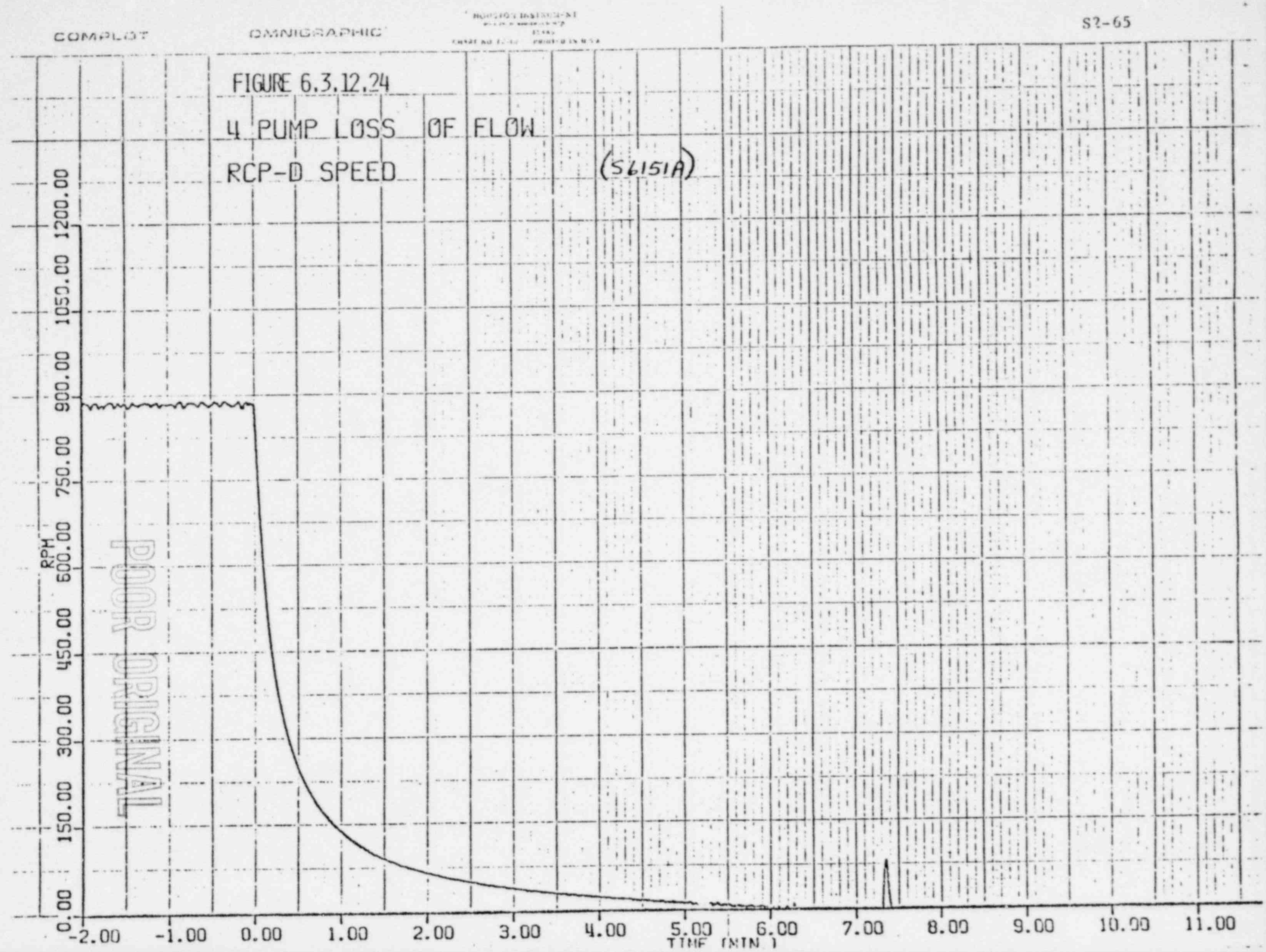
FIGURE 6.3.12.21
4 PUMP LOSS OF FLOW
RCP-A SPEED
(S6121A)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN.)
POOR ORIGINAL



CLMPLOT
OMNIGRAPHIC
S2-63
FIGURE 6.3.12.22
4 PUMP LOSS OF FLOW
RCP-B SPEED
(S6131A)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)
POOR ORIGINAL

COMPLOT' GMNIGRAPHIC




COMPLOT
OMNIGRAPHIC
S2-65
FIGURE 6.3.12.24
4 PUMP LOSS OF FLOW
RCP-D SPEED
(S6151A)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
TIME (MIN)
POOR ORIGINAL

6.3.13 100% TURBINE TRIP TEST

6.3.13.1 Purpose

The 100% turbine trip is conducted to demonstrate the total system performance by the primary and secondary systems in response to a full load-loss transient.

6.3.13.2 Test Method

The turbine trip was manually initiated from the 2C01 panel by the operator. All systems were observed as they automatically responded. Test data was recorded on the mini-computer, brush recorders, computer trend groups and installed control room trace recorders. Test parameters that were monitored included: neutron power, steam header pressures, steam generator pressures and levels, steam and feed flow rates, primary temperature and pressures, pressurizer level, reactor coolant pump speeds and steam dump valve position demand signals.

6.3.13.3 Test Results

Table 6.3.13 lists in detail, the sequence of events following the turbine trip. The main events were recorded as follow: The main turbine was manually tripped and the turbine stop valves and combined stop-entercept valves closed, thus the steam supply was isolated to the main turbine. The pressurizer spray valve and the steam dump valves opened to control the primary and secondary pressure surges. The Plant Protection (PPS) tripped the reactor on low steam generator levels at seven seconds after the turbine trip. The Safety Injection Actuation System (SIAS) energized at 1 minute and 40 seconds after the turbine trip, as did the Containment Cooling Actuation Signal (CCAS). The Reactor Coolant Pumps were isolated and the Main Steam Isolation System (MSIS) actuated at 3.5 and 4.0 minutes respectively after the trip. Secondary pressure was quickly restored as natural circulation was established. The plant was safely returned to hot standby conditions as the SIAS, CCAS, and MSIS were reset and the Reactor Coolant pumps were restarted.

Two component failures caused the transient following the trip. The A steam generator downstream atmospheric dump valve (2CV-0301) didn't respond to the close demand at 21 seconds after the turbine trip and this steam demand continued to decrease the secondary pressure and levels until the MSIS isolated the steam generators. At approximately the same time, the operator was removing the open permissive signal to the dump valve and the valve closed approximately 30 seconds after MSIS. The second component problem concerned the pressurizer spray valve (2CV-4651) which remained partially open following a control demand to close at 21 seconds after the turbine trip. This valve remained open until manually isolated approximately 1 hour following the trip. No significant contribution to the transient was experienced however, because after the reactor coolant pumps were secured, the driving head to the spray valve was also secured.

Figures 6.3.13.1 through 6.3.13.7 display the response of various plant parameters versus time following the trip.

6.3.13.4 Conclusions

The 100% turbine trip test was successfully completed on January 1, 1980, and despite several individual component malfunctions, operating procedures, operator actions and safety systems performed as required and thus verified that the total system performance in response to the 100% turbine trip was satisfactory.

TABLE 6.3.13.1

TIME FROM TRIP Hr:Min:Sec	SEQUENCE OF EVENTS FOLLOWING THE 100% TURBINE TRIP
00:00:00	Main Turbine tripped, A/C power transfers to SU #3
00:00:02	Steam Dump valves 2CV-0301, 2CV-0302, 2CV-0303, 2CV-0306 QO
00:00:02	Pressurizer Spray Valve 2CV-4651 open
00:00:06	Reactor trip on low S/G level
00:00:09	Pressurizer pressure peaks at 2382 psia
00:00:13	S/G pressure reaches 1091 psia on loop B (peak)
00:00:13	S/G pressure reaches 1030 psia on loop A (peak)
00:00:21	Pressurizer spray valve 2CV-4651 gets close signal, (apparently failed partially open here by later indications)
00:00:21	Steam Dump valves 2CV-0301, 2CV-0302, 2CV-0303, 2CV-0306 get close signals. (apparently 2CV-0301 failed to close here by later indications)
00:00:29	2CV-0303, 2CV-0306 show closed indication, 2CV-0301 still open. 2CV-0302 indicated intermediate position but was visually verified closed
00:01:40	Low pressurizer pressure trip (1740 psia) SIAS and CCAS Millstone logic drops out, non-essential 480V, 4160V and 6900V loads - 2DG1, 2DG2 auto start but are not loaded.
00:02:04	Pressurizer level indication drops below zero
00:02:30	Loop A steam pressure below 850 psia
00:02:40	Loop B steam pressure below 850 psia
00:02:54	Pressurizer pressure below 1500 psia
00:02:56	S/G A pressure below 810 psia
00:03:07	A T_H drops to 525° F (low range)
00:03:20	2P32B RCP tripped manually
00:03:22	2P32A RCP tripped manually
00:03:22	2P32C RCP tripped manually

TABLE 6.3.13.1

TIME FROM TRIP Hr;Min:Sec	SEQUENCE OF EVENTS FOLLOWING THE 100% TURBINE TRIP (cont)
00:03:24	2P32D RCP tripped manually
00:03:28	T_H increased above 525°F, natural circulation begins
00:04:00	S/G A low pressure trip (MSIS) (728 psia)
00:04:06	Pressurizer pressure reaches minimum (1350 psia) saturation margin ~ 57°F
00:04:34	2CV-0306, 2CV-0303, 2CV-0302, 2CV-0301 permissive turned off; this action closed 2CV-0301
00:05:05	Pressurizer pressure at 1400 psia and increasing
00:05:20	Pressurizer level indication back on scale
00:05:37	Pressurizer pressure at 1500 psia and increasing
00:09:28	T_H @ 543°F
00:12:-	Reset SIAS
00:13:14	S/G pressure recovering: S/G A at 828 psia Non-essential electrical loads are manually restored
00:19:-	Reset MSIS
00:22:-	Reset CCAS
00:24:21	RC pressure recovered, reaches 2100 psia
00:29:-	Stopped all SIAS pumps
00:34:15	S/G B level recovered above 49%, Trip reset
00:34:30	2P32B restarted
00:40:20	S/G A level recovered above 49%, Trip reset
00:40:30	2P32C restarted
00:42:30	2P32D restarted
00:51:-	Began using 2CV-1001, 2CV-1051 upstream atmospheric dumps to control main steam pressure
00:59:-	Operators suspect that 2CV-4651 pressurizer spray valve is open

TABLE 6.3.13.1

TIME FROM TRIP Hr:Min:Sec	SEQUENCE OF EVENTS FOLLOWING THE 100% TURBINE TRIP (cont)
01:09:-	Stopped B RCP 2P32B
01:09:-	Started A circ. water pump
01:10:-	Entered containment to manually close 2CV-4651, pressurizer spray valve
01:19:-	Started A condensate pump
01:29:-	MSIVs opened, dumping steam to condenser via 2CV-0303
01:48:-	Main turbine on turning gear
02:07:-	Decision to start cooldown

FIGURE 5.3.13.1
100% TURBINE TRIP
PRESSURIZER PRESSURE
(P4626-A)

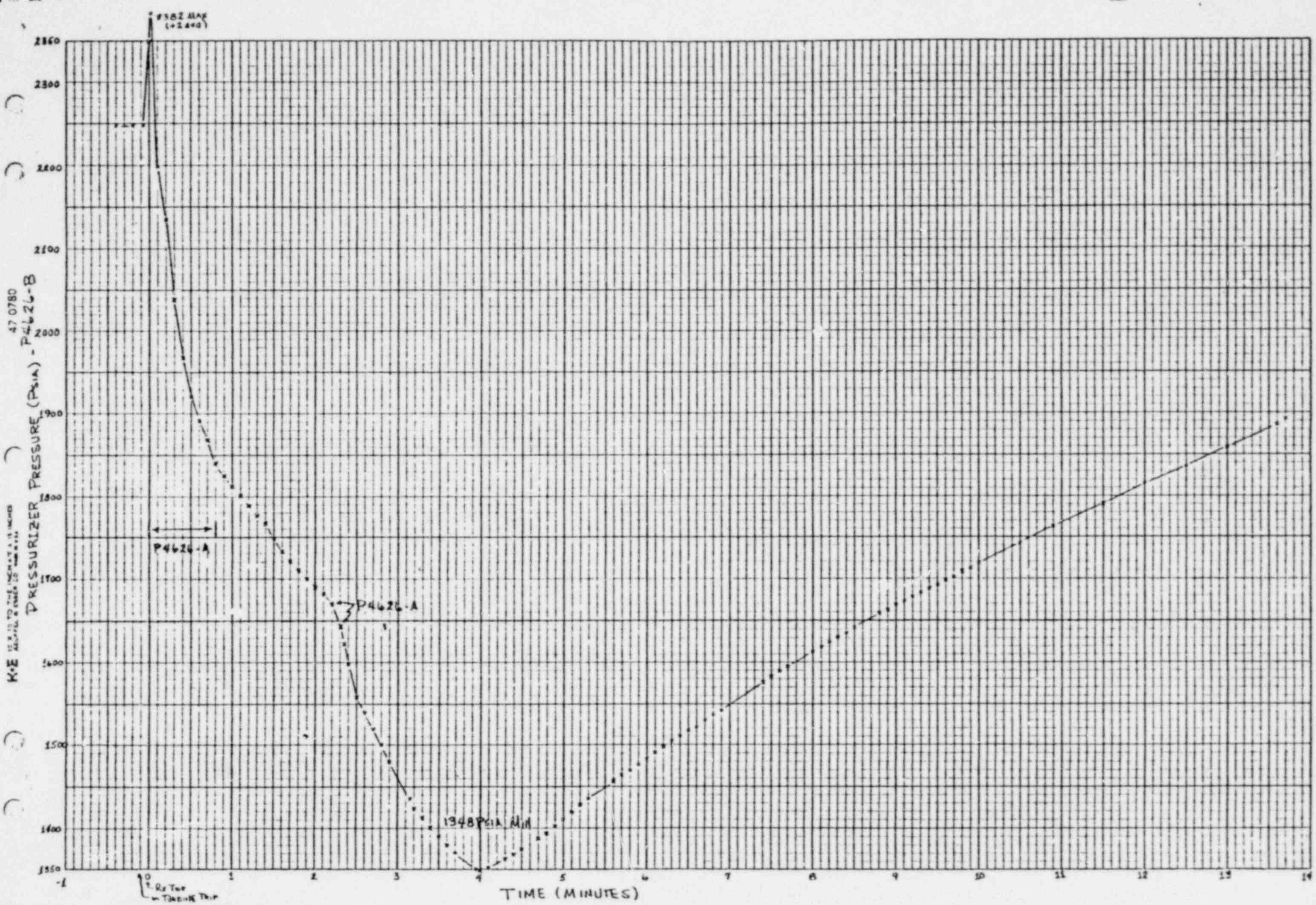


FIGURE 6.3.13.2
100% TURBINE TRIP
LOOP 1 TEMPERATURES
(THOT - T4614)
(TCOLD - T4611-1)

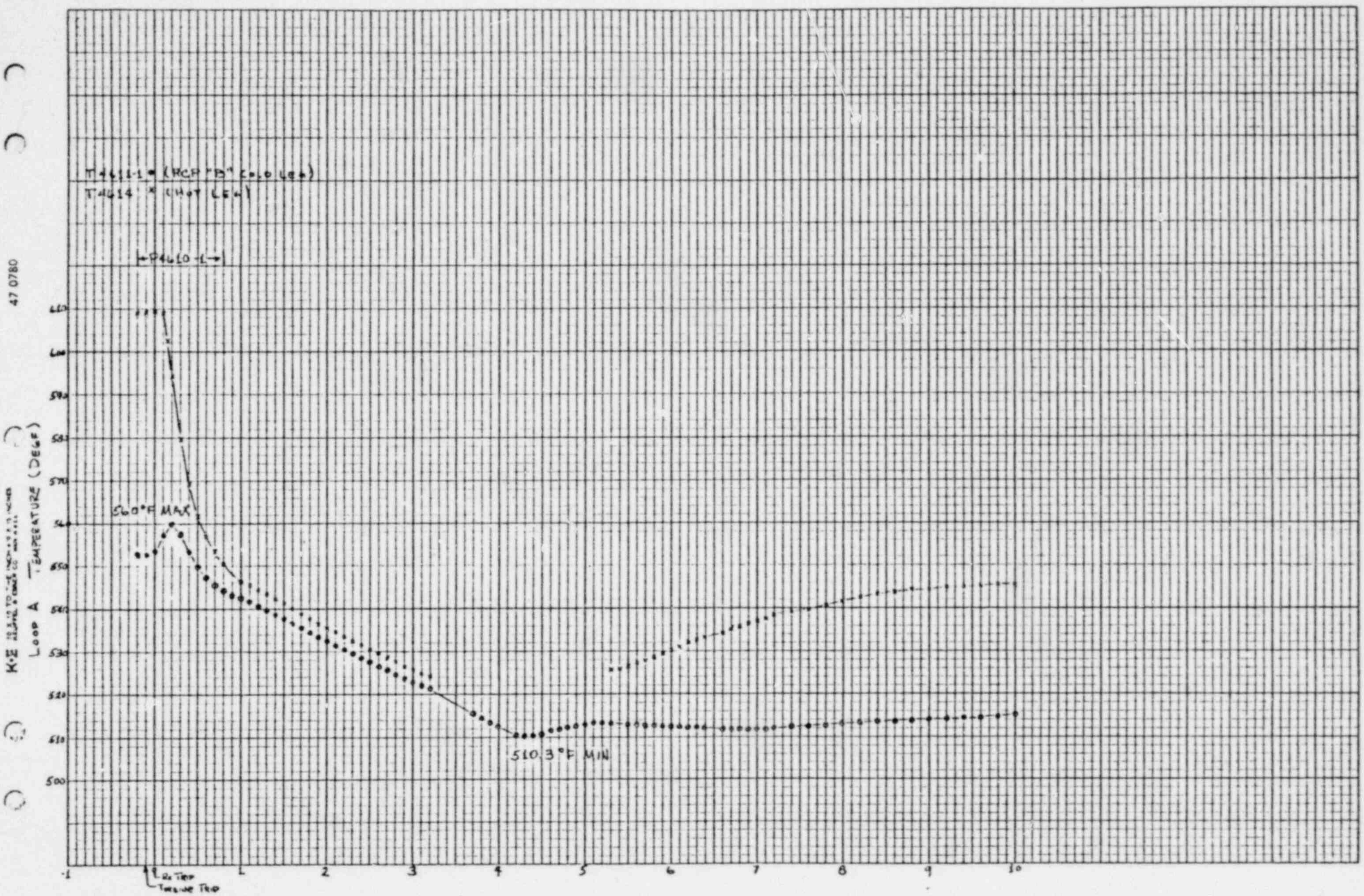
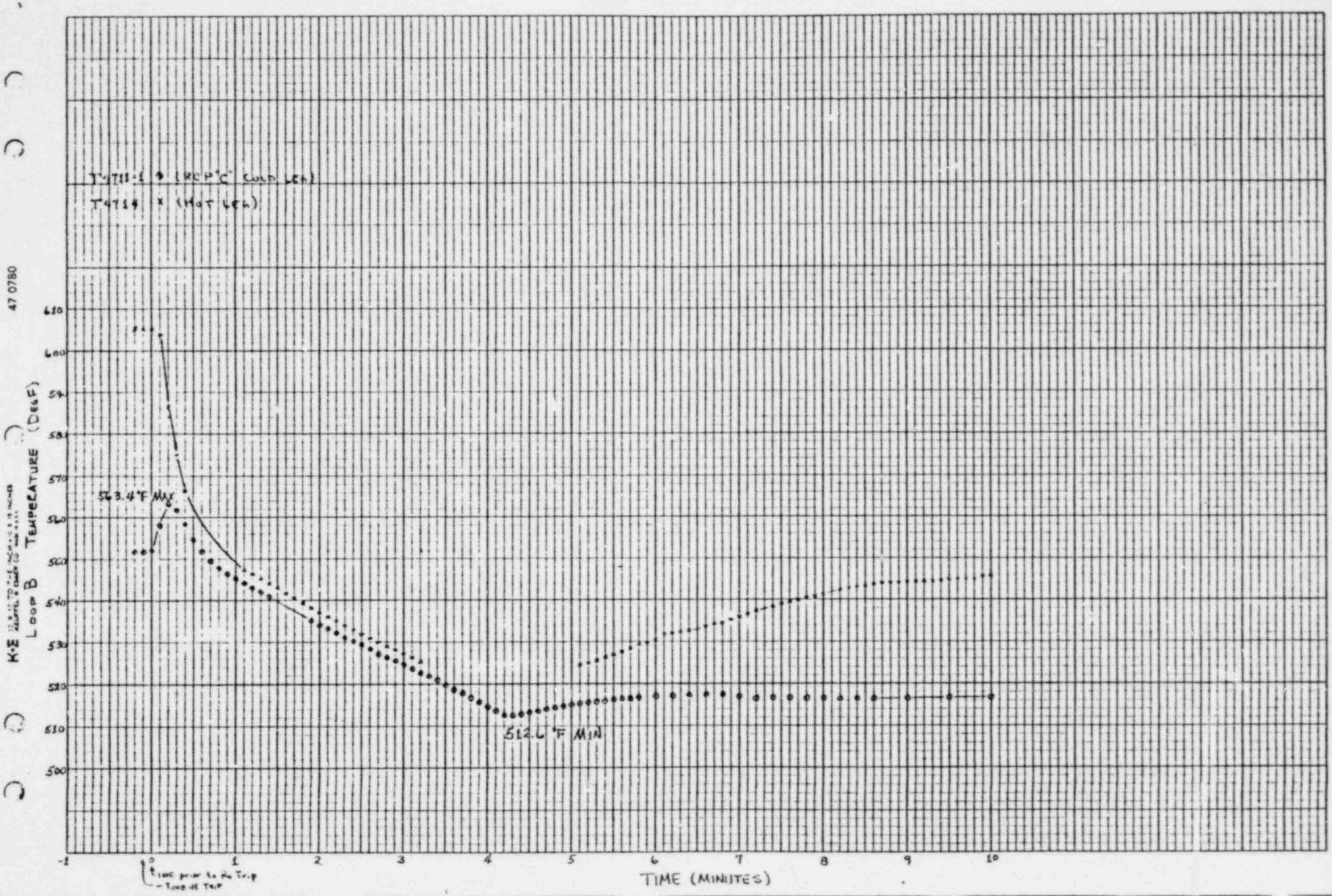
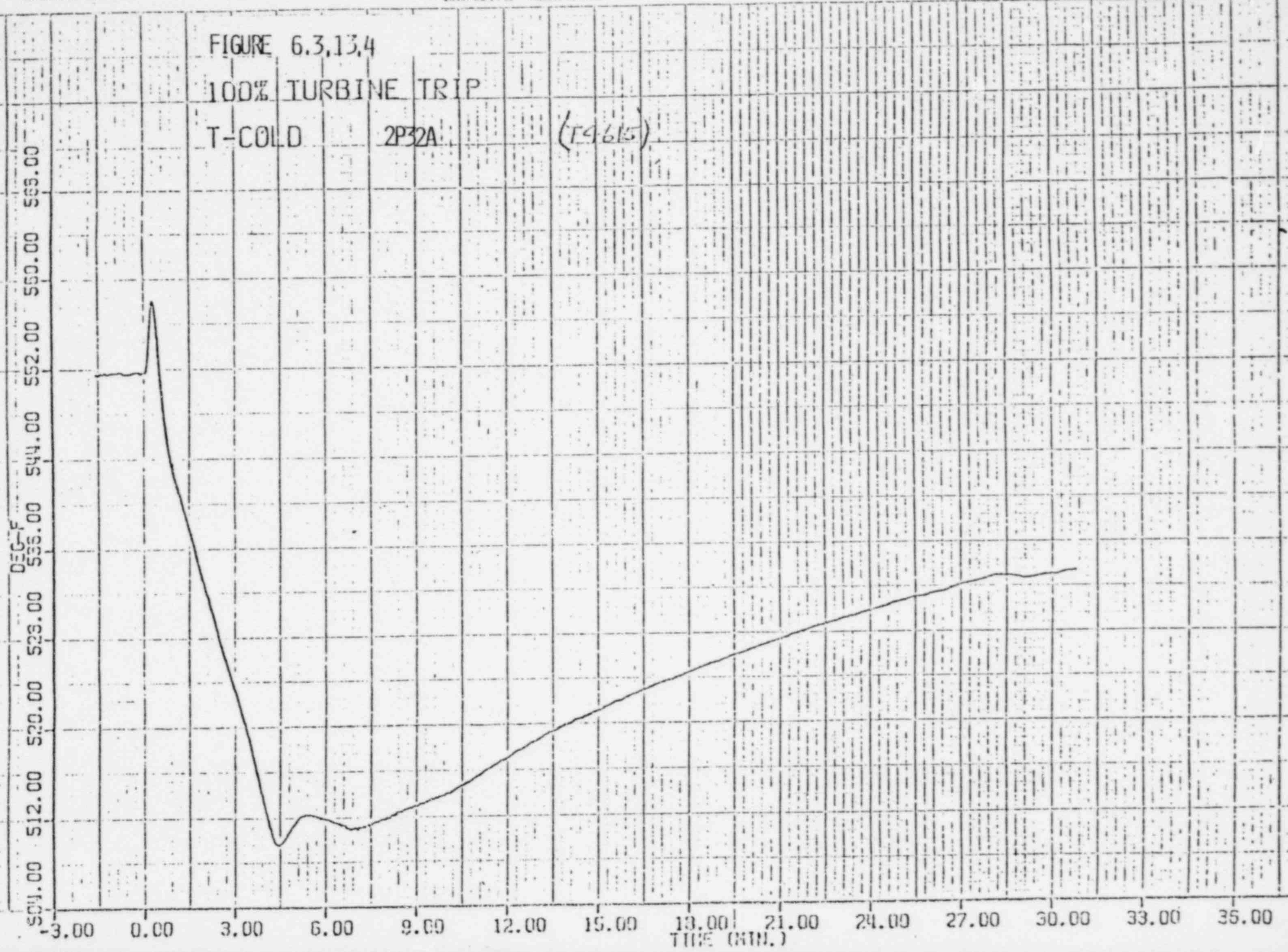


FIGURE 6.3.13.3
100% TURBINE TRIP
LOOP 2 TEMPERATURES
(THOT - T4714)
(TCOLD - T4711-1)

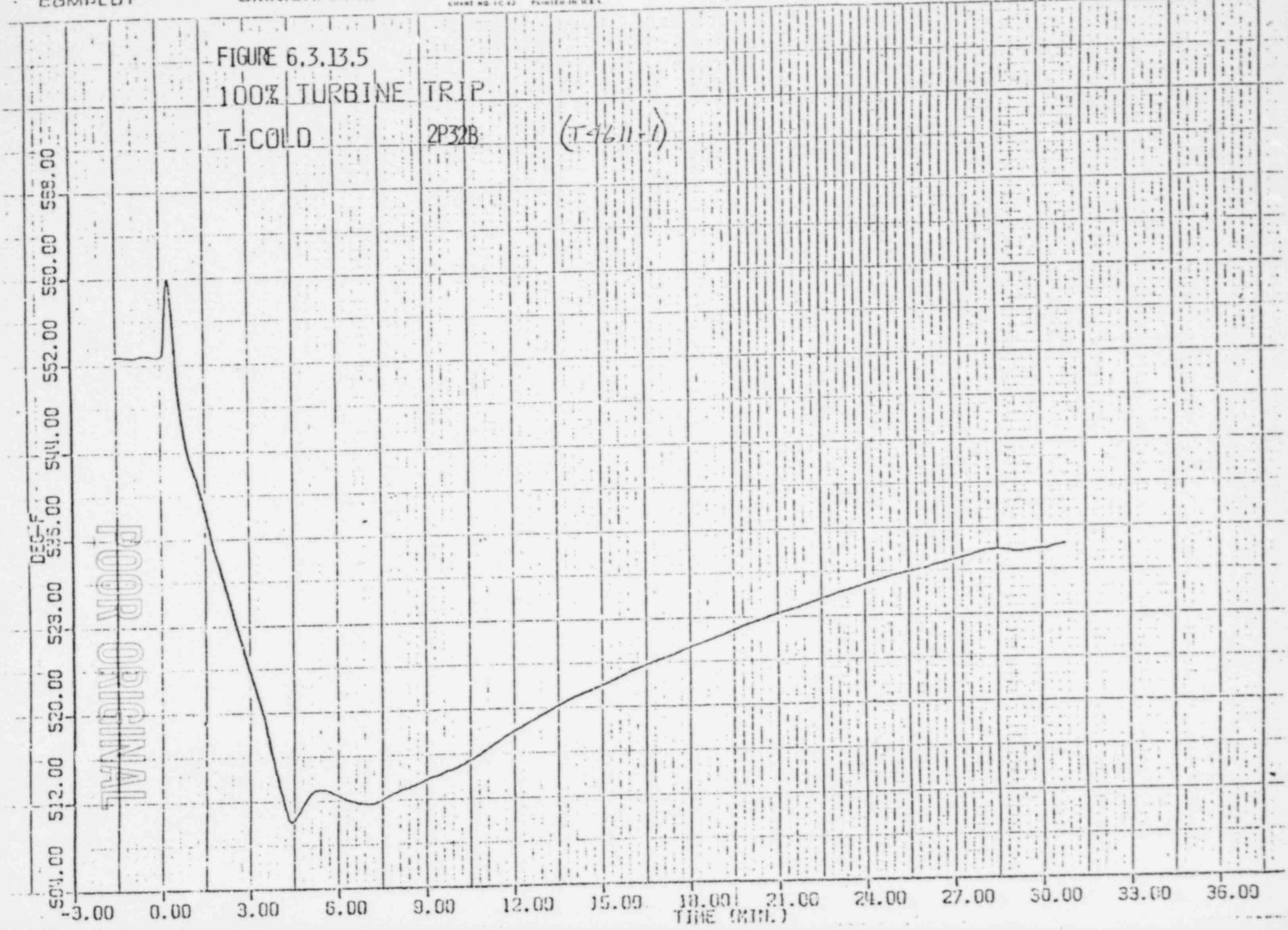


COMPLOT OMNIGRAPHIC

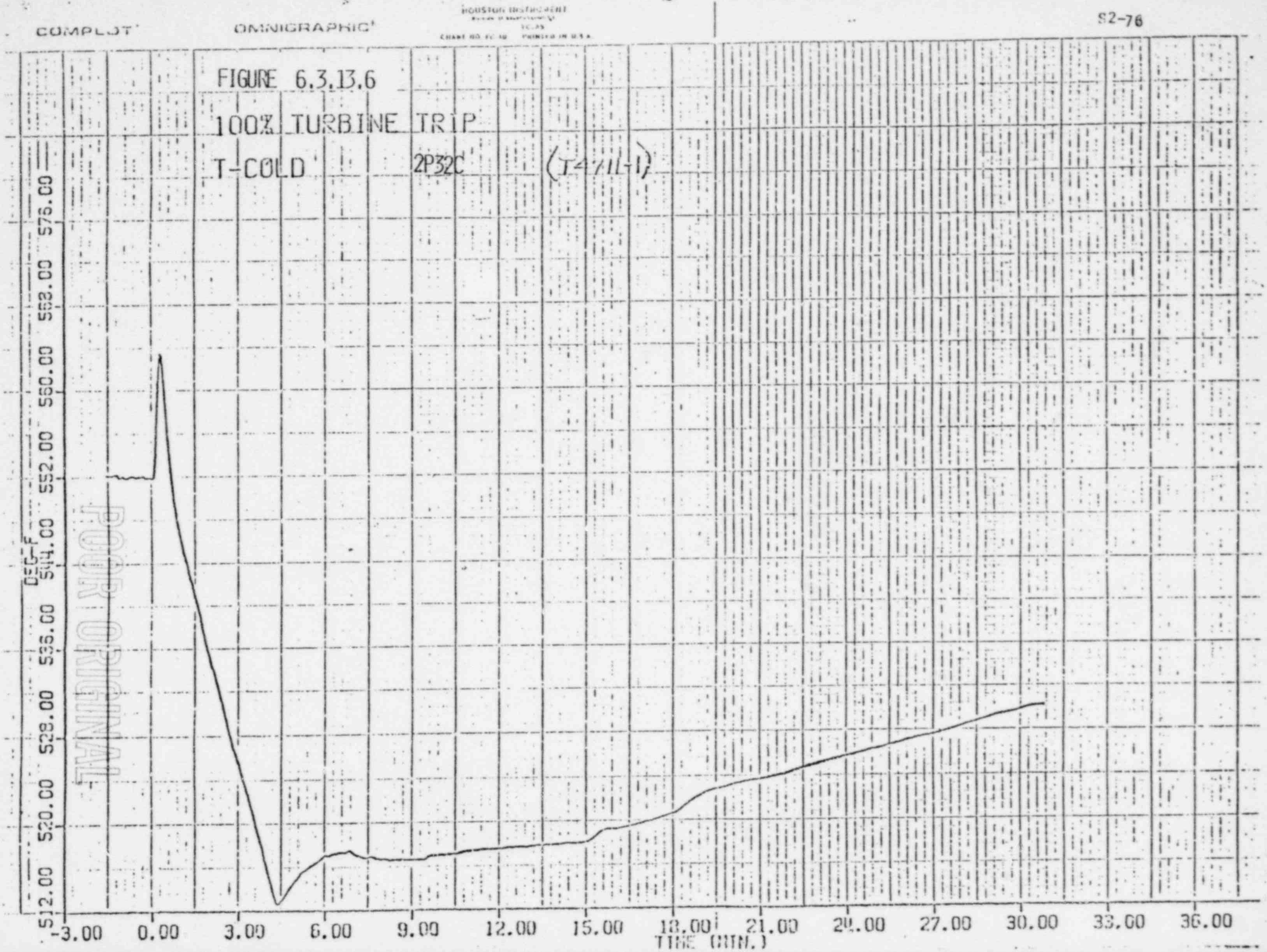


POOR ORIGINAL

S2-75


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.5
100% TURBINE TRIP
T-COLD
2P32B
(T-4611-1)
DEG-F
504.00
512.00
520.00
528.00
536.00
544.00
552.00
560.00
568.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)

S2-76



COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.6
100% TURBINE TRIP
T-COLD
2P32C
(T471L-1)
DEG-F
576.00
568.00
560.00
552.00
544.00
536.00
528.00
520.00
512.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

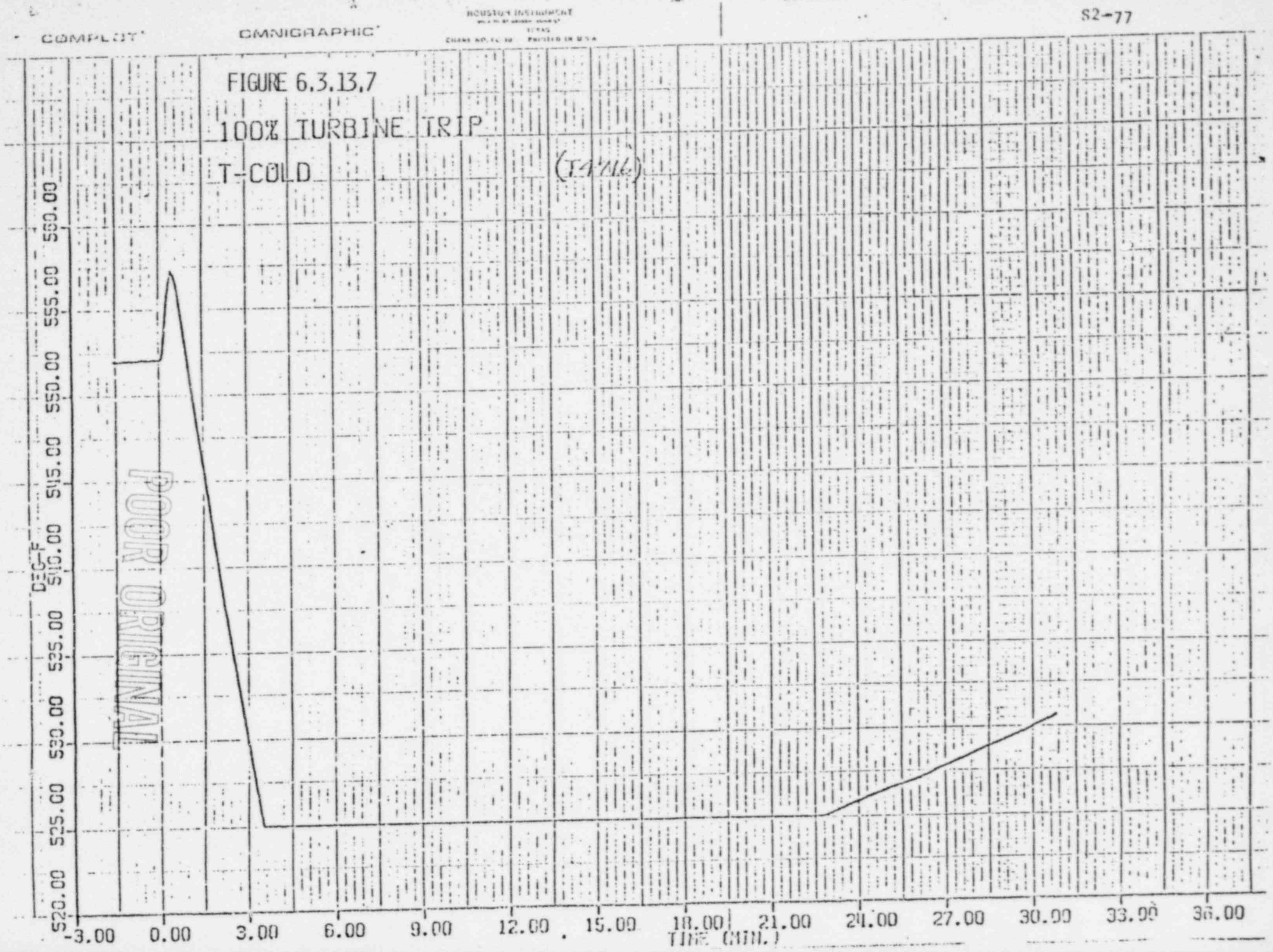
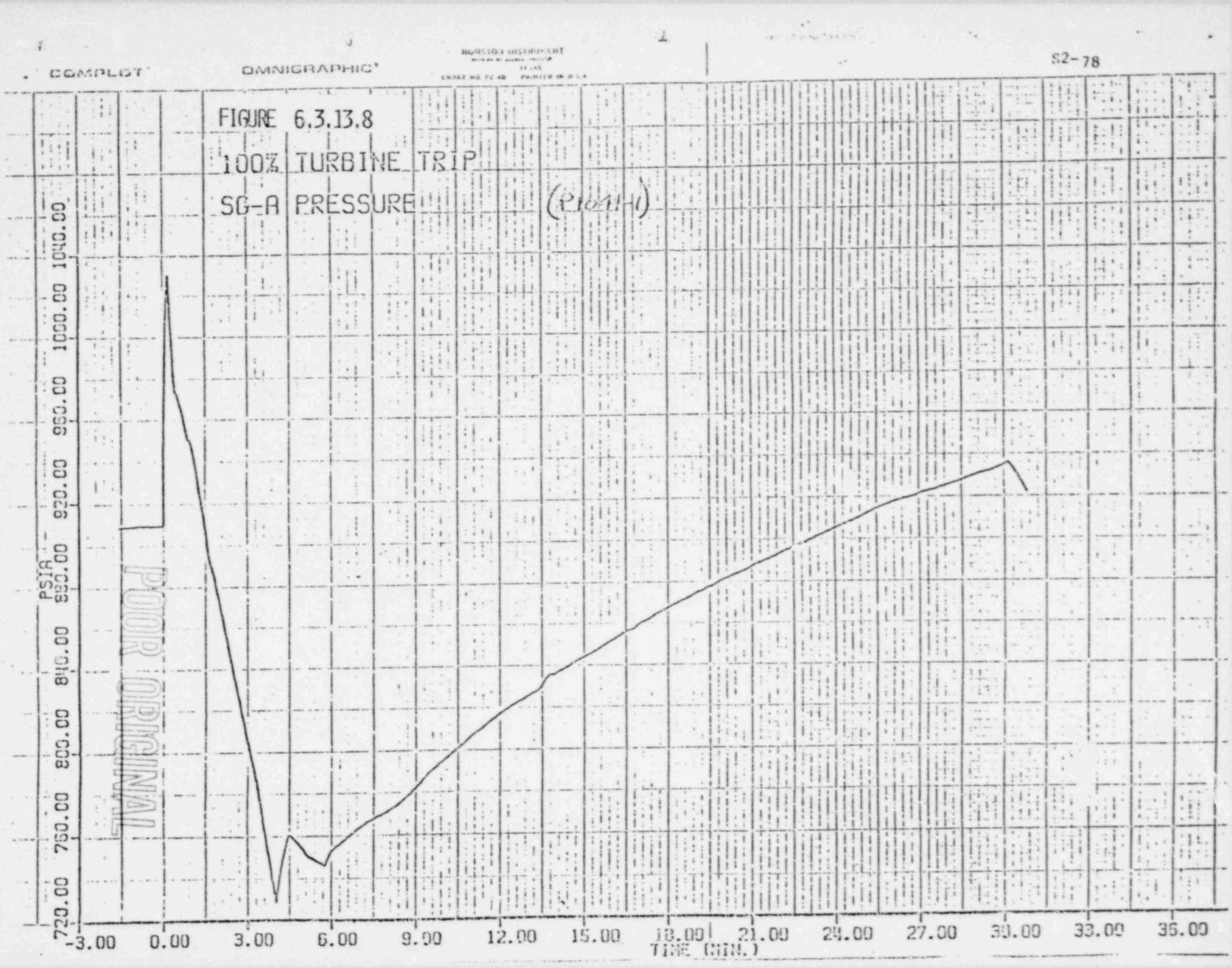
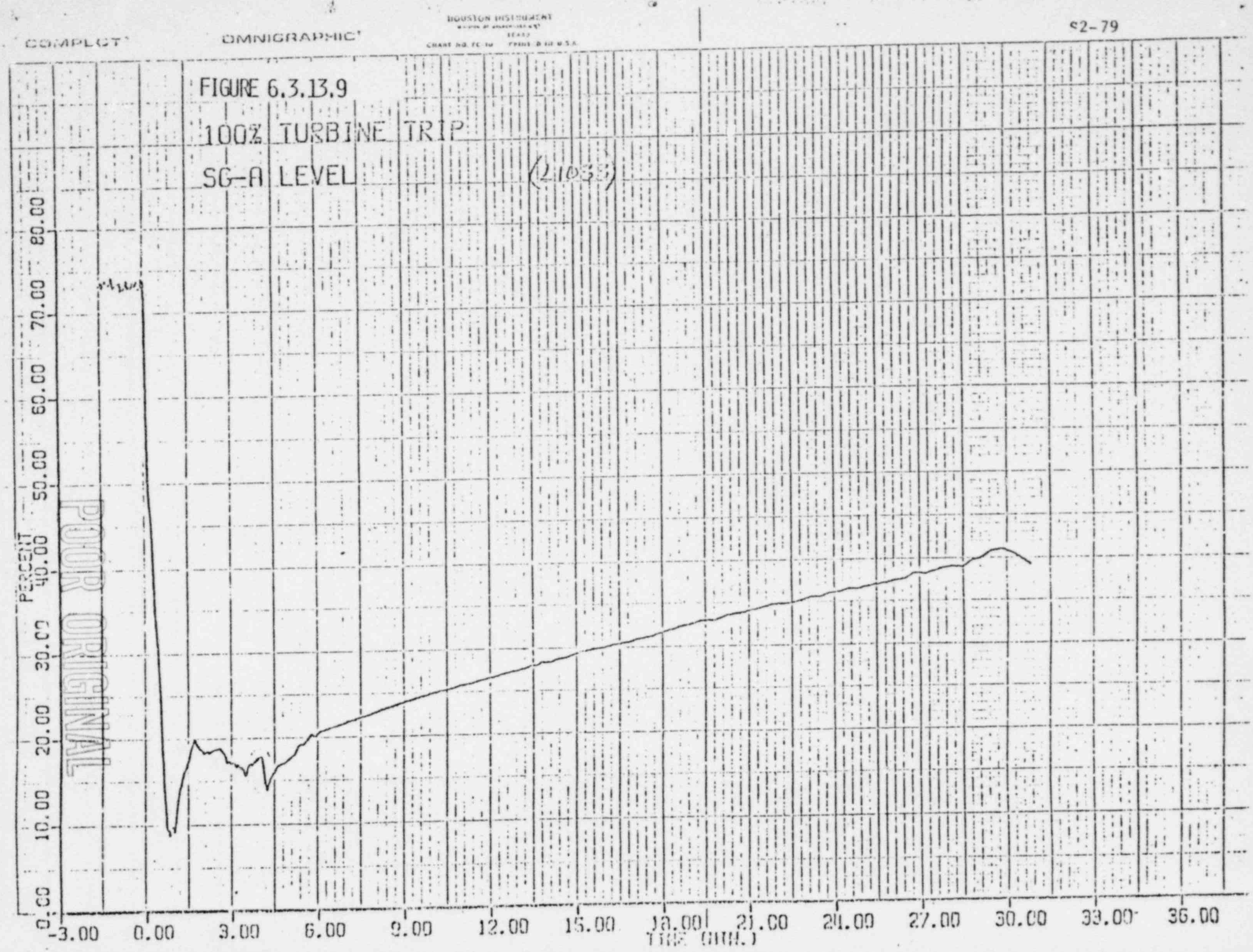


FIGURE 6.3.13.7
100% TURBINE TRIP
T-COLD


COMPLOT
OMNIGRAPHIC
FIGURE 6.3.13.8
100% TURBINE TRIP
SG-A PRESSURE
(R104H)
PSIA
1040.00
1000.00
960.00
920.00
880.00
840.00
800.00
760.00
720.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL



COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
S2-79
FIGURE 6.3.13.9
100% TURBINE TRIP
SG-A LEVEL
(21033)
PERCENT
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

POOR ORIGINAL

FIGURE 6.3.13.10
100% TURBINE TRIP
'A' STEAM GENERATOR
(LEVEL - L1033)
(PRESSURE - P1041-1)

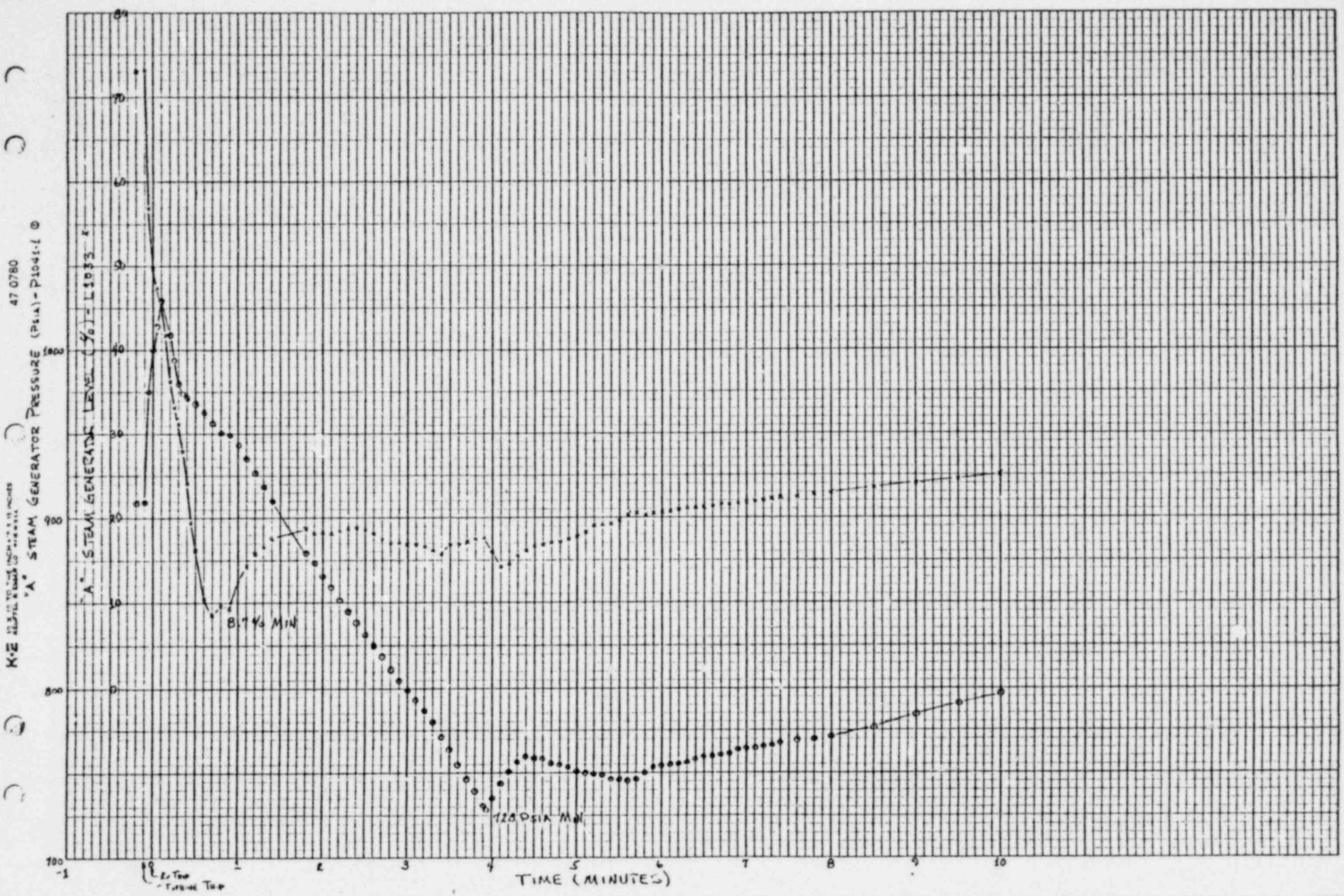
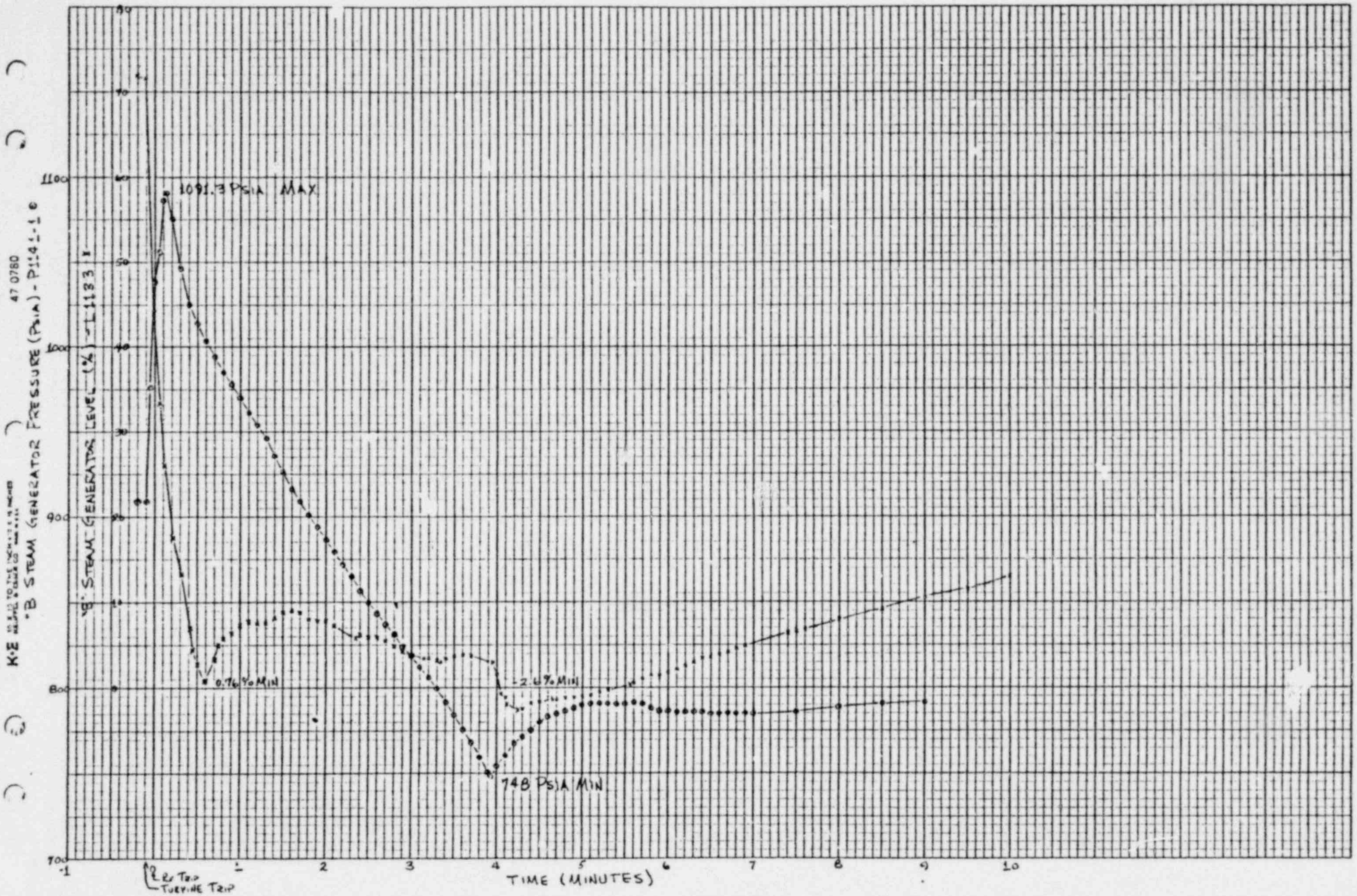
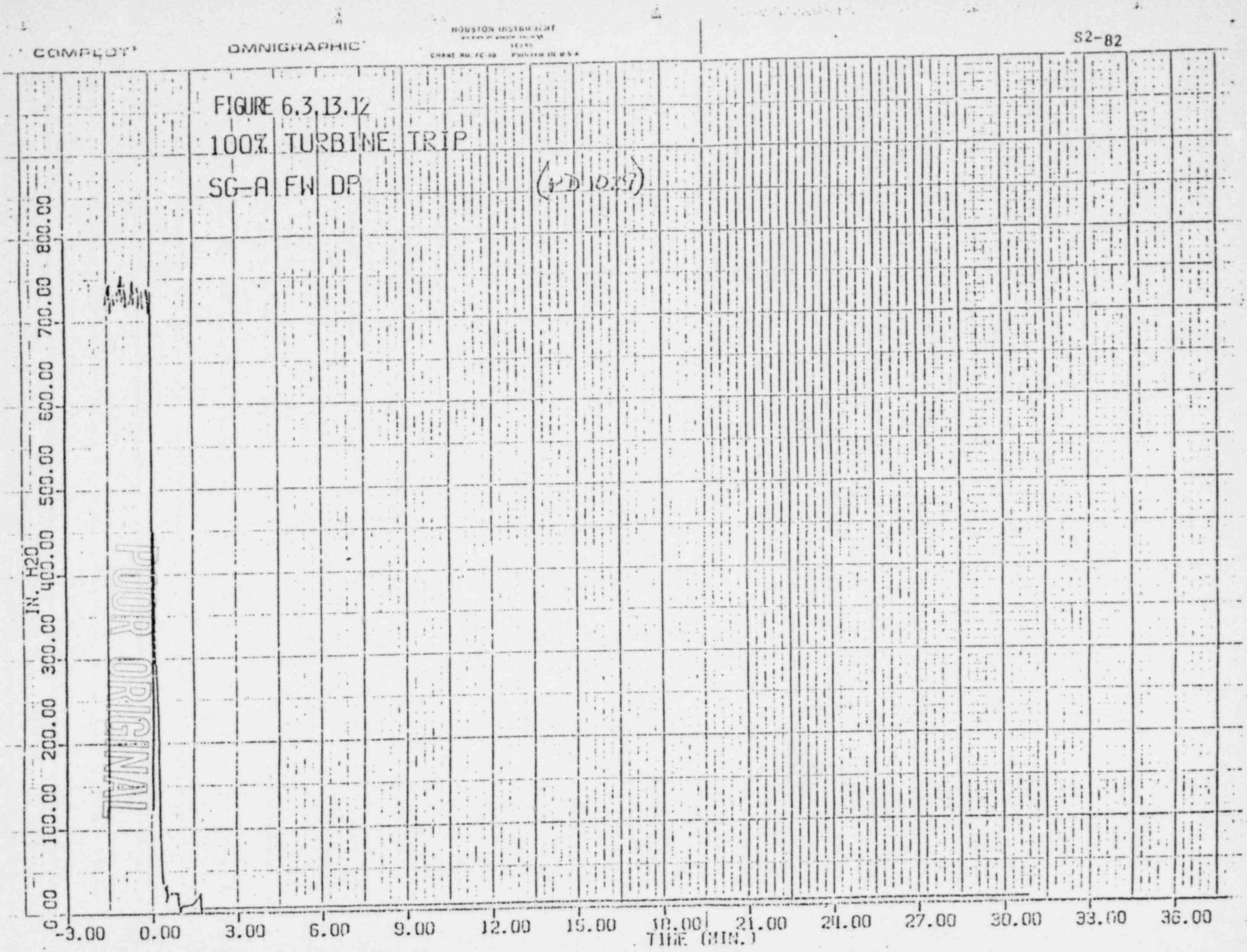
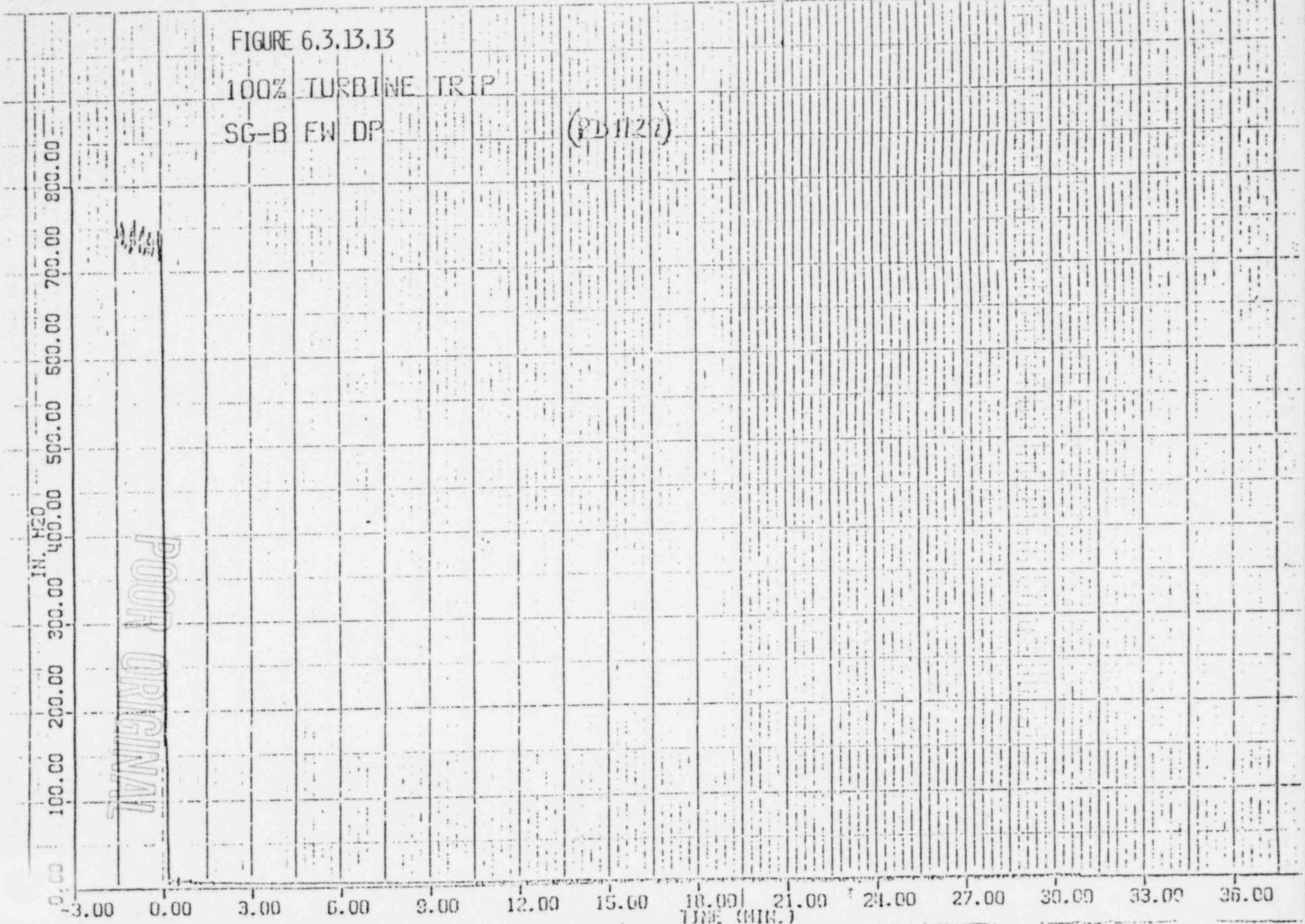


FIGURE 6.3.13.11
100% TURBINE TRIP
'B' STEAM GENERATOR
(LEVEL - L1133)
(PRESSURE - P1141-1)

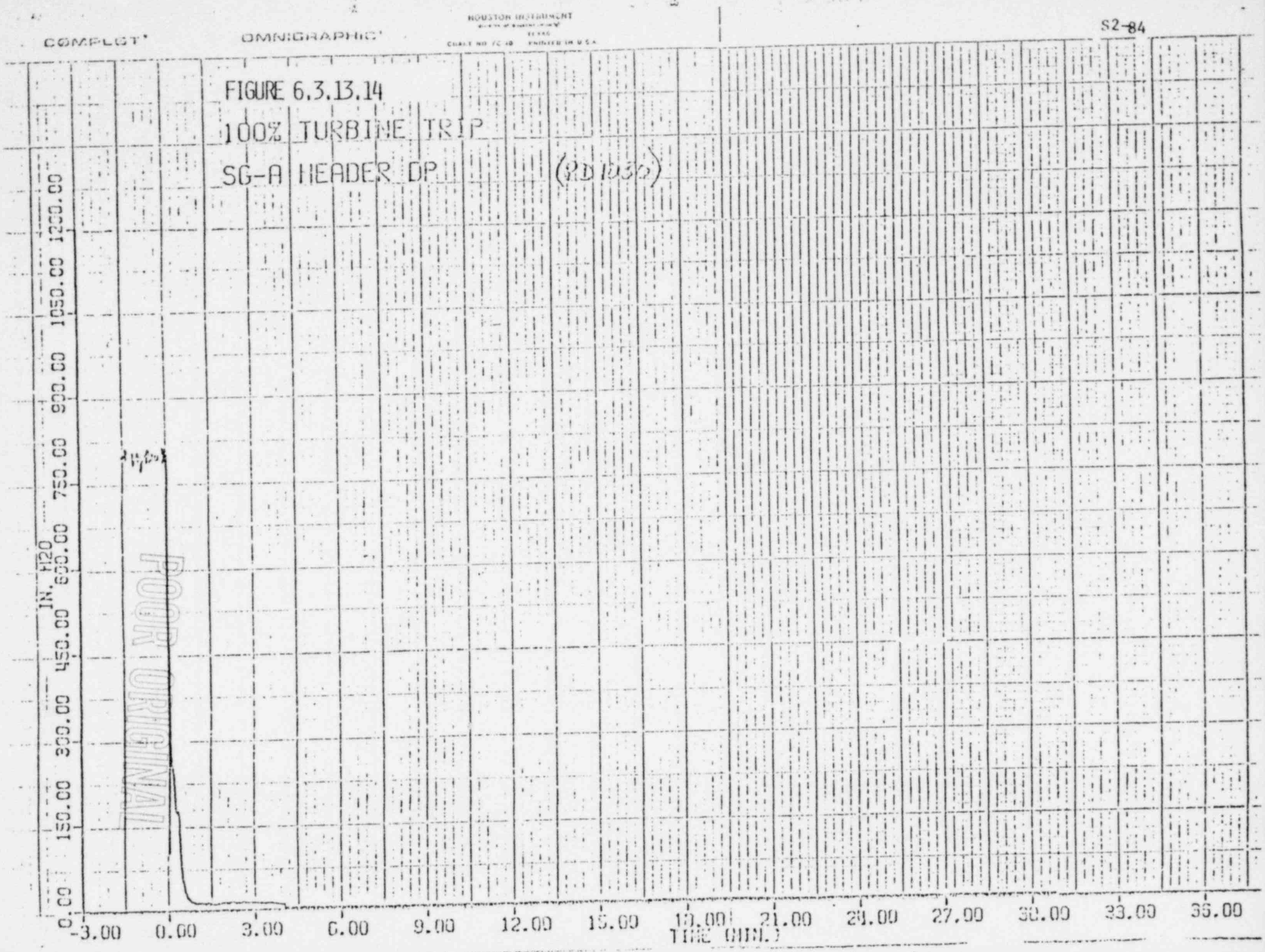


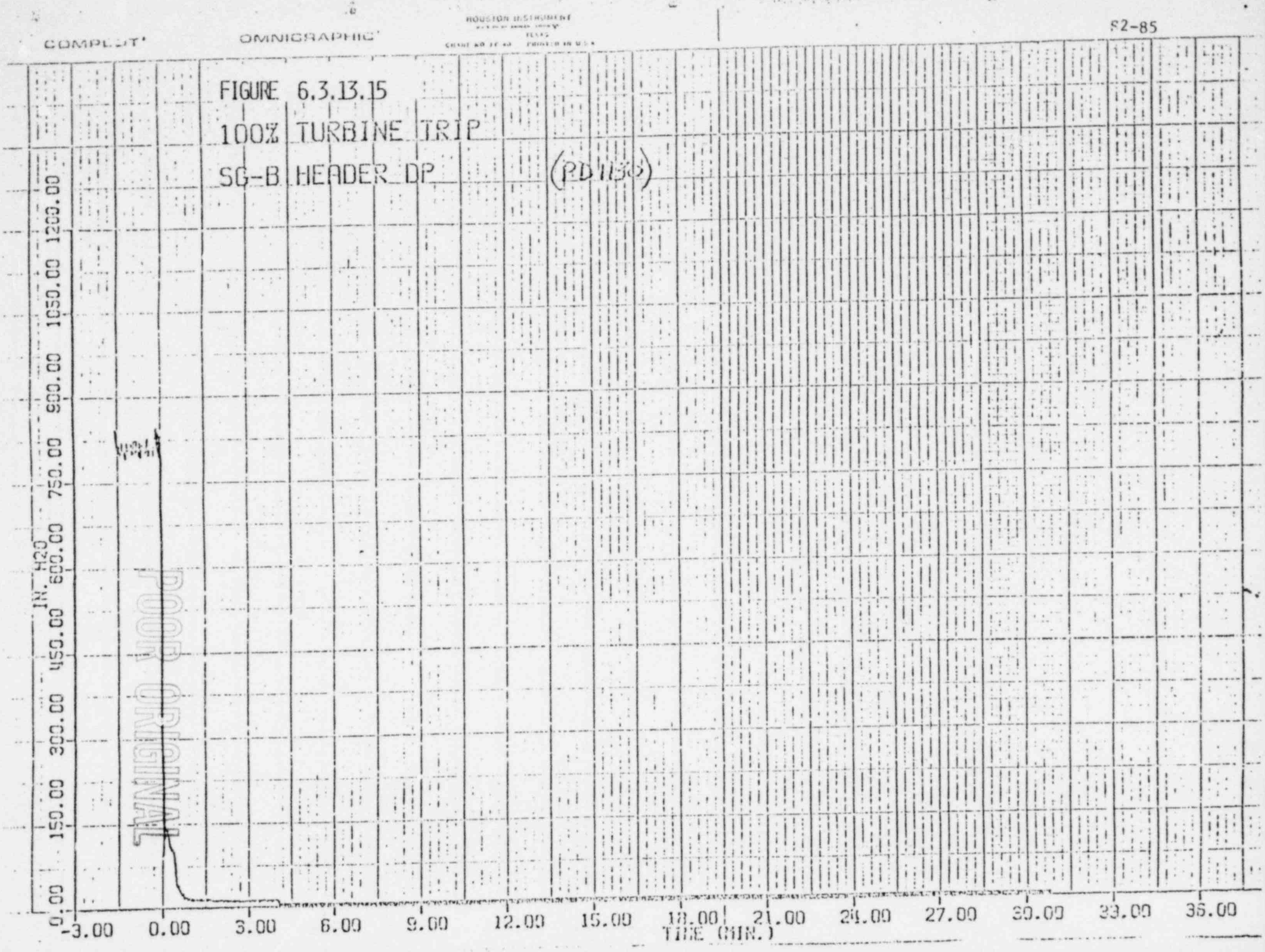

COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
S2-82
FIGURE 6.3.13.12
100% TURBINE TRIP
SG-A FW DP
(PD 1027)
IN. H2O
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

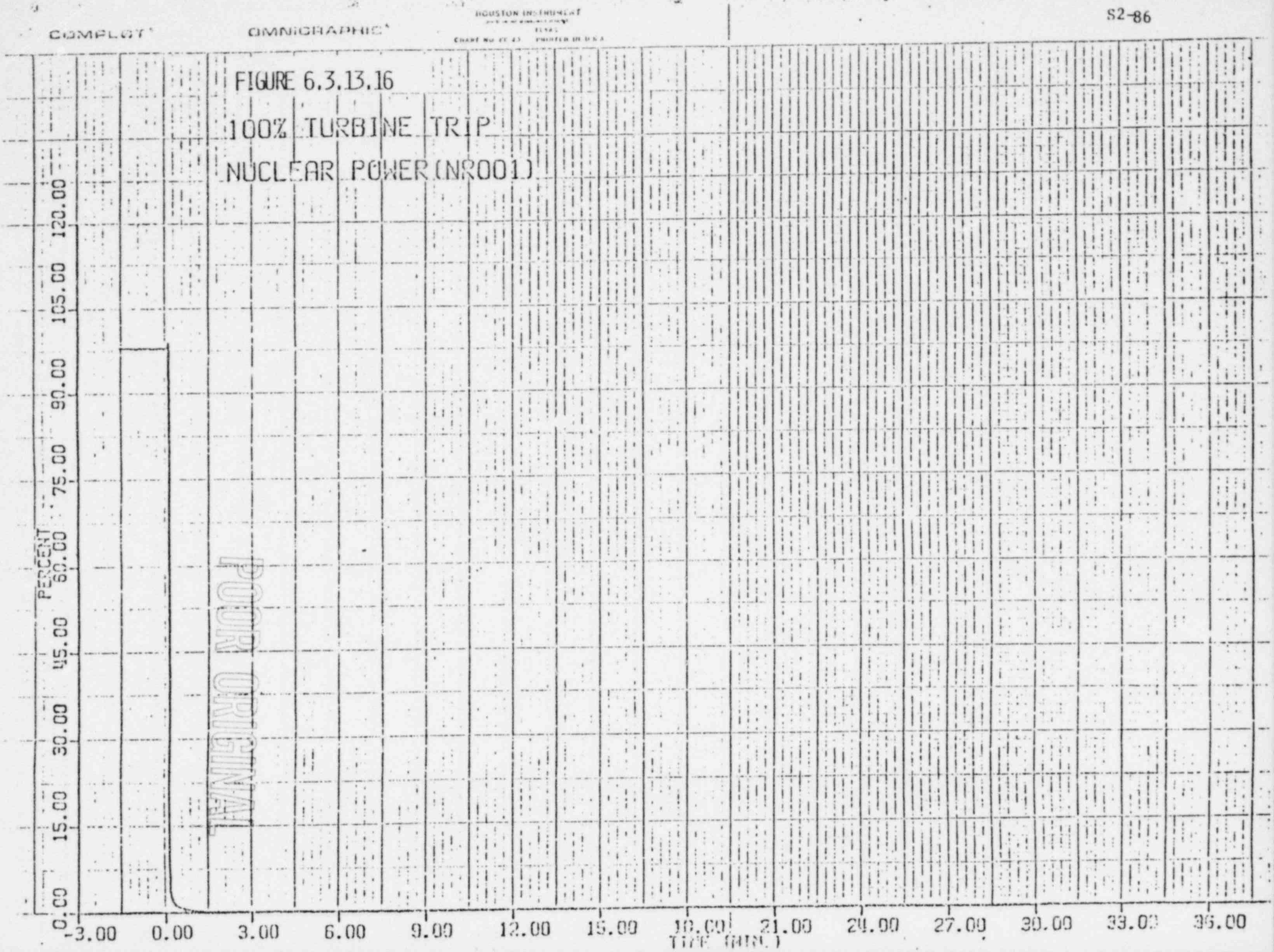
COMPLOT OMNIGRAPHIC HOUSTON INSTRUMENT

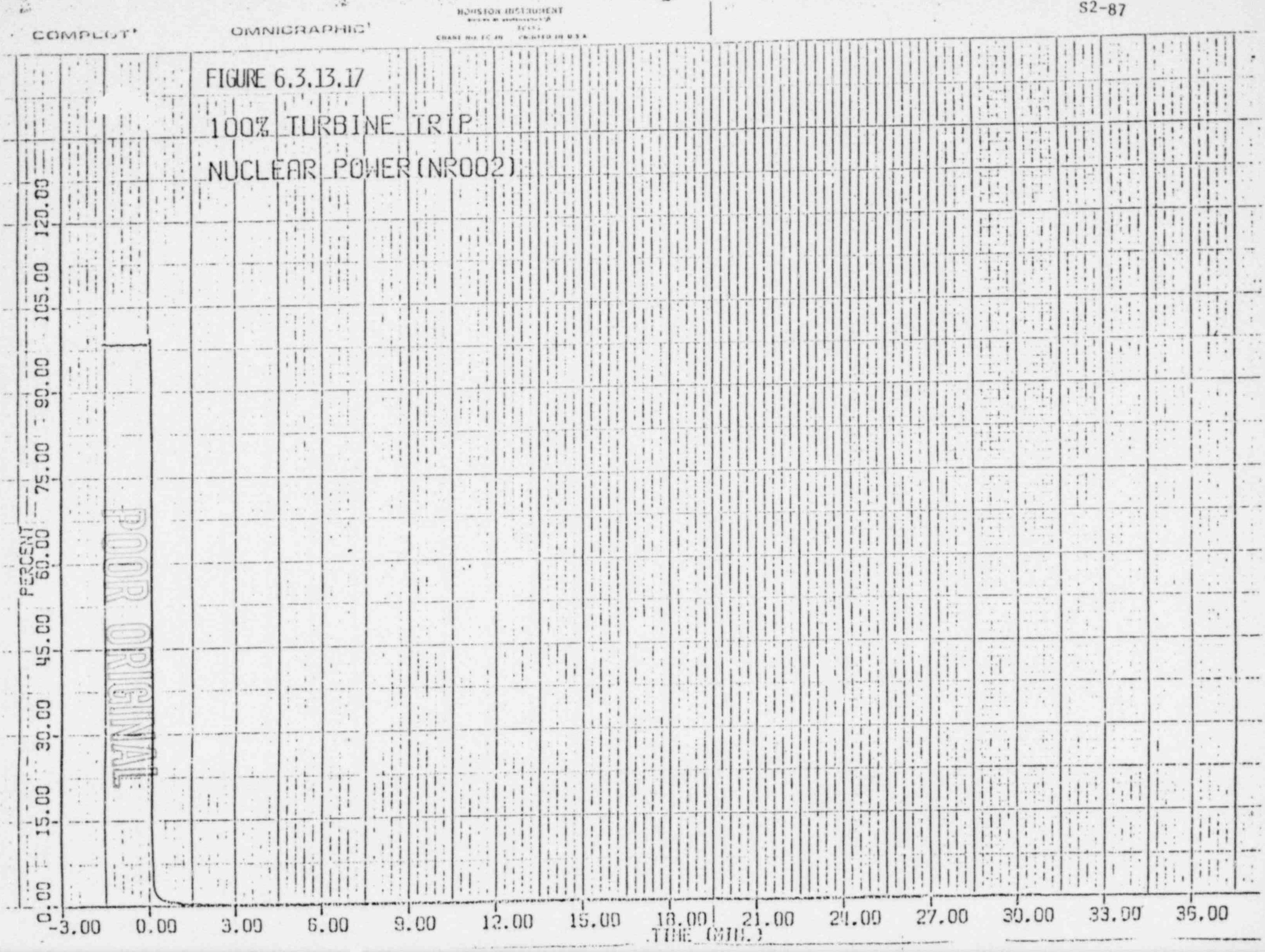


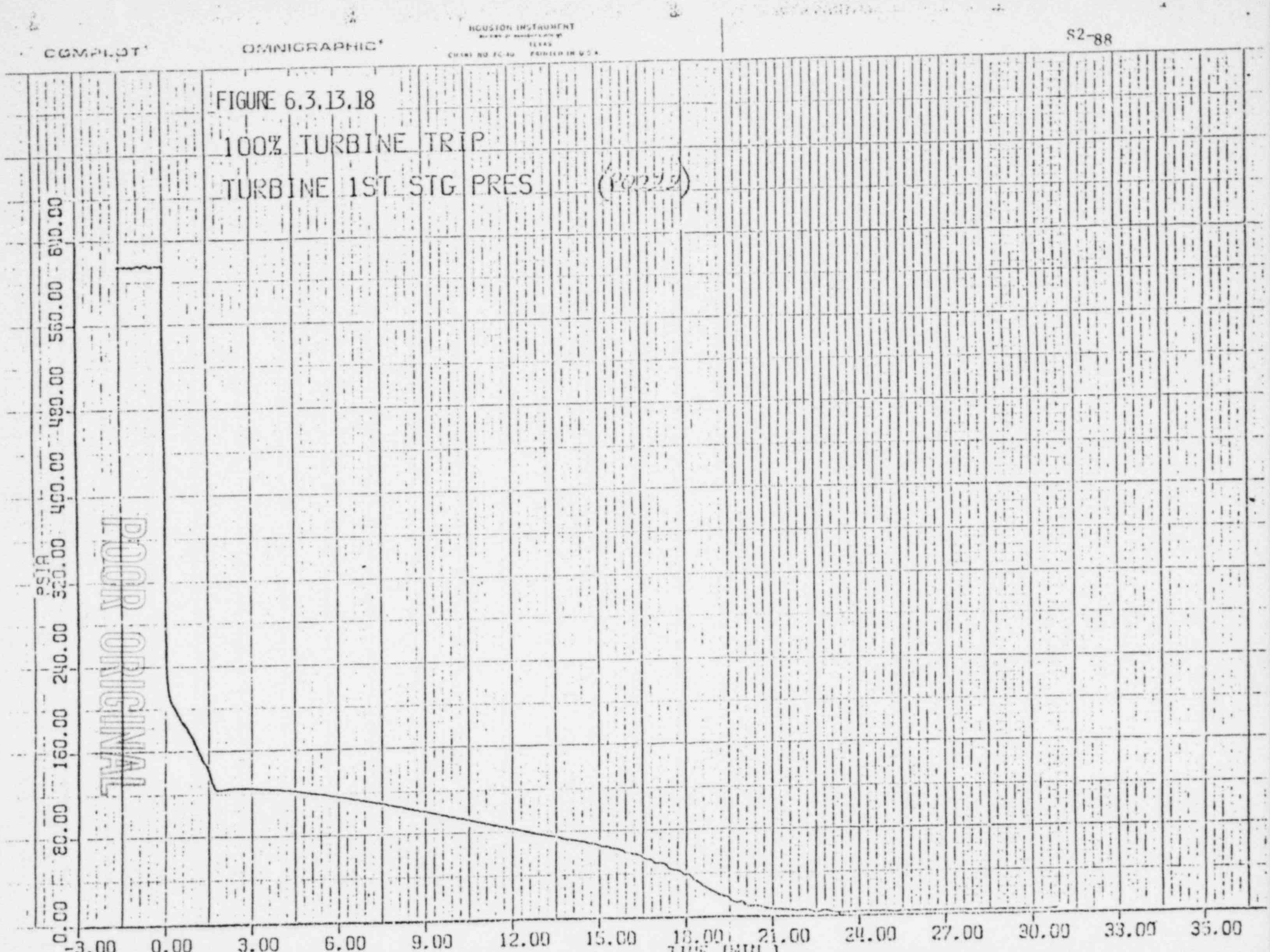
S2-84


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.14
100% TURBINE TRIP
SG-A HEADER DP
(RD1030)
IN. H2O
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
82-85
FIGURE 6.3.13.15
100% TURBINE TRIP
SG-B HEADER DP
(PD1150)
IN. H2O
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.16
100% TURBINE TRIP
NUCLEAR POWER(NR001)
PERCENT
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.17
100% TURBINE TRIP
NUCLEAR POWER(NR002)
PERCENT
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.18
100% TURBINE TRIP
TURBINE 1ST STG PRES
PSIA
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

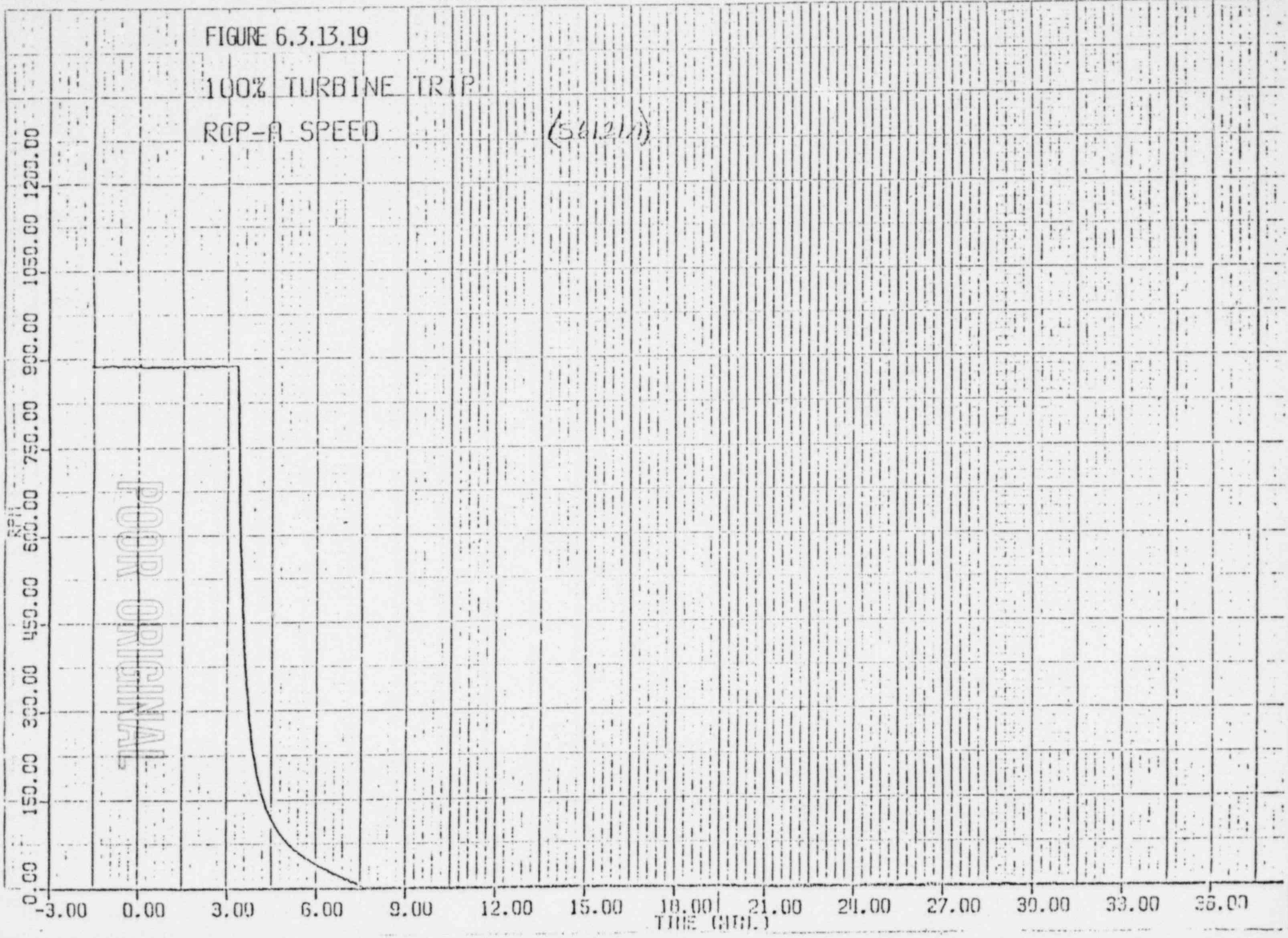
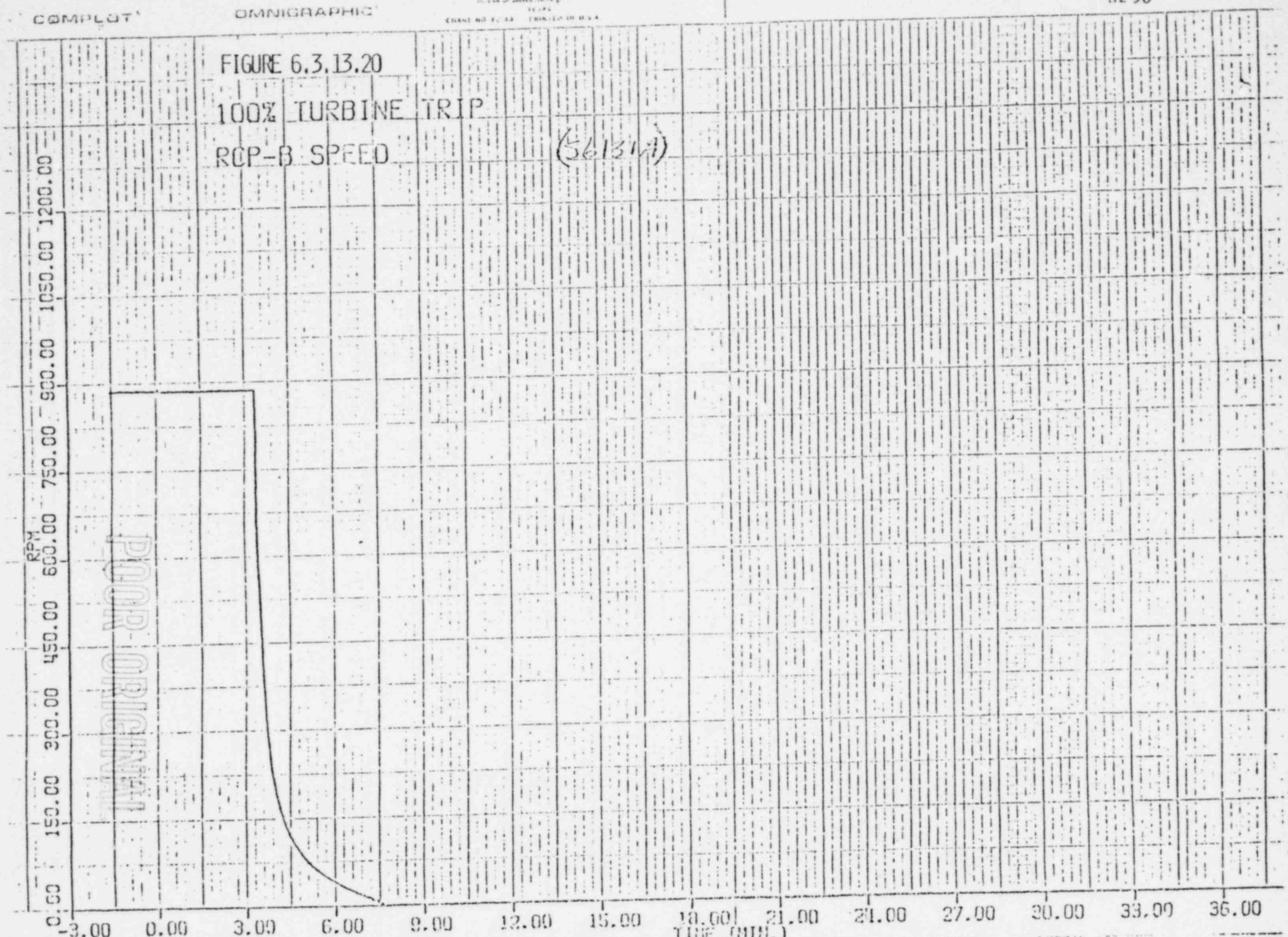
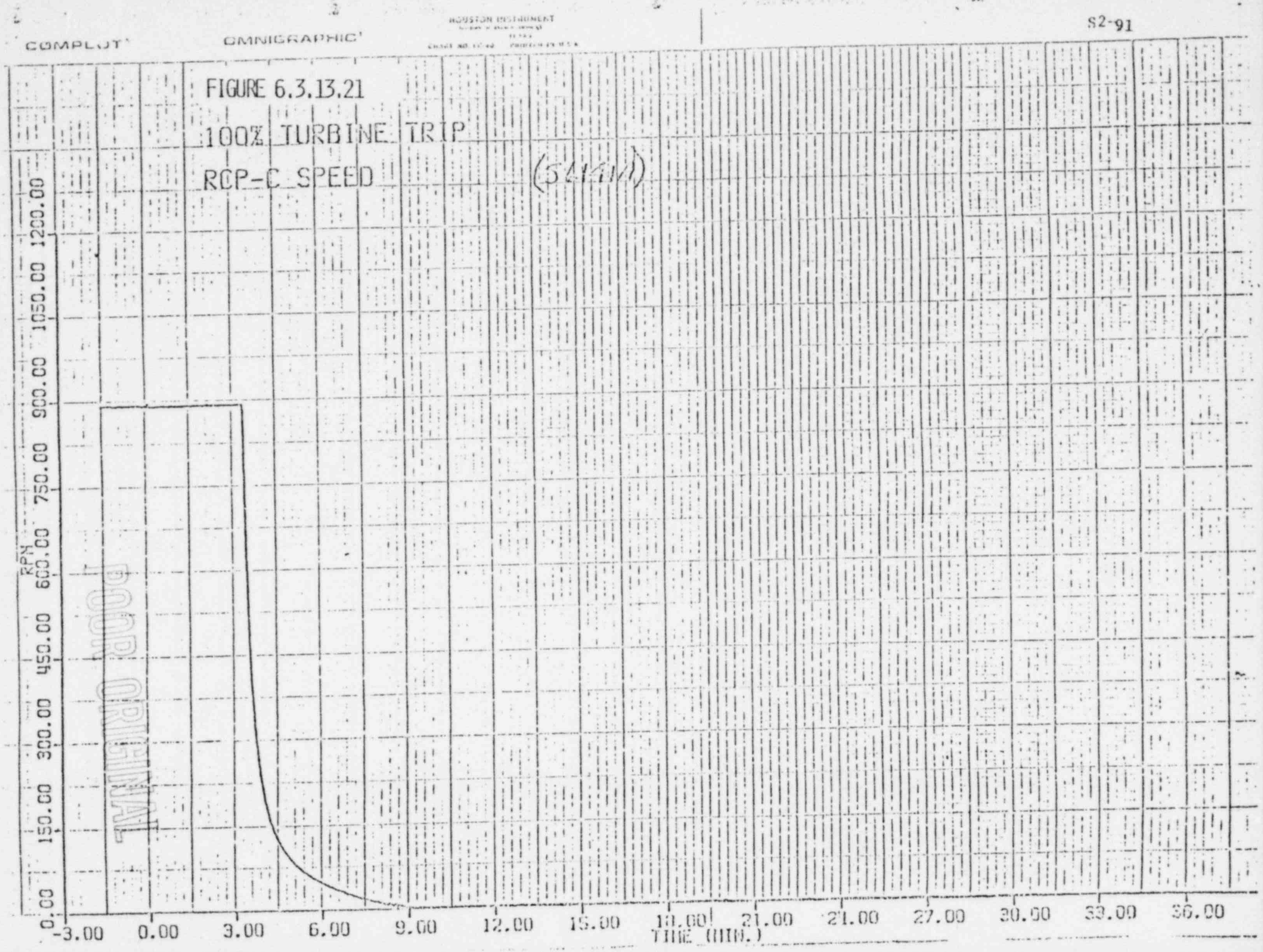
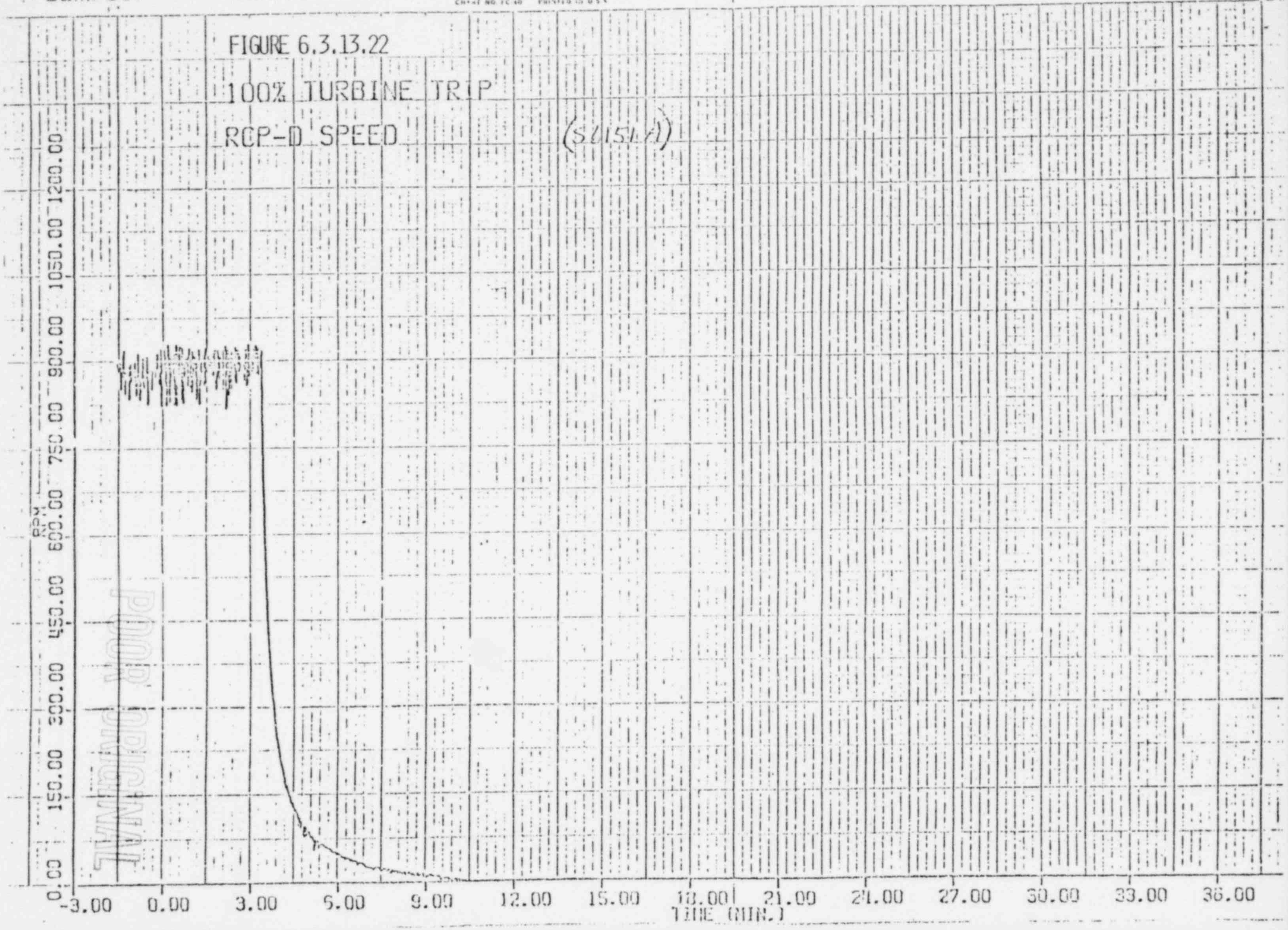


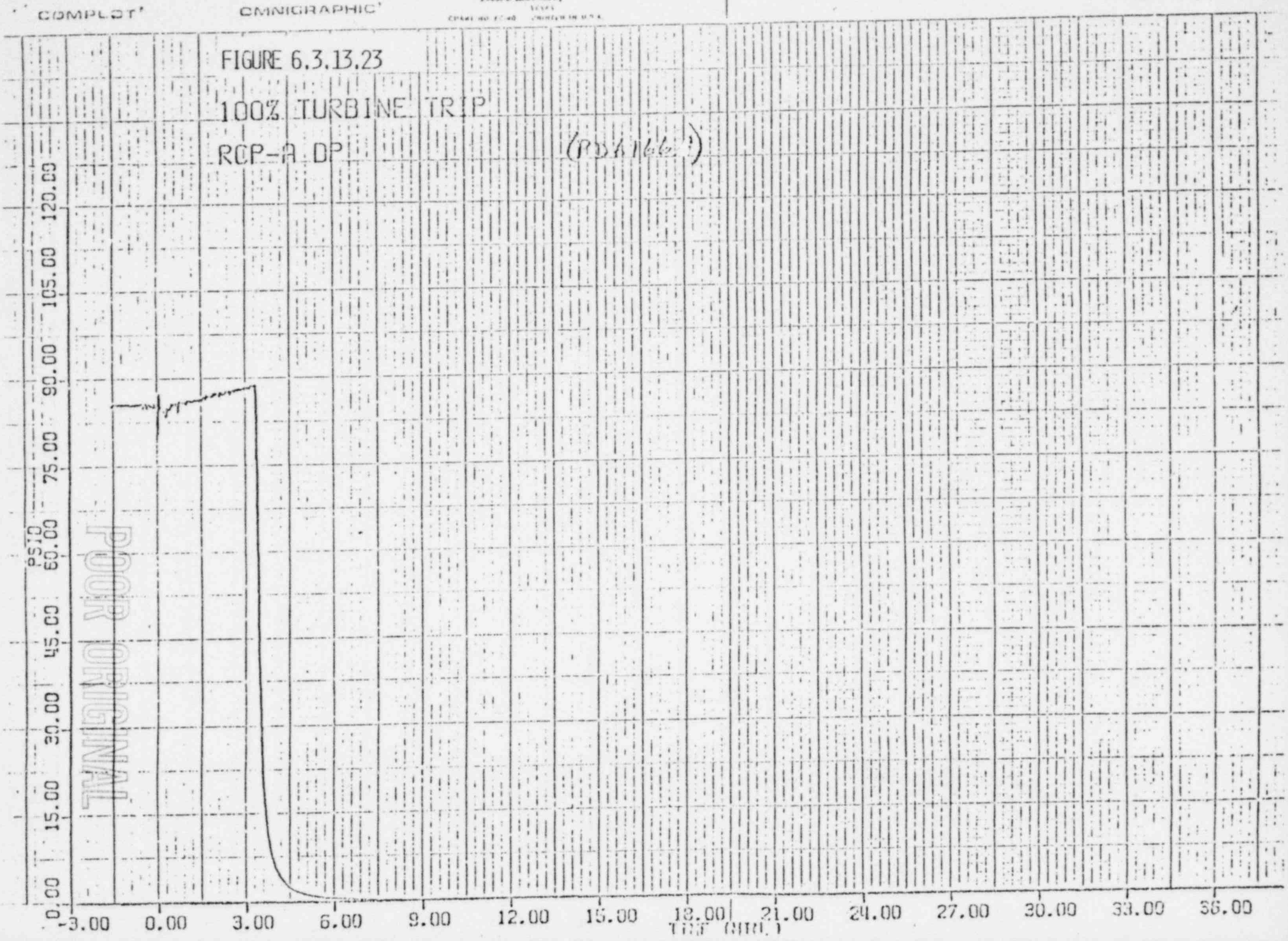
FIGURE 6.3.13.19
100% TURBINE TRIP
RCP-A SPEED
(5/12/17)
RPM
1200.00
1050.00
900.00
750.00
600.00
450.00
300.00
150.00
0.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)

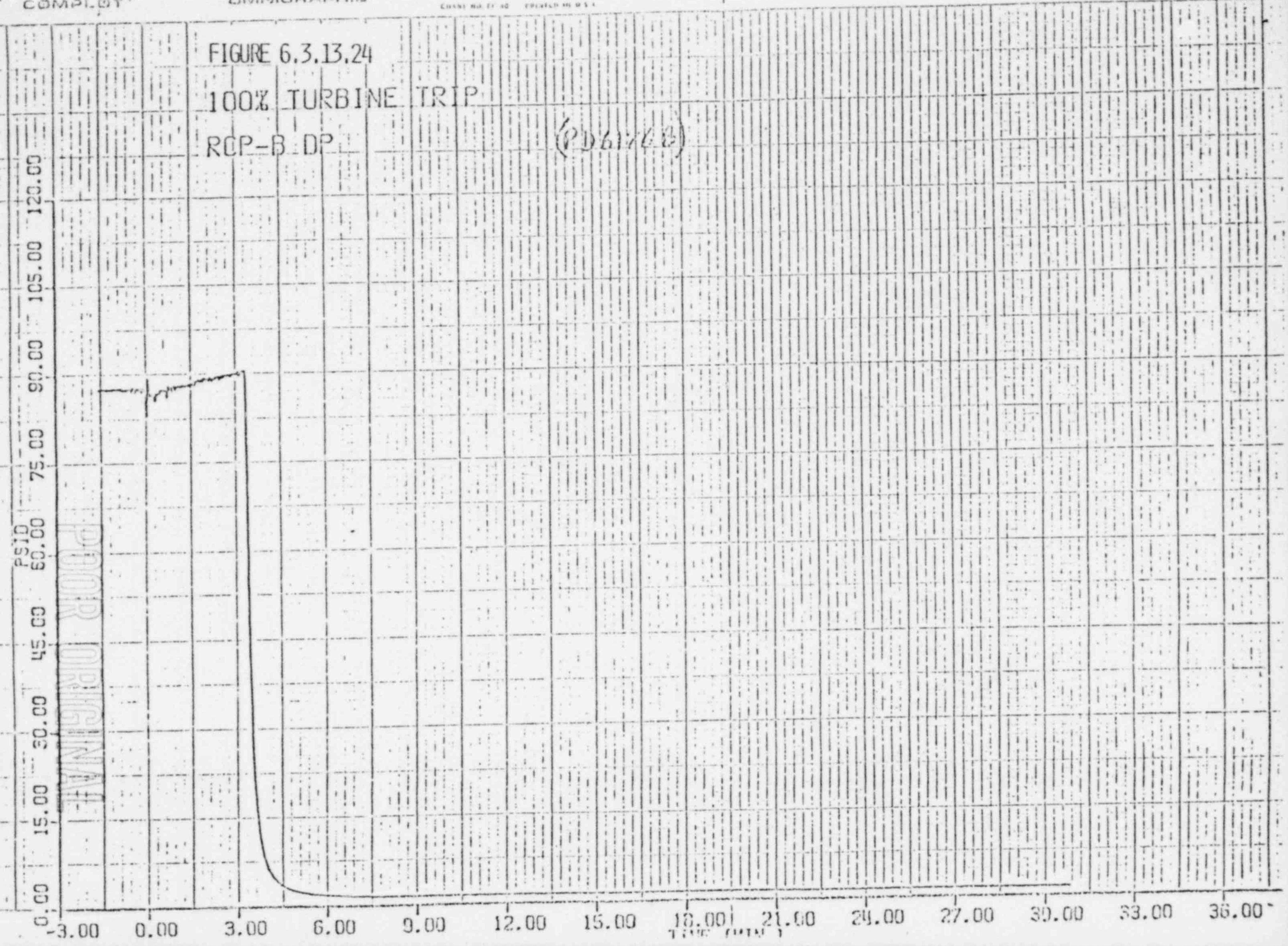
S2-90

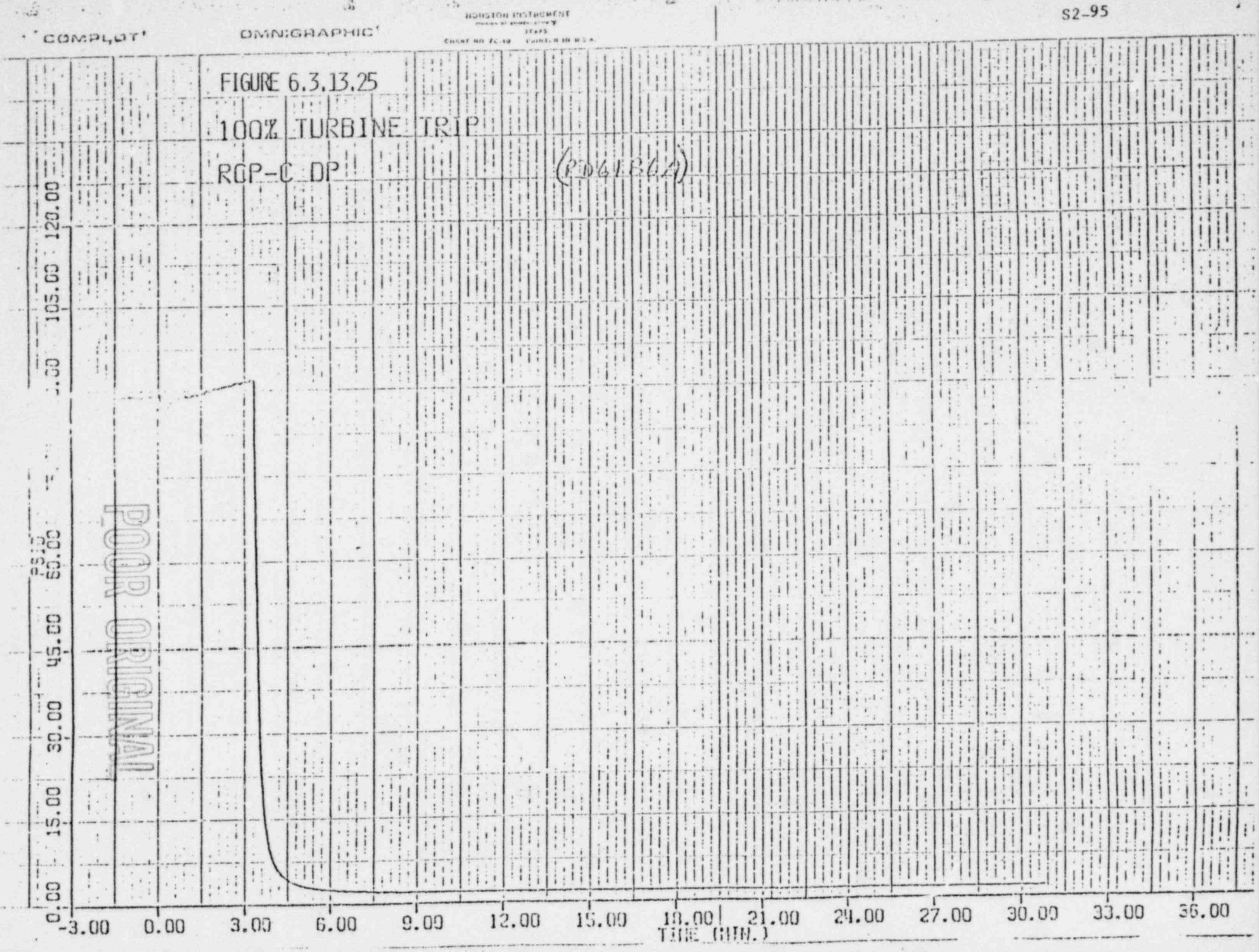

COMPLOT
OMNIGRAPHIC
FIGURE 6.3.13.20
100% TURBINE TRIP
RCP-B SPEED
(56BM)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.21
100% TURBINE TRIP
RCP-C SPEED
(544MI)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.22
100% TURBINE TRIP
RCP-D SPEED
(SU15LA)
RPM
0.00
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL


COMPLOT'
OMNIGRAPHIC'
HOUSTON INSTRUMENT
FIGURE 6.3.13.23
100% TURBINE TRIP
RCP-A DP
PSID
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
POOR ORIGINAL


COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.24
100% TURBINE TRIP
RCP-B DP
(PD6117B)
PSID
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN)
POOR ORIGINAL



'COMPLOT'
OMNIGRAPHIC'
HOUSTON INSTRUMENT
FIGURE 6.3.13.25
100% TURBINE TRIP
RCP-C DP
(PD41BCA)
120.00
105.00
60.00
45.00
30.00
15.00
0.00
PSID
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

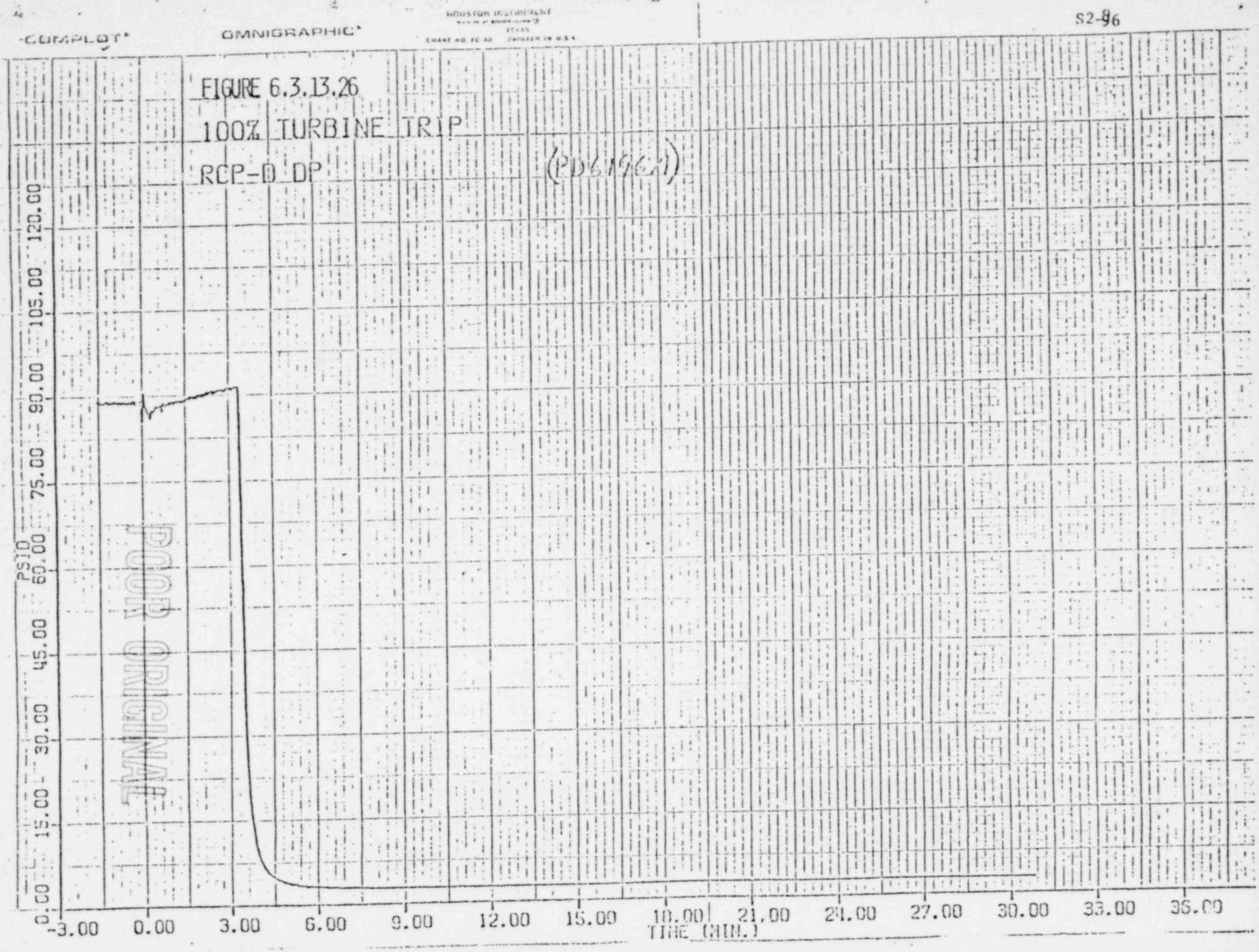
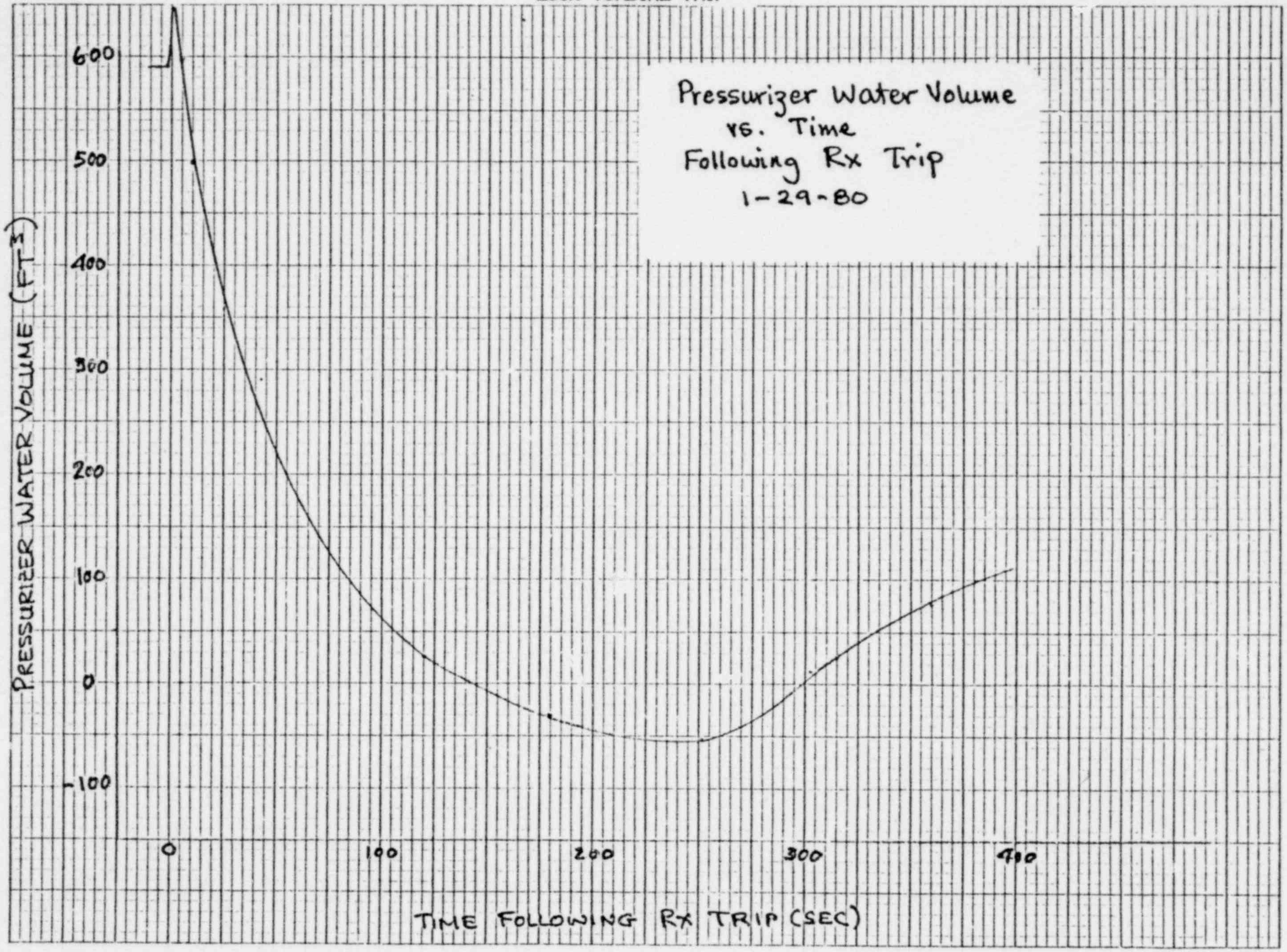

COMPLOT
OMNIGRAPHIC
HOUSTON INSTRUMENT
FIGURE 6.3.13.26
100% TURBINE TRIP
RCP-D DP
(PD61969A)
PSID
120.00
105.00
90.00
75.00
60.00
45.00
30.00
15.00
0.00
-3.00
0.00
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
TIME (MIN.)
POOR ORIGINAL

FIGURE 6.3.13.27

100% TURBINE TRIP



6.3.14 INCORE DETECTOR SIGNAL VERIFICATION

6.3.14.1 Purpose

The purpose of this test is to verify the proper conversion of the current signal from the incore detectors to voltage as read by the plant computer. Comparison of the signal generated by the incore detector to the voltage seen by the plant computer will also verify the proper operation of the incore amplifier.

6.3.14.2 Test Method

This test was performed at 80% and 100% power, the 80% testing being necessary to satisfy acceptance criteria not met for three detectors at the 50% plateau. The test method for either plateau was the same and is described below:

The plant is maintained at nominal power ± 0.2% with RCS pressure at 2250 psia ± 15psia. For the incore detector string to be tested, a special test cable is inserted between the signal input and the amplifier for that detector. Using a picoammeter, the current is measured and recorded for the particular level-wise detector in test. Simultaneously, using the computer D4 function, the row incore raw incore signal is recorded. This process is repeated for the other four levels in that string unless otherwise specified by the test.

6.3.14.3 Test Results

For both power plateaus, four incore detector strins were selected for testing. These four incore detectors were representative of each of the four fixed incore detector amplifier assemblies. The input signals of all the detectors tested were within ± 1% + 1 bit (5mV) of the readings obtained from the plant computer.

These results satisfy acceptance criteria for both the 80% and 100% power plateaus.

6.3.14.4 Conclusion

For both the 80% and 100% power plateaus, the proper conversion of the signal from the incore detectors to voltage, as read by the plant computer, has been verified. Also, this comparison verified the proper of the incore amplifiers.

6.3.15 MOVEABLE INCORE DETECTOR TESTS

6.3.15.1 Purpose

This procedure was performed to provide baseline data for the Moveable Incore Detecotr (MICD) system at the 50% and 100% power plateaus, and to evaluate possible power dependence of the dynamic compensation at 80% power.

6.3.15.2 Test Method

At 50% and 100% power, with reactor power, pressure and temperature stable, and equilibrium xenon, both moveable incore detectors were operated simultaneously in the automatic mode.

At 80% power, with conditions as above, each of the two moveable incore detectors was consecutively inserted into three preselected paths using the semi-automatic mode.

At all three power levels, a Moveable Incore Detector Log was obtained for every path mapped by the incore detectors. Hourly Incore Detector Logs were also obtained at every power level.

6.3.15.3 Test Results

The required data was collected at the 50%, 80% and 100% power plateaus.

6.3.15.4 Conclusions

The MICD system operated satisfactorily and the data obtained was found to be acceptable.

6.3.16 TURBINE GENERATOR LOADING

6.3.16.1 Purpose

The purpose of this test was to perform routine generator loading to 80% and 100% power, perform thrust bearing wear detector final adjustments and collect baseline data for future reference.

6.3.16.2 Test Method

Following completion of 50% testing, the turbine generator was loaded to 80% and 100%. During loading the following tests were performed:

A. Control valve position monitoring

B. Thrust bearing wear detector final adjustment

C. Baseline data collection

6.3.16.3 Test Results

A. While increasing power to 80% and 100%, power levels were recorded at which time control valves CV-3, and CV-3 begin to open and at which time CV-1, CV-2, and CV-3 reached their full open positions.

B. During stable power of 80% and 100%, the thrust bearing wear detector final adjustments were made per GEK-11333A. (GE instructions for adjusting the "Mark I" thrust bearing wear detector).

C. Baseline data was taken during stable plateaus and throughout load changes.

During the load change from 80% to 90%, a vibration problems developed on the #2 bearing, resulting from a turbine rub. At approximately 89%, #2 bearing vibration increased above the 12 mil setpoint and tripped the turbine, causing a plant trip. This occurred twice. On the third attempt to reach 90%, the trip setpoint was increased to 15 mils and was closely monitored throughout the increase. No vibrations above normal were observed.

6.3.16.4 Conclusions

All turbine testing up to 100% has been completed with satisfactory results. General Electric will continue to collect baseline data for analysis.

6.3.17 MAIN & REHEAT STEAM TEST

6.3.17.1 Purpose

The purpose of this test was fourfold:

1) Demonstrate proper operation of the reheat temperature control system.

2) Obtain baseline data for future use in MSR tube leak detection.

3) Obtain additional base data useful in analyzing future MSR performance.

4) Obtain baseline data of main steam.

6.3.17.2 Test Method

Reactor power is increased to the specified nominal power level. A Moisture Seperator and Reheater Performance Calculation and Turbine Performance Calculation is obtained from the plant computer. The obtained data is used to generate base performance and characteristic curves.

6.3.17.3 Test Results

The Main and Reheat Steam Power Escalation test was performed at the 60, 70, 80, 90, and 100% power plateaus. All required data was obtained for the reheat temperature control system and the moisture seperators. Base performance and characteristic curves were then generated.

6.3.17.4 Conclusions

The intent of the test has been fully met at all power plateaus. It has been demonstrated that the reheat control system operates properly. Baseline data for MSR performance evaluations has been obtained, also base performance and characteristic curves have been generated.

6.3.18 CONDENSATE AND FEEDWATER SYSTEM

6.3.18.1 Purpose

The purpose of this test was to:

A. Obtain base operating data while demonstrating the ability of the Main Feedwater System to supply the steam generators at the required pressures, temperatures, and flows under all anticipated steady state conditons.

B. Verify the proper operation of the FWP recirculation valves.

6.3.18.2 Test Method

FWP recirculation valve operation was observed on power ascensions to 50% power. The Feedwater Control System was placed in Mode 1 (full auto) and flows were allowed to stabilize at 50%, 80%, and 100% power plateaus. Following each flow stabilization, main feed pump data and flow valve position data was recorded from local readings, remote readings, and computer data points.

6.3.18.3 Test Results

A. Baseline data was obtained at the 50%, 80% and 100% power plateaus, and was in agreement with test guidelines except for three main feed pump lube oil supply pressure indications.

B. Main feed pump and flow valve position data was obtained and proper operation verified during power ascension.

7.3.18.4 Conclusions

The condensate and feedwater system was capable of maintaining the required pressures, temperatures and flow rates at all power levels up to and including 100% plant capacity with the exception of three main feedwater pump lube oil supply pressures which required adjustment and will be verified on the next ascension to 100% plant power.

6.3.19 MAIN TURBINE ELECTRO-HYDRAULIC CONTROL TESTS

6.3.19.1 Purpose

The purpose of this test was to demonstrate the ability of the EHC system to maintain stable control of the main turbine and to protect the main turbine during scheduled trips within design limits while maintaining the feedwater turbines in operation. Baseline data was also collected during the test.

6.3.19.2 Test Method

This test was performed at the 80% and 100% plateaus. Reactor power was held constant and baseline data was collected on the running EHC pump. Additional data was taken for main turbine throttle pressure, main turbine first stage pressure, main turbine control valve positions, main feed pump control valve position and pump speed. Turbine generator maximum and minimum loads were measured over a 15 minute period. During performance of scheduled trips, main turbine combined intermediate valve position and main feedwater pump speed were monitored to verify proper operation.

Baseline data was compared to expected values and any discrepancies were issued as deficiencies to the test procedure.

6.3.19.3 Test Results

All baseline data was within design limits and Generator output varied 6.26 MWe at 80% and 3.5 MWe at 100% during a fifteen minute period. During scheduled trips, turbine valve position and main feedwater pump speed performance was as expected for turbine protection and EHC performed as designed.

6.3.19.4 Conclusions

All data collection and performance of the EHC system at 80% and 100% was satisfactory.

6.3.20 FEEDWATER HEATER VENTS, DRAINS AND WATER INDUCTION TESTS

6.3.20.1 Purpose

The purpose of this test was twofold:

a) To demonstrate the satisfactory operation of the Feedwater Heaters during steady state conditions at 80% and 100% power.

b) To demonstrate the satisfactory operation of the Feedwater Heater and Heater Drain Tank dump valves at 80% power.

6.3.20.2 Test Method

Each individual Feedwater Heater shell and drain was instrumented with appropriate pressure guages to allow test personnel to monitor the performance of the heaters at 80% and 100% power.

Baseline data was collected, and computer calculational routines were run to determine Feedwater Heater Terminal Temperature Difference, and Drain Cooler Approach Temperatures for both power levels.

At 80% power, the heater drain tank dump valves (2CV-0813 and 2CV-0825) were tested by manually raising the tank level setpoint, thereby raising the level in the appropriate dump tank (2T40A or 2T40B) until the dump valves began to open. The level at which the dump valves actuated was recorded and the level setpoint returned to normal, restoring the system to normal operating conditions.

6.3.20.3 Test Results

At 80% power, the required baseline data was obtained and the heater drain tank dump valves operated satisfactorily.

At 100% power, the required baseline data was confirmed.

6.3.20.4 Conclusions

The dump valves were shown to operate as required. The data collected at 80% and 100% power was found to be acceptable.

6.3.21 VIBRATION AND LOOSE PARTS MONITOR (V&LPM) TESTS

6.3.21.1 Purpose

The purpose of this test was to provide baseline data for core vibration and loose parts monitoring at 80% and 100% of reactor power.

6.3.21.2 Test Method

At the subject power levels, baseline data was taken on the V&LPM during steady state operation. For each area of the RCS which is monitored by the V&LPM, (see Table 6.3.21.2), data was acquired via tape recordings and frequency/power spectrum plots. In addition, during these data runs, various parameters were trended for ~5 minutes on the plant computer.

6.3.21.3 Test Results

The data described above was obtained during the 80% and 100% power plateaus at steady state conditions.

6.3.21.4 Conclusions

Baseline data was obtained per procedure and acceptance criteria were satisfactorily met.

TABLE 6.3.21.1

AREAS MONITORED BY THE V&LPM

CHANNEL #	AREA MONITORED
1A, 1B	Lower Vessel (2 locations)
2A, 2B	Upper Vessel (2 locations)
3A, 3B	*Steam Generator A (2 locations)
4A, 4B	*Steam Generator B (2 locations)
5	CPC Channel A "Neutron Noise"
6	CPC Channel B "Neutron Noise"
7	CPC Channel C "Neutron Noise"
8	CPC Channel D "Neutron Noise
9	Control Channel #1 "Neutron Noise"
10	Control Channel #2 "Neutron Noise"

*Primary Side

6.3.22 HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS PERFORMANCE TESTS

6.3.22.1 Purpose

The purpose of this test procedure was to:

A. Demonstrate the satisfactory performance of plant Heating, Ventilation and Air Condtioning (HVAC) systems under actual operating heat load.

B. Demonstrate that the HVAC system will satisfy the design criteria at plant power levels of 80%.

C. Provide baseline temperature and/or pressure data in selected points of the plant for future reference.

6.3.22.2 Test Method

This test was performed at the 80% power plateau after plant conditions had been stabilized for 24 hours. The HVAC system status was verified to be in the correct operating mode, and data was taken at the selected points in the plant. Temperatures outside of containment were taken using Taylor thermometers and containment temperatures were read remotely, using installed RTD's.

6.3.22.3 Test Results

Temperatures were taken throughout the plant in accordance with the test procedure at the 80% power plateau and an ambient temperature of 60°F. All temperatures were within specification except for three air returns in the Auxiliary building; they were: the Instrument Room, the Chemical Room, and the Secondary Sampling Room.

The 100% plateau testing was deferred due to the test requirement that it be performed during summer conditions.

6.3.22.4 Conclusions

Baseline data was obtained and satisfactory performance of the HVAC system was demonstrated at the 80% power plateau with the excpetion of the three temperatures mentioned above which are under review for resolution. The 100% power plateau testing remains to be performed.

6.3.23 BIOLOGICAL SHIELD SURVEY TESTS

6.3.23.1 Purpose

The test was conducted to accomplish the following objectives:

A. Determine background radiation levels prior to initial criticality.

B. Evaluate the adequacy of plant radiation shielding.

C. Determine radiation levels throughout the plant at various power levels.

6.3.23.2 Test Method

A comprehensive series of gamma and neutron dose rate level surveys, known as the High Power Shield Test, were conducted at a steady state power level between 90% and 100% power.

Dose rate surveys were taken at numerous locations which included but were not limited to the following areas:

A. Locations inside the Reactor Building.

B. Areas adjacent to the Reactor Building wall.

C. Around penetrations through the Reactor Building wall.

C. Selected points in the Turbine and Auxiliary Building.

6.3.23.3 Test Results

Prior to the 100% power turbine trip, representative points at all elevations of the reactor building were surveyed to compare predicted radiation levels to actual readings at the 100% power plateau. The results were mixed and inconslusive. Several factors contributing to the inconclusive results are discussed below.

A. Gamma Dose Rate Level Surveys

1. After the survey the instrument calibration was checked and found to be

from 41% low to 38% high on the ends of the various ranges. This alone, however, would not account for the higher than expected readings.

2. The system activation had increased significantly since the 50% power surveys and was probably a major factor in the increased gamma dose rates above the predicted values.

B. Neutron Dose Rate Level Surveys

Temperature and high humidity may have affected the instrument, however, measured neutron readings did match projected readings on some elevations.

C. Instrument Positioning

Positioning had a large impact on dose rate level readings taken in the areas close to streaming paths.

Table 6.3.23.1 is a list of the number of neutron and gamma dose rate level readings taken at the designated elevations of the reactor building. Table 6.3.23.2 is a summary of the preliminary survey results.

6.3.23.4 Conclusions

The reactor was not at 100% power long enough to complete the High Power Shield Test. When the reactor is returned to 100% power, additional readings will be taken to complete the 100% shield survey and resolve deficiencies or inconsistencies in the data already obtained.

TABLE 6.3.23.1

NUMBER OF PRELIMINARY NEUTRON AND GAMMA DOSE RATE LEVEL READINGS

<table>
<tr><th>REACTOR BUILDING ELEVATION</th><th colspan="2">NUMBER OF NEUTRON AND GAMMA DOSE RATE LEVEL READINGS</th></tr>
<tr><td>EL 424</td><td colspan="2">5</td></tr>
<tr><td>EL 405</td><td colspan="2">7</td></tr>
<tr><td>EL 386</td><td colspan="2">4</td></tr>
<tr><td>EL 376</td><td colspan="2">3</td></tr>
<tr><td>EL 357</td><td colspan="2">3</td></tr>
<tr><td>EL 335</td><td rowspan="2">7</td><td>Outside secondary shield wall 3</td></tr>
<tr><td>EL 335</td><td>Inside secondary shield wall 4</td></tr>
</table>

TABLE 6.3.23.2

SUMMARY OF PRELIMINARY SURVEY RESULTS

REACTOR BUILDING ELEVATION	GAMMA DOSE RATE LEVEL READINGS	NEUTRON DOSE RATE LEVEL READINGS
EL 424	The gamma dose rates were 2 to 5 times higher than projected.	The neutron readings were from 2 to 10 times lower than projected from previous surveys. Some of the 100% power readings were lower than they were at 50% power. Positioning problems may have introduced some error, but not enough to totally account for the problem. Instrument malfunction may have been a factor.
EL 405	Gamma readings varied from 2 to 10 times higher than expected with some readings matching projected dose rates.	Some neutron readings were 3 to 5 times higher than projected which could be the result of positioning problems. Other areas were from 2 times lower to 2 times higher than projected. Still other areas were from 5 to 8 times lower than projected but these readings were also suspected of being the result of positioning problems.
EL 386	Gamma readings were 2 to 9 times higher than projected.	One neutron reading was about 2 times higher than projected but the other readings were about as expected.
EL 376	Gamma readings were 5 to 10 times higher than expected.	Neutron readings were about the same as projected with some being 1.5 times higher than projected.
EL 357	Gamma readings were 5 to 8 times higher than projected.	Neutron readings were about as projected.
EL 355	Outside the secondary shield wall the gamma readings were 10 to 15 times higher than expected. Inside the secondary shield wall the readings were 1.5 to 3 times higher than projected.	Outside the secondary shield walls the neutron readings were about as projected. Inside the secondary shield walls the readings were from 1/2 of projected to the same as projected.

6.3.24 STEADY STATE VIBRATION TEST

6.3.24.1 Purpose

The purpose of this test was to monitor pipe vibrations of the systems listed below during all significant plant operating modes that are likely to cause vibration in the subject system, and are postulated to have a moderate to high probability of occurrence during the plant's lifetime.

1) Main Feedwater System
2) Emergency Feedwater System
3) Main Steam System
4) Reheat Steam System
5) Condensate System
6) Extraction Steam System
7) Service Water System
8) Gaseous Waste (2T17 to CV-2428)
9) Spent Fuel Pool Cooling and Purification
10) Penetration Room Ventilation

Vibration monitoring was limited to a qualitative examination of each system at the specified test mode.

6.3.24.2 Test Method

1) Main Feedwater System:

The Main Feedwater System was tested for steady state vibrations with each train operating simultaneously at 50% capacity (100% plant power).

Verification was made that flow through each feedwater train is 14,200($\pm$500) gpm, as indicated by the computer points for train "A" and "B" respectively. Following flow verification, a walkdown of the system was performed and the piping was inspected to ensure that the steady state vibrations were acceptable.

2) Emergency Feedwater System:

The Emergency Feedwater System (EFS) was tested for steady state vibration with both pumps operating simultaneously at the maximum design flow rate supplying water to Steam Generator 2E24A, then to Steam Generator 2E24A, then to Steam Generator 2E24B.

First, it was verified that the EFS pumps 2P7A and 2P7B are operating and that flow through each EFS train was 575($\pm$25) gpm. Following flow verification, the system was inspected to ensure that the steady state vibrations were acceptable.

3) Main Steam System:

The Main Steam System was tested for steady state vibration with the plant operating at 100% power.

It was first verified that the flow throught the main steam lines from steam generators 2E24A and 2E24B were each 6.2 X 10^6 ($\pm$0.2 X 10^6) lb/hr. The main steam line was inspected and visually verified that the steady state vibration of the system piping was within the acceptance criteria.

4) For the test of the Reheat Steam, Condensate, and Extraction Steam system, the prerequisites were that power range testing be in progress with the plant at a power level greater than 75%, and that the system be in a steady state operating condition.

A walkdown was performed to visually verify that the steady state vibration was acceptable.

5) The Service Water, Gaseous Waste, Spent Fuel Pool Cooling and Purification and Penetration Room Ventilation systems require that the plant be in power ascension testing and the system be in an operating mode. Here also, a walkdown was performed to insure & verify that the steady state vibration of the subject piping is acceptable.

6.3.24.3 Test Results

The test was performed at various power plateaus during ascension from 50 to 100% full power. Each particular section was performed as dictated by the procedure.

There were a number of items that indicated higher than expected steady state vibrations. They were:

a. Train "B" main feed regulating valve bypass piping (2CV-0744, 2FW-0744-A, and 2FW-0744-1).

b. Main steam atmospheric dump valves 2CV-0305 and 2CV-0301.

c. Main steam dump to condenser, specifically 2CV-0306.

d. The No. 1 Main steam header, snubbers of hanger 2EBD-1-H13.

The above noted items are being evaluated and analyzed at the present time.

The spent fuel ppol cooling and purification system was not inspected because the system was empty. This system will be inspected after the pool has been filled and the cooling system has been placed in service.

6.3.24.4 Conclusions

With the exception of the above noted items, the test showed that the piping system steady state vibration is acceptable following visual examination by a qualified Test Engineer with required experience in piping stress analysis.

6.3.25 PIPE/COMPONENT HOT DEFLECTION TEST

6.3.25.1 Purpose

The purpose of this test was to verify that the piping systems listed below respond to thermal expansion in accordance with the design intent.

1) Main Feedwater System
2) Emergency Feedwater System
3) Reheat Steam System
4) Condensate System
5) Extraction Steam System

The design intent is that:

1) The piping expands freely with constraints only at the rigid restraints and anchors.

2) The pipe returns to its approximate baseline position in the cold condition.

Verification of the above is made visually and by measuring deflections at selected points and comparing with expected displacements.

6.3.25.2 Test Method

At ambient conditions the initial temperatures of the piping systems are recorded. The system under test is visually inspected and a verification made that no interference exists with potential obstructions such as pipe whip restraints, cable trays, equipment, or other pipes. The initial positions of the pipes in the system are measured and recorded. The locations within the system where measurements are made constitute "data points".

With the plant stabilized at 80% power, piping system temperatures and deflections are recorded at the data points. Also, a visual inspection is performed to check for any possible interferences or obstructions.

Final piping systems data at ambient conditions are obtained following a cooldown to ambient temperatures. Temperatures and final deflections are recorded and visual inspection of the piping under test is performed.

6.3.25.3 Test Results

The test was performed at the 80% power plateau and verified that no interference exists between piping and any potential obstructions. However, at a number of data points the measurements were outside of acceptance criteria. These points are being evaluated and a determination made as to either acceptability or any required modifications to render the out-of-spec data points acceptable.

6.3.25.4 Conclusions

It was shown that no interference with potential obstructions, such as pipe whip restraints, cable trays, equipment, or other pipes exists. However, not all measured data point deflections, for the Main and Emergency Feedwater Systems, were within the acceptable range. All out of specification data points are being evaluated and required changes will be implemented.

6.3.26 PIPING DYNAMIC TRANSIENT TEST

6.3.26.1 Purpose

The purpose of this test was to verify the adequacy of the piping restraint configuration for the following listed piping systems during a Main Steam Stop Valve trip at 80 & 100% reactor power.

1) Main Steam lines
2) Main Steam dump line to the condenser
3) Main Steam branch lines to the Main Feedwater pump turbine driver
4) Second stage reheat steam supply lines

6.3.26.2 Test Method

The reactor is at the nominal power level (80%, 100%). The instrumentation utilized to measure pipe displacement (measured as maximum pipe displacement in inches), restraint loads (measured in kilopounds), pipe pressure rise (measured as peak difference pressure of first pressure pulse in pounds per square inch), and valve displacement (measured as time required for valve to reach approximately 90% of full travel in seconds) is verified to be connected to the test recorders with proper gain settings. The recorders are started at a speed of $\geq$10 inches per second just prior to a turbine trip, from which a main stop valve closure results. Data recording continues for a minimum of 10 seconds following main stop valve closure. Recorder charts are removed and required data points analyzed.

6.3.26.3 Test Results

The main steam stop valve trip was performed at the 80% and 100% power plateaus. Detailed analysis of the test data yielded satisfactory results.

6.3.26.4 Conclusions

The adequacy of piping restraint configurations for the piping systems under test has been verified.

6.3.27 CESEC VERIFICATION TEST

6.3.27.1 Purpose

The purpose of this test was to acquire data during the following NSSS transient tests.

1.) 80% Loss of Flow Trip

2.) Dropped CEA Test

3.) 100% Turbine Trip Test

The data obtained will subsequently be used by CE-Windsor in a comparison of actual NSSS response to simulated NSSS response as predicted by CESEC, the CE NSSS response code.

6.3.27.2 Test Method

For each transient listed above, various plant parameters were recorded. Each device utilized for recording was carefully set up so that the as-recorded signal was in agreement with the corresponding computer value to within $\pm 1\%$. Upon completion of a particular transient test, the agreement was again checked to determine any drift which may have occurred during the test.

6.3.27.3 Test Results

For each transient described above, the necessary data was obtained. The data was then sent to CE-Windsor for subsequent use in the CESEC comparison.

6.3.27.4 Conclusions

The interim acceptance criteria for this test was satisfactorily met, i.e., the collected data was sent to CE-Windsor. Final acceptance criteria will be satisfied pending a report from CE which documents CE's CESEC analysis.

6.3.28 EJECTED CEA TEST

6.3.28.1 Purpose

The purpose of this test was to verify that the measured power distribution associated with pseudo-CEA ejection from the 100% Power Transient Insertion Limit (i.e., CEA Group 6 insertion to 102" withdrawn) is adequately represented by the predicted values.

6.3.28.2 Test Method

Initial conditions for this test were reactor at 50% power ±0.2%, (following the 80% plateau) constant T_{cold} ±0.2°F, pressurizer level constant ±1% and RCS pressure equal to 2250 psia ±15 psia. The test commenced with the insertion of Group 6 to 100% Power Transient Insertion Limit, (102" WD ± 1.5"WD). Equilibrium Xenon conditions were then allowed to develop. This was followed by the boration of the center CEA, CEA 6-1, to the fully withdrawn position. Following stabilized conditions, incore detector data was taken for the "pseudo-ejected" center CEA configuration, CEA 6-1 was then inserted in trade for the withdrawal of CEA 6-46. CEA 6-1 resulted in being aligned with the Group 6 height while CEA 6-46 was taken to its fully withdrawn position. Conditions were allowed to stabilize and data was taken for the "pseudo-ejected" CEA 6-46 configuration. CEA 6-46 was then realigned with Group 6 while maintaining power & temperature with Group 6 withdrawal. Group 6 was subsequently fully withdrawn. Throughout the test, power and temperature were held constant.

6.3.28.3 Test Results

The test was performed smoothly with power and temperature being maintained as specified.

The acceptance criteria states that the measured incore detector signals can not exceed the predicted values by greater than 20%. Compliance was verified by comparing the relative power density (RPD) ratio for each assembly and ensuring that the % difference between measured and predicted values was less than 20%. The results of these comparisons are presented in Figures 6.3.28.1 and 2.

The largest percent differences occur in the region of the ejected CEA; all are less than 20%.

6.3.28.4 Conclusions

The measured power distributions resulting from pseudo-CEA ejections from 100% Power Transient Insertion Limit have been adequately represented by the predicted distributions.

FIGURE 6.3.28.1

EJECTED CEA 6-1 COMPARISON

Assembly	Predicted Ratio	Measured Ratio	% Difference
1	0.9557	0.9980	-4.43
2	0.9555	1.0275	-7.54
3	0.9555	1.0489	-9.77
4	0.9555	1.0274	-7.53
5	0.9557	0.9979	-4.41
6	0.9571	0.9668	-1.01
7	0.9583	0.9625	-0.43
8	0.9590	0.9726	-1.42
9	0.9595	0.9621	-0.28
10	0.9597	0.9958	-3.76
11	0.9595	0.9624	-0.30
12	0.9590	0.9724	-1.40
13	0.9583	0.9622	-0.41
14	0.9571	0.9668	-1.01
15	0.9575	0.9449	1.32
16	0.9596	0.9654	-0.61
17	0.9630	0.9671	-0.43
18	0.9665	0.9606	0.61
19	0.9696	0.9774	-0.86
20	0.9700	0.9814	-1.17
21	0.9696	0.9763	-0.75
22	0.9665	0.9594	0.73
23	0.9630	0.9657	-0.29
24	0.9596	0.9652	-0.59
25	0.9575	0.9477	1.03
26	0.9571	0.9678	-1.11
27	0.9596	0.9654	-0.61
28	0.9644	0.9630	0.26
29	0.9733	0.9747	-0.15
30	0.9804	0.9859	-0.56
31	0.9863	0.9872	-0.09
32	0.9887	1.0011	-1.25
33	0.9863	0.9844	0.20
34	0.9804	0.9839	-0.36
35	0.9733	0.9710	0.23
36	0.9644	0.9630	0.26
37	0.9596	0.9713	-1.23
38	0.9571	0.9711	-1.46
39	0.9583	0.9642	-0.61
40	0.9630	0.9673	-0.45
41	0.9733	0.9668	0.67
42	0.9869	0.9896	-0.28
43	1.0017	0.9939	0.78
44	1.0154	1.0185	-0.31
45	1.0214	1.0214	0.00
46	1.0154	1.0197	-0.42
47	1.0017	0.9940	0.77
48	0.9869	0.9884	-0.16
49	0.9733	0.9663	0.72
50	0.9630	0.9687	-0.59
51	0.9583	0.9646	-0.65
52	0.9557	0.9987	-4.50
53	0.9590	0.9743	-1.60
54	0.9665	0.9674	-0.09
55	0.9804	0.9844	-0.41
56	1.0017	0.9939	0.77
57	1.0314	1.0260	0.53
58	1.0664	1.0371	2.75
59	1.0849	1.0737	1.03
60	1.0664	1.0438	2.12
61	1.0314	1.0273	0.40
62	1.0017	0.9934	0.83
63	0.9804	0.9836	-0.32
64	0.9665	0.9672	-0.08
65	0.9590	0.9726	-1.43
66	0.9557	0.9950	-4.12
67	0.9555	1.0262	-7.40
68	0.9595	0.9592	0.03
69	0.9696	0.9755	-0.66
70	0.9863	0.9820	0.44
71	1.0154	1.0148	0.05
72	1.0664	1.0416	2.33
73	1.1614	1.1045	4.90
74	1.2546	1.1612	7.44
75	1.1614	1.1023	5.10
76	1.0664	1.0399	2.49
77	1.0154	1.0138	0.16
78	0.9863	0.9804	0.60
79	0.9696	0.9731	-0.41
80	0.9595	0.9552	0.45
81	0.9565	1.0209	-6.84
82	0.9555	1.0490	-9.78
83	0.9597	0.9926	-3.43
84	0.9700	0.9760	-0.61
85	0.9887	0.9941	-0.55
86	1.0214	1.0069	1.42
87	1.0849	1.0676	1.60
88	1.2546	1.1447	8.76
89 ⊗	1.8931	1.6259	14.12
90	1.2546	1.1338	9.63
91	1.0849	1.0631	2.00
92	1.0214	1.0065	1.46
93	0.9887	0.9923	-0.37
94	0.9700	0.9718	-0.18
95	0.9597	0.9887	-3.02
96	0.9555	1.0405	-8.90
97	0.9555	1.0280	-7.59
98	0.9595	0.9621	-0.27
99	0.9696	0.9762	-0.74
100	0.9863	0.9823	0.41
101	1.0154	1.0147	0.07
102	1.0664	1.0408	2.40
103	1.1614	1.1025	5.08
104	1.2546	1.1577	7.72
105	1.1614	1.0988	5.39
106	1.0664	1.0382	2.65
107	1.0154	1.0136	0.18
108	0.9863	0.9808	0.56
109	0.9696	0.9748	-0.59
110	0.9595	0.9619	-0.26
111	0.9555	1.0113	-5.84
112	0.9557	1.0003	-4.67
113	0.9590	0.9761	-1.79
114	0.9665	0.9673	-0.09
115	0.9804	0.9853	-0.50
116	1.0017	0.9934	0.83
117	1.0314	1.0247	0.65
118	1.0664	1.0349	2.96
119	1.0849	1.0668	1.66
120	1.0664	1.0343	3.02
121	1.0314	1.0238	0.74
122	1.0017	0.9935	0.82
123	0.9804	0.9835	-0.32
124	0.9665	0.9674	-0.09
125	0.9590	0.9648	-0.62
126	0.9557	0.9482	0.78
127	0.9583	0.9671	-0.91
128	0.9630	0.9707	-0.80
129	0.9733	0.9717	0.16
130	0.9869	0.9891	-0.23
131	1.0017	0.9919	0.98
132	1.0154	1.0142	0.11
133	1.0214	1.0106	1.07
134	1.0154	1.0136	0.18
135	1.0017	0.9910	1.07
136	0.9869	0.9875	-0.06
137	0.9733	0.9649	0.86
138	0.9630	0.9650	-0.21
139	0.9583	0.9584	0.00
140	0.9571	0.9726	-1.61
141	0.9596	0.9718	-1.28
142	0.9644	0.9663	-0.08
143	0.9733	0.9713	0.20
144	0.9804	0.9837	-0.34
145	0.9863	0.9853	0.10
146	0.9887	0.9949	-0.64
147	0.9863	0.9840	0.24
148	0.9804	0.9828	-0.24
149	0.9733	0.9714	0.19
150	0.9644	0.9604	0.53
151	0.9596	0.9628	-0.33
152	0.9571	0.9634	-0.65
153	0.9575	0.9518	0.59
154	0.9596	0.9731	-1.41
155	0.9630	0.9674	-0.46
156	0.9665	0.9590	0.78
157	0.9696	0.9736	-0.47
158	0.9700	0.9700	0.00
159	0.9696	0.9729	-0.40
160	0.9665	0.9580	0.88
161	0.9630	0.9651	-0.22
162	0.9596	0.9634	-0.39
163	0.9575	0.9426	1.56
164	0.9571	0.9710	-1.45
165	0.9583	0.9628	-0.46
166	0.9590	0.9722	-1.39
167	0.9595	0.9622	-0.29
168	0.9597	0.9917	-3.33
169	0.9595	0.9622	-0.29
170	0.9590	0.9719	-1.36
171	0.9583	0.9625	-0.44
172	0.9571	0.9660	-0.93
173	0.9557	0.9976	-4.37
174	0.9555	1.0272	-7.50
175	0.9555	1.0488	-9.77
176	0.9555	1.0275	-7.54
177	0.9557	0.9977	-4.39

FORMAT

BOX ⊗
XXXXX
YYYYY
ZZ

BOX = ASSEMBLY NUMBER
XXX = PREDICTED RATIO
YYY = MEASURED RATIO
ZZ = % DIFFERENCE

⊗ INDICATES EJECTED CEA ASSEMBLY

POOR ORIGINAL

FIGURE 6.3.28.2

EJECTED CEA 6-46 COMPARISON

Box (Assembly Number)	Predicted Ratio	Measured Ratio	Percent Difference
1	0.9666	0.9663	0.03
2	0.9276	0.9921	-6.96
3	0.9259	1.0097	-9.05
4	0.9246	0.9875	-6.80
5	0.9609	0.9594	0.17
6	0.9387	0.9488	-1.08
7	0.9352	0.9423	-0.76
8	0.9316	0.9436	-1.29
9	0.9290	0.9303	-0.15
10	0.9269	0.9576	-3.31
11	0.9253	0.9231	0.16
12	0.9241	0.9346	-1.14
13	0.9231	0.9320	-0.96
14	0.9223	0.9333	-1.19
15	0.9503	0.9367	1.43
16	0.9435	0.9495	-0.63
17	0.9386	0.9444	-0.62
18	0.9350	0.9304	0.49
19	0.9319	0.9415	-1.03
20	0.9291	0.9402	-1.20
21	0.9269	0.9348	-0.85
22	0.9252	0.9190	0.66
23	0.9237	0.9288	-0.56
24	0.9228	0.9290	-0.67
25	0.9224	0.9117	1.16
26	0.9646	0.9731	-0.88
27	0.9593	0.9643	-0.52
28	0.9521	0.9546	-0.26
29	0.9454	0.9525	-0.75
30	0.9406	0.9526	-1.27
31	0.9364	0.9484	-1.28
32	0.9327	0.9522	-2.10
33	0.9295	0.9394	-1.07
34	0.9271	0.9372	-1.08
35	0.9253	0.9320	-0.73
36	0.9237	0.9271	-0.37
37	0.9226	0.9332	-1.12
38	0.9223	0.9324	-1.09
39	0.9745	0.9763	-0.18
40	0.9696	0.9719	-0.24
41	0.9633	0.9597	0.37
42	0.9556	0.9671	-1.20
43	0.9487	0.9547	-0.63
44	0.9427	0.9642	-2.28
45	0.9374	0.9529	-1.65
46	0.9331	0.9522	-2.05
47	0.9298	0.9341	-0.47
48	0.9274	0.9384	-1.19
49	0.9253	0.9222	0.33
50	0.9237	0.9279	-0.46
51	0.9231	0.9252	-0.23
52	0.9560	1.0306	-7.80
53	0.9883	0.9963	-0.81
54	0.9827	0.9812	0.15
55	0.9761	0.9839	-0.80
56	0.9682	0.9752	-0.72
57	0.9598	0.9798	-2.09
58	0.9514	0.9686	-1.81
59	0.9437	0.9683	-2.61
60	0.9376	0.9499	-1.31
61	0.9332	0.9520	-2.01
62	0.9295	0.9394	-1.03
63	0.9271	0.9360	-0.96
64	0.9252	0.9265	-0.15
65	0.9240	0.9338	-1.06
66	0.8880	0.9568	-7.75
67	1.0081	1.0704	-6.17
68	1.0052	0.9917	1.34
69	1.0010	1.0012	-0.02
70	0.9946	0.9922	0.23
71	0.9857	0.9995	-1.40
72	0.9753	0.9854	-1.03
73	0.9640	0.9895	-2.64
74	0.9522	0.9664	-1.49
75	0.9435	0.9645	-2.75
76	0.9376	0.9499	-1.30
77	0.9331	0.9509	-1.91
78	0.9295	0.9312	-0.18
79	0.9269	0.9322	-0.58
80	0.9253	0.9198	0.59
81	0.9246	0.9832	-6.33
82	1.0298	1.1120	-7.98
83	1.0301	1.0486	-1.80
84	1.0287	1.0222	0.63
85	1.0224	1.0265	-0.40
86	1.0113	1.0110	0.03
87	0.9972	1.0152	-1.80
88	0.9829	1.0000	-1.74
89	0.9664	0.9900	-2.44
90	0.9522	0.9775	-2.66
91	0.9437	0.9691	-2.69
92	0.9374	0.9506	-1.41
93	0.9326	0.9459	-1.43
94	0.9291	0.9352	-0.66
95	0.9269	0.9531	-2.83
96	0.9256	1.0037	-8.41
97	1.0604	1.1122	-4.89
98	1.0685	1.0445	2.24
99	1.0735	1.0580	1.44
100	1.0679	1.0511	1.57
101	1.0503	1.0502	0.01
102	1.0270	1.0263	0.08
103	1.0044	1.0216	-1.71
104	0.9829	0.9926	-0.99
105	0.9648	0.9389	-2.58
106	0.9514	0.9635	-1.28
107	0.9427	0.9606	-1.91
108	0.9364	0.9388	-0.26
109	0.9319	0.9396	-0.82
110	0.9290	0.9298	-0.09
111	0.9276	0.9779	-5.41
112	1.0542	1.1098	-5.28
113	1.1291	1.1046	2.17
114	1.1538	1.0994	4.71
115	1.1525	1.1191	2.90
116	1.1148	1.0787	3.24
117	1.0664	1.0621	0.40
118	1.0270	1.0272	-0.02
119	0.9972	1.0142	-1.70
120	0.9753	0.9860	-1.10
121	0.9598	0.9782	-1.92
122	0.9487	0.9569	-0.87
123	0.9406	0.9501	-1.01
124	0.9350	0.9389	-0.41
125	0.9315	0.9357	-0.44
126	0.8930	0.9209	-3.08
127	1.2340	1.1623	6.19
128	1.3173	1.2008	8.84
129	1.3565	1.2384	9.51
130	1.2320	1.1539	6.34
131	1.1148	1.0799	3.13
132	1.0503	1.0501	-0.04
133	1.0113	1.0117	-0.03
134	0.9857	1.0008	-1.54
135	0.9682	0.9707	-0.26
136	0.9556	0.9648	-0.96
137	0.9454	0.9410	0.46
138	0.9386	0.9408	-0.23
139	0.9352	0.9327	0.27
140	1.3645	1.2428	8.92
141	1.5524	1.3055	15.90
142 ⊛	2.1896	1.7883	18.33
143	1.3685	1.2117	11.45
144	1.1525	1.1112	3.58
145	1.0679	1.0496	1.72
146	1.0224	1.0276	-0.51
147	0.9946	1.0005	-0.60
148	0.9761	[illegible]	-0.71
149	0.9633	0.9629	0.04
150	0.9521	0.9508	0.14
151	0.9435	0.9451	-0.18
152	0.9357	0.9417	-0.32
153	1.5816	1.2940	18.19
154	1.5524	1.3393	13.73
155	1.3173	1.1926	9.46
156	1.1538	1.0926	5.30
157	1.0735	1.0542	1.80
158	1.0287	1.0180	1.03
159	1.0009	1.0005	0.03
160	0.9827	0.9710	1.19
161	0.9696	0.9682	0.14
162	0.9593	0.9609	-0.17
163	0.9503	0.9333	1.79
164	1.3645	1.2470	8.61
165	1.2390	1.1447	7.61
166	1.1290	1.0968	2.85
167	1.0685	1.0414	2.54
168	1.0301	1.0472	-1.66
169	1.0052	0.9946	1.05
170	0.9882	0.9926	-0.44
171	0.9745	0.9723	0.23
172	0.9646	0.9697	-0.53
173	1.1407	1.1040	3.22
174	1.0604	1.1090	-4.59
175	1.0297	1.1106	-7.85
176	1.0081	1.0710	-6.24
177	1.0345	1.0285	0.58

FORMAT

BOX ⊛
XXXXX
YYYYY
ZZ

BOX = ASSEMBLY NUMBER
XXX = PREDICTED RATIO
YYY = MEASURED RATIO
ZZ = PERCENT DIFFERENCE

⊛ INDICATES EJECTED CEA ASSEMBLY

6.3.29 DROPPED CEA TEST

6.3.29.1 Purpose

The purpose of this test was to measure the power distribution resulting from a dropped CEA with the reactor at 50% power, and to measure the plant response to the transient for the purpose of CESEC verification.

6.3.29.2 Test Method

Following the 80% power variable T_{AVG} test, reactor power was reduced to 50% power and the plant stabilized until 3D all rods out (ARO) equilibrium Xe was achieved. At this time, full length CEA 5-60 was dropped into the core by opening the appropriate individual CEA circuit breaker. The turbine load limit was immediately adjusted to match the new reactor power. This new reactor power and the appropriate T_c were maintained for one hour after the CEA drop by adjusting the turbine load limit and/or RCS boron concentration. After one hour had elapsed, the dropped CEA was withdrawn while maintaining constant reactor power by RCS boration. After ARO equilibrium Xe was reestablished, part length CEA P-24 was dropped into the core in an analogous fashion.

6.3.29.2 Test Results

The dropped CEA test was performed at the 50% power plateau after the return to power from the 80% loss of flow trip. The results were analyzed by comparing the predicted versus the measured relative power density (RPD ratios of the dropped radial power distribution to the ARO distribution. For the full length CEA 5-60 drop, the RPD's were axially integrated values whereas for the part length CEA P-24 drop the RPD's were planar values corresponding to the second incore instrument level.

The predicted radial power distributions were obtained from a 3D coarse mesh core physics code and the measured distributions were obtained from CECOR, the Combustion Engineering full core instrument analysis code. Figures 6.3.29.1 and 6.3.29.2 compare the predicted versus measured RPD ratios for the CEA 5-60 and CEA P-24 drops. The acceptance criteria required that the differences between measured and predicted RPD ratios be within ±0.2; the test results were actually within ±0.06 of the predictions.

Figures 6.3.29.3 through 6.3.29.14 display the response of various plant parameters versus time during the dropped CEA transients.

Associated with the full length CEA 5-60 drop was an approximate 10% decrease in reactor power and associated with the part length CEA P-24 drop was an approximate 4% decrease in reactor power. These results are in reasonable agreement with the predicted dropped CEA worths and the measured power coefficients.

6.3.29.4 Conclusions

The agreement between measured and predicted RPD ratios for the 50% power dropped CEAs was well within the acceptance criteria specified by the test procedure, specifically ±0.2. In addition, the data required for CESEC verification was obtained.

FIGURE 6.3.29.1

DROPPED CEA 5-60

					.6793 .6844 -.0051	.5833 .6230 -.0396	.5077 .5582 -.0502	.5833 .6206 -.0373	.6793 .6811 -.0018					
			.8832 .8661 .0172	.8297 .8580 -.0282	.7418 .7604 -.0186	.6161 .6486 -.0325	.3986 .4108 -.0122	.6161 .6449 -.0287	.7418 .7565 -.0147	.8299 .8546 -.0248	.8832 .8681 .0151			
		.9453 .9479 -.0025	.9148 .9293 -.0145	.8727 .8491 .0236	.8130 .8252 -.0122	.7376 .7390 -.0013	.6830 .7251 -.0421	.7376 .7350 .0026	.8130 .8227 -.0097	.8727 .8497 .0229	.9149 .9353 -.0203	.9453 .9612 -.0159		
	.9879 .9706 .0173	.9705 .9919 -.0214	.9476 .9207 .0269	.9185 .9499 -.0314	.8833 .8665 .0168	.8490 .8842 -.0351	.8332 .8220 .0113	.8490 .8775 -.0285	.8833 .8642 .0191	.9185 .9508 -.0323	.9477 .9284 .0193	.9707 1.0117 -.0409	.9881 .9855 .0026	
	1.0062 1.0218 -.0156	.9942 .9658 .0283	.9782 .9974 -.0192	.9594 .9436 .0157	.9395 .9638 -.0243	.9229 .9129 .0101	.9162 .9445 -.0283	.9229 .9073 .0157	.9395 .9610 -.0216	.9595 .9449 .0146	.9787 1.0026 -.0244	.9943 .9748 .0194	1.0063 1.0319 -.0256	
1.0355 1.0242 .0112	1.0260 1.0478 -.0218	1.0161 1.0500 -.0339	1.0050 .9897 .0152	.9930 1.0354 -.0424	.9815 .9751 .0064	.9727 1.0241 -.0513	.9694 .9624 .0070	.9727 1.0066 -.0339	.9815 .9701 .0114	.9931 1.0365 -.0434	1.0050 .9919 .0131	1.0162 1.0540 -.0378	1.0261 1.0560 -.0299	1.0355 1.0402 -.0048
1.0452 1.0642 -.0190	1.0405 1.0691 -.0286	1.0342 1.0205 .0137	1.0269 1.0591 -.0322	1.0194 1.0122 .0072	1.0125 1.0495 -.0370	1.0077 1.0057 .0020	1.0059 1.0437 -.0378	1.0077 1.0037 .0040	1.0126 1.0480 -.0354	1.0194 1.0114 .0080	1.0270 1.0583 -.0313	1.0342 1.0201 .0141	1.0407 1.0752 -.0344	1.0452 1.0705 -.0253
1.0550 1.0971 -.0421	1.0526 1.0552 -.0026	1.0488 1.1044 -.0556	1.0444 1.0387 .0057	1.0398 1.0873 -.0475	1.0357 1.0321 .0036	1.0328 1.0803 -.0474	1.0319 1.0326 -.0007	1.0328 1.0926 -.0597	1.0358 1.0345 .0014	1.0399 1.0851 -.0452	1.0495 1.0347 .0048	1.0489 1.0938 -.0449	1.0527 1.0538 -.0011	1.0550 1.0971 -.0421
1.0630 1.0867 -.0237	1.0623 1.0954 -.0331	1.0606 1.0508 .0098	1.0581 1.0958 -.0377	1.0555 1.0506 .0048	1.0531 1.0939 -.0408	1.0515 1.0502 .0013	1.0508 1.0942 -.0434	1.0515 1.0530 -.0015	1.0531 1.0949 -.0419	1.0555 1.0497 .0058	1.0582 1.0921 -.0338	1.0607 1.0458 .0149	1.0624 1.0954 -.0330	1.0630 1.0814 -.0184
1.0688 1.0733 -.0045	1.0700 1.1041 -.0341	1.0700 1.1133 -.0433	1.0689 1.0618 .0071	1.0675 1.1155 -.0480	1.0662 1.0631 .0031	1.0652 1.1169 -.0517	1.0650 1.0634 .0016	1.0652 1.1154 -.0502	1.0662 1.0628 .0034	1.0676 1.1168 -.0492	1.0690 1.0574 .0116	1.0701 1.1075 -.0374	1.0701 1.0967 -.0265	1.0688 1.0530 .0158
	1.0768 1.1099 -.0331	1.0774 1.0649 .0124	1.0773 1.1196 -.0423	1.0768 1.0714 .0054	1.0762 1.1153 -.0391	1.0757 1.0724 .0033	1.0756 1.1155 -.0399	1.0757 1.0706 .0051	1.0762 1.1132 -.0370	1.0768 1.0682 .0086	1.0773 1.1097 -.0325	1.0775 1.0577 .0197	1.0768 1.1024 -.0255	
	1.0818 1.0236 -.0018	1.0828 1.1322 -.0494	1.0836 1.0755 .0080	1.0837 1.1323 -.0486	1.0836 1.0745 .0091	1.0836 1.1355 -.0519	1.0836 1.0765 .0070	1.0836 1.1318 -.0481	1.0837 1.0715 .0123	1.0837 1.1290 -.0453	1.0836 1.0675 .0160	1.0829 1.1254 -.0426	1.0818 1.0767 .0051	
		1.0867 1.1199 -.0332	1.0880 1.1375 -.0495	1.0888 1.0737 .0151	1.0892 1.1134 -.0242	1.0895 1.0728 .0166	1.0895 1.1211 -.0316	1.0896 1.0708 .0187	1.0892 1.1105 -.0212	1.0888 1.0687 .0201	1.0880 1.1232 -.0353	1.0868 1.1094 -.0225		
			1.0909 1.0957 -.0048	1.0919 1.1316 -.0397	1.0929 1.1242 -.0313	1.0936 1.1313 -.0378	1.0937 1.0925 .0012	1.0936 1.1297 -.0361	1.0930 1.1227 -.0297	1.0919 1.1315 -.0396	1.0909 1.0881 .0028			
					1.0956 1.1003 -.0047	1.0960 1.1232 -.0272	1.0960 1.1420 -.0460	1.0960 1.1225 -.0266	1.0956 1.0993 -.0037					

x.xx y.yy .zz

x.xx = Predicted RPD Ratio DROPPED / ARO

y.yy = Measured (CECOR) RPD Ratio DROPPED / ARO

.zz = Difference

POOR ORIGINAL

FIGURE 6.3.29.2

DROPPED CEA P-24

					.9338 .9371 -.0033	.9269 .9504 -.0235	.9235 .9630 -.0394	.9269 .9475 -.0205	.9338 .9335 .0004					
			.9658 .9626 .0032	.9528 .9939 -.0411	.9354 .9622 -.0267	.9189 .9508 -.0319	.9111 .9170 -.0059	.9189 .9452 -.0262	.9354 .9578 -.0224	.9528 .9888 -.0360	.9658 .9627 .0032			
		.9831 .9909 -.0078	.9731 .9988 -.0257	.9577 .9401 .0176	.9339 .9530 -.0191	.8991 .8985 .0006	.8722 .9309 -.0586	.8992 .8962 .0031	.9339 .9505 -.0167	.9577 .9384 .0192	.9731 1.0029 -.0298	.9831 1.0047 -.0215		
	.9977 .9837 .0140	.9911 1.0142 -.0231	.9809 .9601 .0208	.9650 1.0052 -.0402	.9387 .9275 .0111	.8874 .9326 -.0452	.7588 .7552 .0037	.8874 .9302 -.0429	.9387 .9257 .0130	.9651 1.0007 -.0355	.9809 .9662 .0147	.9911 1.0374 -.0463	.9977 .9997 -.0019	
	1.0043 1.0237 -.0194	.9987 .9742 .0244	.9898 1.0138 -.0240	.9764 .9666 .0099	.9556 .9872 -.0316	.9243 .9306 -.0064	.8997 .9621 -.0624	.9243 .9309 -.0066	.9556 .9867 -.0311	.9763 .9658 .0105	.9898 1.0175 -.0278	.9987 .9830 .0156	1.0043 1.0318 -.0275	
1.0159 1.0229 -.0069	1.0117 1.0392 -.0275	1.0066 1.0400 -.0335	.9995 .9869 .0127	.9898 1.0315 -.0417	.9771 .9713 .0058	.9635 1.0025 -.0390	.9568 .9571 -.0003	.9635 1.0047 -.0412	.9771 .9710 .0061	.9898 1.0294 -.0395	.9995 .9879 .0116	1.0066 1.0428 -.0362	1.0117 1.0418 -.0300	1.0158 1.0236 -.0078
1.0197 1.0516 -.0319	1.0174 1.0504 -.0330	1.0137 .9992 .0145	1.0088 1.0385 -.0296	1.0026 .9953 .0073	.9953 1.0292 -.0339	.9891 .9838 .0053	.9864 1.0209 -.0345	.9891 .9837 .0054	.9954 1.0284 -.0330	1.0026 .9939 .0086	1.0088 1.0385 -.0296	1.0138 1.0001 .0138	1.0174 1.0487 -.0313	1.0197 1.0498 -.0301
1.0236 1.0770 -.0534	1.0223 1.0276 -.0052	1.0201 1.0598 -.0397	1.0169 1.0071 .0098	1.0130 1.0543 -.0413	1.0091 1.0035 .0056	1.0059 1.0461 -.0402	1.0048 .9993 .0054	1.0059 1.0453 -.0395	1.0091 1.0020 .0070	1.0130 1.0516 -.0386	1.0169 1.0065 .0104	1.0200 1.0613 -.0413	1.0223 1.0260 -.0037	1.0236 1.0729 -.0493
1.0269 1.0594 -.0326	1.0265 1.0606 -.0341	1.0252 1.0121 .0131	1.0234 1.0553 -.0319	1.0212 1.0142 .0070	1.0190 1.0543 -.0353	1.0173 1.0124 .0049	1.0167 1.0513 -.0347	1.0173 1.0109 .0065	1.0190 1.0525 -.0335	1.0212 1.0125 .0087	1.0234 1.0533 -.0304	1.0252 1.0114 .0138	1.0265 1.0582 -.0317	1.0269 1.0506 -.0237
1.0295 1.0387 -.0092	1.0297 1.0618 -.0321	1.0293 1.0661 -.0367	1.0286 1.0191 .0095	1.0274 1.0685 -.0411	1.0262 1.0202 .0059	1.0253 1.0684 -.0431	1.0250 1.0184 .0066	1.0253 1.0635 -.0382	1.0262 1.0183 .0079	1.0274 1.0679 -.0406	1.0286 1.0169 .0117	1.0293 1.0652 -.0359	1.0297 1.0552 -.0256	1.0293 1.0130 .0163
	1.0326 1.0614 -.0288	1.0327 1.0175 .0152	1.0325 1.0690 -.0364	1.0319 1.0240 .0080	1.0314 1.0634 -.0320	1.0310 1.0230 .0080	1.0308 1.0631 -.0323	1.0310 1.0224 .0085	1.0314 1.0624 -.0310	1.0319 1.0220 .0110	1.0324 1.0625 -.0301	1.0327 1.0152 .0176	1.0326 1.0575 -.0249	
	1.0347 1.0333 .0014	1.0350 1.0765 -.0415	1.0352 1.0243 .0109	1.0353 1.0768 -.0415	1.0351 1.0271 .0134	1.0350 1.0742 -.0392	1.0350 1.0245 .0105	1.0350 1.0777 -.0427	1.0351 1.0223 .0128	1.0353 1.0763 -.0411	1.0352 1.0209 .0143	1.0350 1.0773 -.0423	1.0347 1.0321 .0026	
		1.0367 1.0616 -.0248	1.0372 1.0803 -.0432	1.0375 1.0191 .0184	1.0377 1.0548 -.0171	1.0377 1.0185 .0193	1.0378 1.0648 -.0270	1.0377 1.0188 .0189	1.0377 1.0553 -.0176	1.0375 1.0187 .0188	1.0372 1.0719 -.0347	1.0367 1.0581 -.0213		
			1.0386 1.0387 -.0001	1.0388 1.0693 -.0304	1.0393 1.0654 -.0262	1.0396 1.0738 -.0342	1.0396 1.0403 -.0007	1.0396 1.0712 -.0315	1.0393 1.0666 -.0274	1.0388 1.0771 -.0383	1.0386 1.0377 .0009			
					1.0404 1.0462 -.0058	1.0405 1.0718 -.0313	1.0405 1.0921 -.0515	1.0405 1.0714 -.0309	1.0404 1.0465 -.0062					

x.xx y.yy .zz

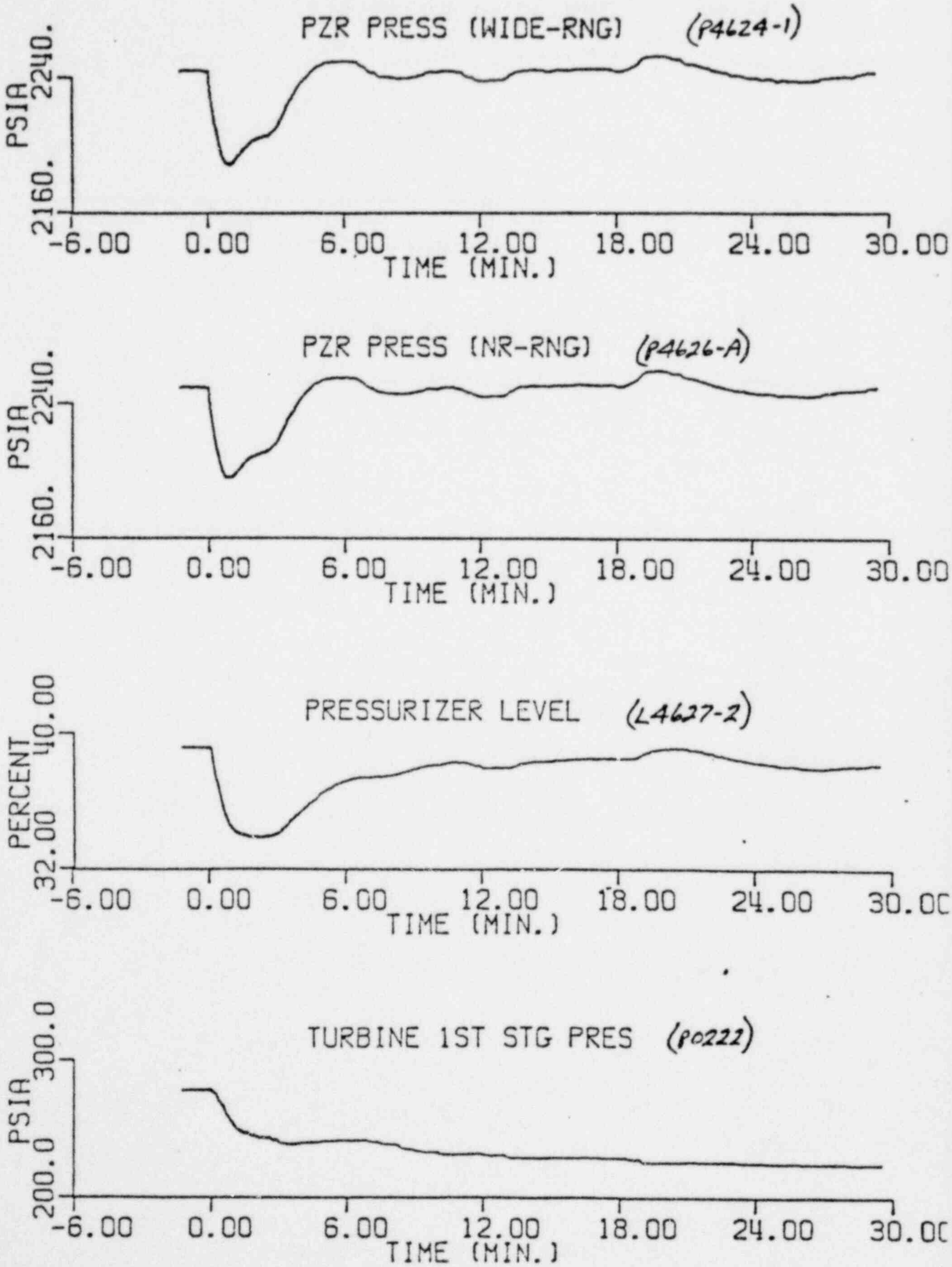
x.xx = Predicted RPD/Plane 7 Ratio DROPPED / ARO

y.yy = Measured (CECOR) RPD/Level 2 Ratio DROPPED / ARO

.zz = Difference

FIGURE 6.3.29.3

DROPPED CEA (5-60)



DROPPED CEA (5-60)

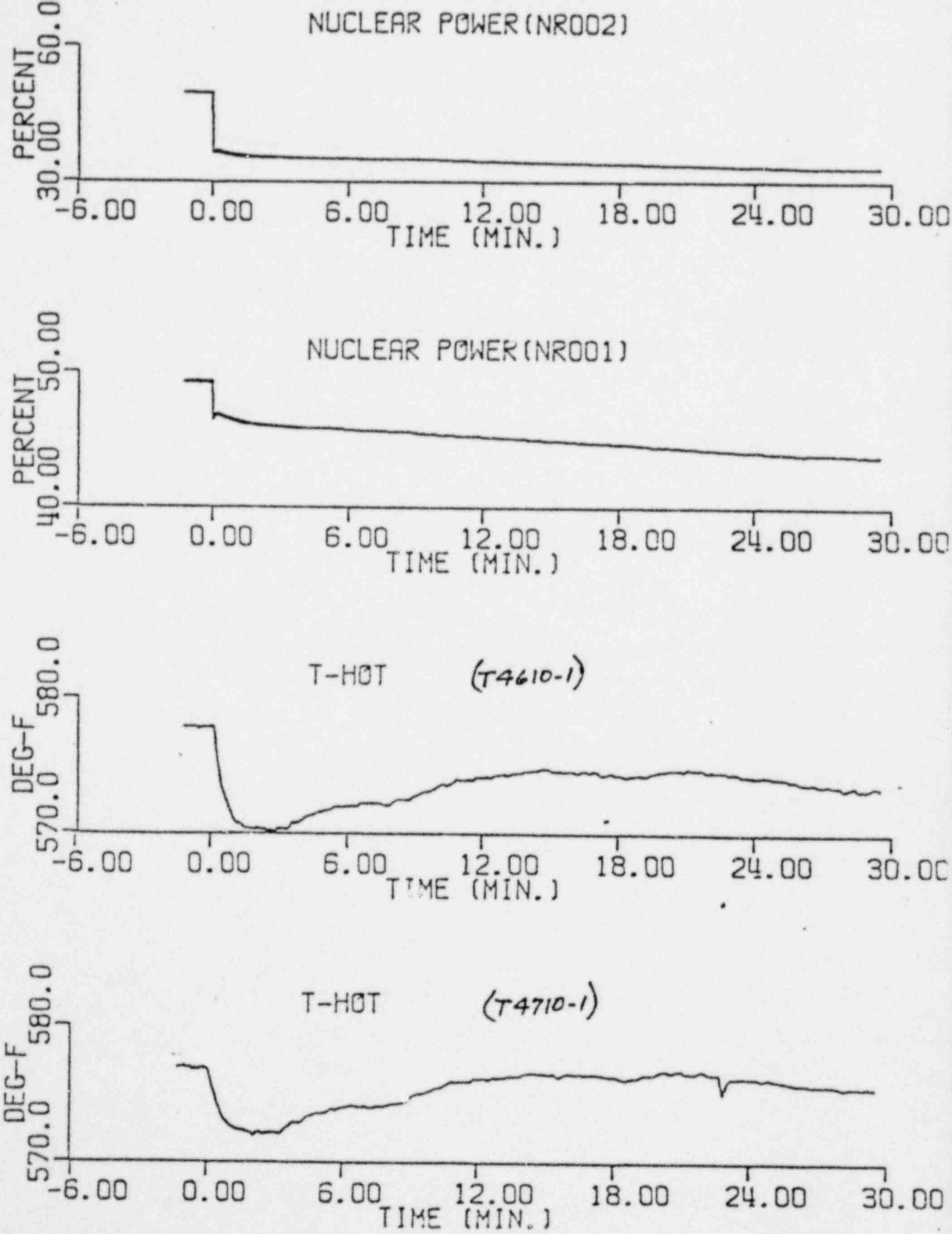


FIGURE 6.3.29.5

DROPPED CEA (5-60)

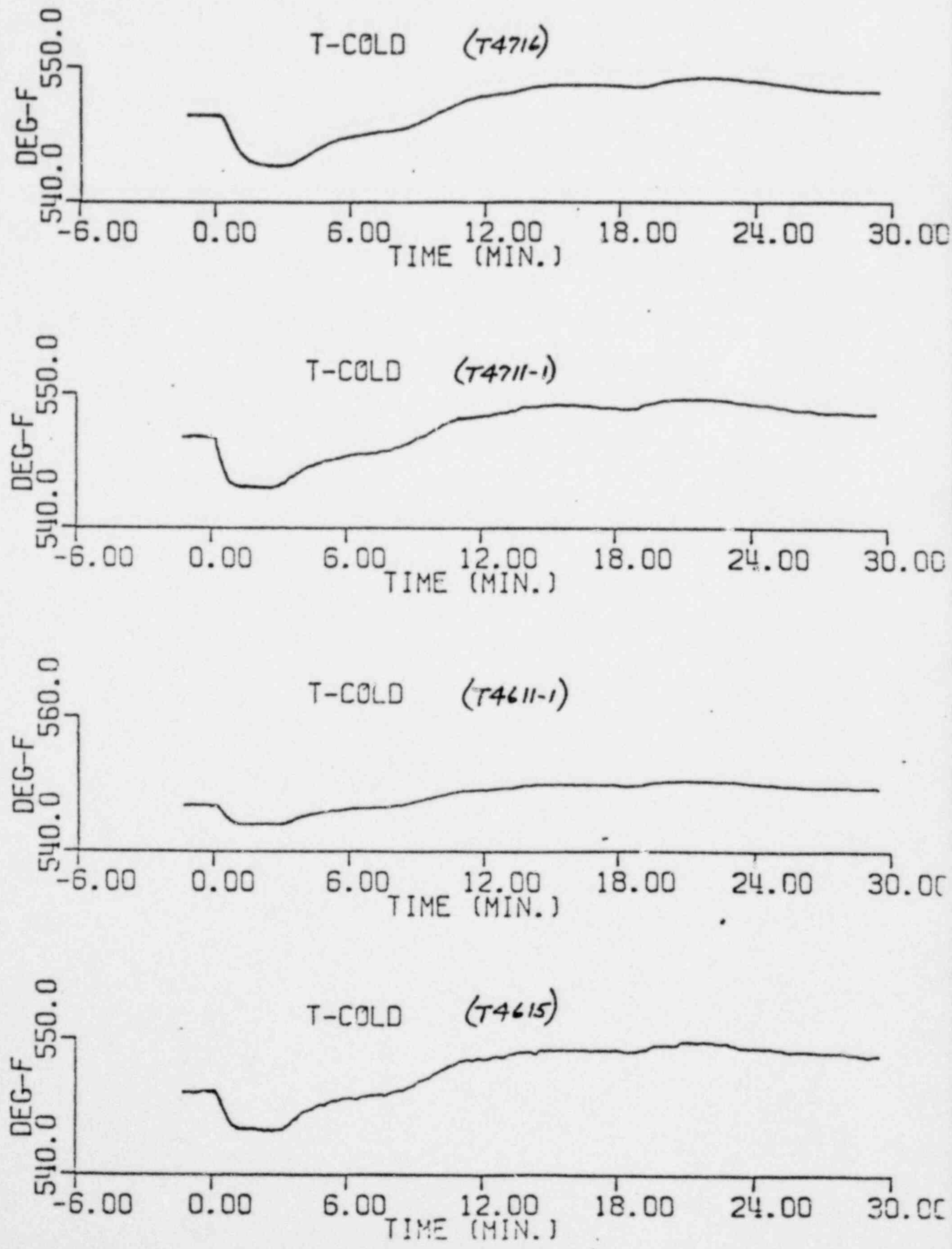
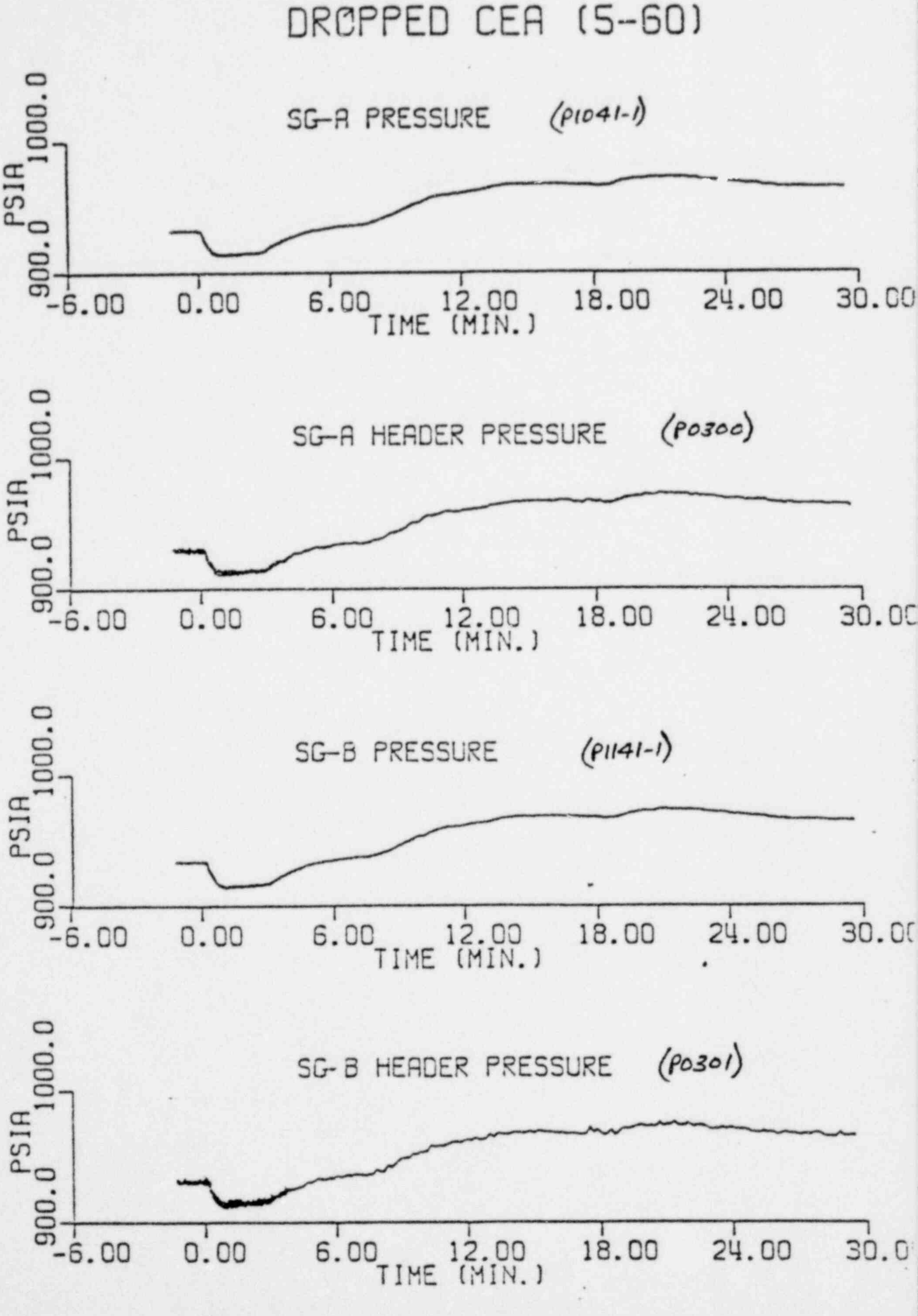
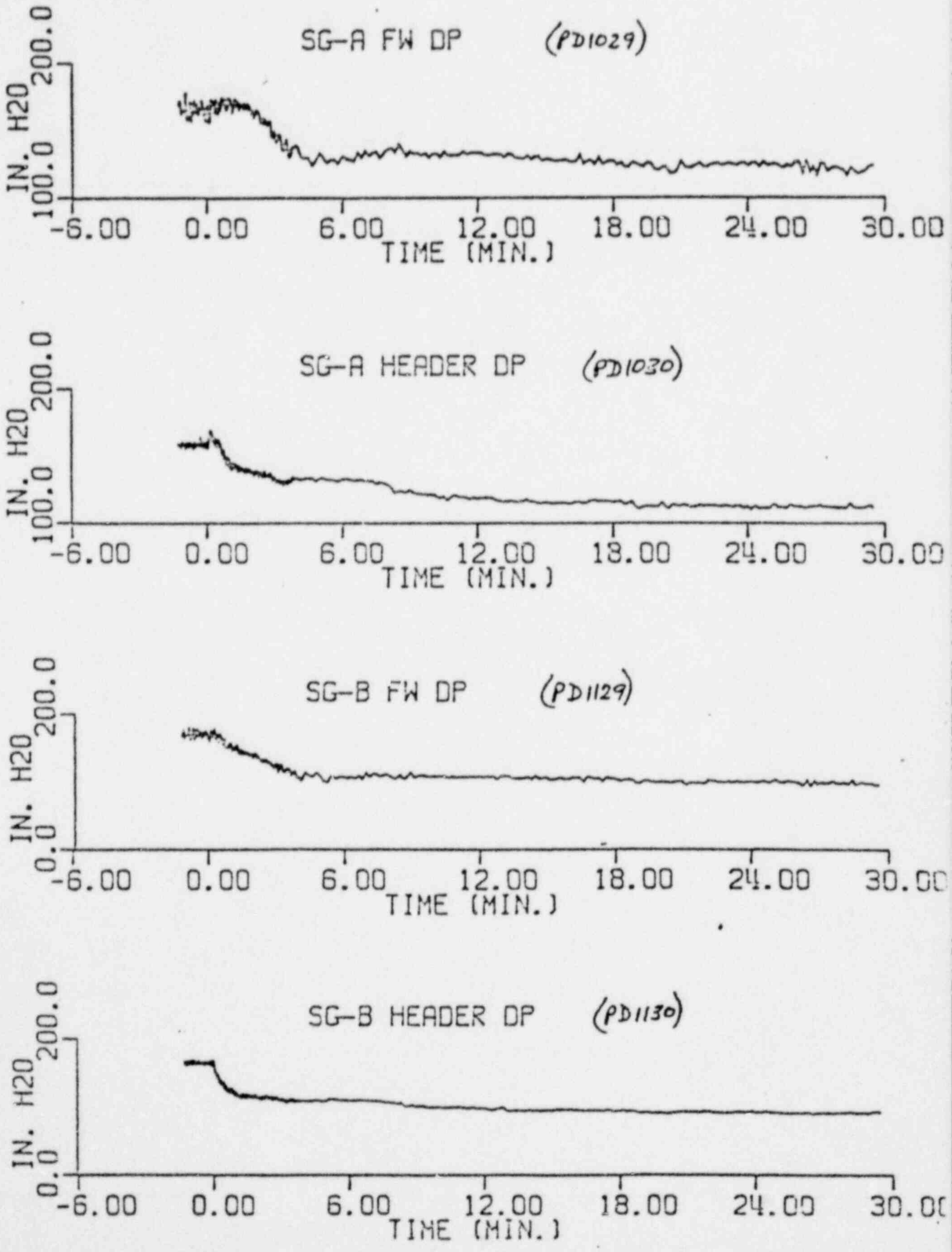


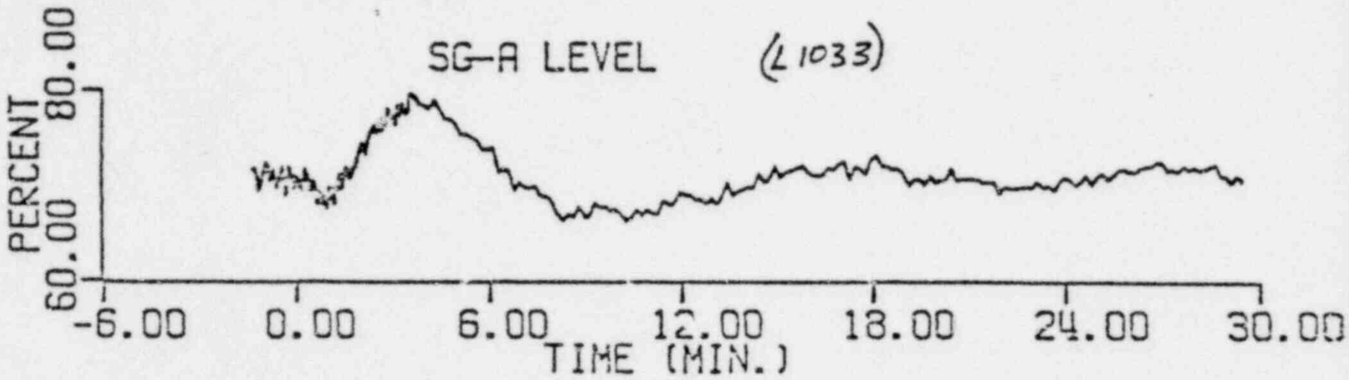
FIGURE 6.3.29.6



DROPPED CEA (5-60)



DROPPED CEA (5-60)



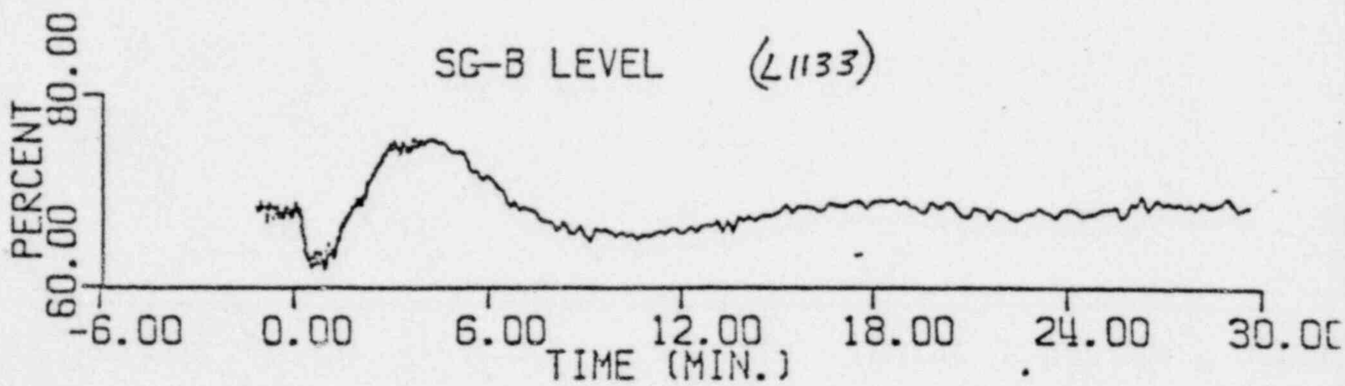


FIGURE 6.3.29.9

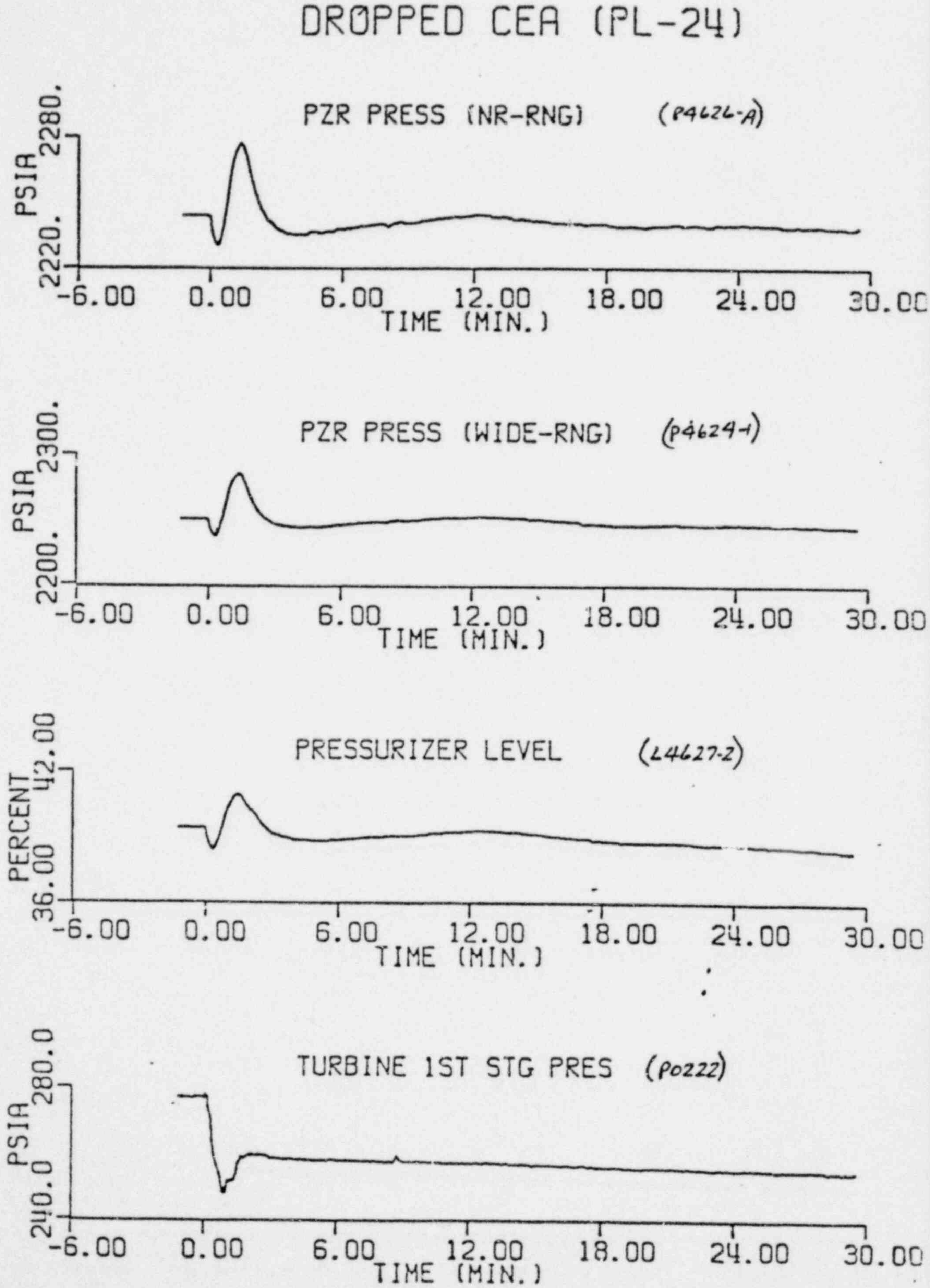
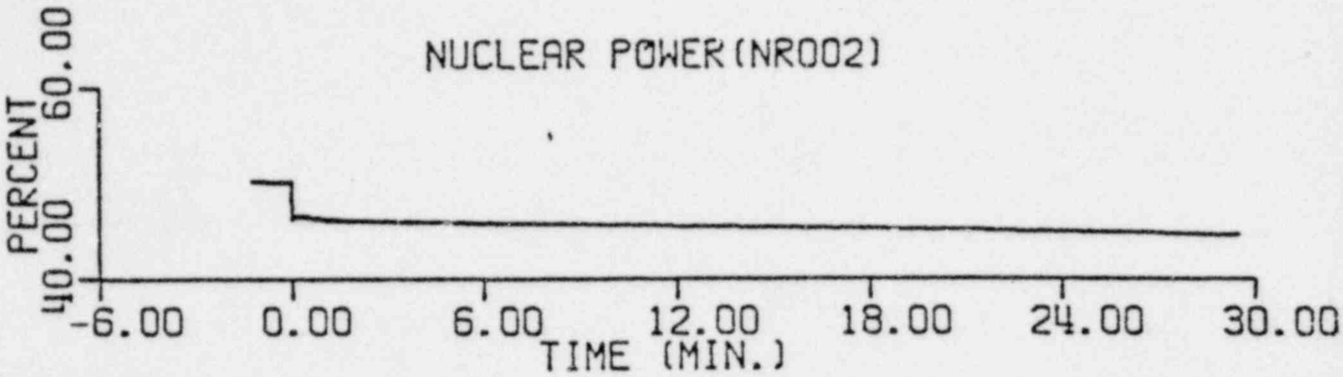
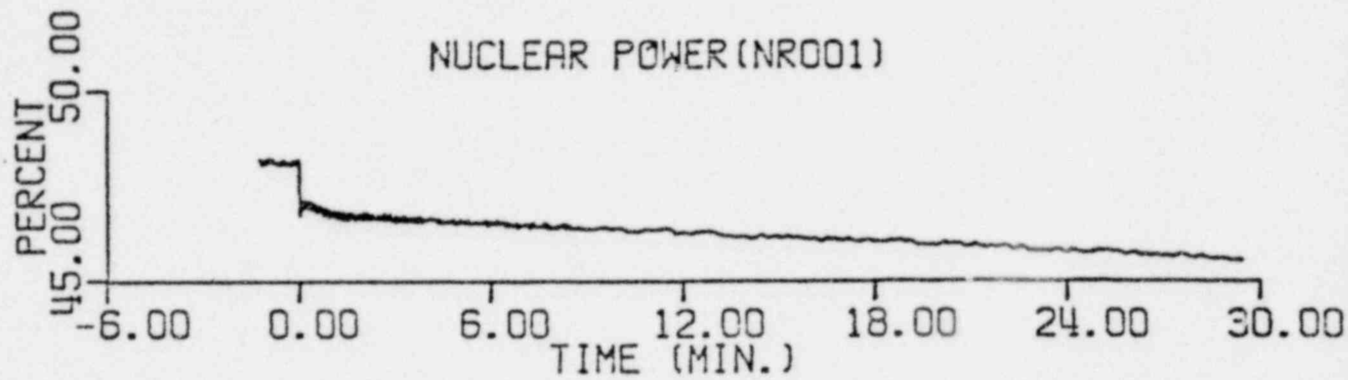
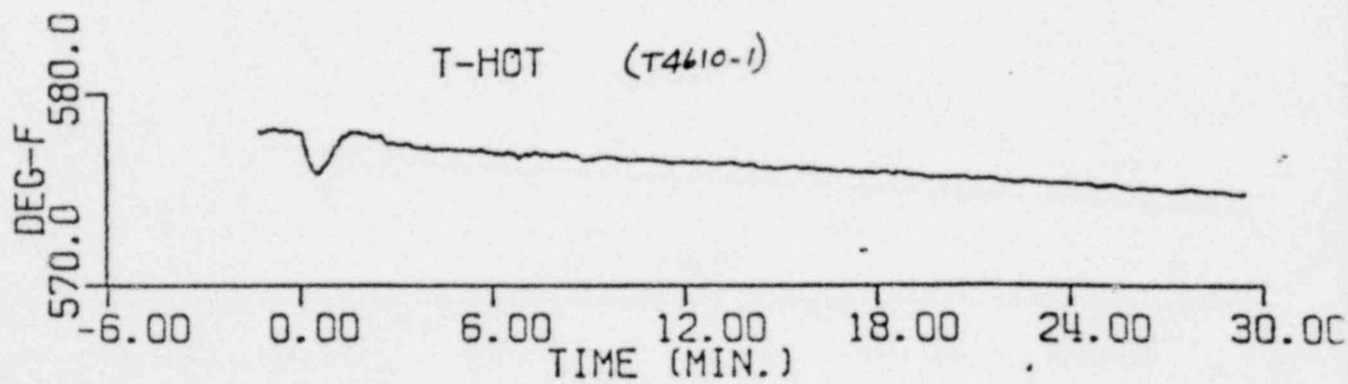


FIGURE 6.3.29.10

DROPPED CEA (PL-24)







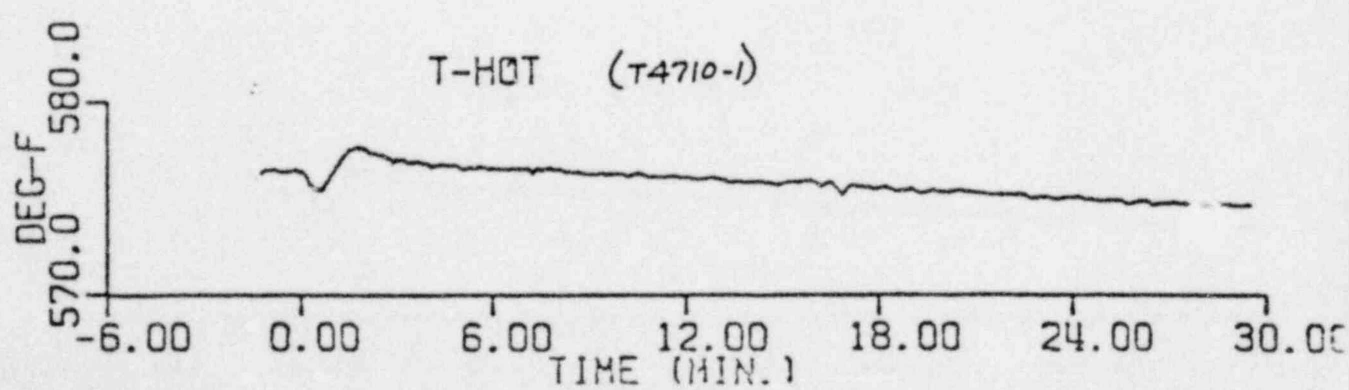


FIGURE 6.3.29.11

DROPPED CEA (PL-24)

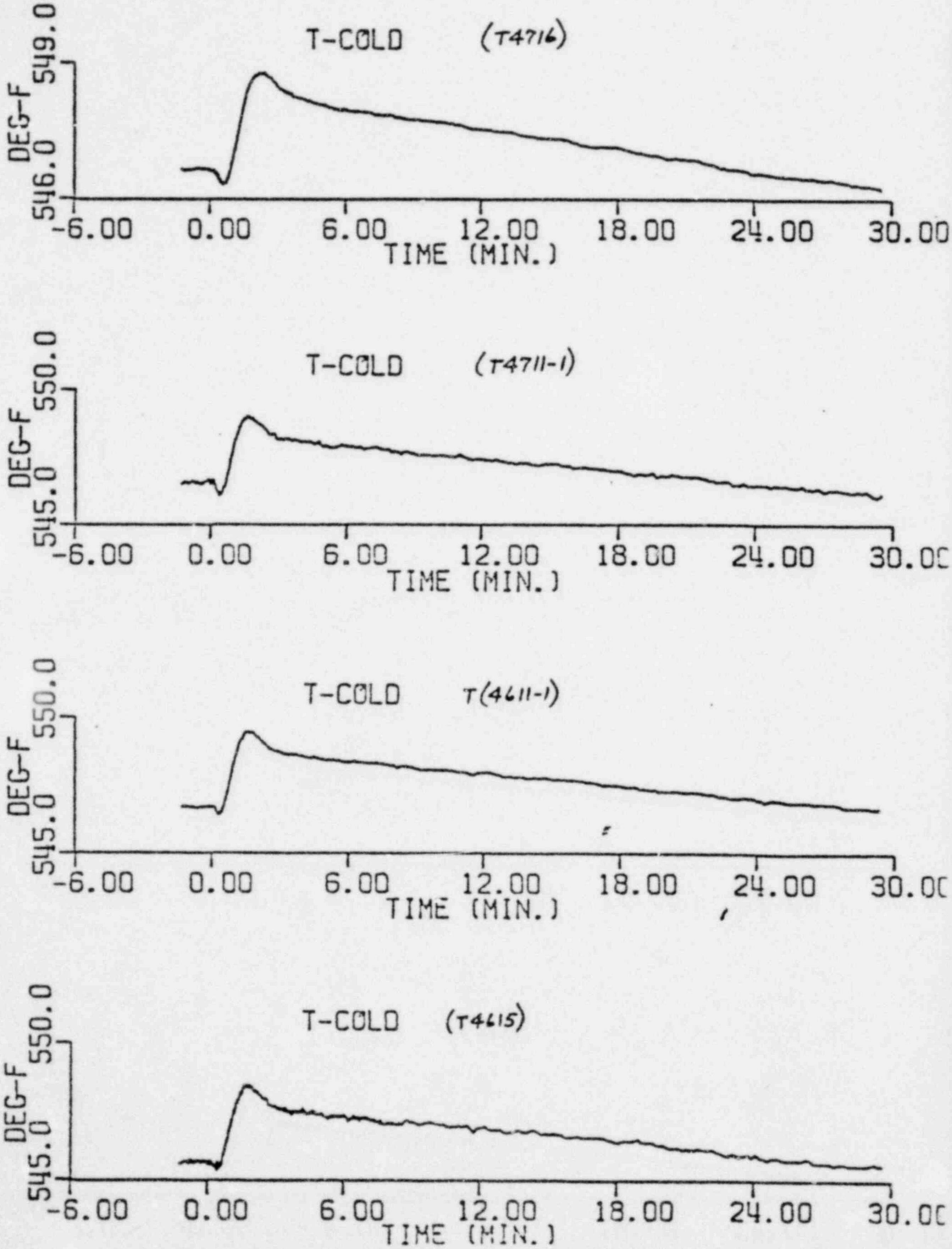


FIGURE 6.3.29.12

DROPPED CEA (PL-24)

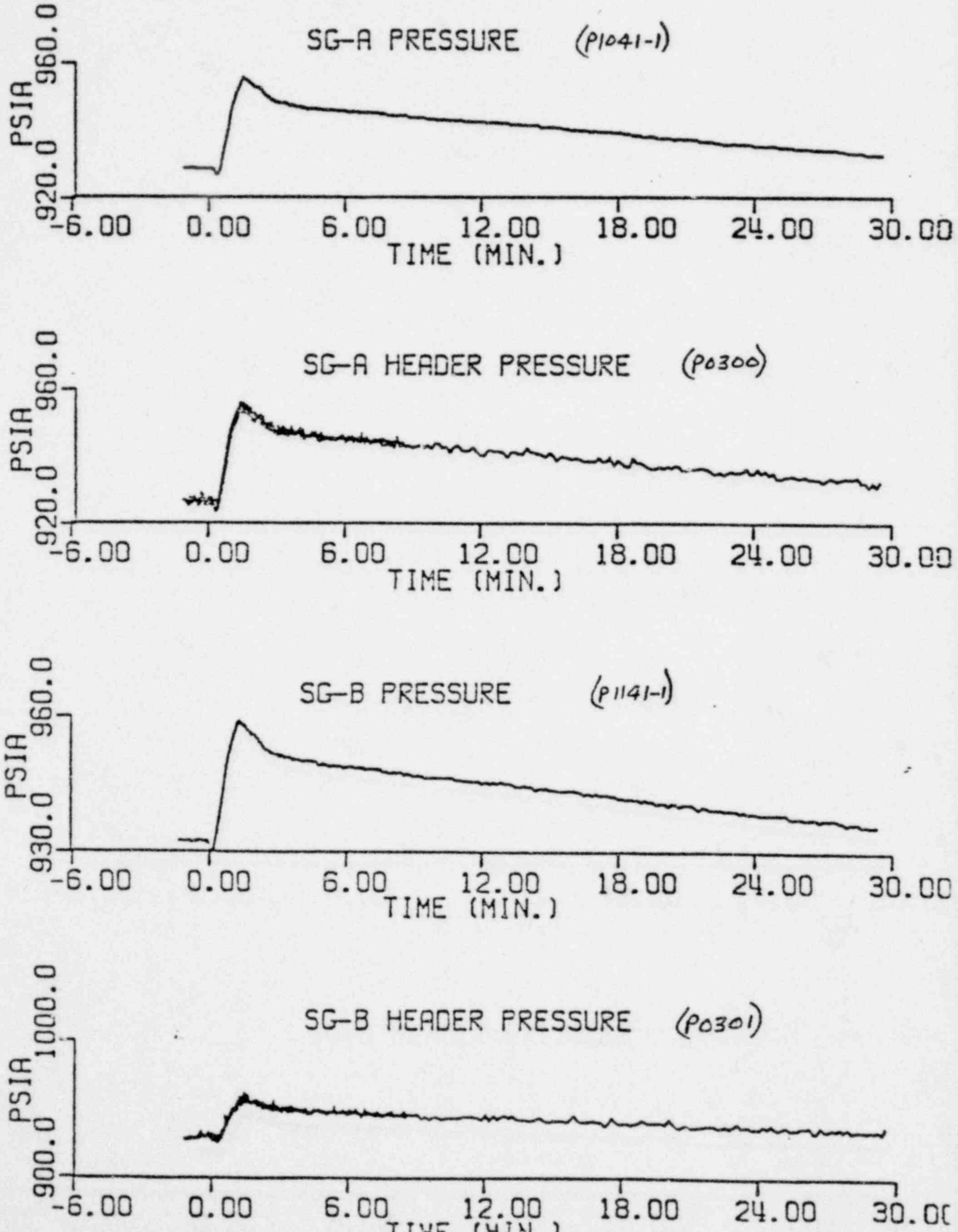


FIGURE 6.3.29.13

DROPPED CEA (PL-24)

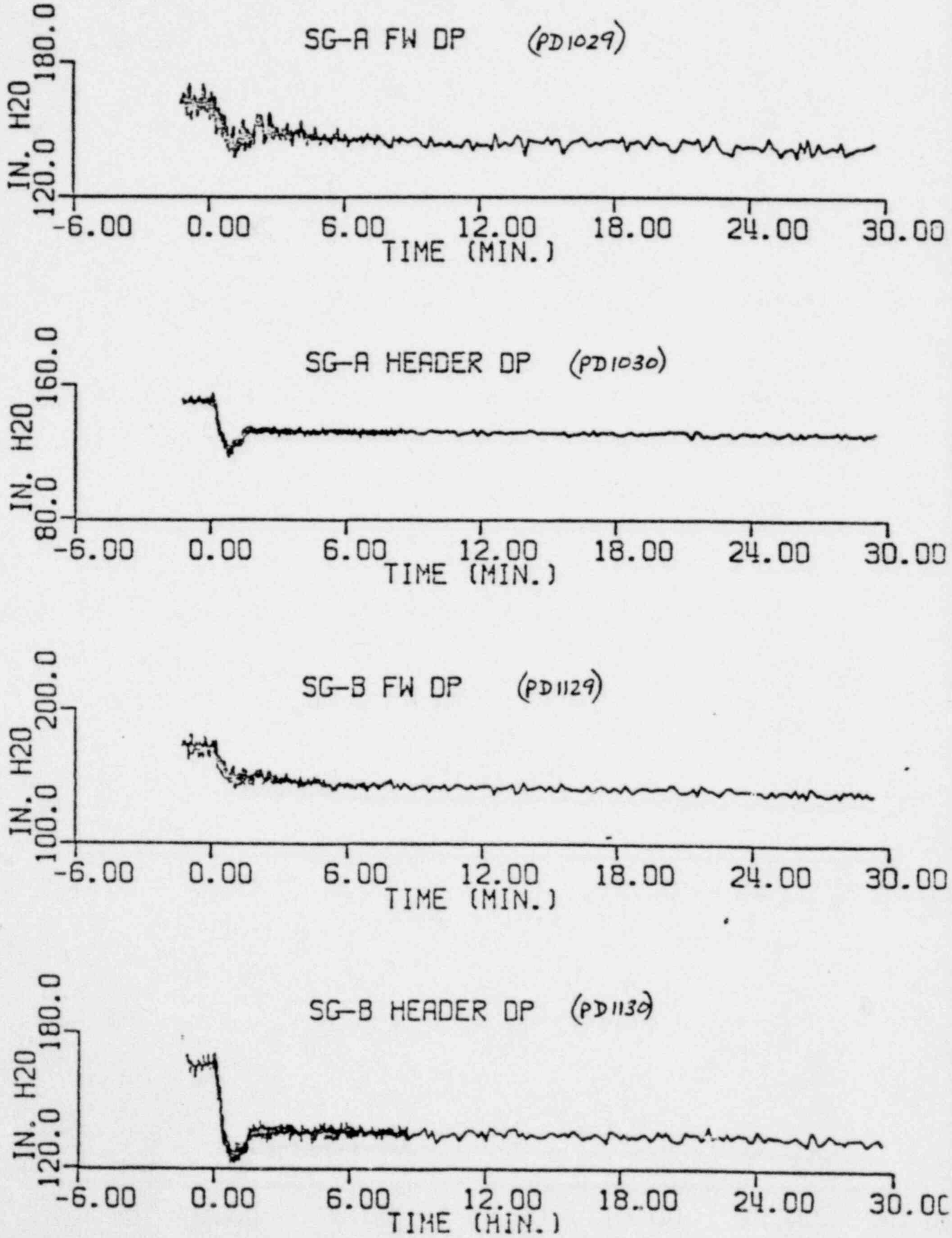
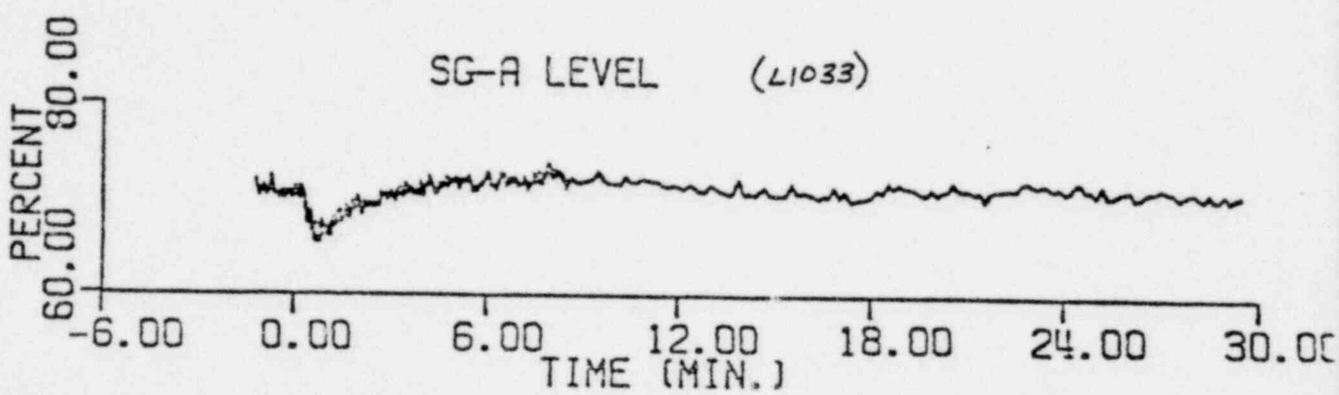
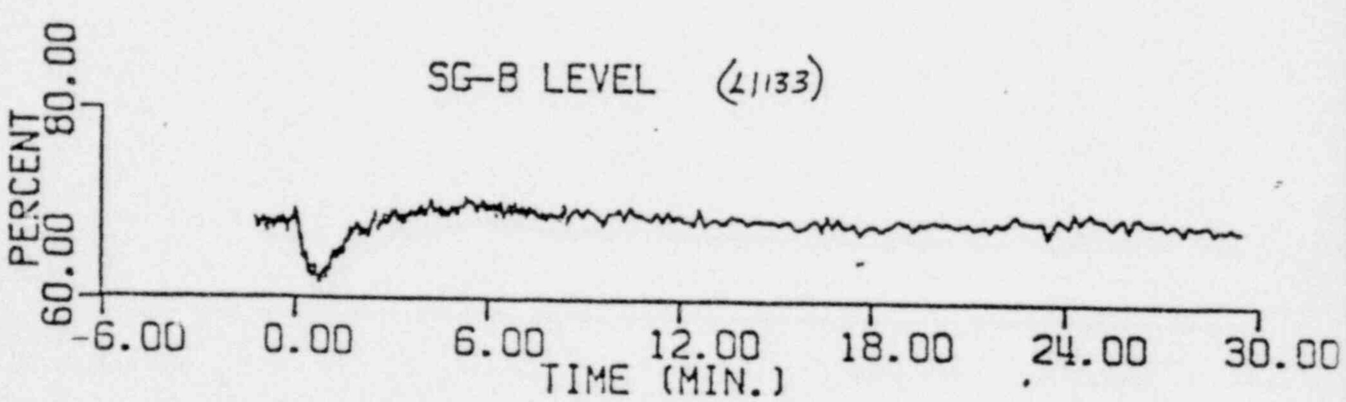


FIGURE 6.3.29.14

DROPPED CEA (PL-24)





6.3.30 PLCEA XENON CONTROL

6.3.30.1 Purpose

The primary purpose of this test was to demonstrate damping of an axial Xenon oscillation using the part length CEA's. A secondary objective was to collect data that could be utilized to determine the uncertainties associated with using CECOR or INCA when the part length CEA's are inserted.

6.3.30.2 Test Method

Successful damping of an axial Xenon oscillation is predicated upon knowing the value of the equilibrium shape index (ESI) for the plant conditions at which damping is performed This test was performed at 65% by initially ins[illegible]ng part length groups P1 and P2 to $\sim$37.5" wit[illegible]wn while maintaining reactor power constant by dilution of the RCS. This position of the PLCEA's corresponds to centering of the poison section in the core.

Following insertion of the PLCEA's, plant conditions were maintained for approximately 36 hours. During this period, baseline axial shape index (ASI) data was collected for the purpose of computing the ESI value about which ASI would be controlled.

An axial oscillation was then induced by inserting group 6 CEA's to 100" withdrawn (reactor power maintained constant by dilution) and allowing ASI to reach its peak value (predicted to occur $\sim$6 hours hours following insertion of group 6). At this time Group 6 was borated to its upper electrical limit.

The ensuing axial oscillation was damped by controlling ASI within a $\pm$0.01 margin about the measured ESI. When ASI reached the limit of the control band as indicated by COLSS, the PLCEA's were moved to bring the ASI to the center of the control band.

6.3.30.3 Test Results

At 1345 on 1-14-80, the part length CEA's were inserted to 37.37" withdrawn while maintaining reactor power at 65% ± 0.2%. During the following 33 hour period, baseline ASI data was collected from COLSS and all four CPC channels. Using the baseline data, a best estimate value of COLSS ESI was obtained by fitting an analytical function to the data and then obtaining the mean value of the function over the period of interest. The predicted ESI value was 0.318.

Group 6 CEA's were inserted to 100.5" withdrawn at 0002 on 1-16-80. The peak ASI value of .3335 occurred at 0300, at which time Group 6 was borated to its upper electrical limit. Following withdrawal of Group 6, ASI continued to decrease at a rate of approximately .058 per hour. As ASI reached the bottom of the control band, the PLCEA's were withdrawn to increase ASI to 0.0318. PLCEA motion was discontinued when a position of ~75" withdrawn was reached. This occurred at 0940 on 1-16-80. Four hours later ASI reached its minimum value of -.0125 and began to increase. At 1850 the PLCEA's were first inserted to decrease ASI to .0318. Between 1850, 1-16-80 and 0145, 1-17-80, PLCEA motion became less frequent, as ASI was changing at a continually decreasing rate. This was due, in part, to the damping maneuver. At 0145 a reactor trip occurred and testing was suspended.

Figure 6.3.30.1 presents rod movement (Group 6 and P) and ASI versus time over the period of this test.

6.3.30.4 Conclusions

Due to the reactor trip at 0145 on 1-17-80, this test was not completed in its entirety. However, a review of the pre-trip data indicated that the test objectives had been met. Data that was to be collected during performance of the steps was not essential to fulfilling either test objective.

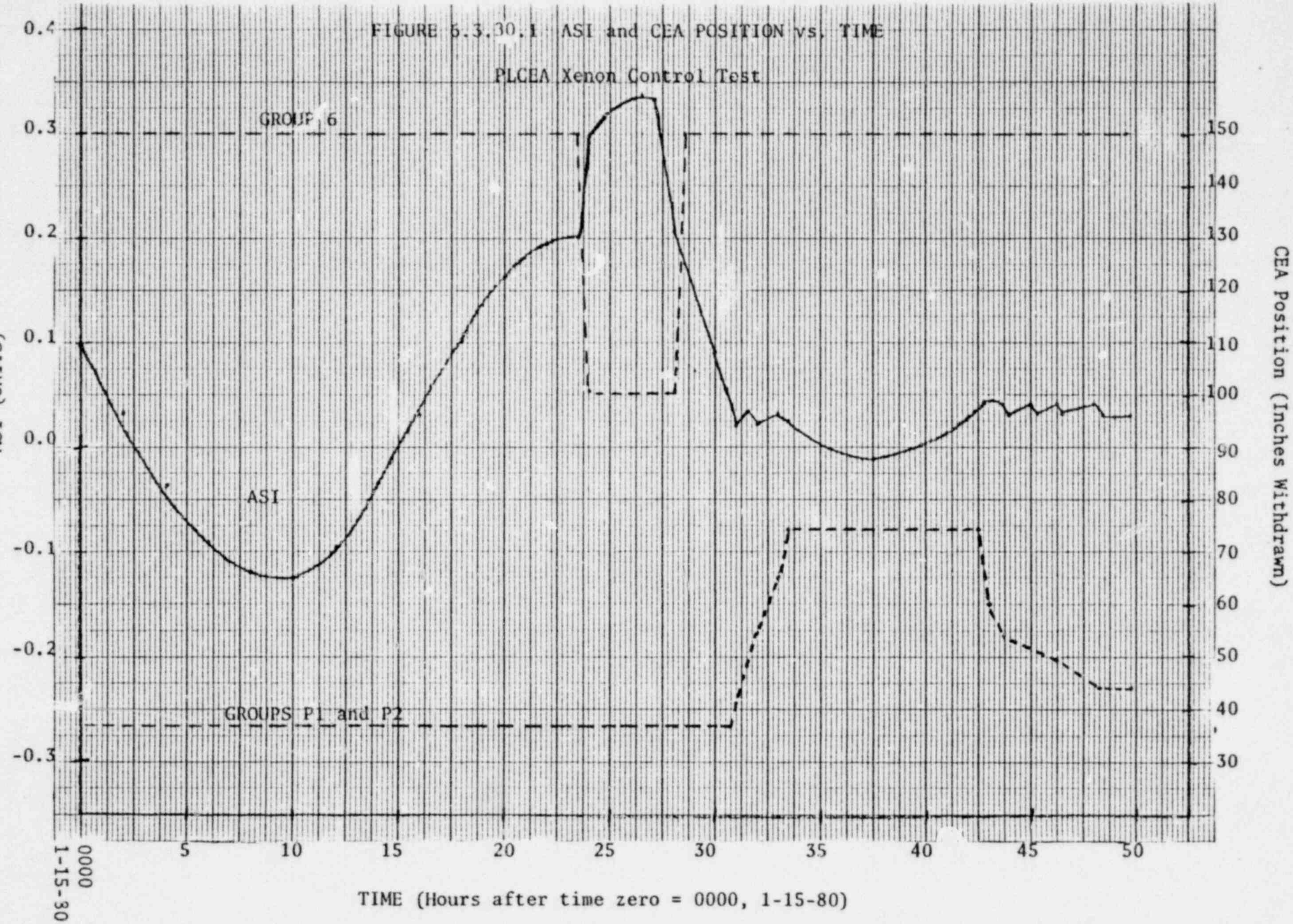


FIGURE 6.3.30.1 ASI and CEA POSITION vs. TIME
PLCEA Xenon Control Test
GROUP 6
ASI
GROUPS P1 and P2
ASI (UNITS)
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
CEA Position (Inches Withdrawn)
150
140
130
120
110
100
90
80
70
60
50
40
30
0000
1-15-30
5
10
15
20
25
30
35
40
45
50
TIME (Hours after time zero = 0000, 1-15-80)

7.2 CONCLUSION (50% THRU 100% POWER)

During the period of this report, testing from 50% to 100% power has been essentially completed. Continued monitoring of the T_{hot} anomaly over this reporting period indicates little change in the characteristics of the anomaly from those observed previously. On January 29, 1980, the reactor was tripped from 100% power per the "100% Turbine Trip Test" (section 6.3.13). This also initiated an outage required to install additional safety features as required by NUREG 0578.

Upon return to power, it is expected that the remaining testing/re-testing will be concluded.

ATTACHMENT A

POST INSPECTION RESTART TESTING PROGRAM

A.I INTRODUCTION

Following the outage for inspection of the reactor core (starting October 4, 1979), and subsequent to core reassembly, it was necessary to verify the following:

1.) that the reactor control characteristics had not degraded and the control element drive system operated as designed.

2.) that the RCS flow was still within design.

3.) that the physics characteristics of the core were as predicted.

Consequently, a testing program consisting of basically three sections was performed:

1.) Hot Functional Tests (HFT)

2.) Low Power Physics Tests (LPPT)

3.) Power Ascension Tests (PAT)

Each of these sections is described in detail in this attachment.

A.II TESTING METHOD

A.II.a Hot Functional Tests (HFT)

Hot Functional Testing was performed during heatup and while at hot standby conditions (i.e., 545°F, 2250 psia, 4 RCPs running). Testing consisted of monitoring permanent and temporary instrumentation to check instrument performance during heatup and to monitor temperature variations, vessel movement, listen for loose parts, etc. While at hot standby conditions, testing was performed which measured the total RCS flow rate, determined CEA drop times, and intercompared instrumentation.

A.II.b Low Power Physics Testing (LPPT)

Low Power Physics Testing was performed at hot zero power conditions (i.e., 545°F, 2250 psia, 4 RCPs running, and the reactor critical at $\leq 10^{-2}$% power). LPPT consisted of the following tests:

1) CEA Coupling Checks

Each CEA is inserted individually until the core reactivity is decreased by at least 0.5¢ as measured by the on-line reactivity computer.

2) CEA Symmetry Test

Each of the group 6 CEAs are inserted to their lower electrical limits individually while compensating for reactivity by trading with a symmetric counterpart. The core reactivity is measured (with the reactivity computer) and compared for each of the symmetric CEAs in group 6.

3) All Rods Out Critical Boron Concentration (ARO CBC)

While maintaining hot zero power conditions, the reactor is borated such that CEA group 6 is between 130" and 150" withdrawn. The boron concentration is allowed to stabilize and several boron samples are taken to confirm stability. The remainder of CEA Group 6 is withdrawn and the reactivity subsequently measured. The reactivity measured is converted to a boron equivalent and added to the measured boron concentration to determine the ARO CBC.

4) CEA Groups 5 & 6 Reactivity Worth Measurement

While maintaining hot zero power conditions the reactor is diluted from ARO and reactivity changes are compensated by stepwise insertion of CEA groups 6 and then 5. Reactivity changes are measured and the reactivity worth of each CEA group determined by summing the reactivity steps. During this test, neutron noise baselines are recorded.

A.II.c Power Ascension Tests (PAT)

Power ascension testing was performed at various power plateaus as reactor power was escalated from hot zero power to 50% power. Above 50% the normal Startup Test Program was resumed and was supplemented with monitoring tests relating to the T_H anomaly. Power ascension tests consisted of the following:

1) Hot Leg Temperature Monitoring and Data Collection

During power increase and throughout testing at each steady state power plateau, data is collected on recorders and computer trends of the individual hot leg temperature RTDs (both old and new) as well as the summed signals used by the CPCs. In addition, selected reactor vessel and RCP differential pressure signals and external hot leg thermocouple readings are monitored and recorded. Steady state measurements are conducted at each 10% power increment starting at 20% power.

2) NSSS Calorimetric Measurements and Instrumentation Calibration

Verification of the process computer calorimetric calculations is accomplished by comparing to hand calculations. This comparison is done at 20%, 30%, 40%, and 50% power with instrumentation adjustment or calibration performed as necessary to give better agreement.

3) Power Distribution Measurements

For the purpose of post-inspection monitoring, this test was performed at 30% and 50% power. The test involved comparing measured axial and radial power distribution to corresponding predicted distributions. Incore detectors were utilized, along with the CE incore instrumentation analysis computer code, to produce the measured distributions.

4) CEA Group Insertions Tests

The objective of this test is to establish the effect of CEA group insertion upon the CPC ΔT power calculations and on the temperature distribution of the hot leg coolant. While operating at steady state, equilibrium Xenon conditions at 50% power, CEA groups 6 and 5 are diluted in. Data is collected from the hot leg RTDs, Reactor vessel ΔP instrumentation, external hot leg thermocouples, and the incore detectors. Then the CEA groups are borated back out and equilibrium conditions reestablished.

5) Single CEA Insertion Tests

The objective of this test is to establish the effect of selected single CEA insertions upon the CPC ΔT power calculations and on the temperature distribution in the hot leg coolant. While operating at steady state, equilibrium Xenon conditions at 50% power, selected single CEAs are diluted in. Data is collected from the hot leg RTDs, Reactor vessel ΔP instruments, external hot leg thermocouples and incore detectors.

A.III TESTING RESULTS

A.III.a Hot Functional Tests

Temperature Monitoring and vessel movement monitoring during heatup to hot standby conditions yielded no unusual observations. The total RCS flow rate was measured to be 364,062.6 GPM which is within the acceptance criteria of 362,000 ± 10,860 GPM. The instrumentation intercomparison yielded satisfactory results after minor calibration adjustments were made. CEA Drop times were measured for all full length CEAs and each was within the acceptance criteria of ≤ 3 seconds from full out to 90% inserted.

A.III.b Low Power Physics Tests

For all cases of LPPT, the acceptance criteria were met. Agreement to prediction was very good in all measurements. Table A-1 presents the results of low power physics tests.

TABLE A-1

POST INSPECTION LPPT RESULTS

TEST	PREDICTED	MEASURED	ACCEPTANCE CRITERIA
CEA Coupling Check	N/A	All Rods Out	All Rods Coupled
CEA Symmetry Check	N/A	Symmetry of Group 6 Demonstrated	Group 6 Symmetry Demonstrated
ARO CBC	960 PPM	983 PPM	± 100 PPM
CEA Group 6 Worth	.571%Δk/k	.579%Δk/k	(a)
CEA Group 5 Worth (with Group 6 inserted)	.479%Δk/k	.480%Δk/k	(a)

(a) Measured CEA Group worths must be within ± 15% or ± 0.1%Δk/k of their predicted worths, whichever is larger.

A.III.c Power Ascension Tests

Hot leg temperatures were monitored and corresponding data recorded at the appropriate plateaus as the reactor was escalated in power. In addition, external hot leg thermocouple readings were recorded along with signals from reactor vessel and RCP differential pressure instrumentation. All observed readings and trends were as expected based on pre-inspection observations. NSSS Calorimetric tests were done at 20%, 30%, 40%, and 50%. The results of each test are presented in Table A-2. Tests above 50% power performed under the normal power ascension test program are presented in Section 6.3.2 of this Startup Report. Power distribution comparisons made between measured and predicted yielded acceptable agreement. Distribution comparisons were done for 30% and 50% power, equilibrium conditions and results are presented in Table A-3. Tests above 50% power were performed under the normal power ascension test program and are presented in Section 6.3.7 of this Startup Report. Group CEA insertions and single CEA insertions were performed with acceptable results. Concurrent data for hot leg RTDs, reactor vessel differential pressure instrumentation, external hot leg thermocouples, and incore detectors were obtained. No unexpected variations in the hot leg temperature profiles were observed as a result of these CEA insertion tests.

TABLE A-2

POST INSPECTION PAT RESULTS FOR
NSSS CALORIMETRIC TESTS

POWER LEVEL	ACCEPTANCE CRITERIA	ADJUSTMENTS NEEDED	COMMENTS
20%	± 2%	NO	Non-Equilibrium Xenon
30%	± 2%	NO	Non-Equilibrium Xenon
30%	± 0.4%	YES[1]	Equilibrium Xenon
40%	± 2%	NO	Non-Equilibrium Xenon
50%	± 2%	YES[1]	Non-Equilibrium Xenon
50%	± 0.2%	YES[1]	Equilibrium Xenon

[1] BDELT out of agreement with calculated core power.

TABLE A-3

POST INSPECTION POWER DISTRIBUTION
COMPARISON RESULTS

% POWER	RADIAL RMS[1]	AXIAL RMS[1]
30%	1.162	2.566
50%	0.959	2.235

[1] Acceptance Criteria: RMS $\leq$ 5

ATTACHMENT B

ANO-2 HOT LEG TEMPERATURE ANOMALY UPDATE

INTRODUCTION

It has previously been reported that a temperature bias was observed between RTD's located on different sides of the reactor hot legs at ANO-2. Associated with this bias has been a temperature flip observed wherein the lower reading hot leg temperature indicators increased and the higher reading indicators decreased. This phenomena, termed the T_H anomaly, was described in detail in Supplement 1, Attachment A of this Startup Report.

In attempts to define this anomaly, testing and monitoring were carried out over several months time. The results of initial investigations yielded the following:

1. Radial reactor internals motion is very small and within expected bounds.

2. No evidence of loose parts was found, or of any identifiable impacting within the reactor.

3. There is no evidence that the phenomenon originates within the core. Incore flux and temperature detectors do not correlate with the bias or the flips.

4. The effect is most likely due to thermal hydraulic causes, occurring between the top of the core and the T_{hot} RTD's.

Because of the continued uncertainty of the exact cause of the anomaly, the plant was shut down for an inspection of the reactor on October 4, 1979. The results of this inspection yielded no indications which would define the cause nor adverse effects of the temperature switching anomaly.

In order to further understand the observed phenomena, and to evaluate its effects on plant operation, additional instrumentation, including permanently installed T_{hot} RTD's, additional temporary thermocouples on the exterior of the hot leg piping and temporary reactor vessel displacement transducers (LVDTs), were added.

INVESTIGATION

The plant resumed startup testing/operation in early December of 1979. Throughout the period of December 1979, to January 29, 1980, the T_{hot} anomaly was monitored at various power levels. Data was taken from all instrumentation to verify that the anomaly had not changed adversely as a result of the core inspection. Extensive T_{hot} testing was performed at each 10% power plateau, including single and group CEA insertions at 50% power. Thermocouple and accelerometer data was taken during power increases and at regular intervals during each test plateau. Continuous monitoring of RTD's (old and new), LVDT's and new CPC T_{hot} averaged signals was maintained. In addition, using excore uncompensated ionization detectors neutron correlation measurements were taken.

RESULTS

The results of the above testing showed that the T_{hot} anomaly has remained relatively unchanged from its pre-outage characteristics, with the following exceptions:

1. The frequency of the T_{hot} flips on the 'A' hot leg was decreased from 4-6 per hour previously, to 1-2 per hour.

2. The frequency of the T_{hot} flips on the 'B' hot leg has decreased from about 1 every 6-8 hours to about 1 every 12 hours. The flips are smaller in magnitude than those observed previously.

3. The average duration of the spikes has decreased for both hot legs.

The system responses to single CEA and group insertions were typical of those observed prior to the inspection. The characteristics of the temperature bias across the pipes, have remained similar to those observed previously as have the relative shapes of the temperature spikes.

The character of the hot leg temperature anomaly was found to be essentially as expected. That is, the magnitude of the bias was found to be approximately linear with Reactor power level and measured ~6°F at 100% power.

FURTHER INVESTIGATION

In order to assure adequate baseline data for future reference, continuous monitoring for 10 days to 2 weeks will resume following return to steady state 100% power.

Subsequently, monitoring of the T_H anomaly will be performed on a monthly basis during which the magnitude of the hot leg temperature steady state bias and flips, as well as the magnitude of the flips as seen by the CPC's will be observed and recorded.