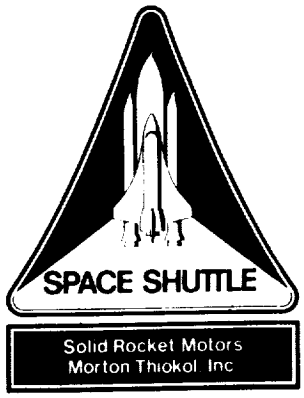
TWR-18519



Three-in-One Gage Final Test Report

September 1988

Prepared for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

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Publications No. 89181

Three-in-One Gage
Final Test Report

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CONTENTS

FIGURES

TABLES

1

INTRODUCTION

The Three-in-One Gage is a three-way gage designed to measure pressure, temperature, and displacement at the same port continuously. The Two-in-One Gage is a two-way gage designed to measure pressure and temperature in the same port continuously. The Two-in-One is an adaptation of the Three-in-One to incorporate dual seals, however, without the proximity sensor. The Three-in-One Gage as shown in Figure 1 is assembled using two Type K thermocouples, 1 Kulite Pressure Transducer XCQ-103-093-1000A, and one Kaman Proximity Displacement Sensor. The main body and seal was designed by Morton Thiokol, Inc.

Testing was completed on 2 August 1988.

Gage Cutaway

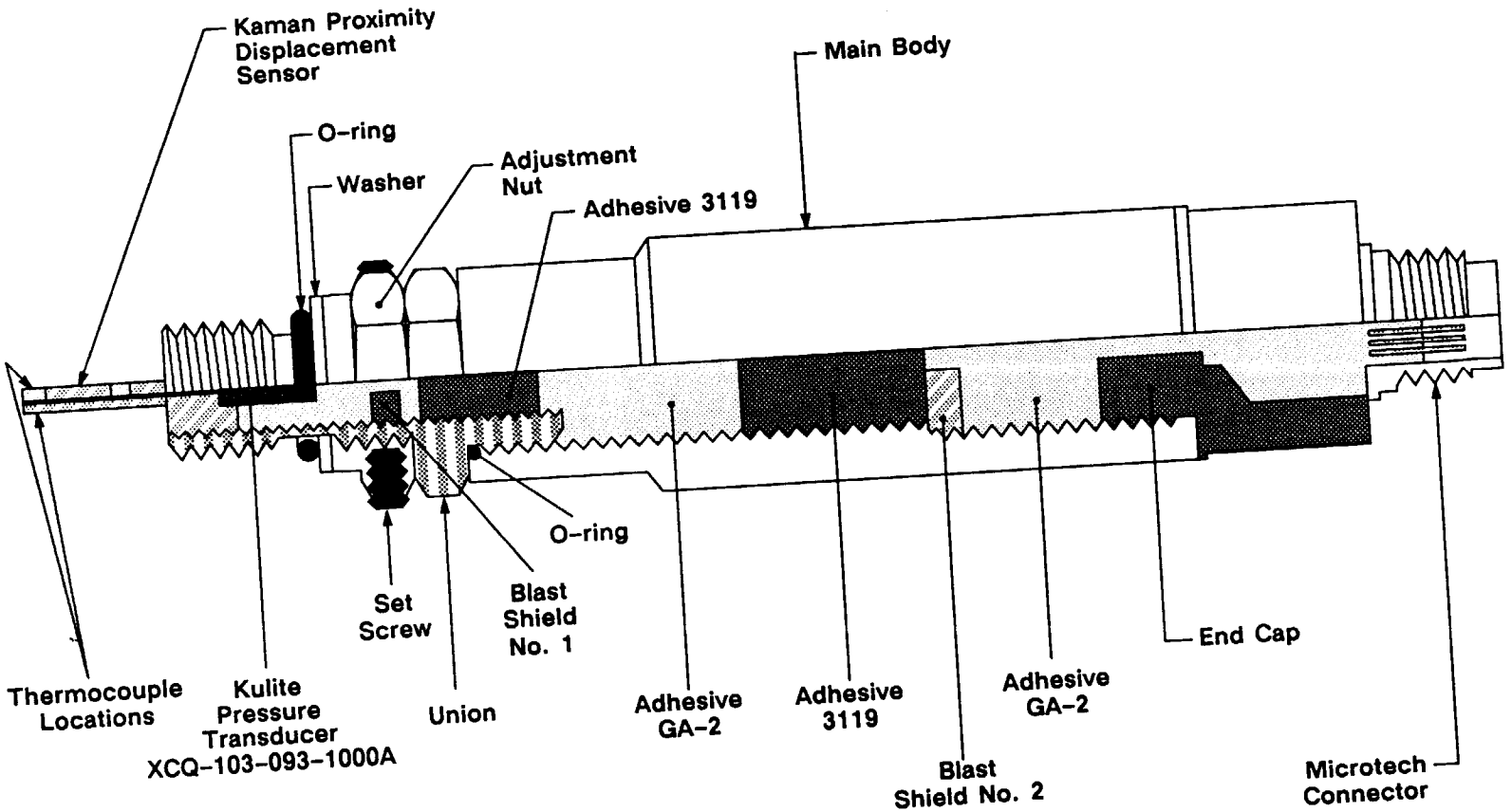


Figure 1. Three-in-One Gage

A018291aR1

TEST OBJECTIVES

The objectives for this test are as follows:

** 1. Verify the pressure measurement of the Three-in-One and Two-in-One Gages to be accurate to ±5 percent of full-scale (1,000 psi).

* 2. Verify the displacement measurement of the Three-in-One Gage to be accurate to ±5 percent of full-scale (0.020 in.).

** 3. Verify pressure and displacement calibration remains constant following vibration loading specified in WTP-0175.

** 4. Determine if the Three-in-One and Two-in-One Gages remains functional following 150 percent of maximum operating pressure.

*** 5. Determine performance of the Two-in-One Gage dual seals in a 70-lb motor hot fire environment.

** 6. Determine gage bursting pressure at ambient temperature.

*** 7. Determine Two-in-One Gage bursting pressure at 175°F.

---

*Objective applies to Three-in-One Gage only.
**Objective applies to Three-in-One and Two-in-One Gages.
***Objective applies to Two-in-One Gage only.

APPLICABLE DOCUMENTS

The latest revision of the following documents are applicable to the extent specified herein.

WTP-0175	Three-in-One Combination Gage Development Test Plan
7U76436	Three-in-One Combination Gage
MIL-STD-45662	Calibration Systems Requirements
SE-019-049-2H	Solid Rocket Booster Vibration, Acoustic and Shock Design and Test Criteria
No Number	General Safety and Health Manual
TWR-10163	Safety Plan for Space Shuttle Redesigned Solid Rocket Motor Project
TWR-10161	Quality Plan for Space Shuttle Solid Rocket Motor Project

4

TEST SUMMARY, RESULTS, AND CONCLUSIONS

4.1 TEST SUMMARY RESULTS

Four Two-in-One and two Three-in-One Gages were tested. Table I shows part numbers and serial numbers for each gage and the testing performed on each.

Table I. 7U76436 Gages Tested (WTP-0175)

Dash No.	Serial No.	Vib	Cal	150 Percent Maximum Pressure	70-lb Motor	175°F Burst	Amb Burst
-02	01	X	X	X			
*-03	01	X	X	X	X	X	
*-04	05	X	X	X	X		
*-04	07	X	X	X			X
*-05	03	X	X	X	X		
-02	04	(Nonfunctional gage; no calibration charts)					X

A Random Vibration Test was performed to verify structural integrity of the Two-in-One and Three-in-One Gages. Each gage was subjected to 6.9 grms vibration for 6 minutes. During the vibration test 1,000 psi was supplied to the gage.

After vibration testing, each gage was pressurized to 1,500 psia, which is 150 percent of the rated pressure (1,000 psi). The output voltage of the pressure transducers were recorded during this test to verify that they remained functional.

Following the vibration, each gage was calibrated for displacement and pressure. Type K thermocouples are controlled by MIL-STD-45662 so no

*Two-in-One Gage (dual seal configuration; pressure and temperature only)

temperature calibration is required. The gages were calibrated for pressure according to Morton Thiokol Metrology Labs and not Para 8.2.2 of WTP-0175. The proximity sensor was not calibrated in accordance with Para 8.2.3 of WTP-0175 but was calibrated by Morton Thiokol Metrology Labs using a 21-point calibration procedure over a range of 0.000 to 0.020 inch.

Two 70-lb motors were fired with Two-in-One Gages measuring chamber pressure and temperature and joint chamber pressure and temperature. A CEC 5000 pressure transducer with an adapter was used on each 70-lb motor to verify pressure to the seals of the Two-in-One Gages.

The 7U76436-04 S/N 07 Two-in-One Gage was subjected to an ambient burst test. The 7U76436-03 S/N 01 was subjected to a 175°F burst test. These gages were selected because they contained damaged electronics, but the gages were structurally intact.

4.2 CONCLUSIONS

A summary of conclusions as they relate to the test objectives is stated below. The section where the results are discussed in detail is also listed.

Objective	Conclusion
1. Verify the pressure measurement of the gages will be accurate to ±5 percent of 1,000 psi (full-scale).	The maximum full-scale offset observed was 0.2 percent. Section 7.3
2. Verify the displacement measurement will be accurate to ±5 percent of 0.020 in. (full-scale).	The maximum full-scale offset observed for the test gages was ±6.7 percent, which does not meet the requirement. Section 7.3
3. Verify pressure and displacement calibration remains constant following vibration loading specified in WTP-0175.	Each gage was calibrated following vibration testing. Objective 1 and Objective 2 above satisfy Objective 3. Section 7.1
4. Determine if the Three-in-One Gage remains operational following 150 percent of the maximum operational pressure.	All gages remained functional following the 150 percent of rated pressure test.

5. Determine the performance of the gage dual seals in working environment using a 70-lb motor test.	All swab samples verified the seal for the gage. Section 7.4 and 7.5
6. Determine gage bursting pressure at ambient temperature	The tested gage maintained a pressure of 20,000 psi for 2 min without bursting. The gage showed no visible evidence of leakage or damage (Figures 4 and 5).
7. Determine Two-in-One Gage bursting pressure at 175°F.	The tested gage maintained a pressure of 20,000 psi for 2 min without bursting. The gage showed no visible evidence of leakage or damage (Figure 3).

4.3 RECOMMENDATIONS

The gages are recommended for use on full-scale RSRM tests to accurately measure temperature and pressure but displacement data should be considered developmental.

Every transducer should be calibrated and overpressure tested prior to use.

Anomalies

Damage to coil from installation.

5

INSTRUMENTATION

Instrumentation for this test was selected to support the test objectives. During calibration, laboratory standards were used in accordance with MIL-STD-45662.

All instrumentation functioned before and during the test.

6

PHOTOGRAPHY

Photography consisted of several still photographs documenting test set-up and Three-in-One Gage physical condition after structural and hot fire tests.

7

TEST RESULTS AND DISCUSSION

7.1 VIBRATION TEST

7.1.1 Introduction

A random vibration test was performed in two axis directions to verify the structural integrity of the gages. Each gage was subjected to 1,000 psi pressure and vibration loading to simulate RSRM vibration and pressure loading during static firing. The vibration test fixture is shown in Figure 2. Flight vibration test criteria was used as specified in SE-019-049-2H and listed below.

20 - 50 Hz at 0.020 g^2/Hz
50 - 150 Hz at +3 dB/Oct
150 - 500 Hz at 0.060 g^2/Hz
500 - 2,000 Hz at -6 dB/Oct
6.9 grms for 6 minutes

A001 and A002 were recorded on strip charts by the T-53 vibration facility and the vibration criteria listed above was verified by the T-53 personnel.

7.1.2 Objectives

The vibration test was performed to support the following test objective:

- Verify pressure and displacement calibration remain constant following vibration loading.

7.1.3 Results and Discussion

The vibration test verified the structural integrity of the gages to maintain 1,000 psi during vibration loading. No visible leakage occurred.

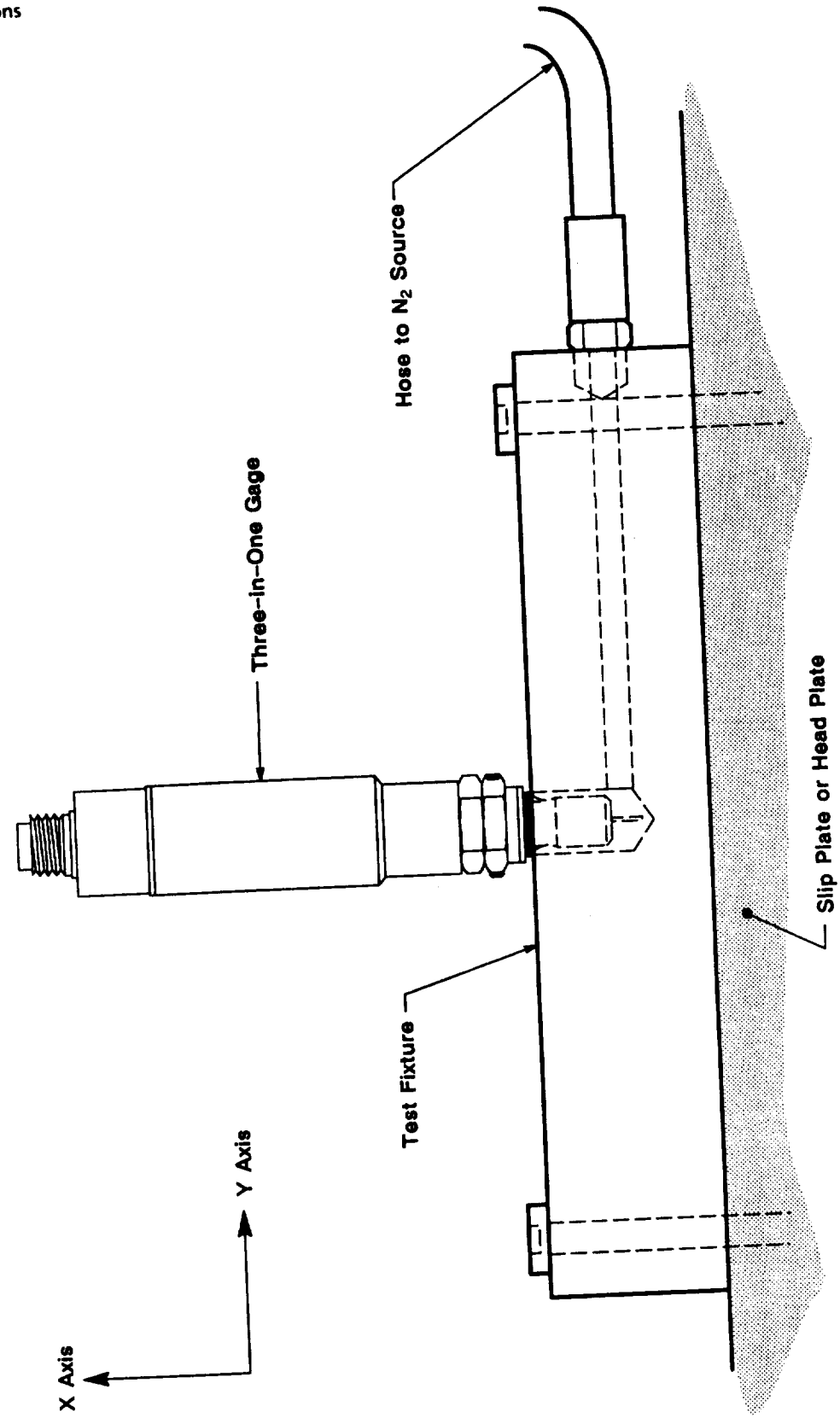


Figure 2. Vibration Test Fixture

The structural integrity of the pressure transducer and the proximity sensor in each Three-in-One Gage was verified by calibration and is discussed in Section 7.3 of this report.

7.2 150 PERCENT MAXIMUM PRESSURE TEST

7.2.1 Introduction

Each gage was pressurized to 1,500 psi, which is 150 percent of the rated pressure (1,000 psi). The output voltage of the pressure transducer was recorded during this test to verify that the pressure transducer remained functional.

7.2.2 Objectives

The 150 percent maximum pressure test supports the following test objective:

- Determine if the gage remains functional following 150 percent of the maximum operational pressure.

7.2.3 Results and Discussion

The pressure traces during the 150 percent over-pressure test are contained in Appendix B. All pressure transducers functioned during the test and all gages returned to zero following the test.

7.3 CALIBRATION TEST

7.3.1 Introduction

An 11-point pressure calibration from 0 to 1,000 psi and a 21-point calibration displacement calibration from 0 to 0.020 in. was performed according to Morton Thiokol Metrology Labs to verify accuracy of the gages and to verify that they were functional after vibration loading.

The calibration was performed as listed below by Morton Thiokol Metrology Labs. These data were recorded using laboratory standards.

1. 5 Vdc was supplied to the pressure transducer input and the output voltage was recorded.
2. The pressure was then increased to 1,000 psi and then decreased back to 0 psi in 200 psi increments. The lab standard pressure and gage

pressure transducer voltage output was measured and recorded at each 200 psi increment.

The 21-point displacement calibration over the range ±0.010 in. was performed as listed below. It should be noted that the procedure used was different than the procedure called out in the test plan. Displacement was calibrated in a range of 0 to 0.020 in. instead of ±0.010 inch. This differs slightly in that WTP-0175 calls for calibration over a range of ±10 mils, which Morton Thiokol Metrology Labs are not equipped to do. Since these pressure data were accurate to 0.5 percent of 1,000 psi and deflection data accurate to ±6.7 percent of 0.020 in. (which is above the ±5 percent accuracy required) the accuracy of the gage is demonstrated, provided the displacement data are considered developmental. The calibration was performed by Morton Thiokol Metrology Labs and these data were recorded using laboratory standards.

1. 28 Vdc was supplied to the proximity sensor and the output voltage was recorded.
2. The target was incremented through a 21-point calibration cycle in 0.002 in. steps. The proximity sensor output voltage was recorded at each 0.002 in. calibration step. The displacement calibration was performed for a range of 0 to 0.020 inch. The test plan specified calibration over a range of ±0.010 inch.

7.3.2 Objectives

The calibration test support the following test objectives:

1. Verify the pressure measurement of the Three-in-One and Two-in-One Gages to be accurate to ±5 percent of full-scale (1,000 psi).
2. Verify the displacement measurement of the Three-in-One Gage to be accurate to ±5 percent of full-scale (0.020 in.).

7.3.3 Results and Discussion

The calibration procedure was carried out by the Morton Thiokol Metrology Labs using an automated test unit. Three separate runs were made on each transducer and documented on standard transducer calibration sheets.

The pressure transducer accuracy was better than 0.5 percent of full-scale which satisfies the requirement of 5 percent of full-scale accuracy. The displacement transducers accuracy was 6.7 percent of full-scale which does not satisfy the requirement of 5 percent of full-scale.

It should be noted that the software allowed for only three calibration runs per device while the test plan called for five calibration runs. The change to three calibration runs was approved by the Design Engineer and Project Engineer prior to the calibration test.

7.4 70-lb MOTOR NUMBER ONE

7.4.1 Introduction

A pair of Two-in-One Gages were installed on a 70-lb motor. The two gages were installed in a vent port. A CEC 5000 pressure transducer was installed in an adjacent vent port to verify pressure to the seals of the Two-in-One Gage.

One Two-in-One Gage was installed in a port to measure direct chamber pressure. The installation procedure called out in the test plan was used to install the gages, except torque paint was not applied after the gages had been torqued.

Detailed gage installation locations and corresponding data plots can be found in Appendix C.

7.4.2 Objectives

70-lb Motor Number One was fired to support the following test objective:

- Determine the performance of the Two-in-One Gage dual seals in working environment using a 70-lb motor.

7.4.3 Results and Discussion

The 70-lb motor ballistic results are detailed in Table II. After the hot firing, there was no evidence of hot gas past any of the gages on the motor. Swab samples verified no gas passed the primary O-ring on the 2 Two-in-One Gages, the Endevco 8530B-1000 Pressure Transducer/Adapter, or on the CEC 5000/Adapter.

Table II. 70-lb Motor No. 1 Ballistic Results

Ambient Temperature	70°F
Propellant Weight	74.4 lb
Nozzle Initial Diameter	0.485 in.
Nozzle Final Diameter	0.614 in.
Total Action Time	82.54 sec
Total Burn Time	81.45 sec
Burn Rate	0.381 in./sec

Because torque paint was not applied, these data were not collected to verify if the gages held torque. The Two-in-One Gages in the vent ports saw a maximum pressure of 60 psi, while the Two-in-One Gage in the chamber pressure port saw a maximum pressure of 790 psi.

From the results described above, it was decided by Project Engineering to fire another 70-lb motor.

7.5 70-lb MOTOR NUMBER TWO

7.5.1 Introduction

The second 70-lb motor was fired on 23 July 1988 using the procedure contained in WTP-0175.

A pair of Two-in-One Gages were installed in vent ports with a CEC 5000/Adapter in an adjacent vent port. One Two-in-One Gage was installed in a port to measure direct chamber pressure. The installation procedure contained in WTP-0175 was followed.

Detailed gage installation locations and corresponding data plots can be found in Appendix C.

7.5.2 Objectives

70-lb Motor Number Two was fired to support the same test objective as 70-lb Motor Number One as listed below.

- Determine the performance of the Three-in-One Gage dual seals in working environment using a 70-lb motor hot firing.

7.5.3 Results and Discussion

The 70-lb motor ballistic results are detailed in Table III. After the hot firing, there was no evidence of hot gas past any of the gages on the motor. The vent port saw a maximum pressure of 590 psi, while the chamber pressure ports saw a maximum pressure of 836 psi. Swab samples verified no gas passed the primary O-ring on the Two-in-One Gages, the Endevco 8530B Pressure Transducer/Adapter, or the CEC 5000 Pressure Transducer/Adapter.

At disassembly, the torque paint was verified to be intact before the gages were removed.

7.6 BURST TESTS

7.6.1 Introduction

Two burst tests were conducted to determine the structural integrity of the gages; both a Two-in-One and a Three-in-One were tested.

The pressure was incremented gradually with an analog scale and not in 500 psi increments as called out in WTP-0175 as digital increments are not possible.

The 7U76436-03 S/N 01 Three-in-One Gage was burst tested at M-9. Before the burst test, the gage was placed in an oven at 180°F for 15 min to guarantee a 175°F heat soak. After the 15-min soak time, the gage was removed from the oven and installed in the test chamber and subjected to the burst test in accordance with WTP-0175.

7.6.2 Objectives

The burst tests were performed to support the following objectives:

- Determine Two-in-One Gage bursting pressure at 175°F.
- Determine Two-in-One and Three-in-One Gages bursting pressure at ambient temperature.

7.6.3 Results and Discussion

During the 175°F burst test the pressure was increased from 0 to 20,000 psi. A pressure of 20,000 psi was held for 2 min and then the pressure was reduced back to 0 psi. The pressure trace during this test is shown in Figure 3. The periodic pressure fluctuations during the 2-min hold period were caused by a small leak in the high pressure line to the test article. The leak was not caused by the Two-in-One Gage. The tested gage showed no visible evidence of leakage or damage.

During the ambient temperature burst test, the pressure was increased to 20,000 psi and held for 2 minutes. The pressure was then decreased to 0 psi. The pressure trace during the ambient temperature burst test is shown in Figures 4 and 5. Visible inspection of the gage verified no damage or leakage.

Table III. 70-lb Motor No. 2 Ballistic Results

Ambient Temperature	70°F
Propellant Weight	73.4 lb
Nozzle Initial Diameter	0.479 in.
Nozzle Final Diameter	0.608 in.
Total Action Time	82.59 sec
Total Burn Time	81.10 sec
Burn Rate	0.382 in./sec

A018239a

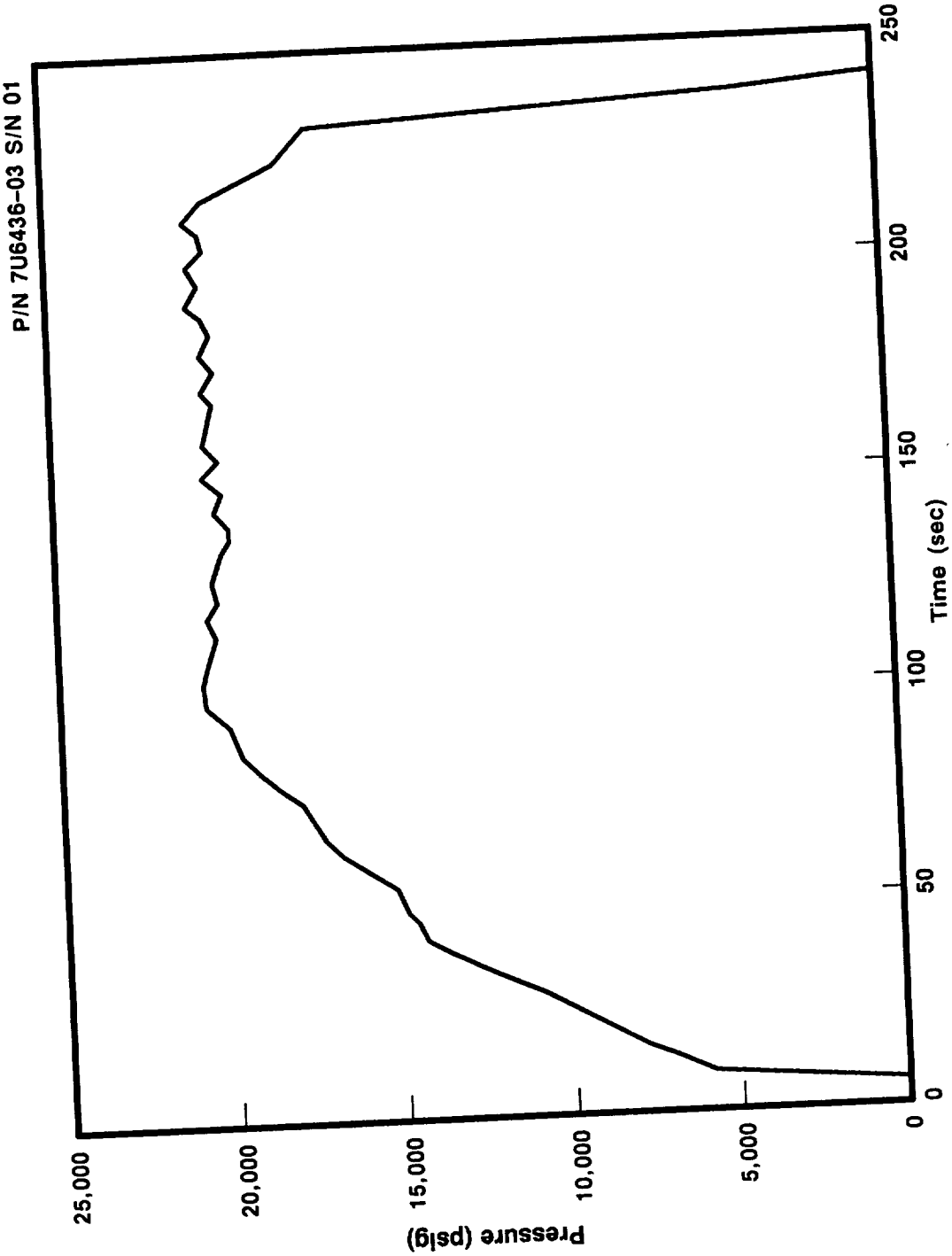


Figure 3. Burst Curve of 7U6436-03 S/N 01

A018240a

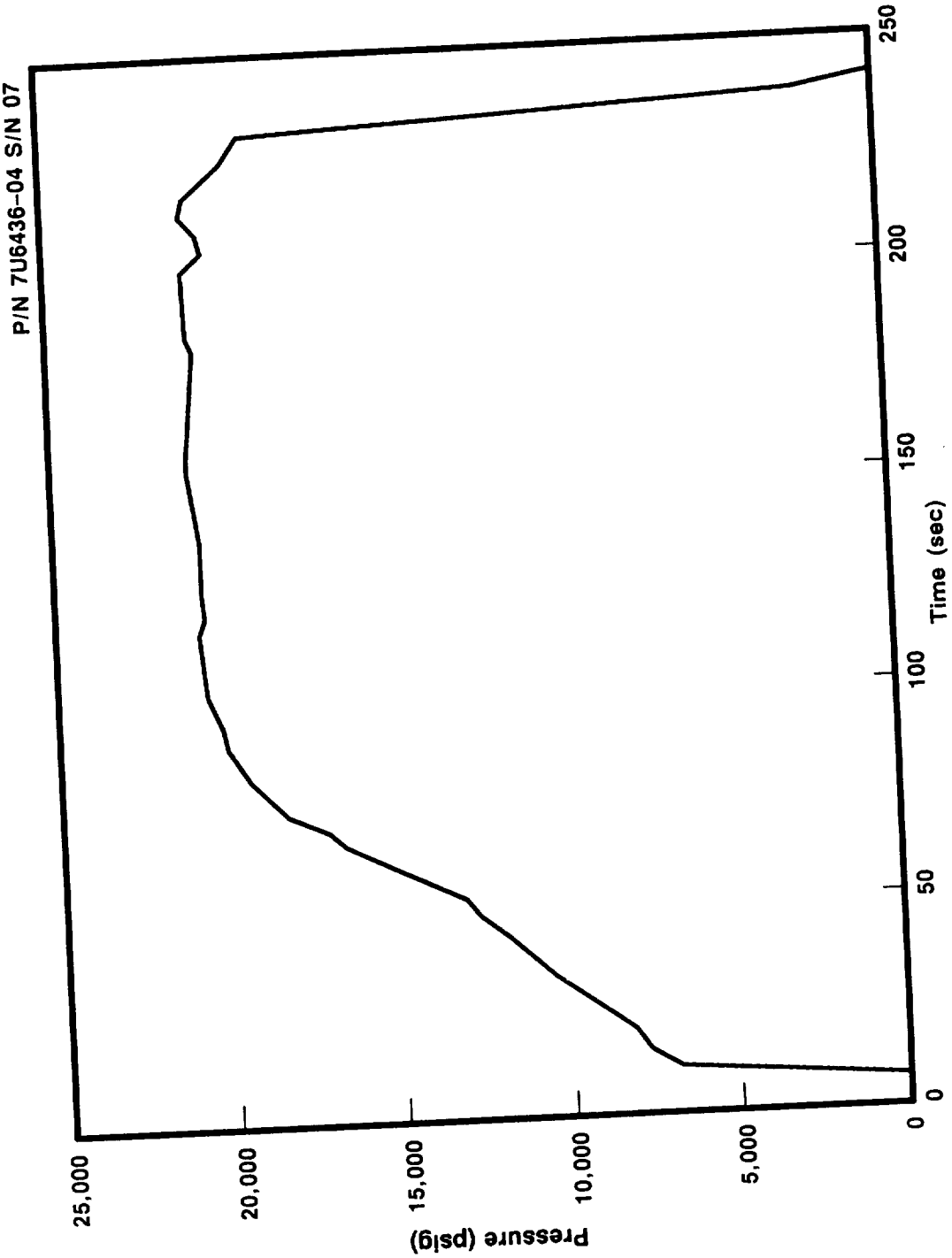


Figure 4. Burst Curve of 7U6436-04 S/N 07

A021557a

Figure 5. Burst Curve of 7U76436-02 S/N 04

Appendix A
Calibration Data

A018252a

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL	7476436-02 ~~8 IN 1 GAGE~~	01	06 JUL 88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
1000 PSI	NA POS	4.9999	19.140 N
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	0.02
#2 =	0.01	80%=	80.01	60%=	0.04
#3 =	0.00	60%=	60.00	40%=	0.04
#4 =	0.01	40%=	40.00	20%=	0.04
		20%=	19.99	0%=	0.01

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL	7476436-02 ~~8 IN 1 GAGE~~	01	06 JUL 88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
1000 PSI	NA POS	4.9999	19.140 N
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	0.02
#2 =	0.01	80%=	80.01	60%=	0.04
#3 =	0.00	60%=	60.00	40%=	0.04
#4 =	0.01	40%=	40.00	20%=	0.04
		20%=	19.99	0%=	0.01

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER WORKSHEET I AP 27 A1

MFG.: MORTON THIOKOL
MODEL#: ~~T-IN-T BASE~~ 7076036-02
SERIAL#: 01
RANGE: 1000 PSI
DATE: 06 JUL 88
SL#: NA
READOUT: 24158
MODE: POS
REF.STD: 16856
SHUNTS: N MV/V
INS.RES.>NA MEG OHMS

N MV/V SHUNTS	-ZERO		%F.S.	SH/LIN
ZERO=	0.000	0.000		
#1 =	0.000	0.000	0.00	0.00
#2 =	0.005	0.005	0.01	0.01
#3 =	0.000	0.000	0.00	0.00
#4 =	0.005	0.005	0.01	0.01

TEMP.DEG.F = 74
EXCITATION = 4.9999 V.DC
SENSITIVITY = 15.140 MV/V
POT OUT = 0.8720 MV
CONVERSION FACTOR = 1.32103305

LOAD	RUN 1	RUN 2	RUN 3	AVERAGE	AVE-ZERO	% F.S.	HYSTERESIS
0%=	0.001	0.001	0.000	0.001	0.000	0.00	
20%=	15.136	15.131	15.138	15.135	15.134	19.99	
40%=	30.268	30.279	30.290	30.279	30.278	40.00	
60%=	45.412	45.424	45.420	45.419	45.418	60.00	
80%=	60.561	60.571	60.576	60.569	60.569	80.01	
100%=	75.686	75.691	75.720	75.699	75.698	100.00	
80%=	60.572	60.584	60.586	60.581	60.580	80.03	0.02
60%=	45.448	45.450	45.450	45.449	45.449	60.04	0.04
40%=	30.303	30.310	30.316	30.310	30.309	40.04	0.04
20%=	15.160	15.171	15.162	15.164	15.164	20.03	0.04
0%=	0.004	0.006	0.007	0.006	0.005	0.01	0.01

Y=A+BX+CX^2 A=-2.643E-03 B=.757033999 C= 1.4E-07
RR= .999999973

CALIBRATING TECHNICIAN'S STAMP

TRANSDUCER CALIBRATION REPORT

MORTON THIOKOL — MANUFACTURER
[illegible] — MODEL #
[illegible] — SERIAL #
06 JUL 88 — DATE/APPROVAL

1000 PSI — RANGE
[illegible] — SL # / MODE
[illegible] — EXCITATION V.DC.
[illegible] — MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL		LINEARITY		HYSTERESIS	
SHUNT CALIB	[illegible]	[illegible]	0.00	80%=	0.02
#1	[illegible]	[illegible]	0.01	60%=	0.04
#2	[illegible]	[illegible]	0.00	40%=	0.04
#3	[illegible]	[illegible]	0.00	20%=	0.04
#4	[illegible]	[illegible]	0.01	0%=	0.01

TCC 01629 STDS

TRANSDUCER CALIBRATION WORKSHEET

MANUFACTURER	MODEL	SERIAL NO.	RANGE
MTI	7U76436-02	01	.020 INCH
ANNEL	CALIBRATION DATE	EXCITATION	LOADING INSTRUMENT
	8 JULY 1988	32V & 4VPP @ 20 KHZ	45023
BAROMETER	MEGOHMS TO GROUND	BATTERY	STANDARD
			25646
LOADING TECH.	RECORDING TECH.	COMPUTING TECH.	READ OUT
	16783		25646
☐ DOUBLE SHUNT	SENSITIVITY MV/V	COMPRESSION F.S.	AVERAGE F.S.
☐ SINGLE SHUNT	SHUNT MODULE MV/V	TENSION F.S.	CONVERSION FACTOR
☐ RECEIVING INSP.			

STEPS	SHUNTS	% OF F.S.
1		
2		
3		
4		
5		
6		

APPLIED LOAD %	DISTANCE IN INCHES	OUTPUT IN VOLTS DC RUN 1	RUN 2	RUN 3		AVERAGE	% OF F.S.	LIN	HYS
Z OUT									
0	0	0.107	0.110	0.109					
20	.002	0.494	0.497	0.503					
40	.004	1.189	1.199	1.172					
60	.006	2.100	2.106	2.097					
80	.008	3.116	3.112	3.103					
100	.010	4.110	4.097	4.102					
80	.012	5.022	4.995	5.006					
60	.014	5.836	5.795	5.807					
40	.016	6.537	6.492	6.504					
20	.018	7.130	7.090	7.085					
0	.020	7.634	7.575	7.578					
-20	.018	7.130	7.090	7.084					
-40	.016	6.545	6.501	6.508					
-60	.014	5.839	5.808	5.813					
-80	.012	5.029	5.015	5.017					
-100	.010	4.124	4.094	4.113					
-80	.008	3.120	3.097	3.129					
-60	.006	2.108	2.079	2.097					
40	.004	1.206	1.191	1.203					
-20	.002	0.509	0.502	0.501					
-0	0	0.110	0.112	0.110					
Z OUT									

TRANSDUCER CALIBRATION REPORT

THIOKOL	ZU76436-05	-03	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	12.289
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

TCC 01629 STDS

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.01	100%=	100.00	80%=	0.34
#2 =	0.01	80%=	79.94	60%=	0.50
#3 =	0.00	60%=	59.78	40%=	0.65
#4 =	0.01	40%=	39.52	20%=	0.82
		20%=	19.33	0%=	0.67

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER CALIBRATION REPORT

THIOKOL	ZU76436-05	-03	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	12.289
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

TCC 01629 STDS

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.01	100%=	100.00	80%=	0.34
#2 =	0.01	80%=	79.94	60%=	0.50
#3 =	0.00	60%=	59.78	40%=	0.65
#4 =	0.01	40%=	39.52	20%=	0.82
		20%=	19.33	0%=	0.67

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER WORKSHEET I AP 27 A1

			MV/V SHUNTS	-ZERO	%F.S.	SH/LIN
MFG.:	THIOKOL	ZERO=	-0.004	0.000		
MODEL#:	7U76436-05	#1 =	0.005	0.009	0.01	0.01
SERIAL#:	-03	#2 =	0.000	0.004	0.01	0.01
RANGE:	0 TO 1000 PSI	#3 =	-0.002	0.002	0.00	0.00
DATE:	07-11-88	#4 =	0.001	0.005	0.01	0.01
SL#:	N/A					
READOUT:	24158	TEMP.DEG.F = 72				
MODE:	POS	EXCITATION = 5.0000 V.DC				
REF.STD:	26793	SENSITIVITY = 12.789 MV/V				
SHUNTS:	MV/V	POT OUT = 0.9340 MV				
INS.RES.>1K	MEG OHMS	CONVERSION FACTOR = 1.56381132				

LOAD	RUN 1	RUN 2	RUN 3	AVERAGE	AVE-ZERO	% F.S.	HYSTERESIS
0%=	0.000	-0.006	0.000	-0.002	0.000	0.00	
20%=	12.338	12.365	12.376	12.360	12.362	19.33	
40%=	25.260	25.273	25.275	25.269	25.271	39.52	
60%=	38.198	38.274	38.195	38.222	38.224	59.78	
80%=	51.032	51.260	51.056	51.116	51.118	79.94	
100%=	63.902	63.964	63.967	63.944	63.946	100.00	
80%=	51.290	51.416	51.290	51.332	51.334	80.28	0.34
60%=	38.535	38.559	38.542	38.545	38.547	60.28	0.50
40%=	25.669	25.713	25.682	25.688	25.690	40.17	0.65
20%=	12.875	12.842	12.937	12.885	12.887	20.15	0.82
0%=	0.420	0.432	0.424	0.425	0.427	0.67	0.67

Y=A+BX+CX^2 A=-.112762 B=.631230999 C= 1.013E-04
RR= .999974814

TCC 18361 STDS

CALIBRATING TECHNICIAN'S STAMP

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

THIOKOL	7U76436-05	-03	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	12.789
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.01	100%=	100.00	80%=	0.34
#2 =	0.01	80%=	79.94	60%=	0.50
#3 =	0.00	60%=	59.78	40%=	0.65
#4 =	0.01	40%=	39.52	20%=	0.82
		20%=	19.33	0%=	0.67

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

THIOKOL	ZU76436-04	-07	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	15.220
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	-0.01
#2 =	0.00	80%=	80.02	60%=	0.00
#3 =	0.00	60%=	60.02	40%=	-0.01
#4 =	0.01	40%=	40.01	20%=	-0.02
		20%=	19.98	0%=	0.02

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

THIOKOL	ZU76436-04	-07	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	15.220
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	-0.01
#2 =	0.00	80%=	80.02	60%=	0.00
#3 =	0.00	60%=	60.02	40%=	-0.01
#4 =	0.01	40%=	40.01	20%=	-0.02
		20%=	19.98	0%=	0.02

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER WORKSHEET I AP 27 A1

MFG.: THIOKOL
MODEL#: 7U76436-04
SERIAL#: -07
RANGE: 0 TO 1000 PSI
DATE: 07-11-88
SL#: N/A
READOUT: 24158
MODE: POS
REF.STD: 26793
SHUNTS: MV/V
INS.RES. >1K MEG OHMS

MV/V SHUNTS	-ZERO	%F.S.	SH/LIN
ZERO= 8.000	0.000		
#1 = 8.001	0.001	0.00	0.00
#2 = 8.001	0.001	0.00	0.00
#3 = 8.001	0.001	0.00	0.00
#4 = 8.004	0.004	0.01	0.01

TEMP.DEG.F = 72
EXCITATION = 5.0000 V.DC
SENSITIVITY = 15.220 MV/V
POT OUT = 18.1570 MV
CONVERSION FACTOR = 1.31407771

LOAD	RUN 1	RUN 2	RUN 3	AVERAGE	AVE-ZERO	% F.S.	HYSTERESIS
0%=	7.999	8.000	8.000	8.000	0.000	0.00	
20%=	23.198	23.215	23.200	23.204	15.205	19.98	
40%=	38.439	38.456	38.451	38.449	30.449	40.01	
60%=	53.669	53.688	53.674	53.677	45.677	60.02	
80%=	68.875	68.909	68.894	68.893	60.893	80.02	
100%=	84.088	84.112	84.096	84.099	76.099	100.00	
80%=	68.873	68.896	68.900	68.890	60.890	80.01	-0.01
60%=	53.668	53.684	53.668	53.673	45.674	60.02	0.00
40%=	38.416	38.465	38.437	38.439	30.440	40.00	-0.01
20%=	23.177	23.200	23.184	23.187	15.187	19.96	-0.02
0%=	8.018	8.018	8.007	8.014	0.015	0.02	0.02

Y=A+BX+CX^2 A=-8.90499999E-03 B=.761607999 C= -4.83E-06
RR= .999999888

TCC 18361 STDS

CALIBRATING TECHNICIAN'S STAMP

TRANSDUCER CALIBRATION REPORT

TCC Q1629 STDS

THIOKOL	7U76436-04	-07	07-11-88
MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
0 TO 1000 PSI	N/A POS	5.0000	15.220
RANGE	SL # / MODE	EXCITATION V.DC.	MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	-0.01
#2 =	0.00	80%=	80.02	60%=	0.00
#3 =	0.00	60%=	60.02	40%=	-0.01
#4 =	0.01	40%=	40.01	20%=	-0.02
		20%=	19.98	0%=	0.02

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL MANUFACTURER	7476436-04 ~~2 IN 1 GAGE~~ MODEL #	05 SERIAL #	07/06/88 DATE/APPROVAL
1000 PSI RANGE	N/A POS SL # / MODE	4.9969 EXCITATION V.DC.	3.256 MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	-0.01
#2 =	0.00	80%=	79.98	60%=	-0.05
#3 =	0.00	60%=	59.95	40%=	-0.05
#4 =	0.00	40%=	39.96	20%=	-0.08
		20%=	19.97	0%=	-0.04

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL MANUFACTURER	7476436-04 ~~2 IN 1 GAGE~~ MODEL #	05 SERIAL #	07/06/88 DATE/APPROVAL
1000 PSI RANGE	N/A POS SL # / MODE	4.9969 EXCITATION V.DC.	3.256 MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	-0.01
#2 =	0.00	80%=	79.98	60%=	-0.05
#3 =	0.00	60%=	59.95	40%=	-0.05
#4 =	0.00	40%=	39.96	20%=	-0.08
		20%=	19.97	0%=	-0.04

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER WORKSHEET 1 AP 28 A1

			MV/V	SHUNTS	-ZERO	%F.S.	SH/LIN
MFG.:	MORTON THIOKOL	ZERO=	0.001	0.000			
MODEL#:	~~3 IN 1 GAGE~~	#1 =	0.001	0.000	0.00	0.00	
SERIAL#:	05	#2 =	0.000	-0.001	0.00	0.00	
RANGE:	1000 PSI	#3 =	-0.002	-0.003	0.00	0.00	
DATE:	07/06/88	#4 =	0.001	0.000	0.00	0.00	
SL#:	N/A	TEMP.DEG.F = 74					
READOUT:	24158	EXCITATION = 4.9969 V.DC					
MODE:	POS	SENSITIVITY = 13.236 MV/V					
REF.STD:	16856	POT OUT = 2.1860 MV					
SHUNTS:	MV/V	CONVERSION FACTOR = 1.51200532					
INS.RES.>N/A	MEG OHMS						

LOAD	RUN 1	RUN 2	RUN 3	AVERAGE	AVE-ZERO	% F.S.	HYSTERESIS
0%=	0.001	-0.002	0.000	0.000	0.000	0.00	
20%=	13.164	13.223	13.228	13.205	13.205	19.97	
40%=	26.337	26.468	26.474	26.426	26.427	39.96	
60%=	39.555	39.707	39.690	39.651	39.651	59.95	
80%=	52.786	52.956	52.947	52.896	52.897	79.98	
100%=	66.044	66.170	66.197	66.137	66.137	100.00	
80%=	52.801	52.910	52.965	52.892	52.892	79.97	-0.01
60%=	39.526	39.624	39.691	39.614	39.614	59.90	-0.05
40%=	26.322	26.419	26.448	26.396	26.397	39.91	-0.05
20%=	13.133	13.161	13.171	13.155	13.155	19.89	-0.08
=	-0.077	-0.008	-0.004	-0.030	-0.029	-0.04	-0.04

Y=A+BX+CX^2 A=-1.215E-03 B=.660182999 C= 1.223E-05
RR= .999999984

TCC 12232 STDS

CALIBRATING TECHNICIAN'S STAMP

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
RANGE	SL # / MODE	EXCITATION V.DC	MV/ SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	0.0%	-0.0
#2 =	0.00	80%=	79.99		
#3 =	0.00	60%=	59.98		
#4 =	0.00	40%=	39.97		
		20%=	19.97		

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL MANUFACTURER	7476436-03 ~~3 IN 1 BASE~~ MODEL #	01 SERIAL #	07/06/88 DATE/APPROVAL
1000 PSI RANGE	N/A POS SL # / MODE	5.0001 EXCITATION V.DC.	2.510 N MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	0.03
#2 =	0.00	80%=	79.99	60%=	0.05
#3 =	0.00	60%=	59.98	40%=	0.08
#4 =	0.00	40%=	39.96	20%=	0.08
		20%=	19.96	0%=	0.05

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MORTON THIOKOL MANUFACTURER	7476436-03 ~~3 IN 1 BASE~~ MODEL #	01 SERIAL #	07/06/88 DATE/APPROVAL
1000 PSI RANGE	N/A POS SL # / MODE	5.0001 EXCITATION V.DC.	2.510 N MV/V SENS./ MV/V SHUNT MOD.

ELECTRICAL SIMULATION		LINEARITY		HYSTERESIS	
#1 =	0.00	100%=	100.00	80%=	0.03
#2 =	0.00	80%=	79.99	60%=	0.05
#3 =	0.00	60%=	59.98	40%=	0.08
#4 =	0.00	40%=	39.96	20%=	0.08
		20%=	19.96	0%=	0.05

DATE	FIRING BAY	NO. FIRINGS	REMARKS

TRANSDUCER WORKSHEET I AP 28 A1

MFG.:	MORTON THIOKOL	N MV/V	SHUNTS	-ZERO	%F.S.	SH/LIN
MODEL#:	~~3 IN 1 GAGE~~ 947 6436-03	ZERO=	-0.002	0.000		
SERIAL#:	01	#1 =	-0.002	0.000	0.00	0.00
RANGE:	1000 PSI	#2 =	-0.004	-0.002	0.00	0.00
DATE:	07/06/88	#3 =	-0.003	-0.001	0.00	0.00
SL#:	N/A	#4 =	-0.004	-0.002	0.00	0.00
READOUT:	24412	TEMP.DEG.F = 74				
MODE:	POS	EXCITATION = 5.0001 V.DC				
REF.STD:	16856	SENSITIVITY = 12.510 MV/V				
SHUNTS:	N MV/V	POT OUT = 2.2470 MV				
INS.RES.>	N/A MEG OHMS	CONVERSION FACTOR = 1.59866991				

LOAD	RUN 1	RUN 2	RUN 3	AVERAGE	AVE-ZERO	% F.S.	HYSTERESIS
0%=	0.000	-0.002	0.001	0.000	0.000	0.00	
20%=	12.482	12.484	12.487	12.484	12.485	19.96	
40%=	24.991	24.995	24.999	24.995	24.995	39.96	
60%=	37.506	37.516	37.524	37.515	37.516	59.98	
80%=	50.019	50.034	50.045	50.033	50.033	79.99	
100%=	62.542	62.557	62.556	62.552	62.552	100.00	
80%=	50.035	50.057	50.065	50.052	50.053	80.02	0.03
60%=	37.551	37.551	37.549	37.550	37.551	60.03	0.05
40%=	25.048	25.049	25.045	25.047	25.048	40.04	0.08
20%=	12.542	12.533	12.530	12.535	12.535	20.04	0.08
0%=	0.048	0.033	0.019	0.033	0.034	0.05	0.05

Y=A+BX+CX^2 A=-5.132E-03 B=.624722 C= 8.85E-06
RR= .99999994

TCC 12232 STDS

CALIBRATING TECHNICIAN'S STAMP

TRANSDUCER CALIBRATION REPORT

TCC 01629 STDS

MANUFACTURER	MODEL #	SERIAL #	DATE/APPROVAL
RANGE	SL # / MODE	EXCITATION V.DC	MV/V SENS./ MV/V SHUNT MOD.

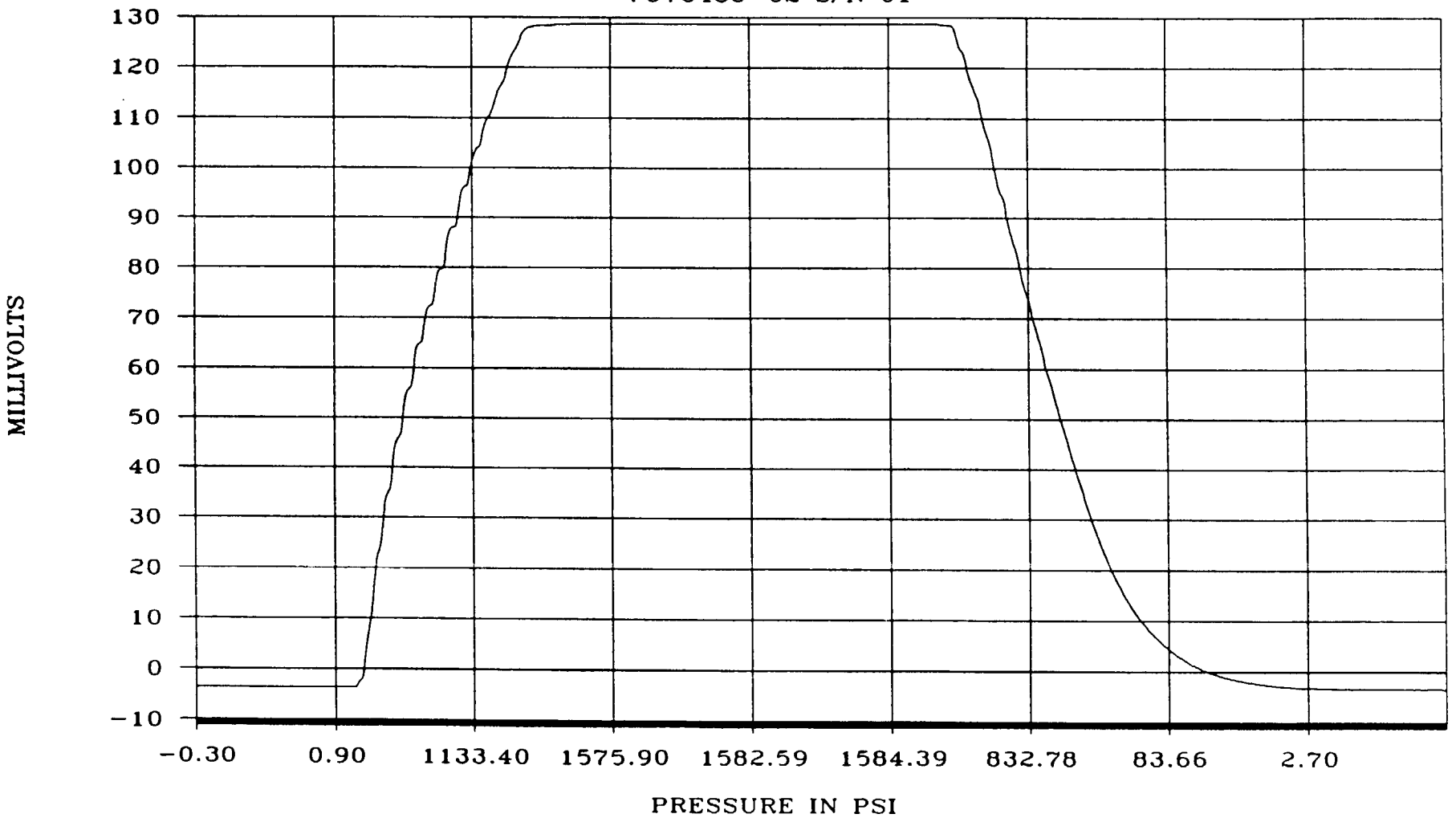
	ELECTRICAL SIMULATION	LINEARITY		HYSTERESIS
#1 =	0.00	100%=		0.00
#2 =	0.00	80%=		0.00
#3 =	0.00	60%=		0.00
#4 =	0.00	40%=		0.05
		20%=		
		0%=		

Appendix B
150 Percent Over-Pressure Test

A018253a

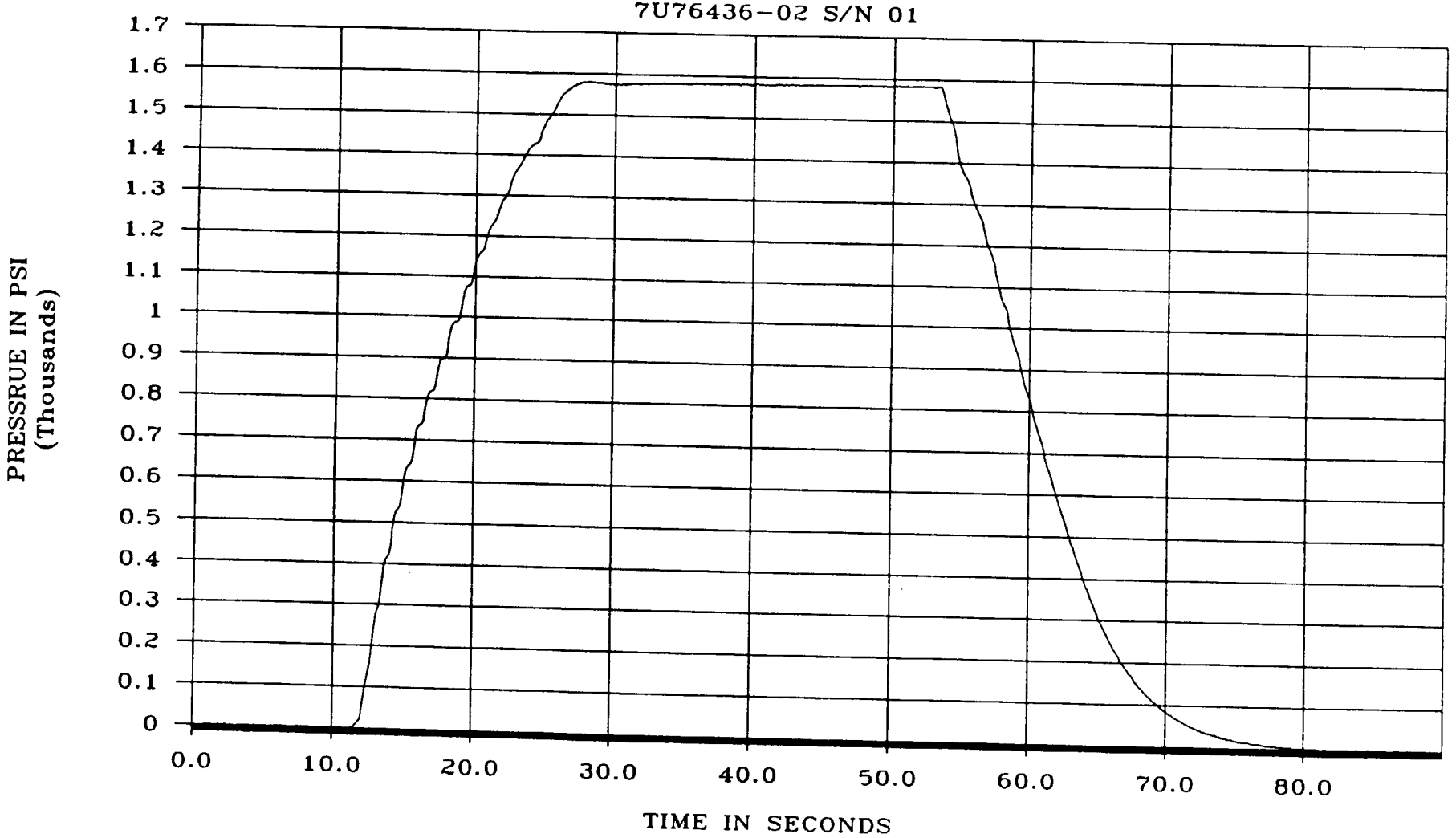
OVERPRESSURE TEST

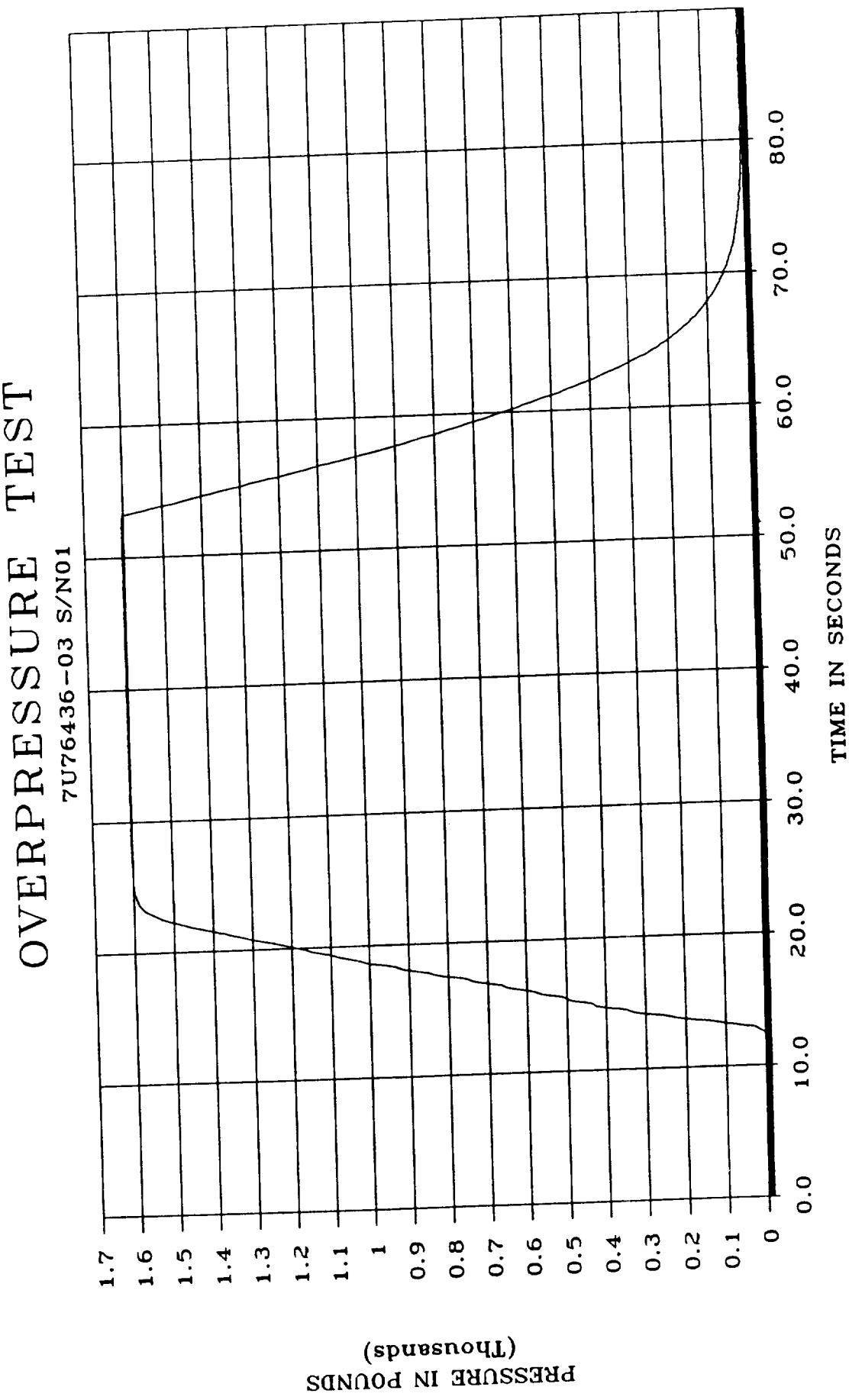
7U76436-02 S/N 01



OVERPRESSURE TEST

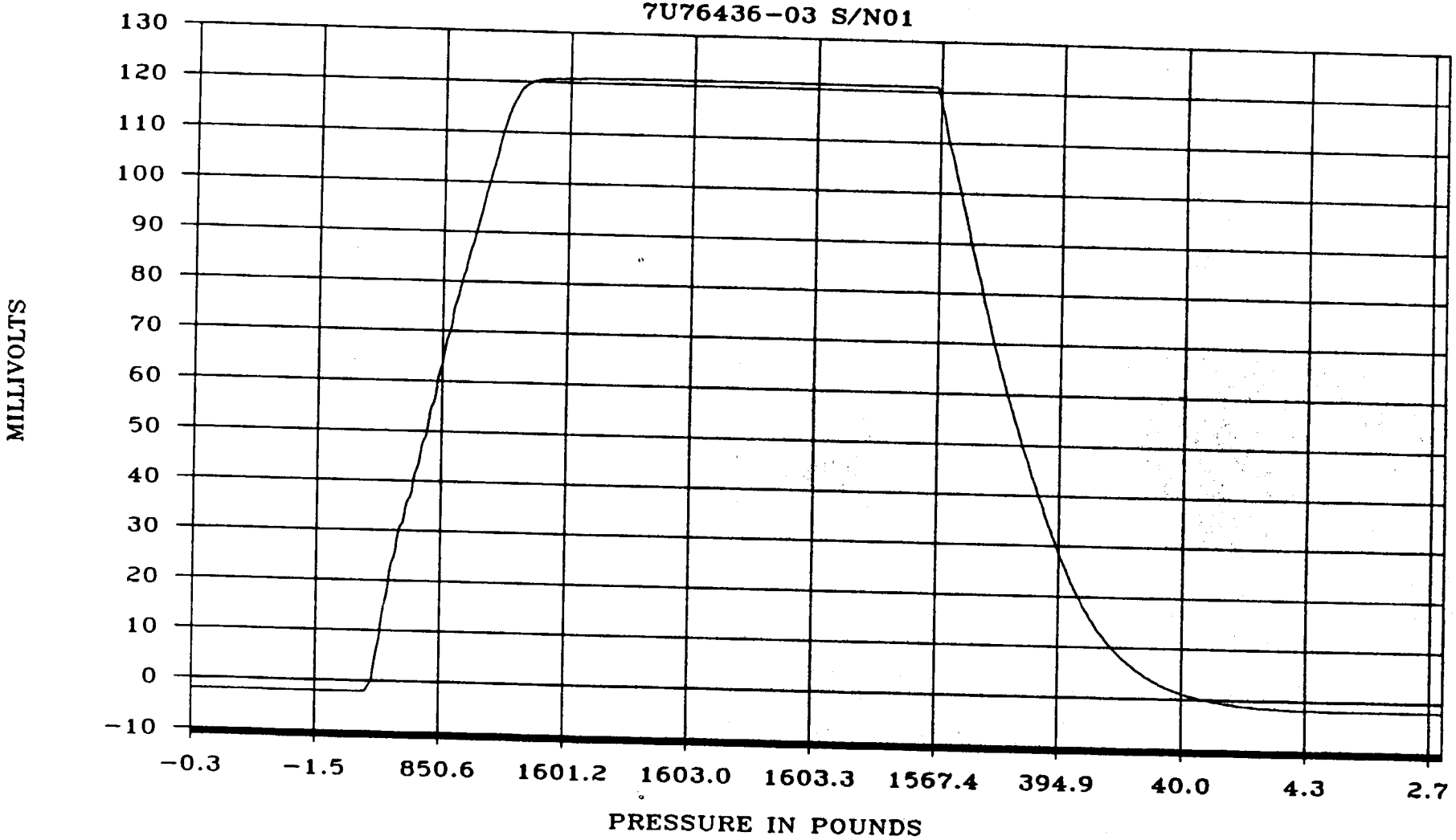
7U76436-02 S/N 01




OVERPRESSURE TEST
7U76436-03 S/N01
PRESSURE IN POUNDS
(Thousands)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
TIME IN SECONDS

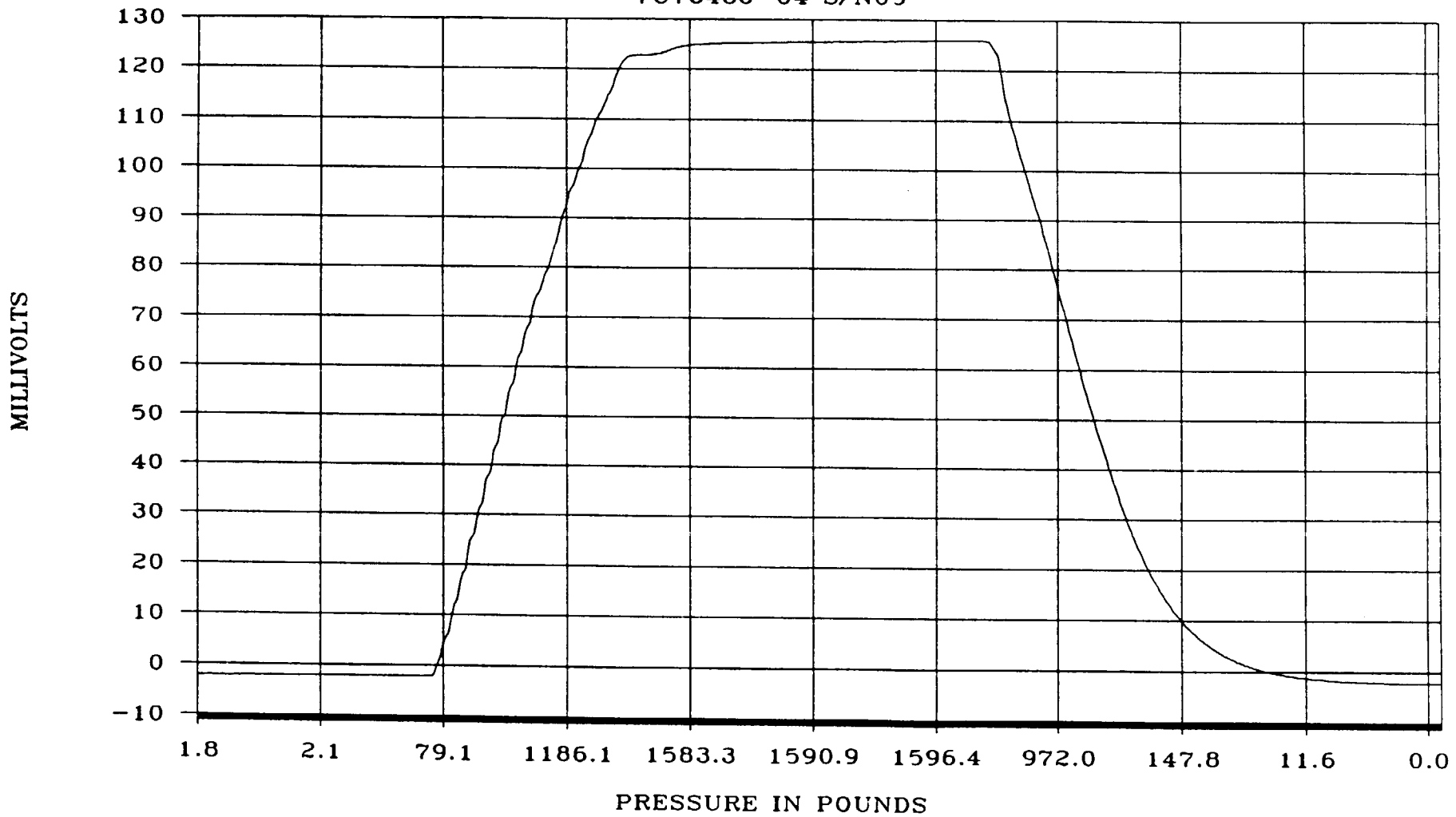
OVERPRESSURE TEST

7U76436-03 S/N01



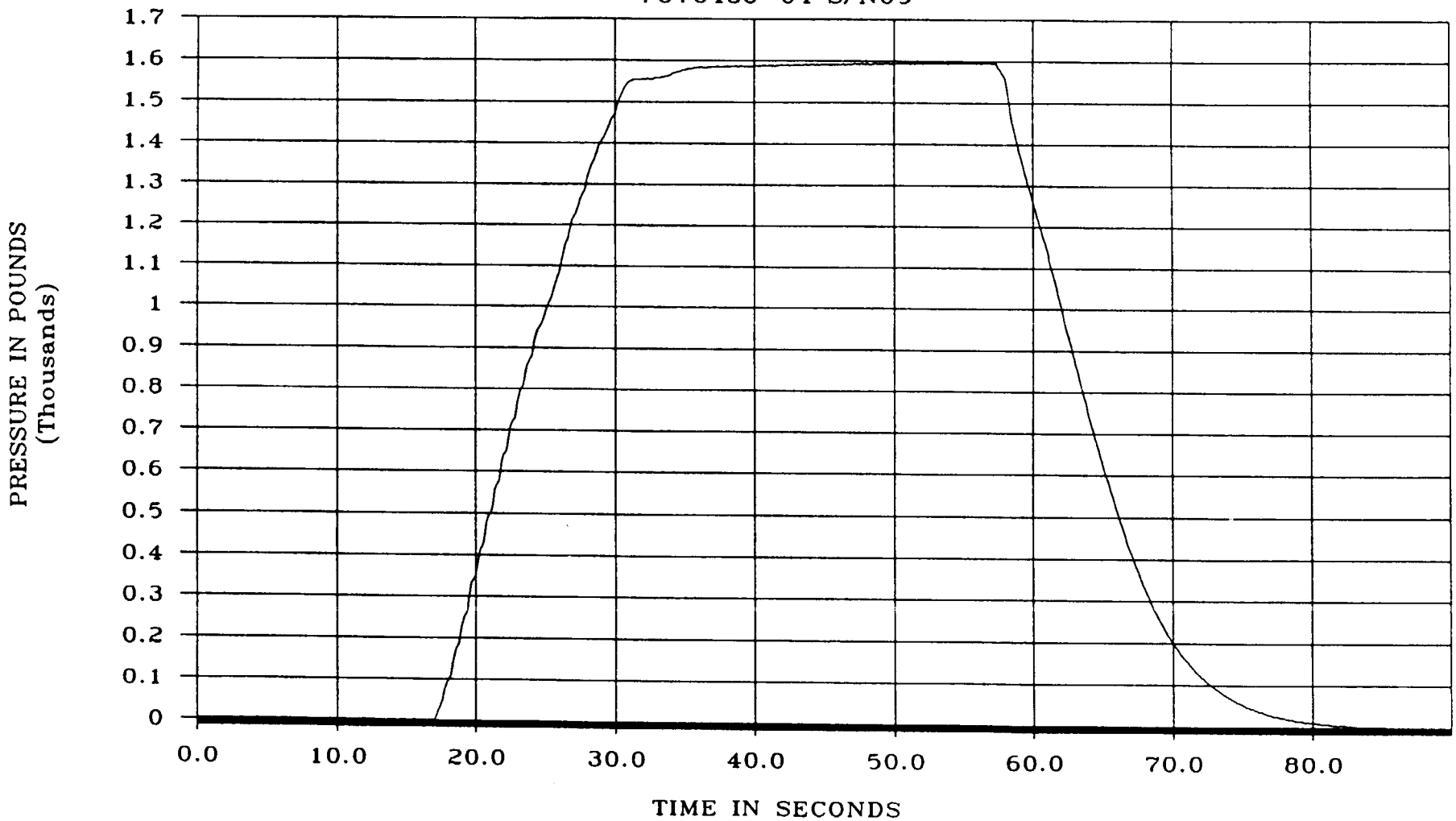
OVERPRESSURE TEST

7U76436-04 S/N05



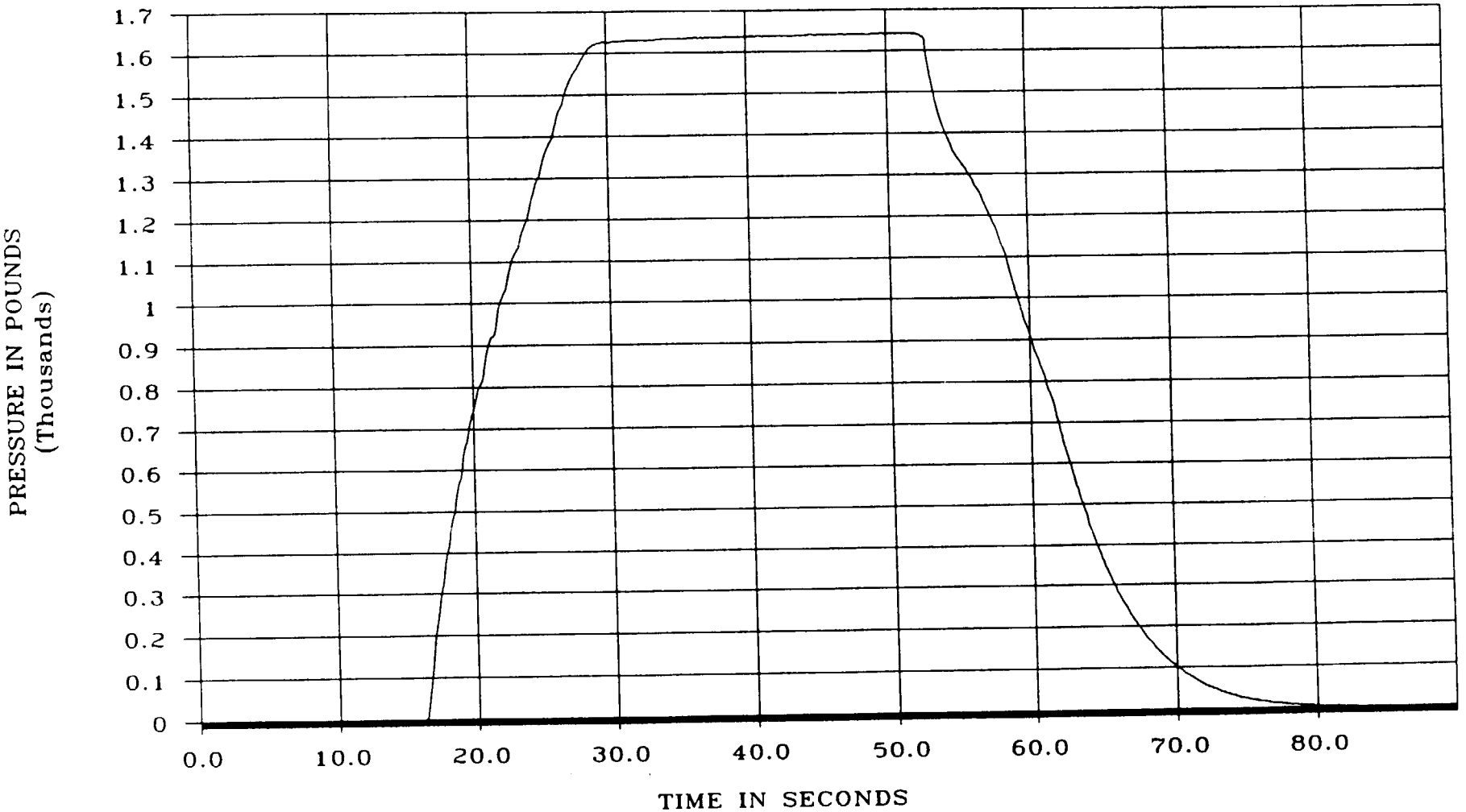
OVERPRESSURE TEST

7U76436-04 S/N05



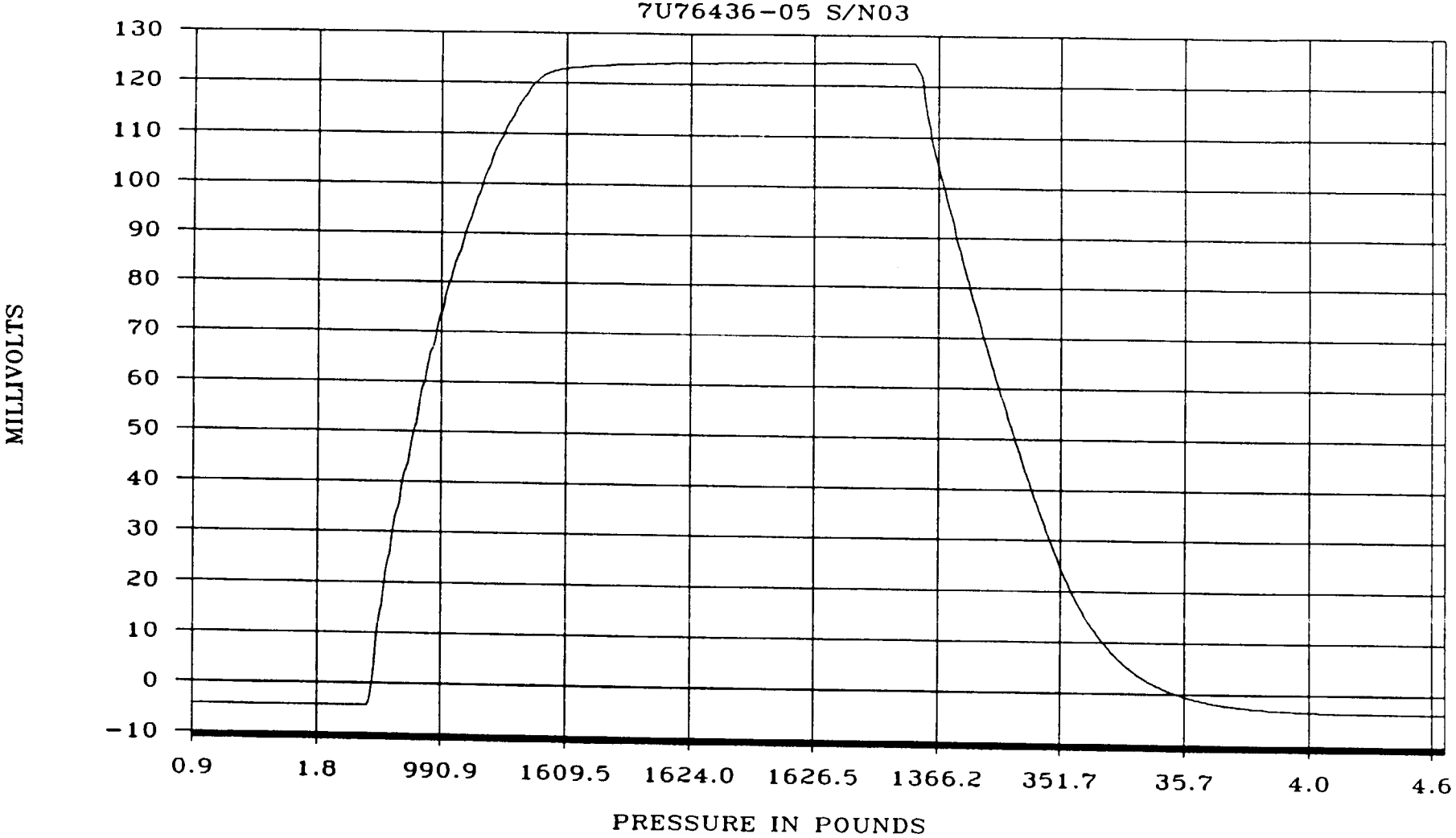
OVERPRESSURE TEST

7U76436-04 S/N07



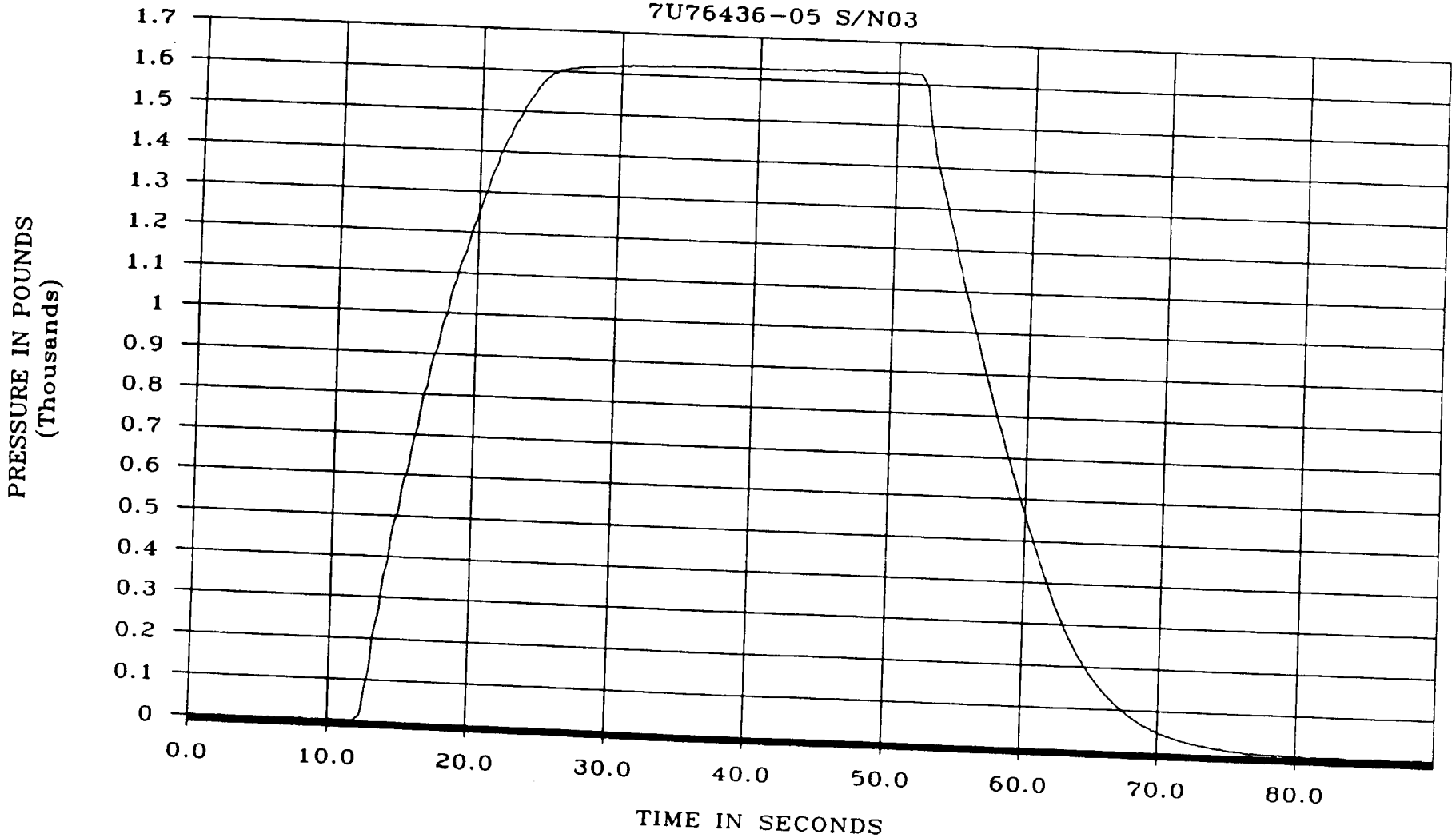
OVERPRESSURE TEST

7U76436-05 S/N03



OVERPRESSURE TEST

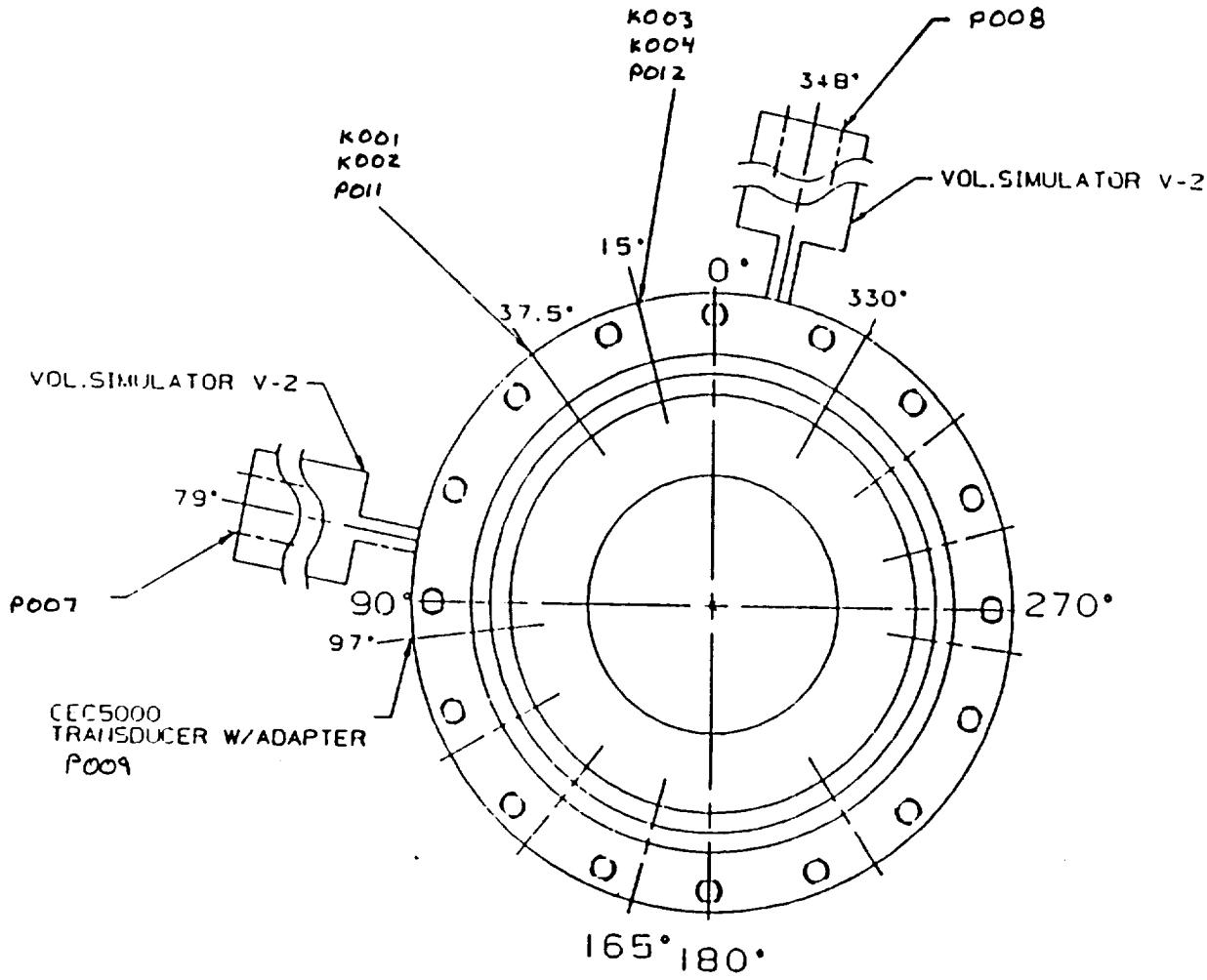
7U76436-05 S/N03



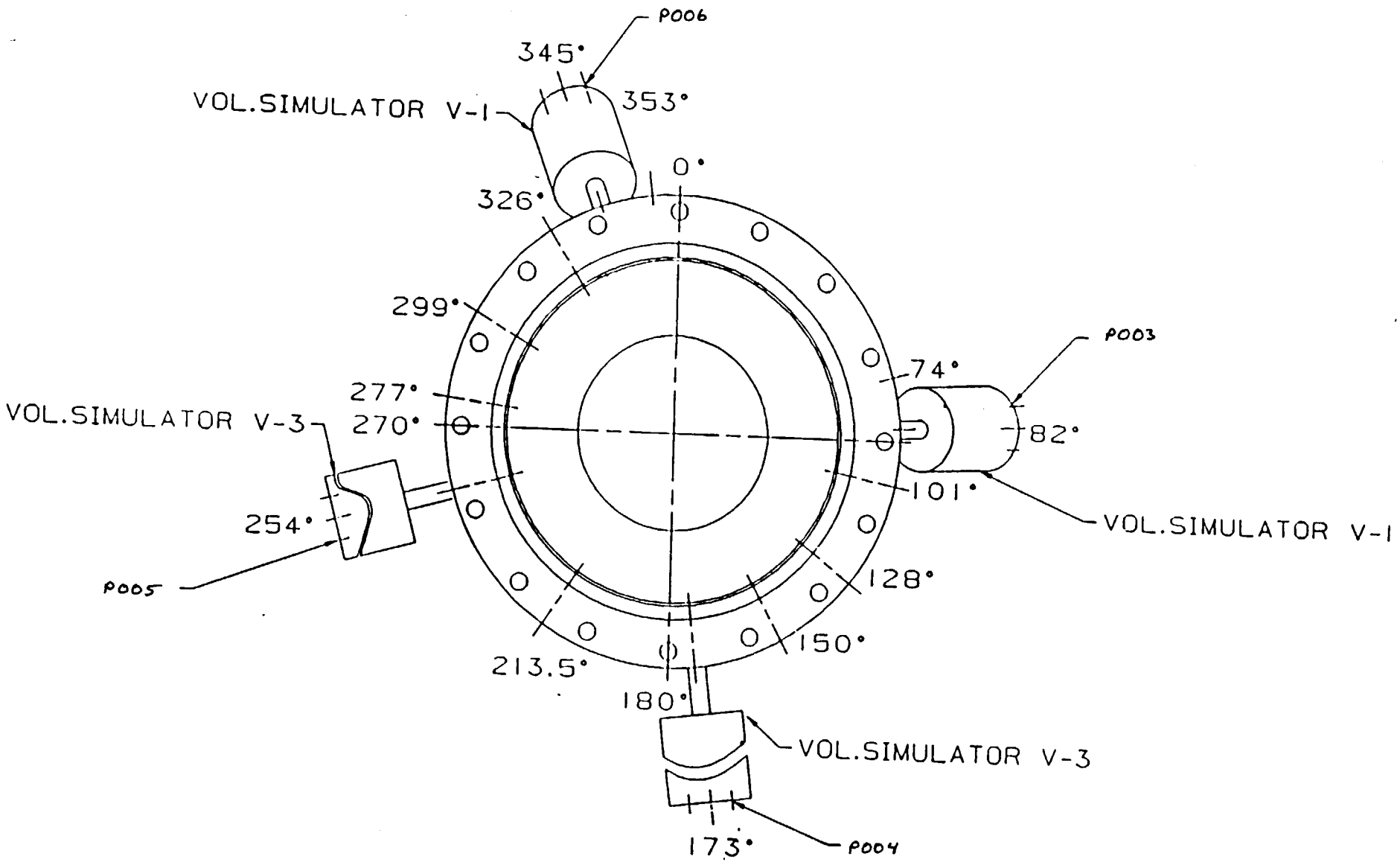
Appendix C

70–lb Motor Number One

A018254a

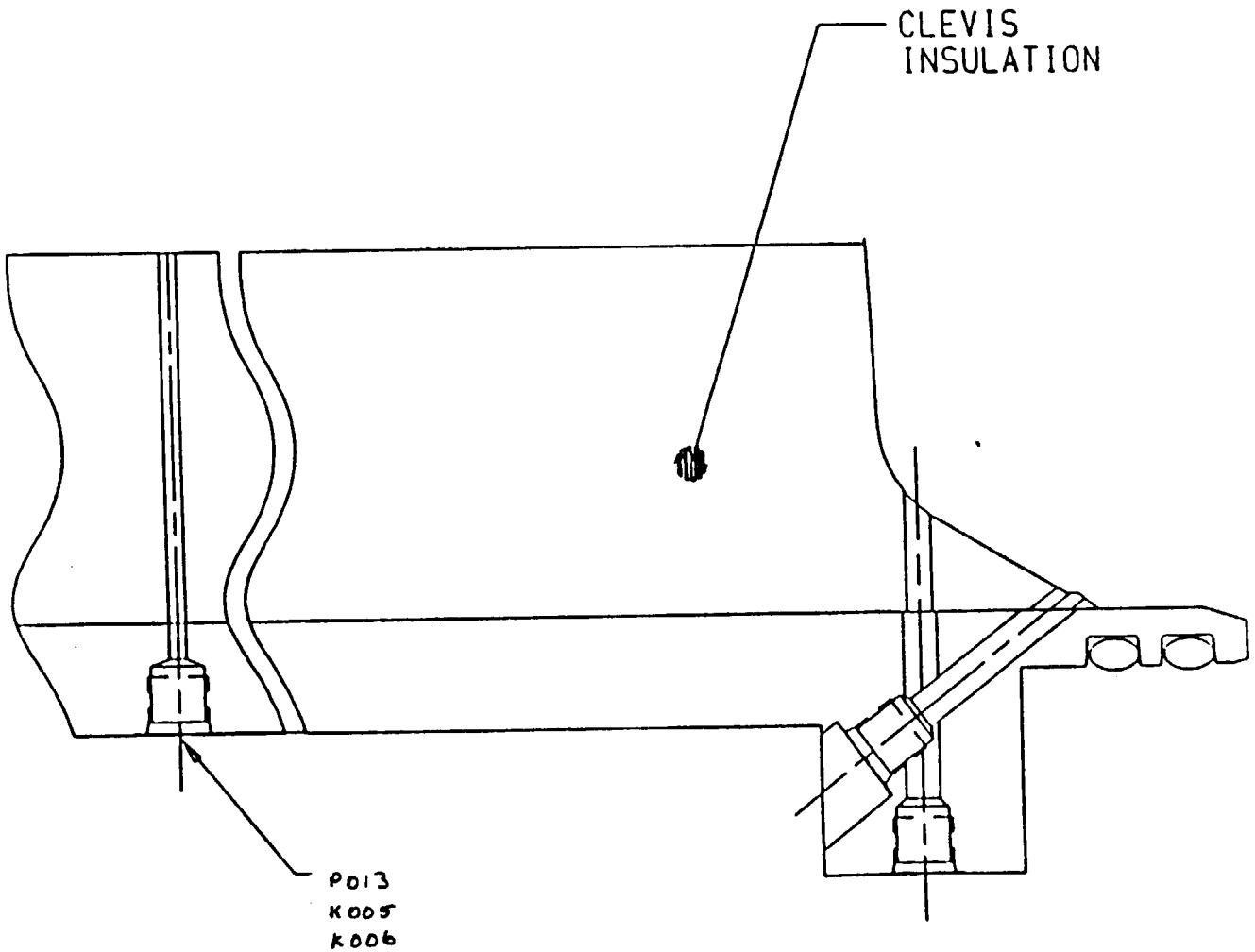


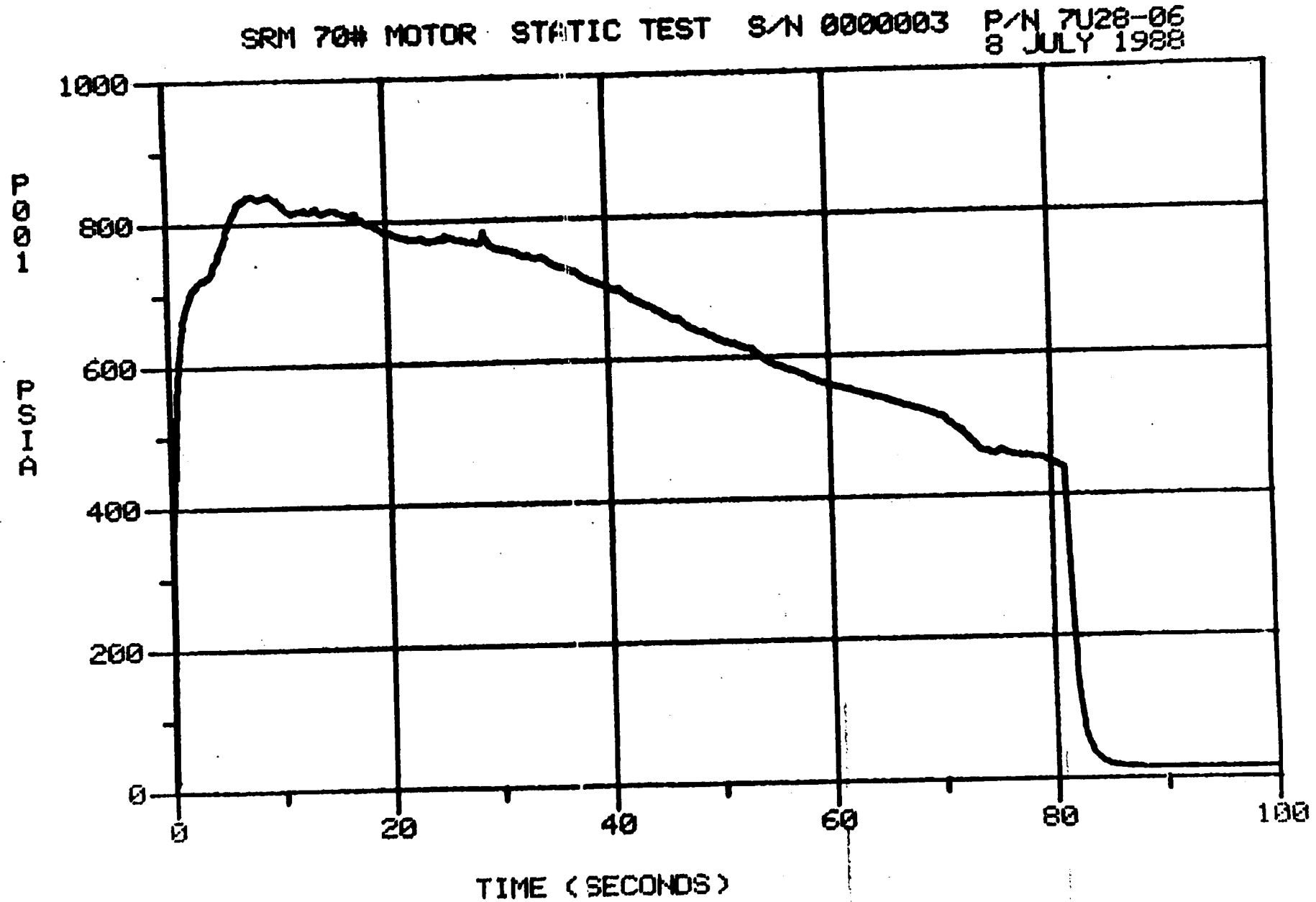
TANG
LOOKING AFT

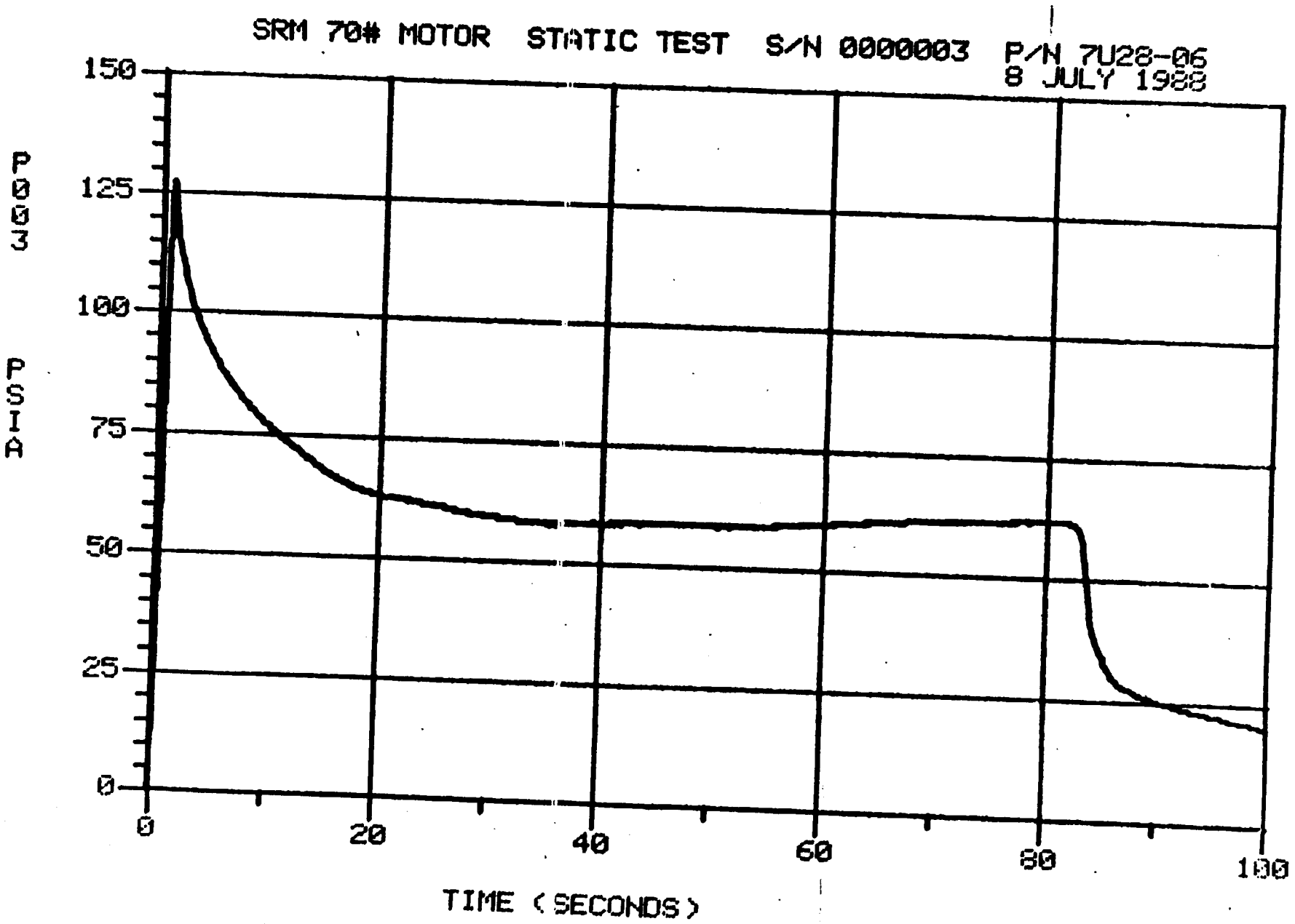


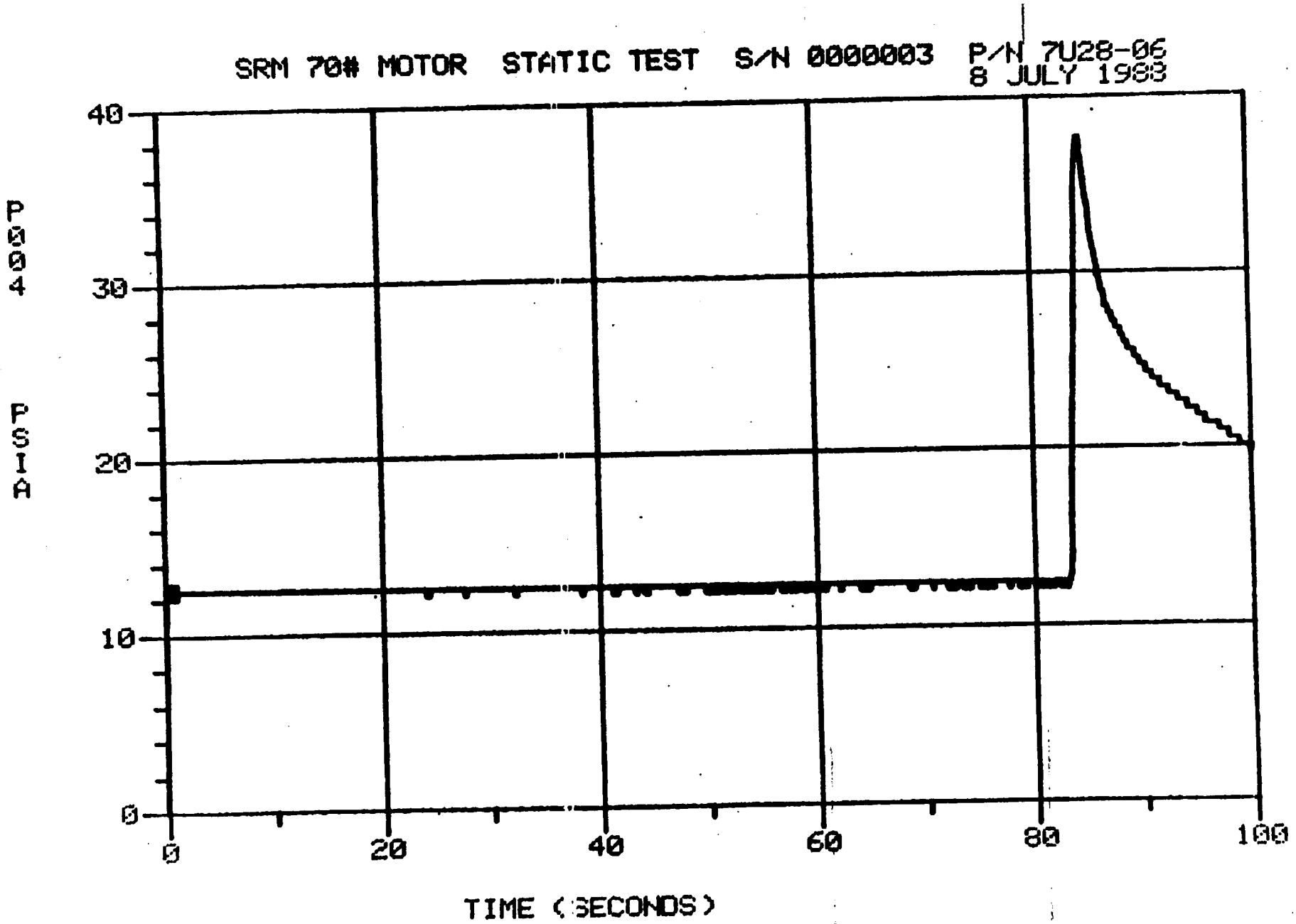
CLEVIS

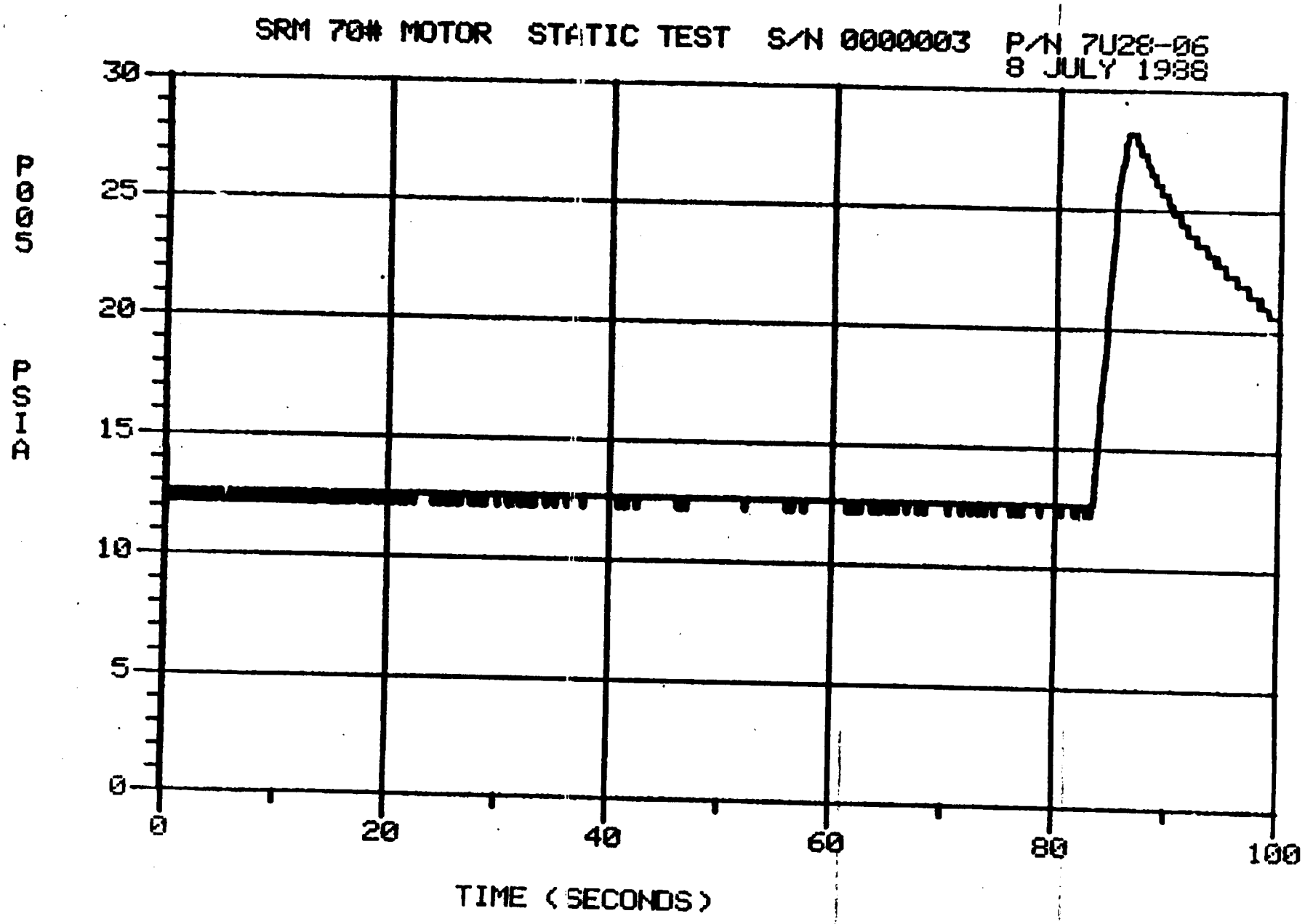
LOOKING FWD

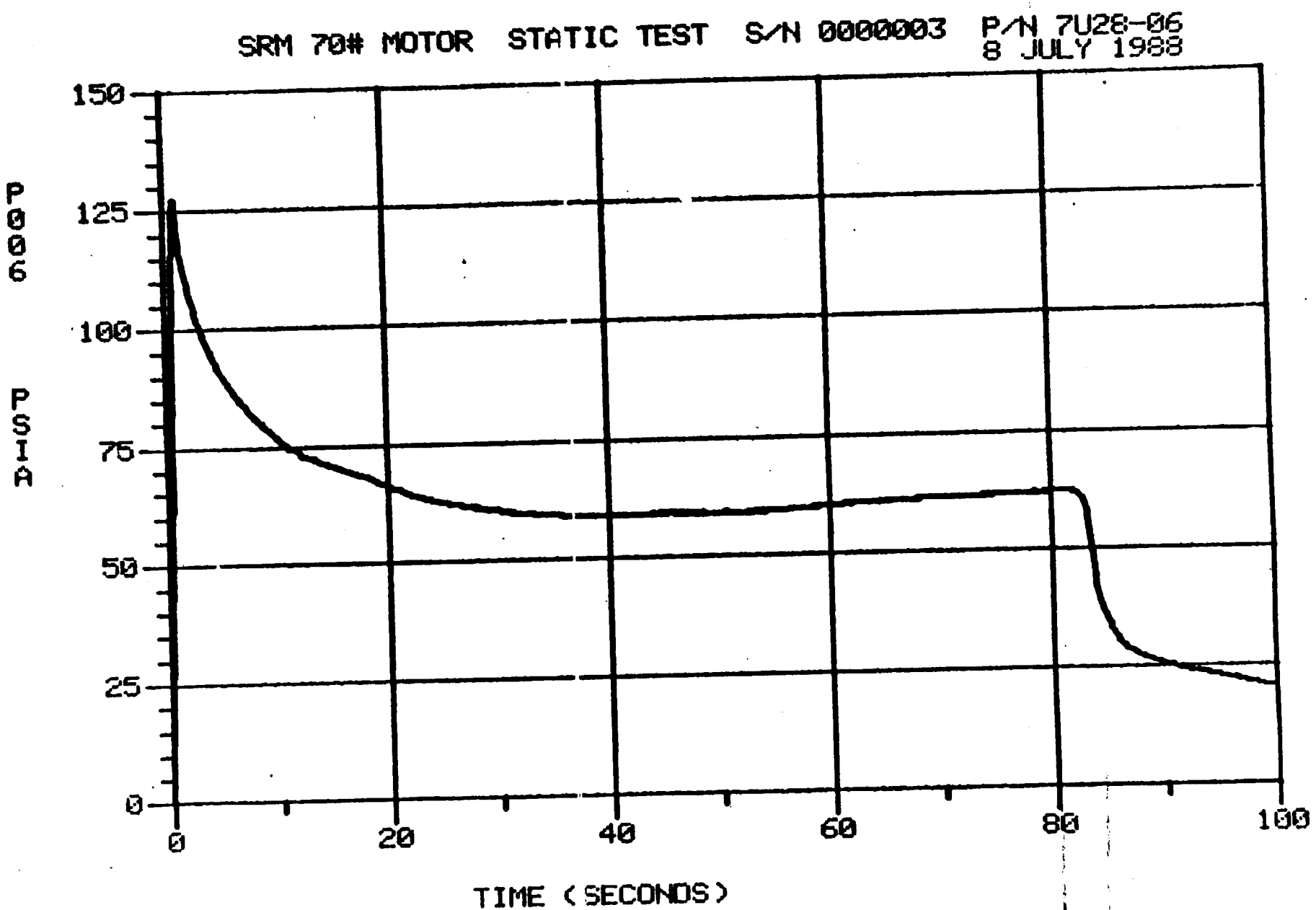

CLEVIS
INSULATION
P013
K005
K006


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
1000
800
600
400
200
0
P
0
0
1
P
S
I
A
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
P
0
0
3
P
S
I
A
150
125
100
75
50
25
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1983
P
0
0
4
P
S
I
A
40
30
20
10
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
P
0
S
P
S
I
A
30
25
20
15
10
5
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
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P
0
0
6
P
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125
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75
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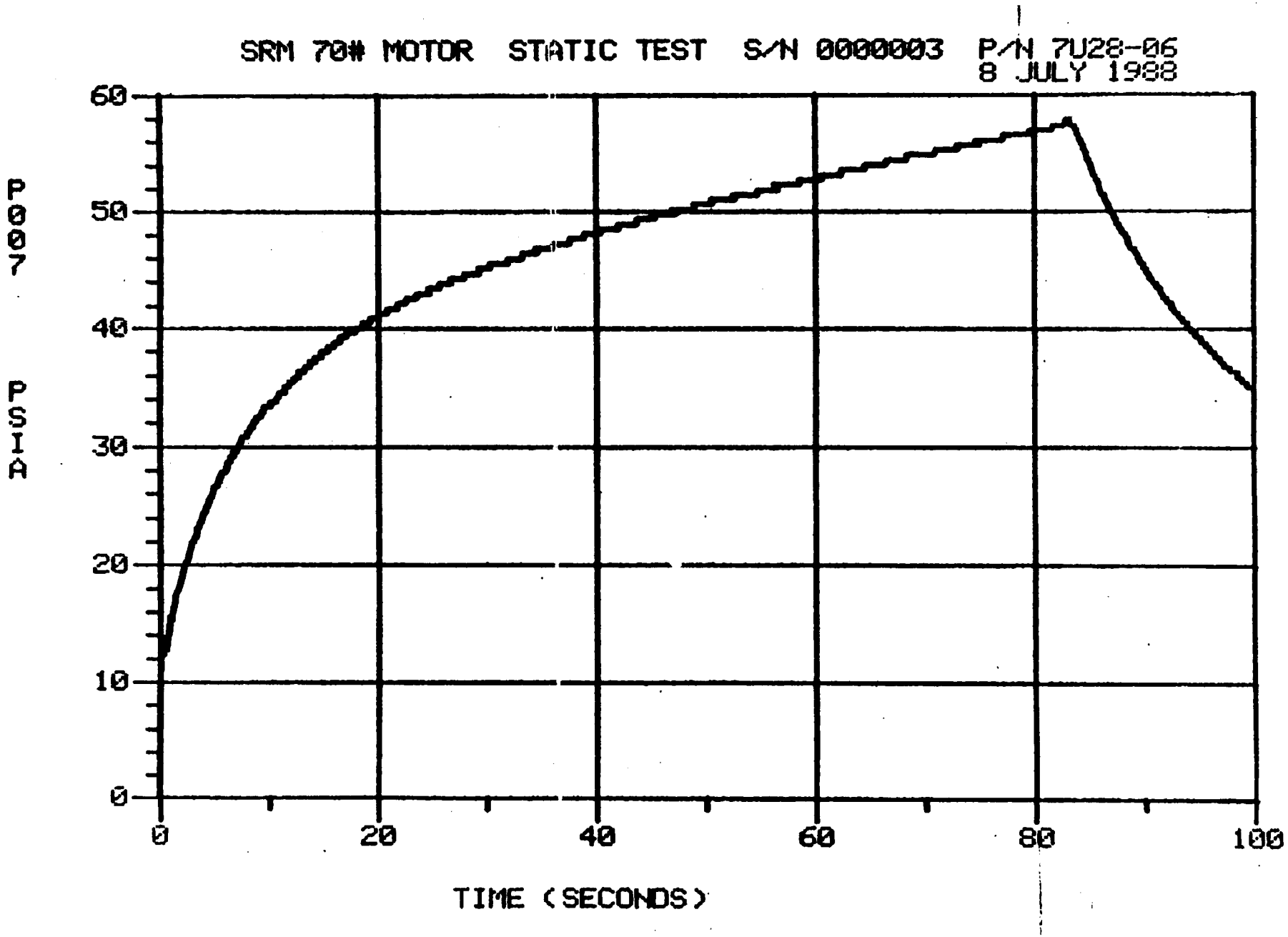
20
40
60
80
100
TIME (SECONDS)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P007 PSIA
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80
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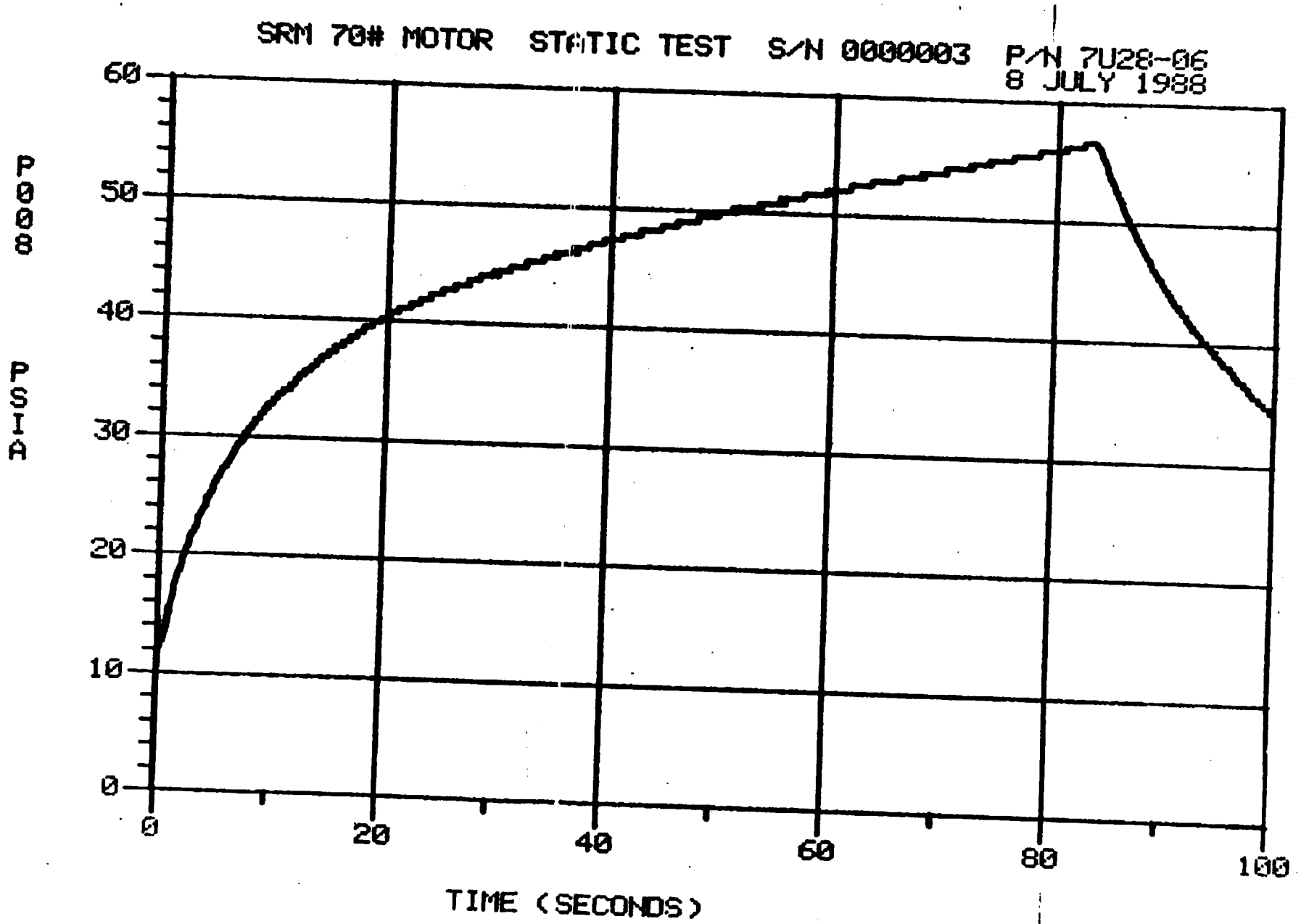
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
P
0
0
8
P
S
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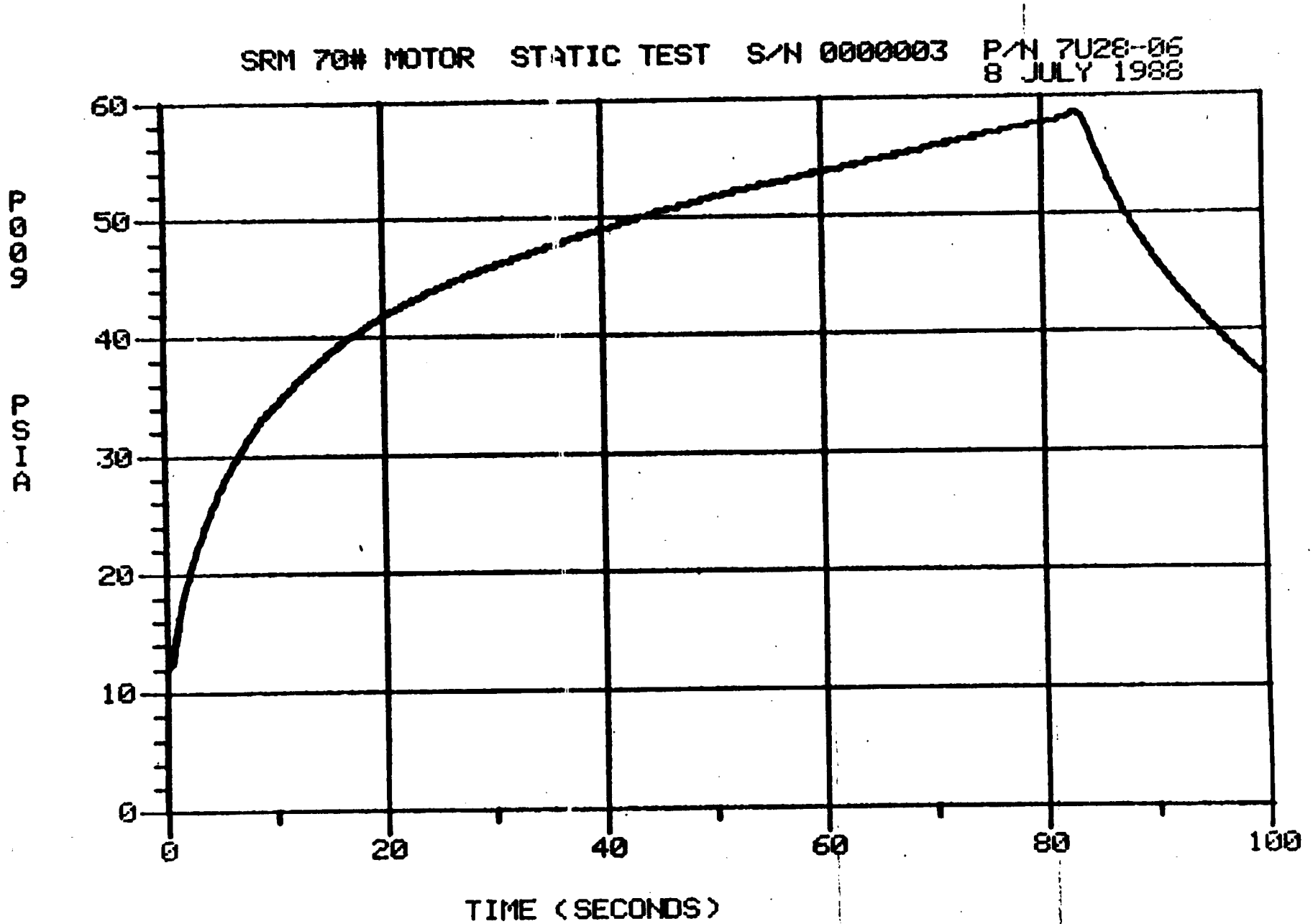
A
60
50
40
30
20
10
0
0
20
40
60
80
100
TIME (SECONDS)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8 JULY 1988
P
0
0
9
P
S
I
A
60
50
40
30
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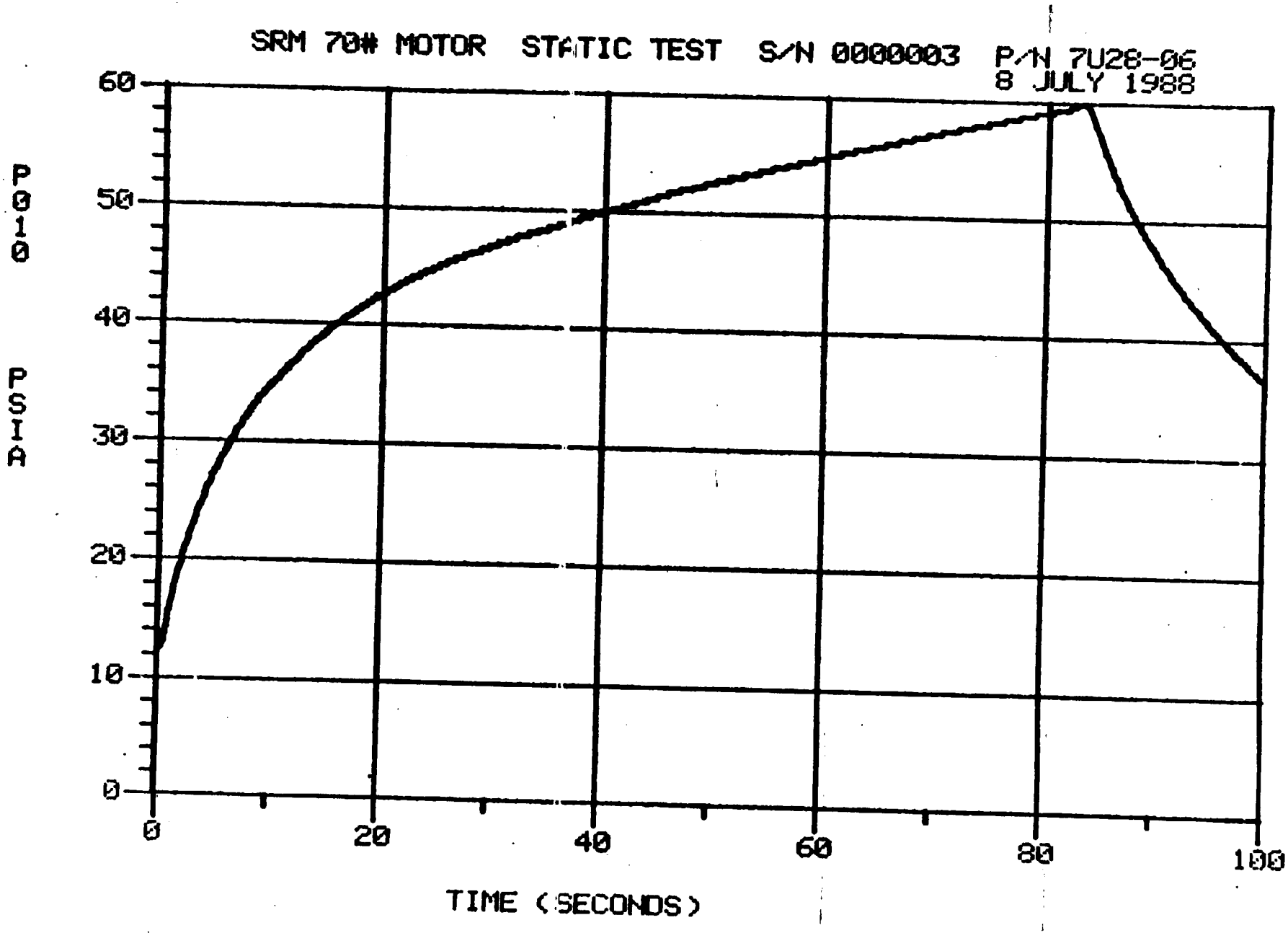
10
0
0
20
40
60
80
100
TIME (SECONDS)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P0 10 PSIA
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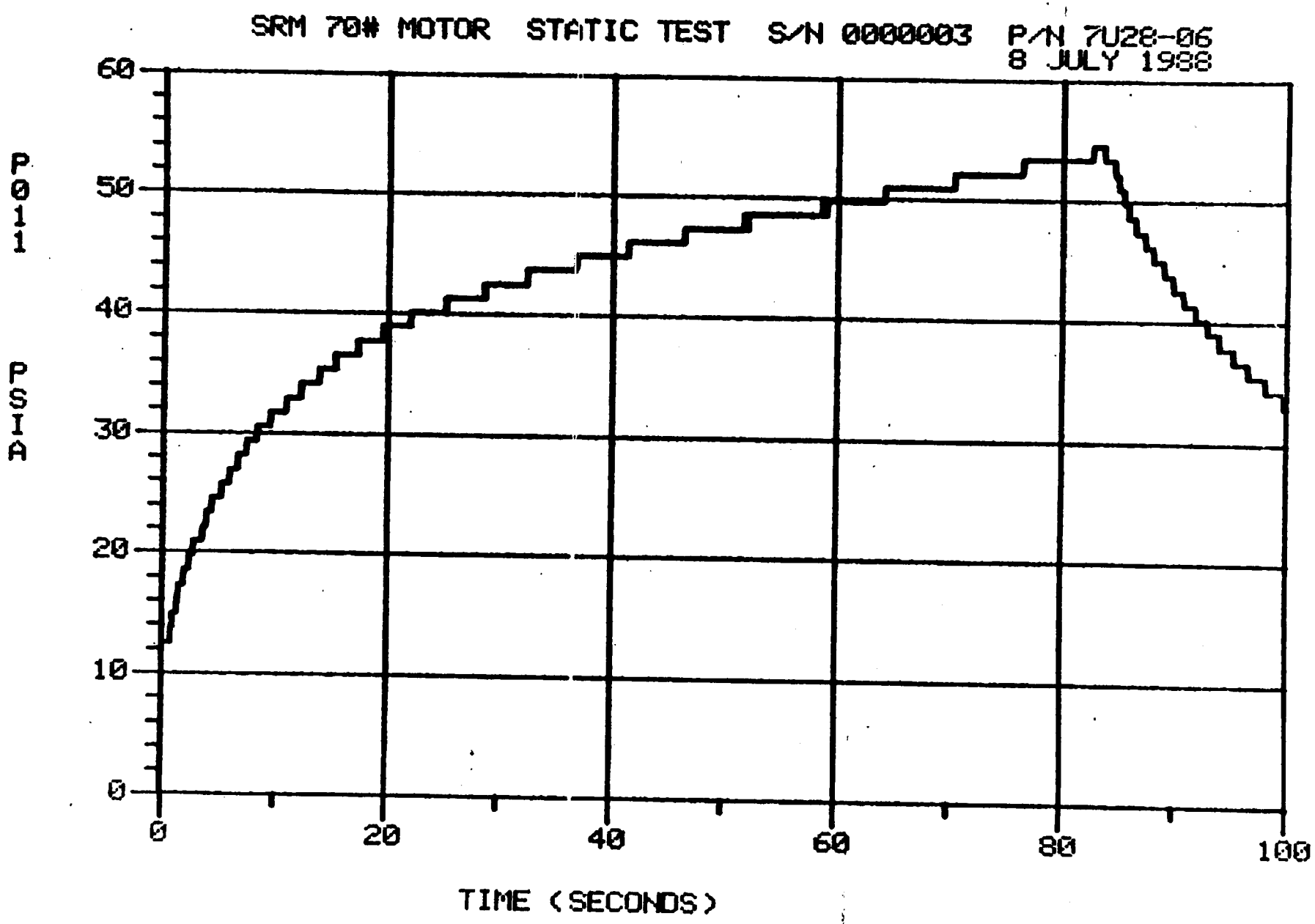
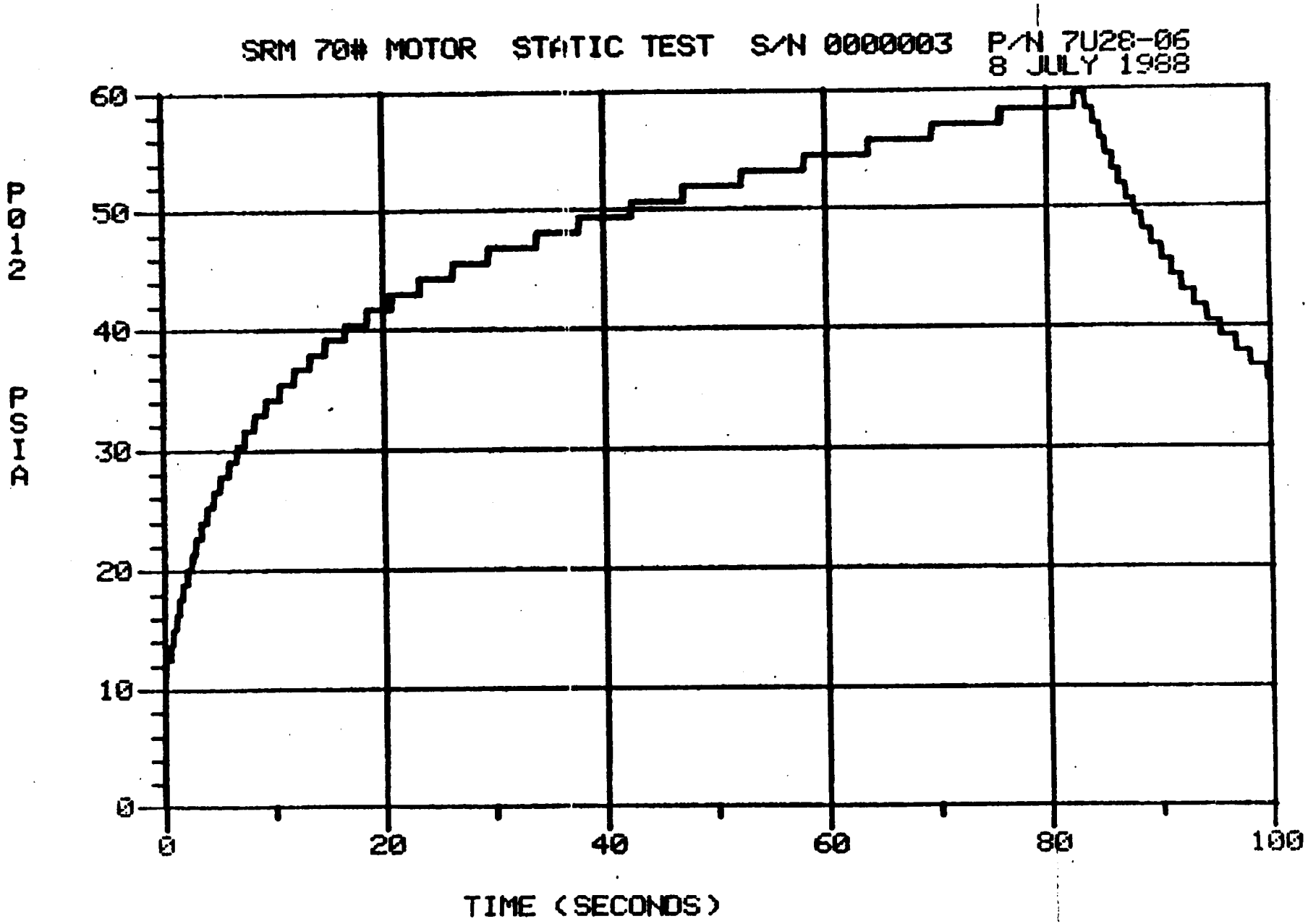
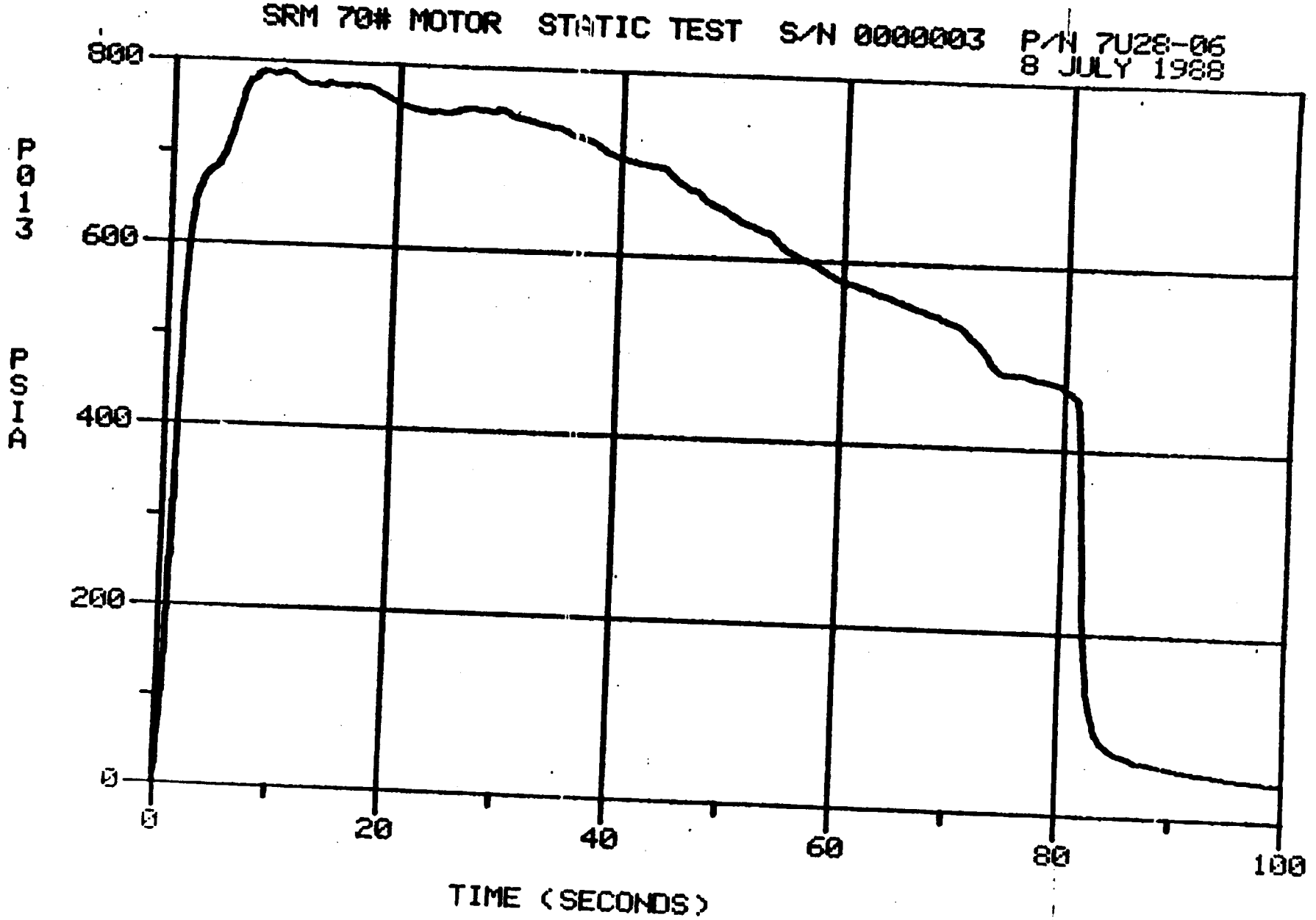
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
P011
PSIA
60
50
40
30
20
10
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
P012 PSIA
60
50
40
30
20
10
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
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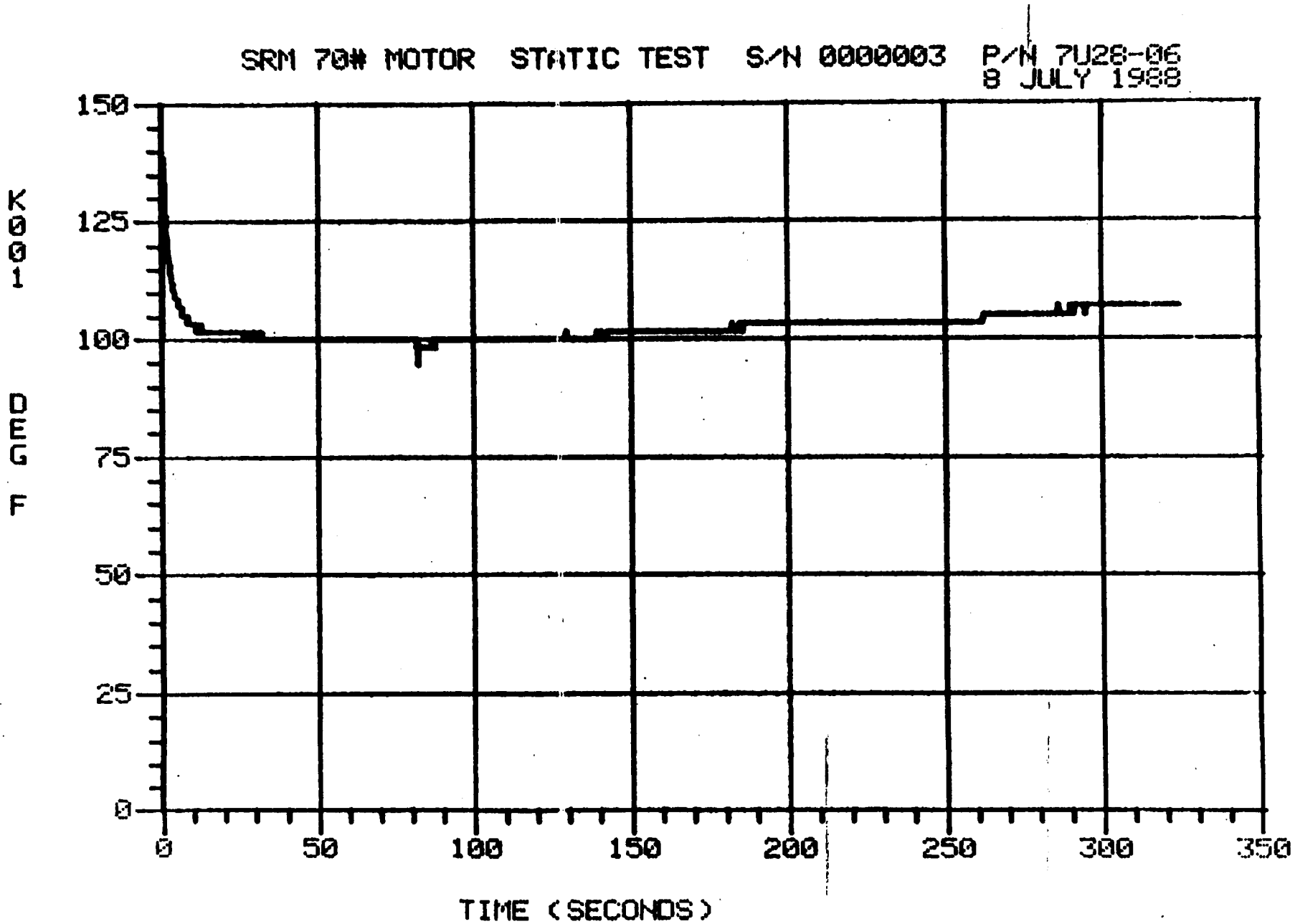
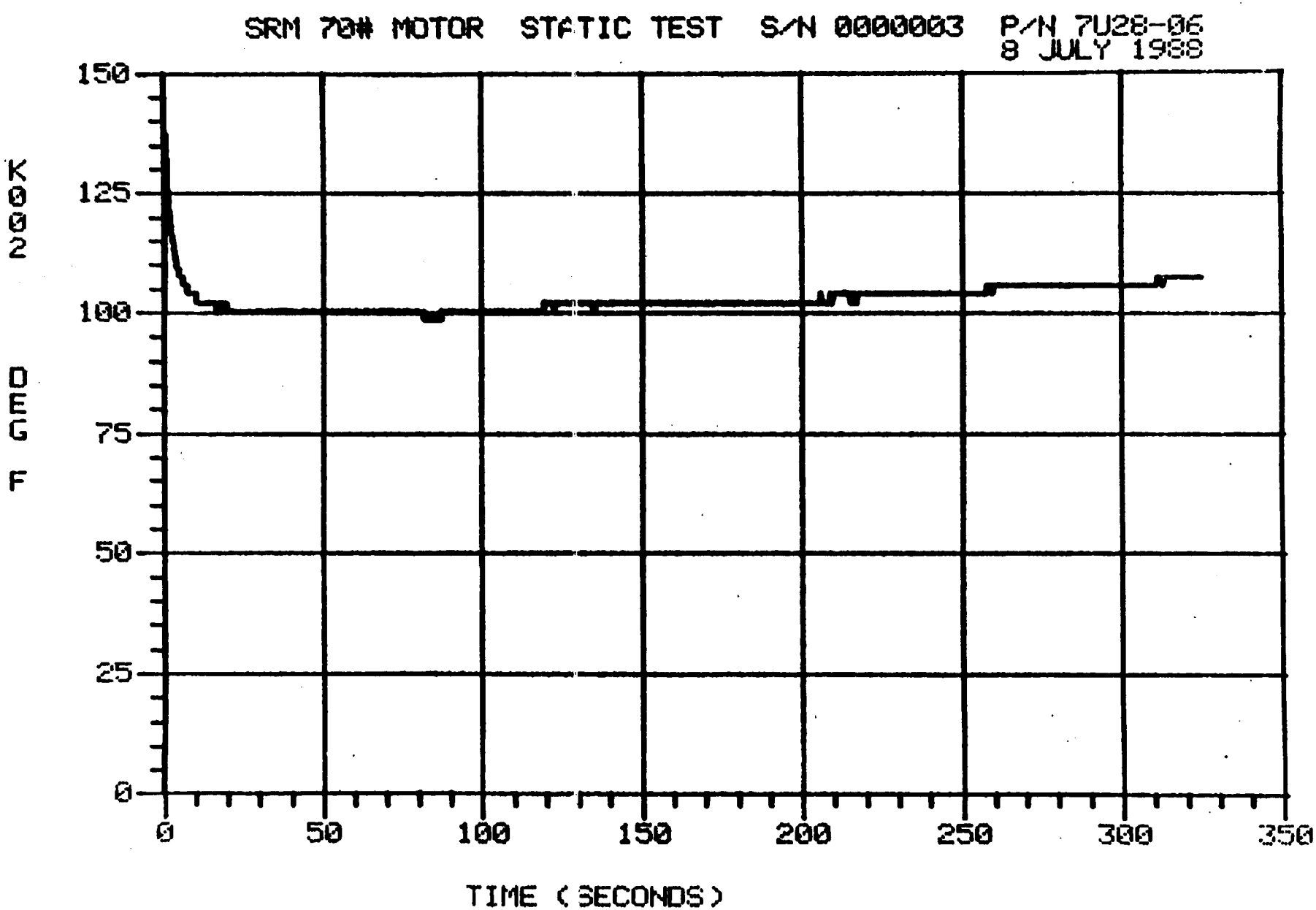
P013
PSIA
800
600
400
200
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
K001
DEG F
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
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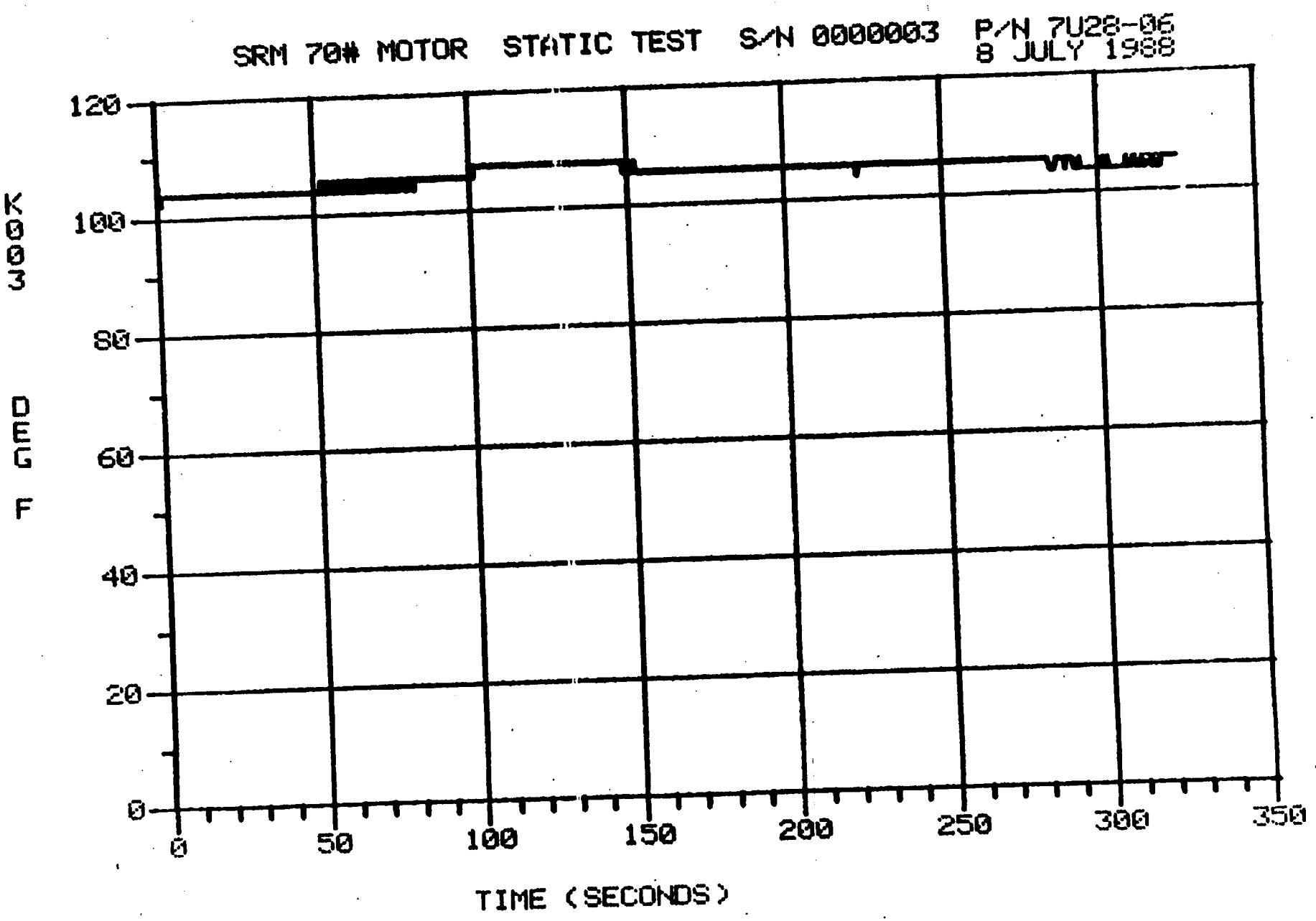
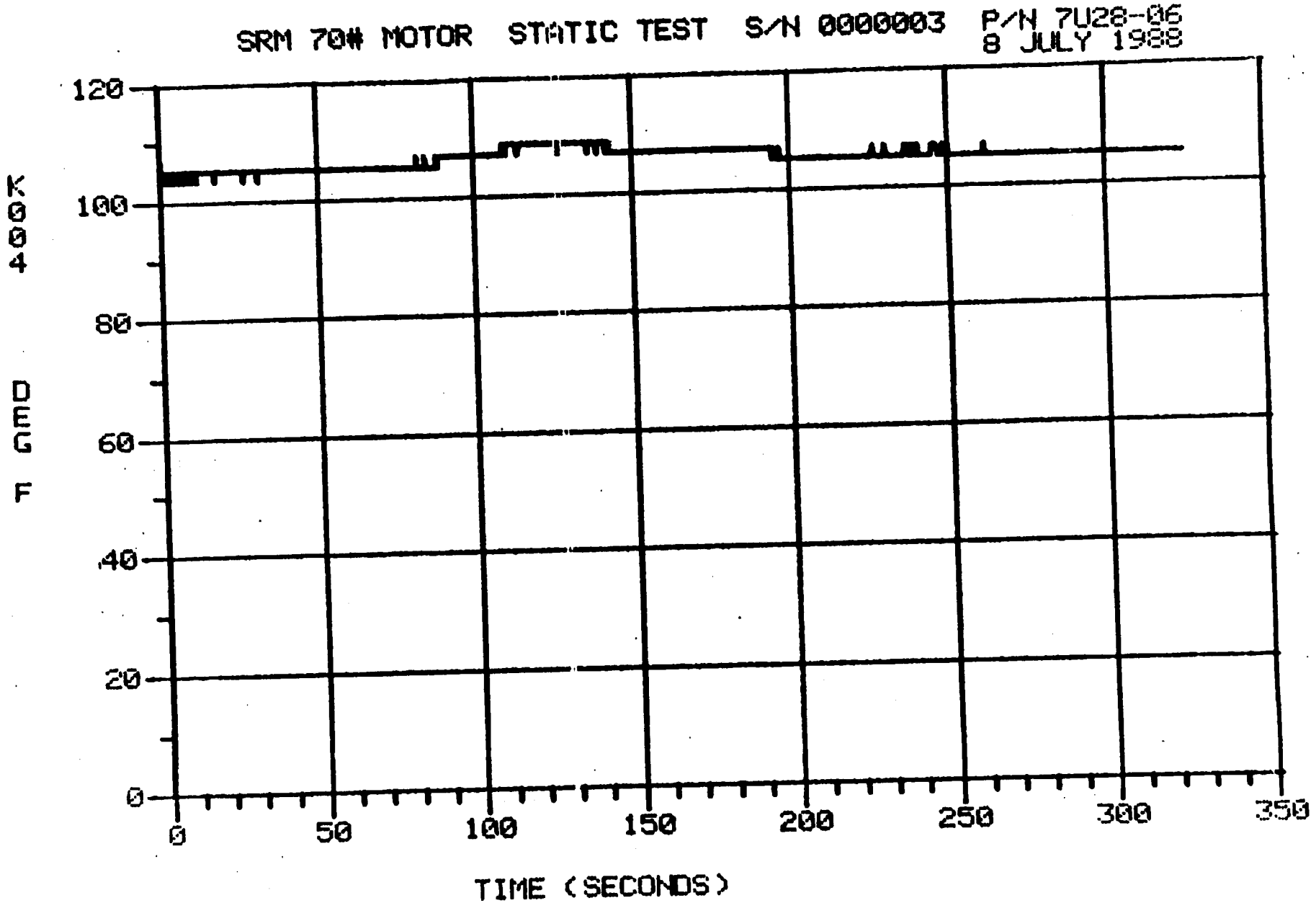
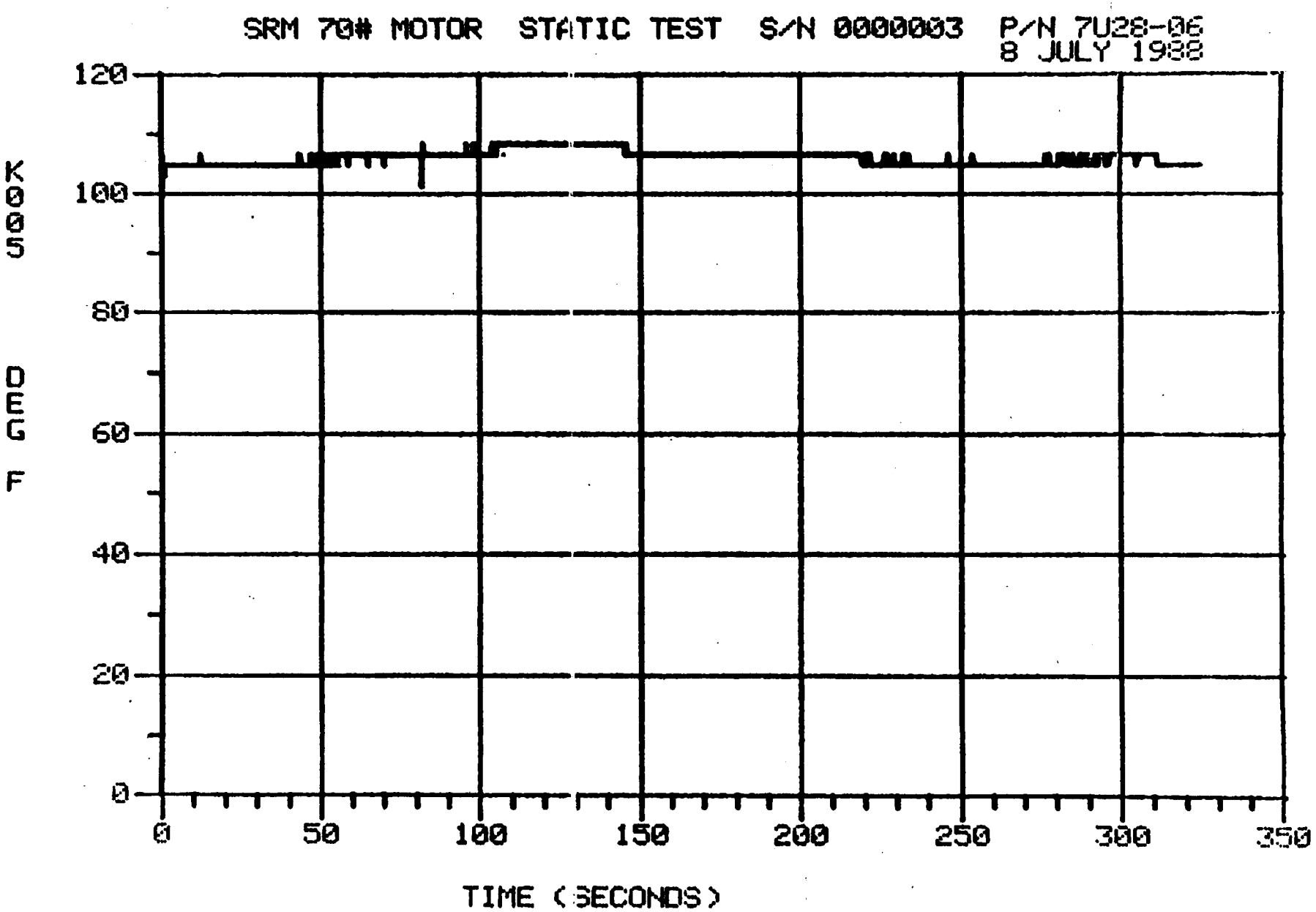
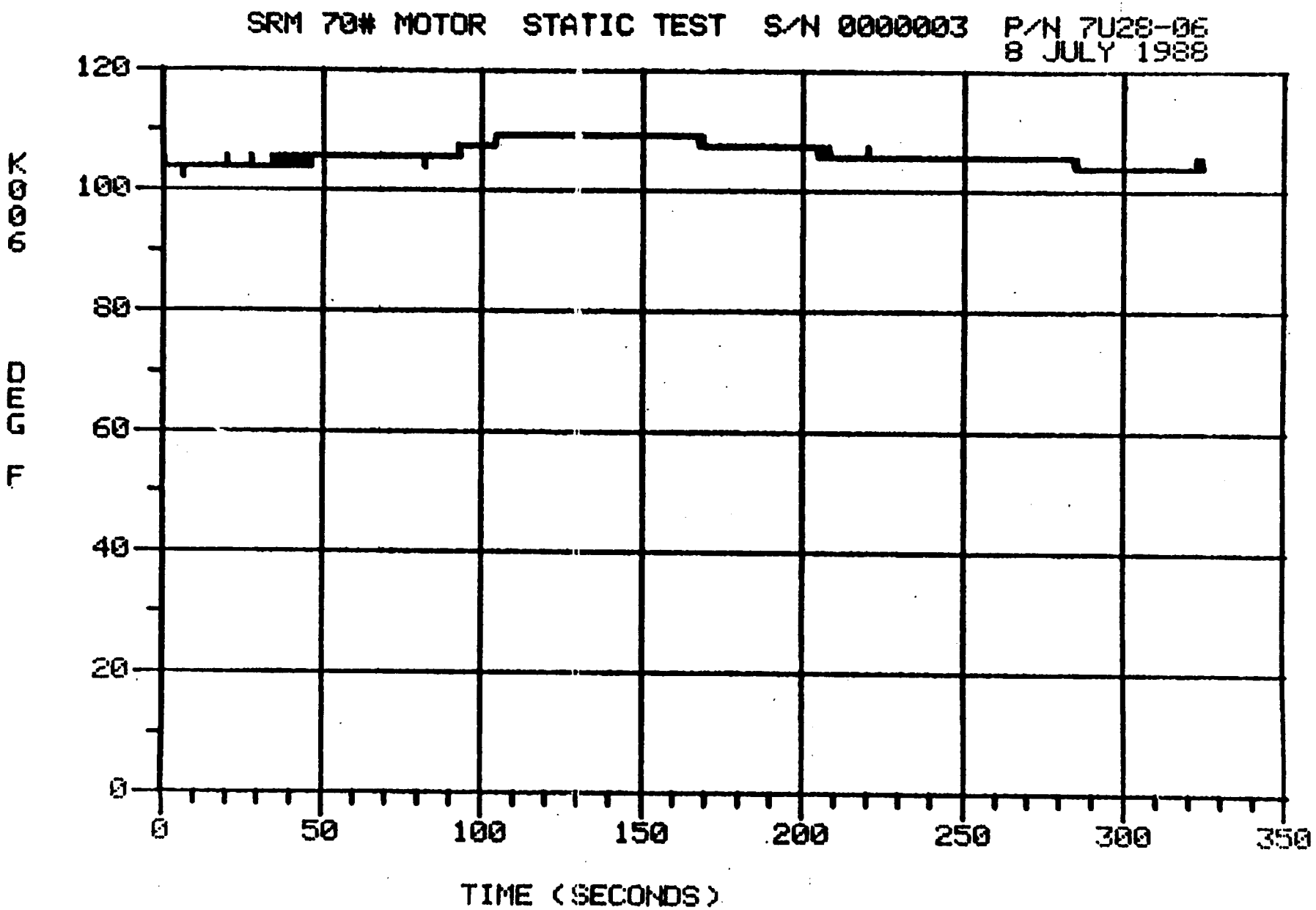
125
100
75
50
25
0
0
50
100
150
200
250
300
350
TIME (SECONDS)
K
0
0
2
D
E
G
F


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
300K
DEG F
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
400K
DEG F
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
TIME (SECONDS)

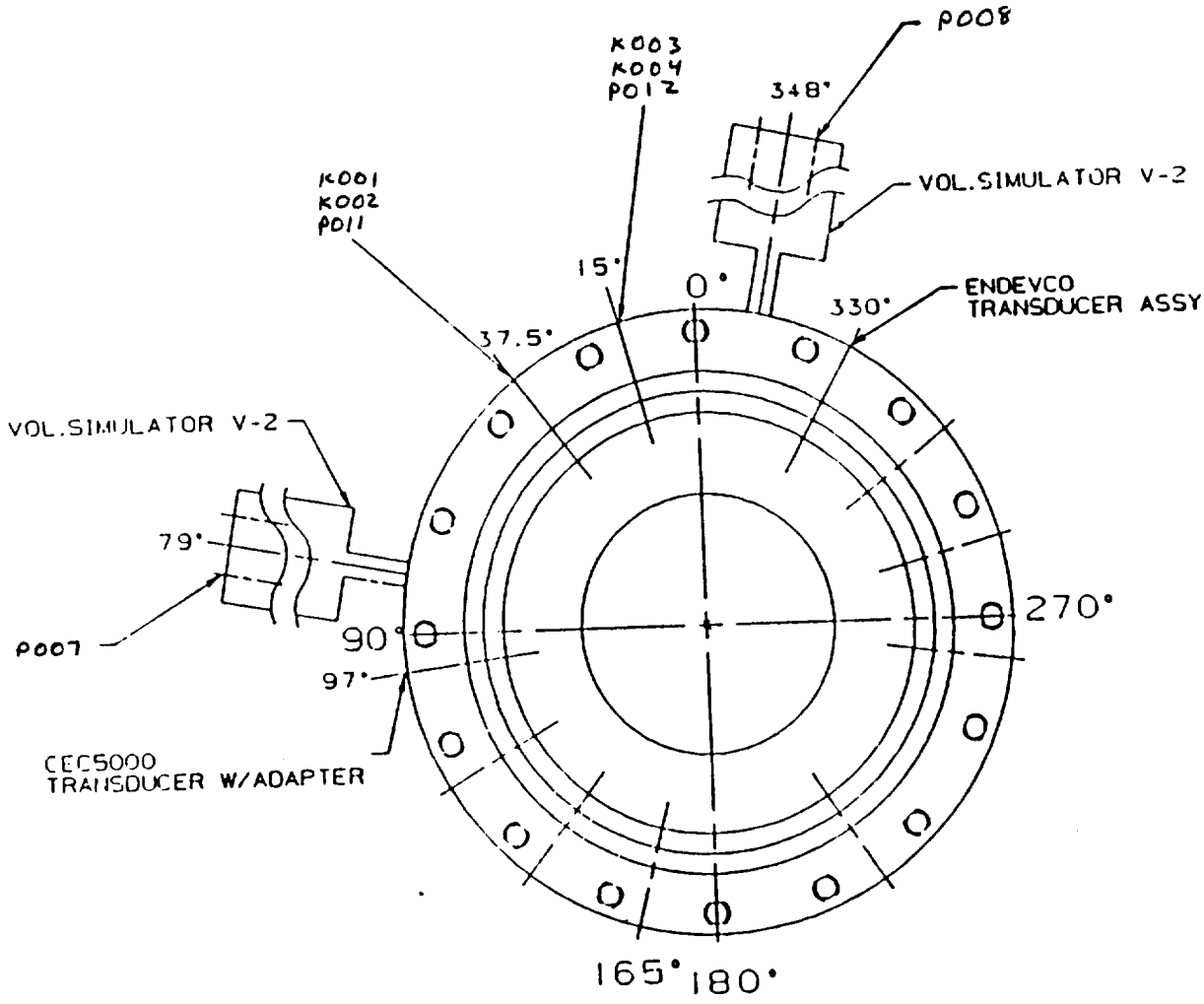

SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
500K
DEG F
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000003 P/N 7U28-06
8 JULY 1988
DEG F 600K
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
TIME (SECONDS)

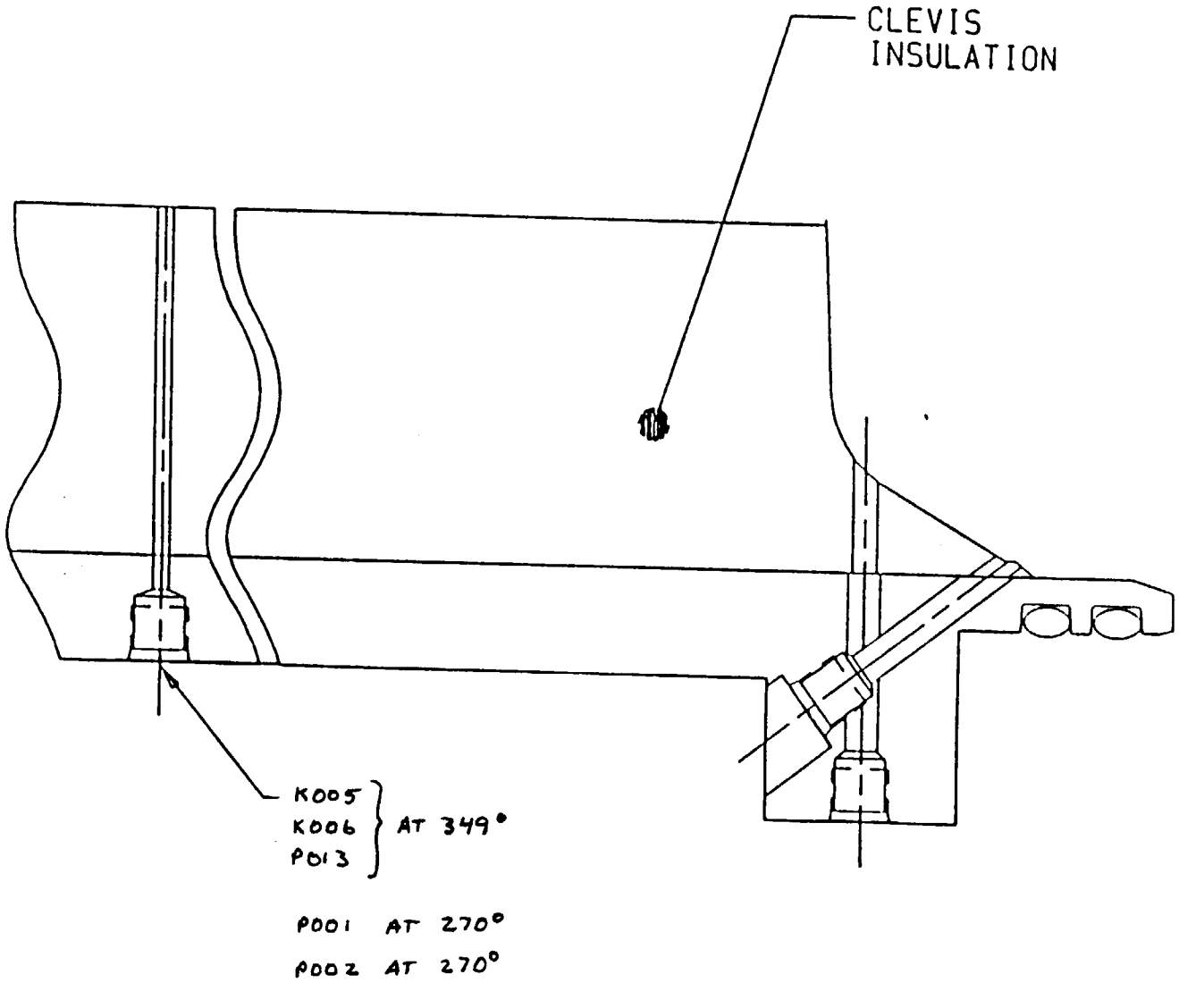
Appendix D

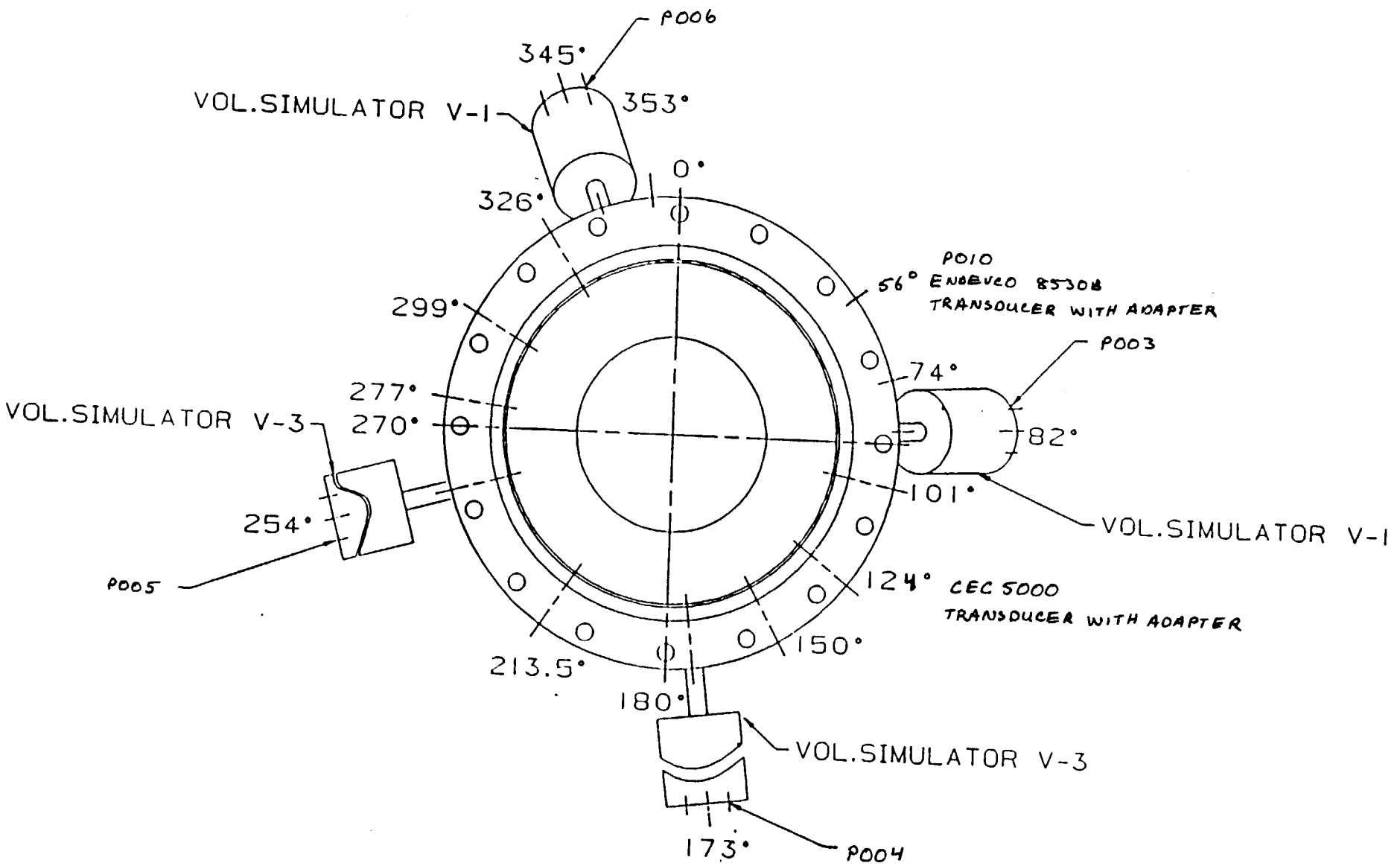
70-lb Motor Number Two

A018255a



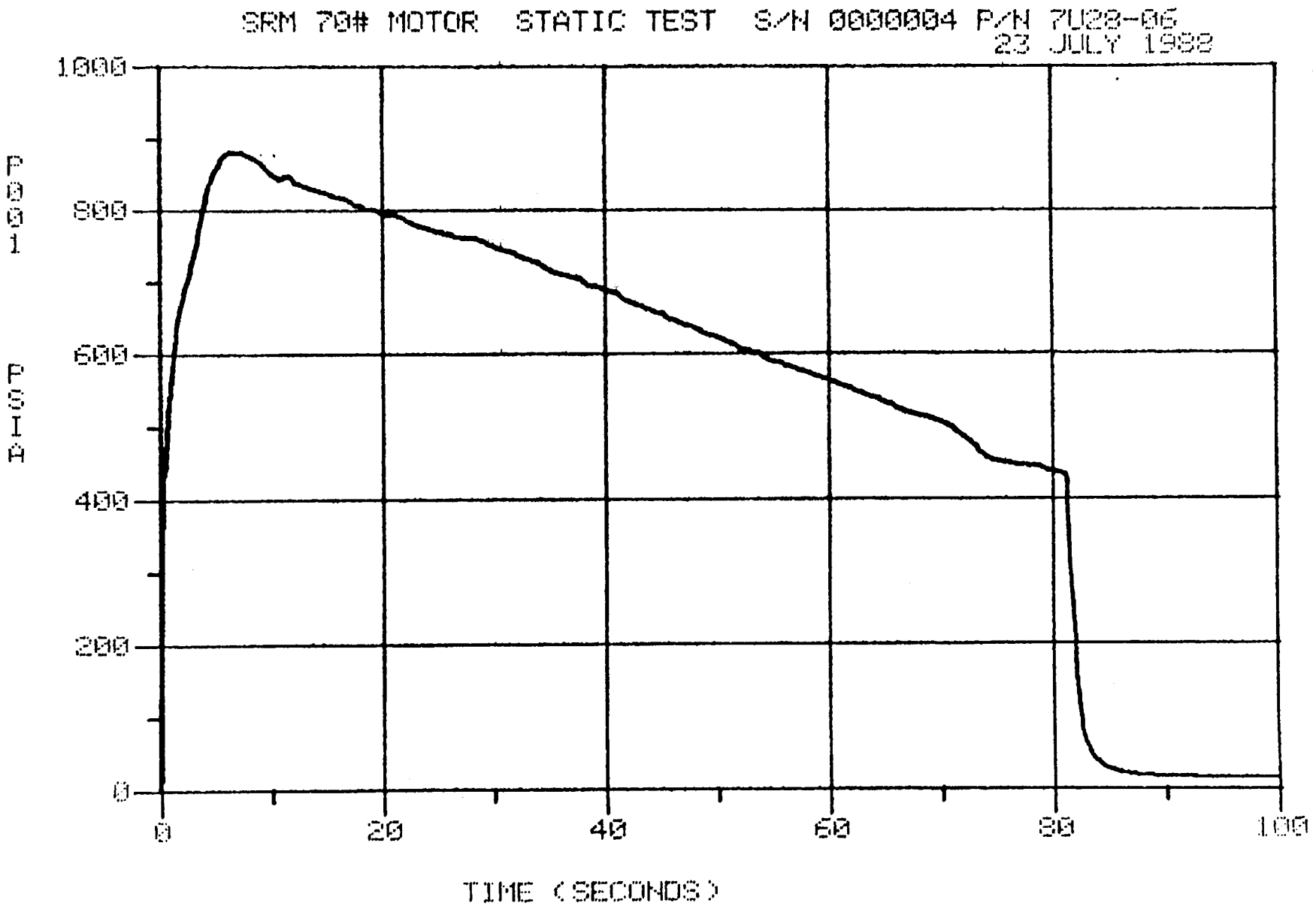
TANG
LOOKING AFT

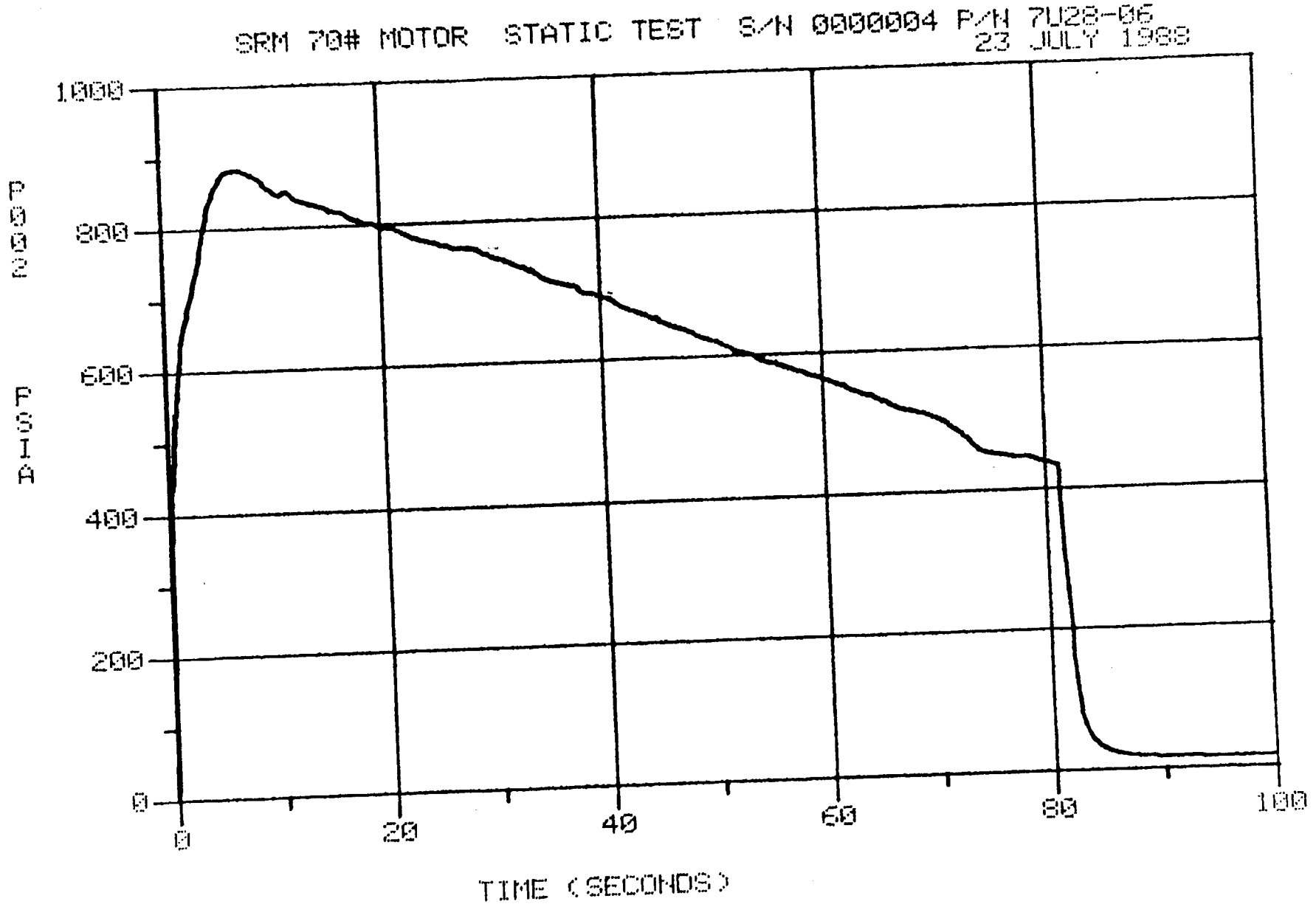

CLEVIS
INSULATION
K005
K006
P013
AT 349°
P001 AT 270°
P002 AT 270°

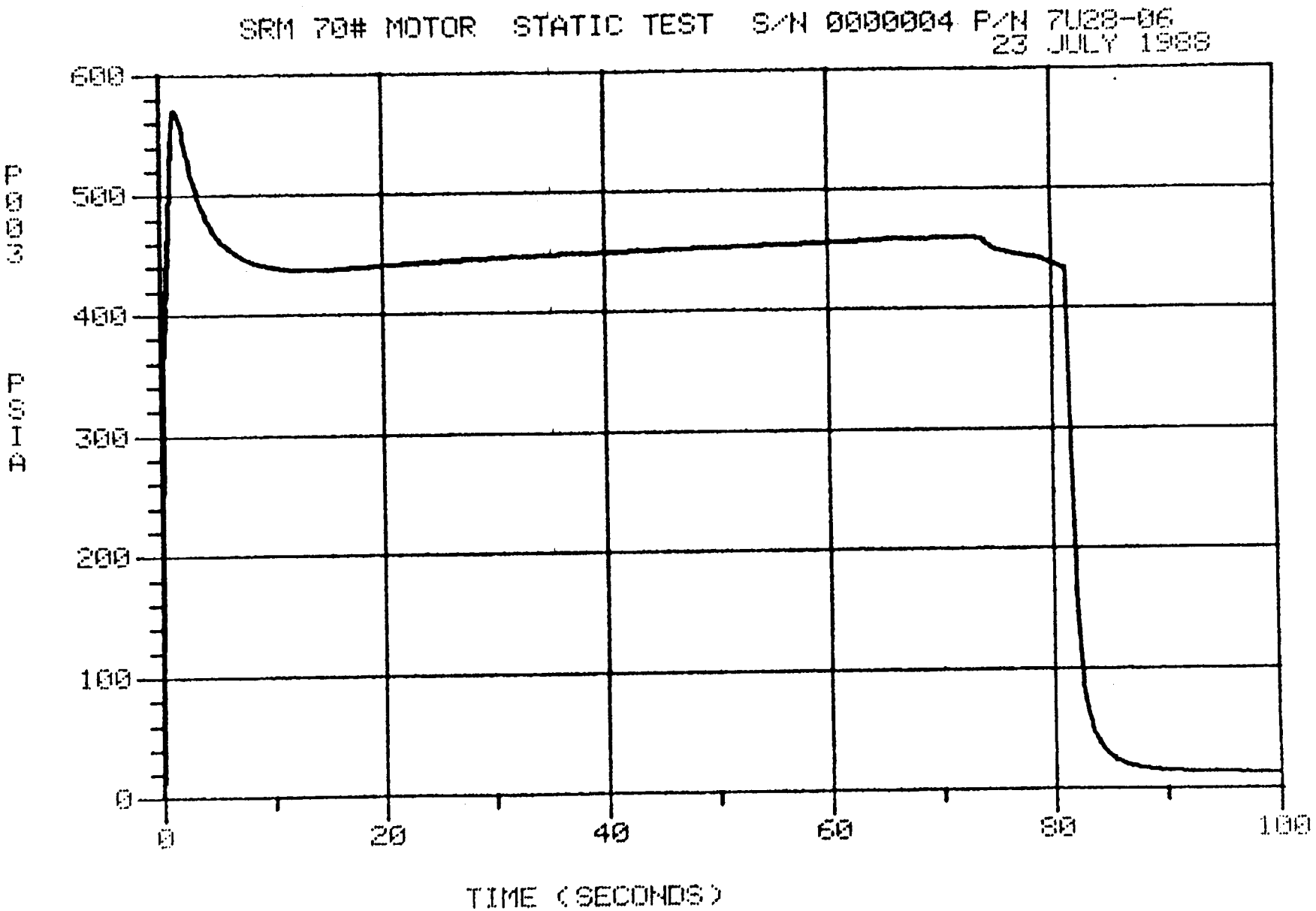


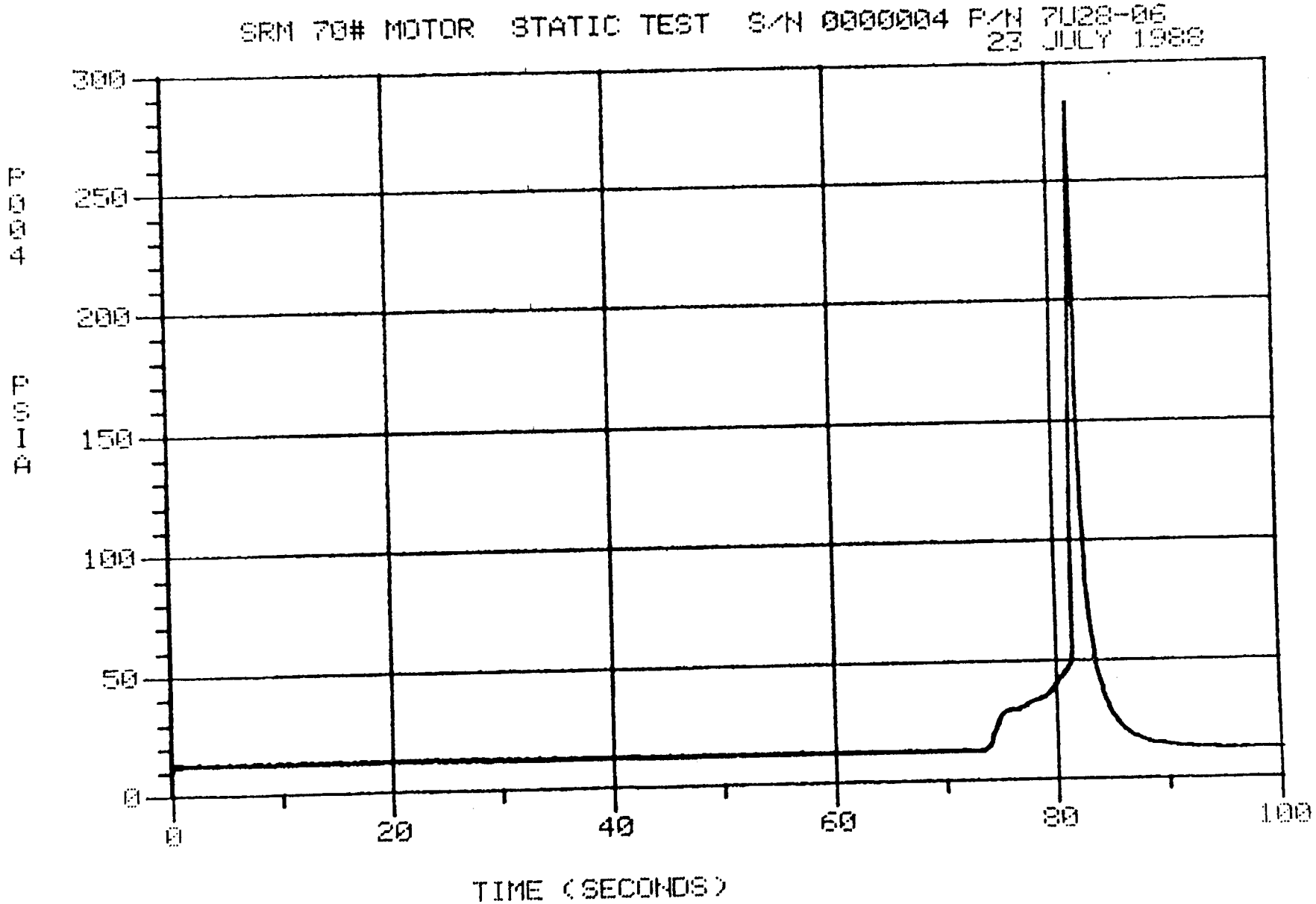
CLEVIS

LOOKING FWD


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
23 JULY 1988
P001 PSIA
1000
800
600
400
200
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
23 JULY 1988
PRESSURE PSIA
1000
800
600
400
200
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
23 JULY 1988
PSIA
600
500
400
300
200
100
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
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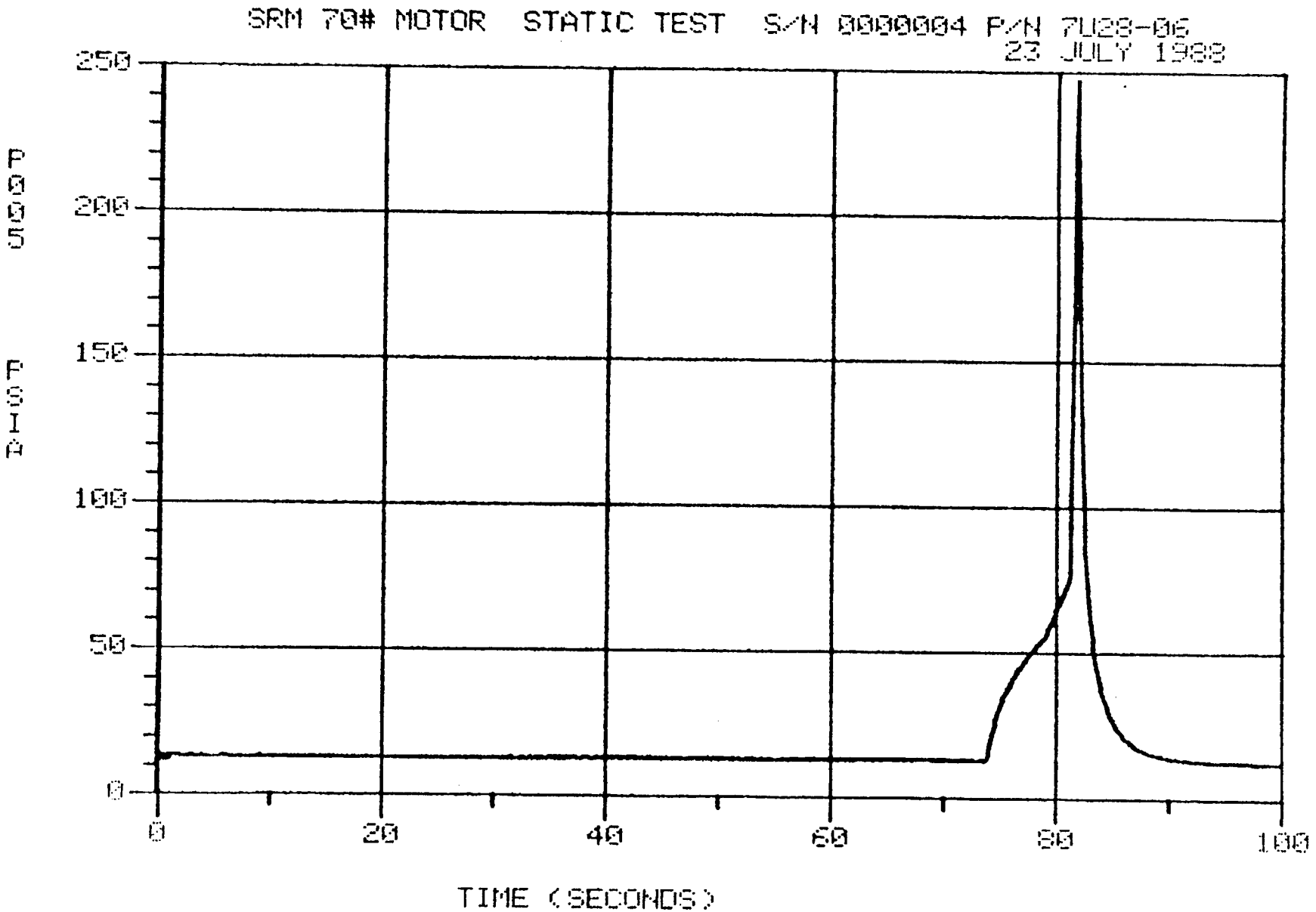
P004 PSIA
300
250
200
150
100
50
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
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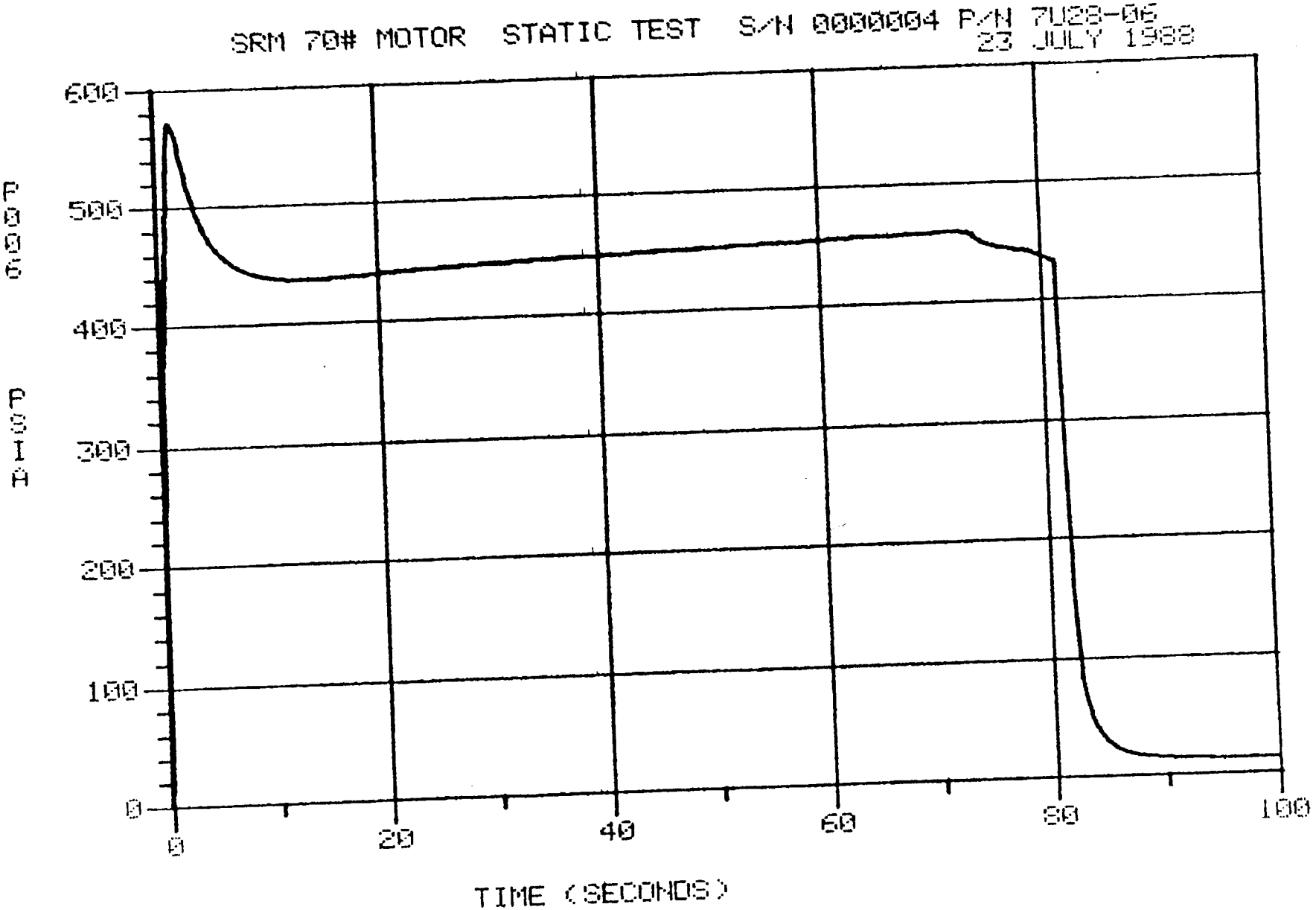
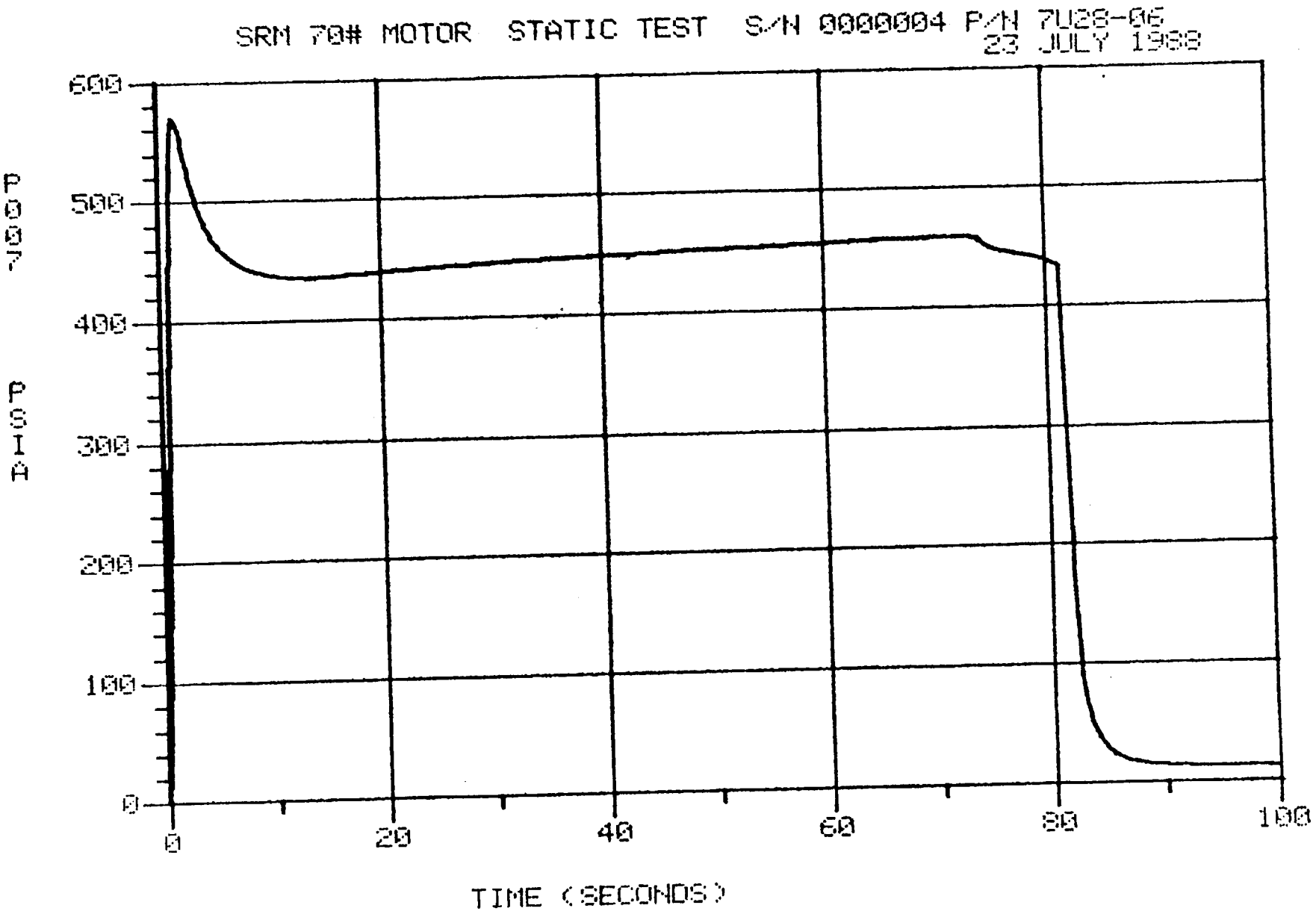
PSIA P005
250
200
150
100
50
0
0
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
23 JULY 1988
600
500
400
300
200
100
0
0
20
40
60
80
100
P
R
E
S
S
U
R
E
P
S
I
A
TIME (SECONDS)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P00- PSIA
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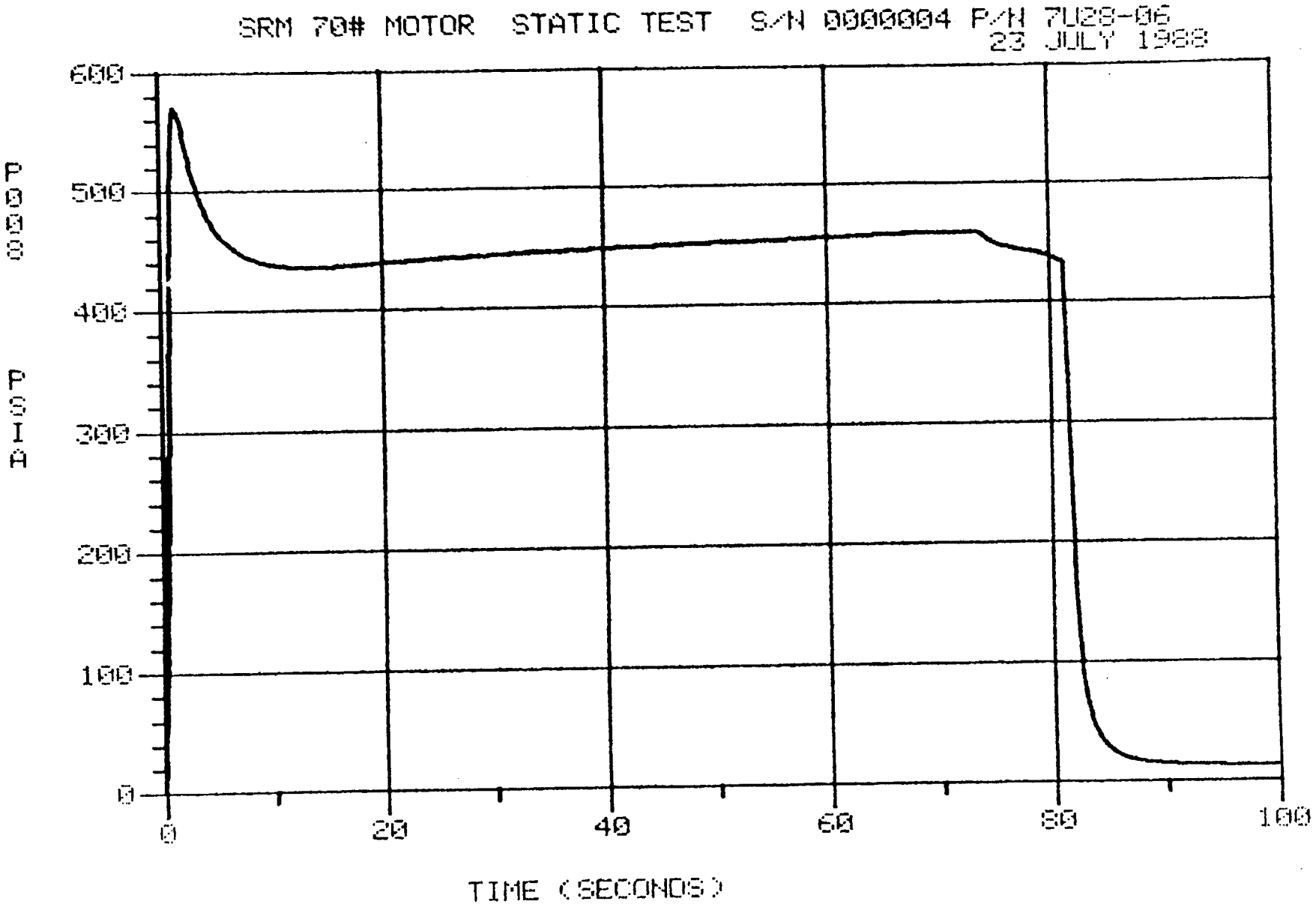
60
80
100
TIME (SECONDS)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PSIA
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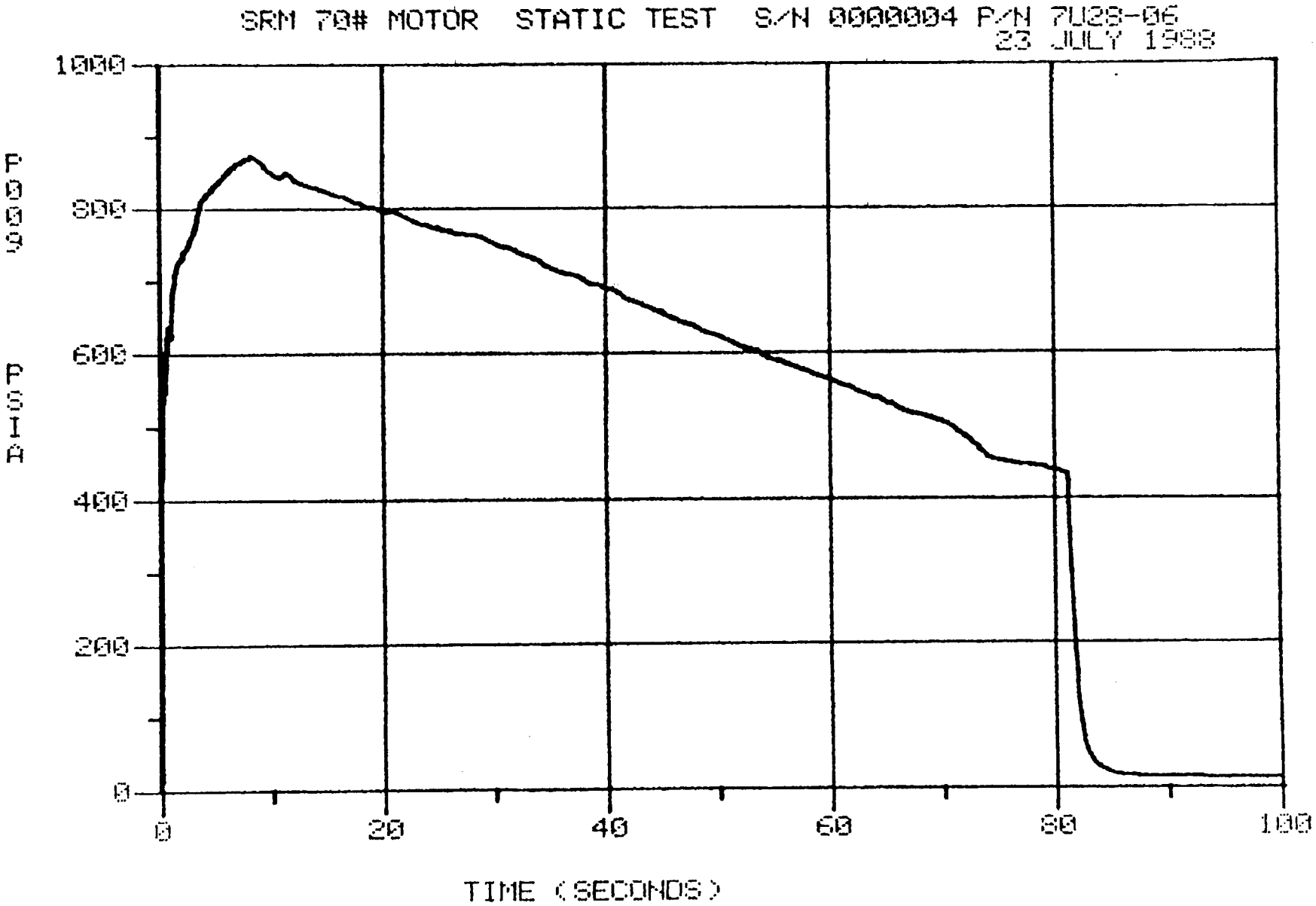
20
40
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
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PRESSURE PSIA
1000
800
600
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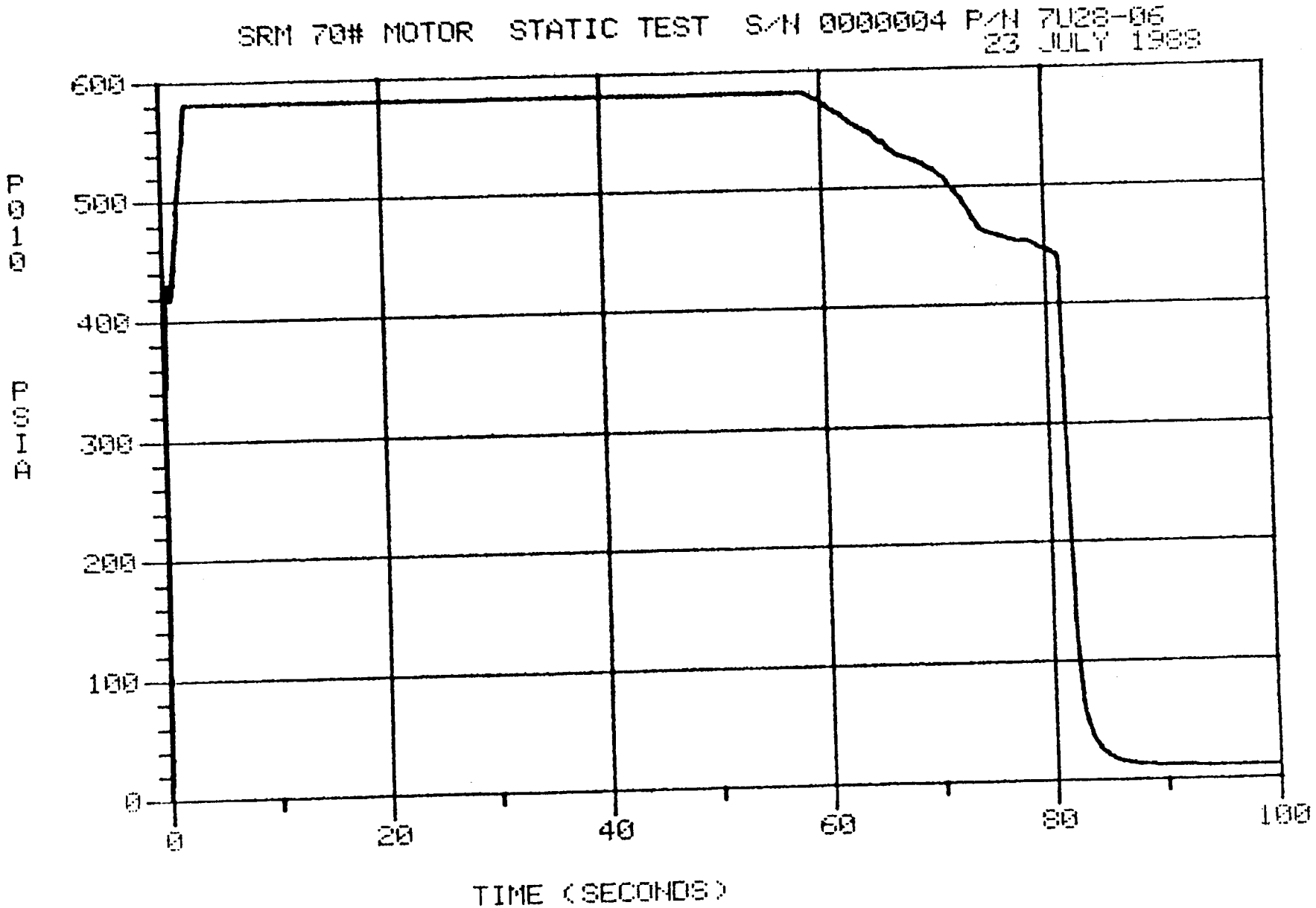
20
40
60
80
100
TIME (SECONDS)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P
0
1
0
P
S
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500
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200
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20
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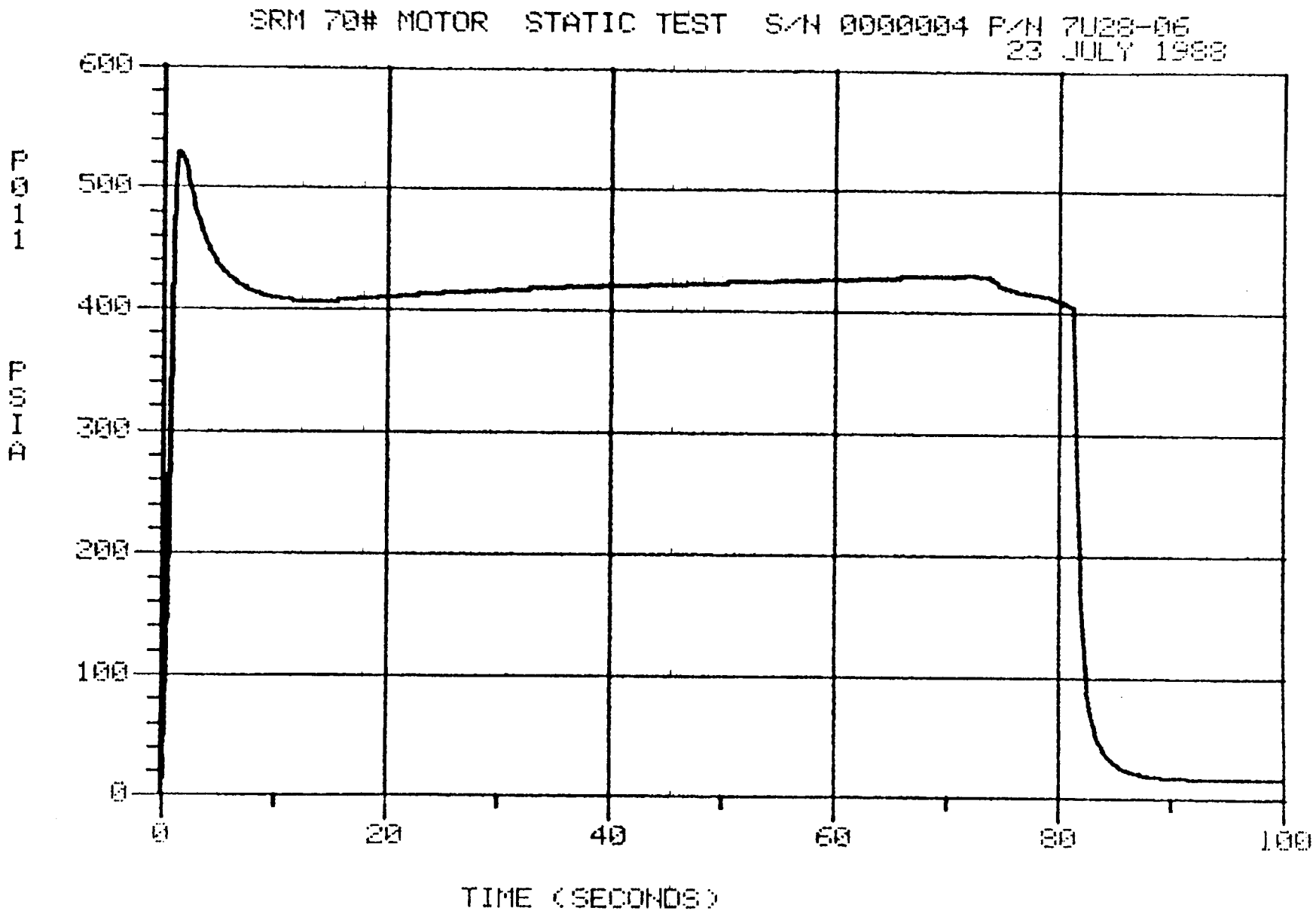
60
80
100
TIME (SECONDS)


SRM 70# MOTOR STATIC TEST S/N 0000004 P/N 7U28-06
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P011
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400
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100
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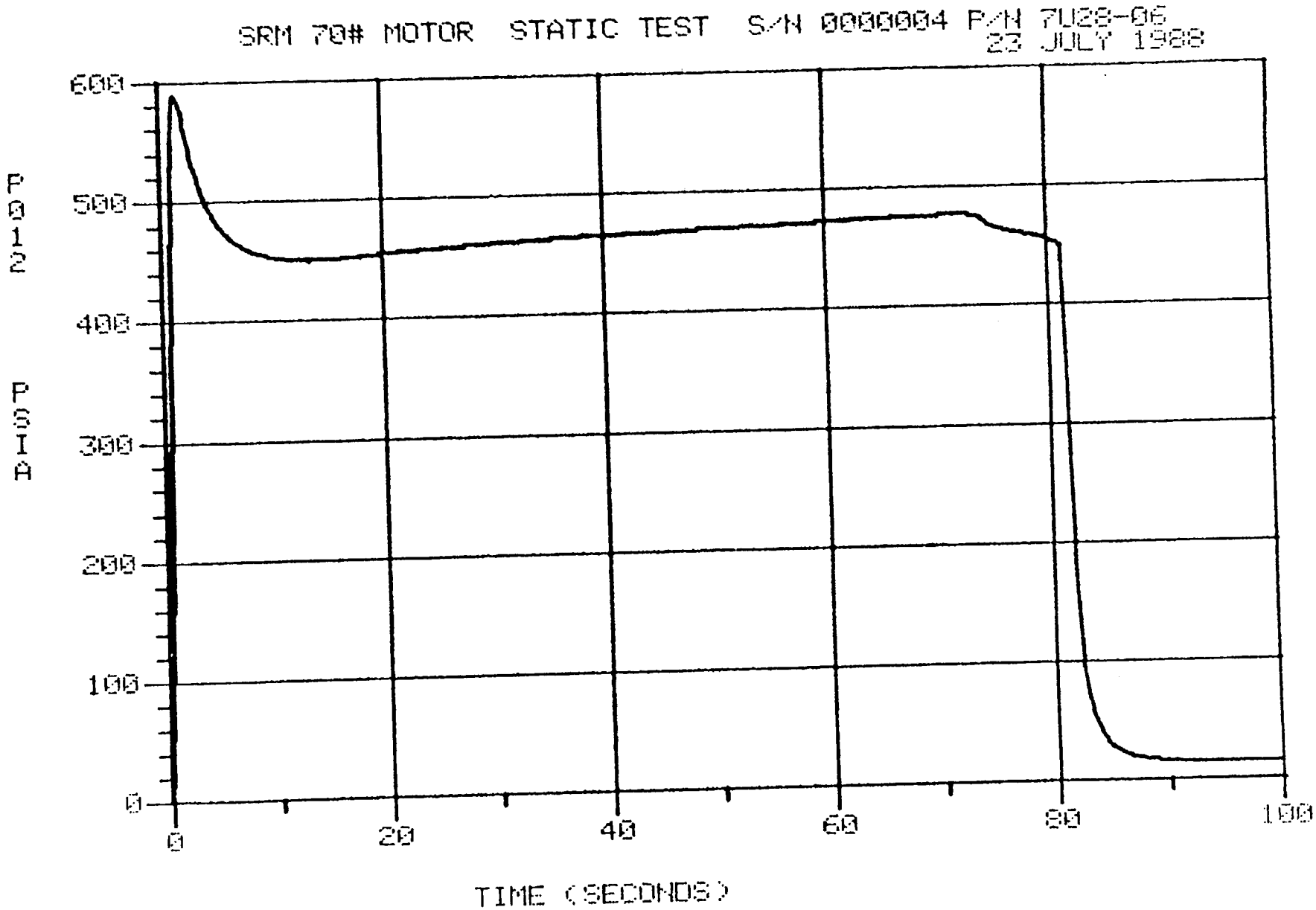
20
40
60
80
100
TIME (SECONDS)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PSIA
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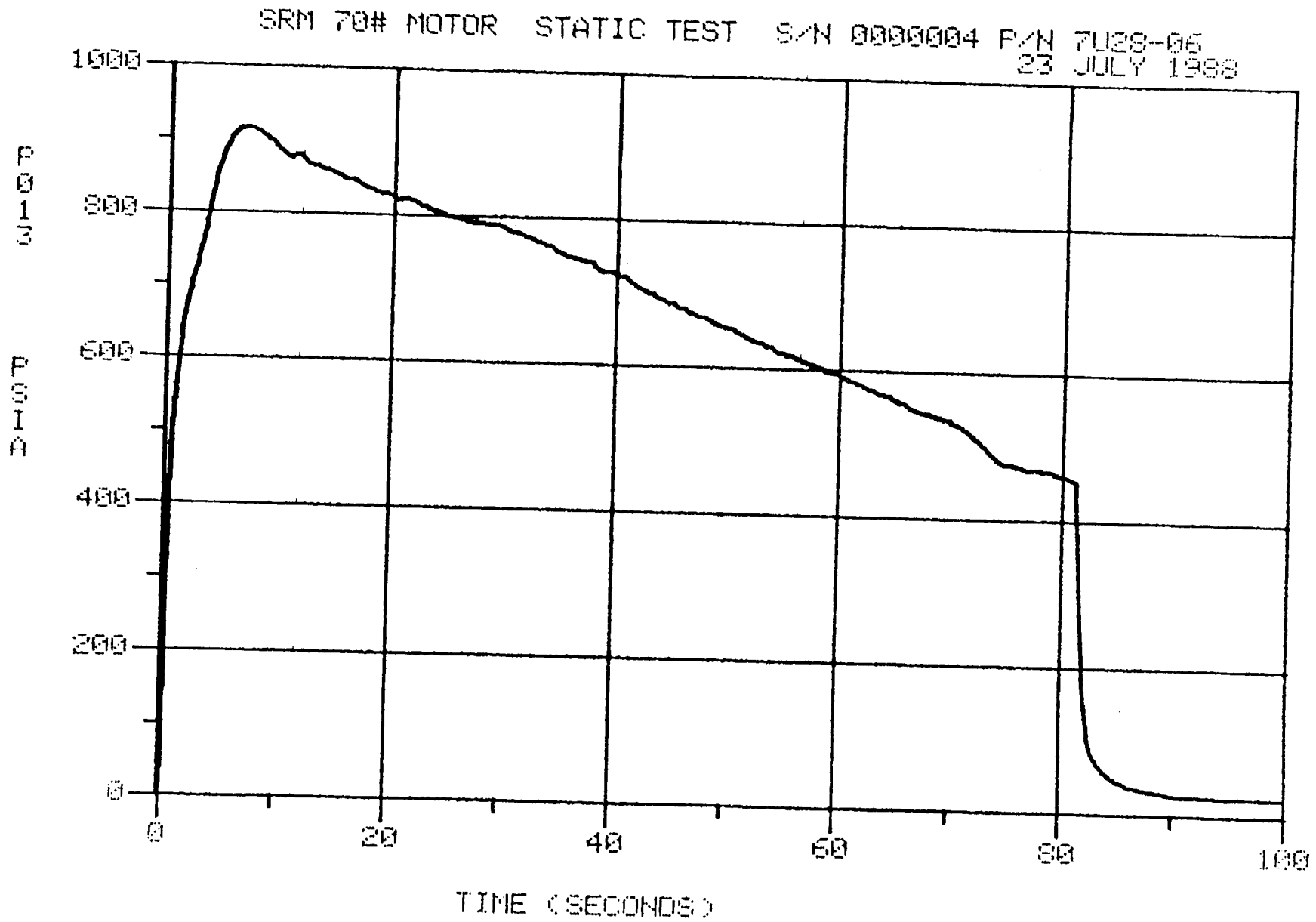
20
40
60
80
100
TIME (SECONDS)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800
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400
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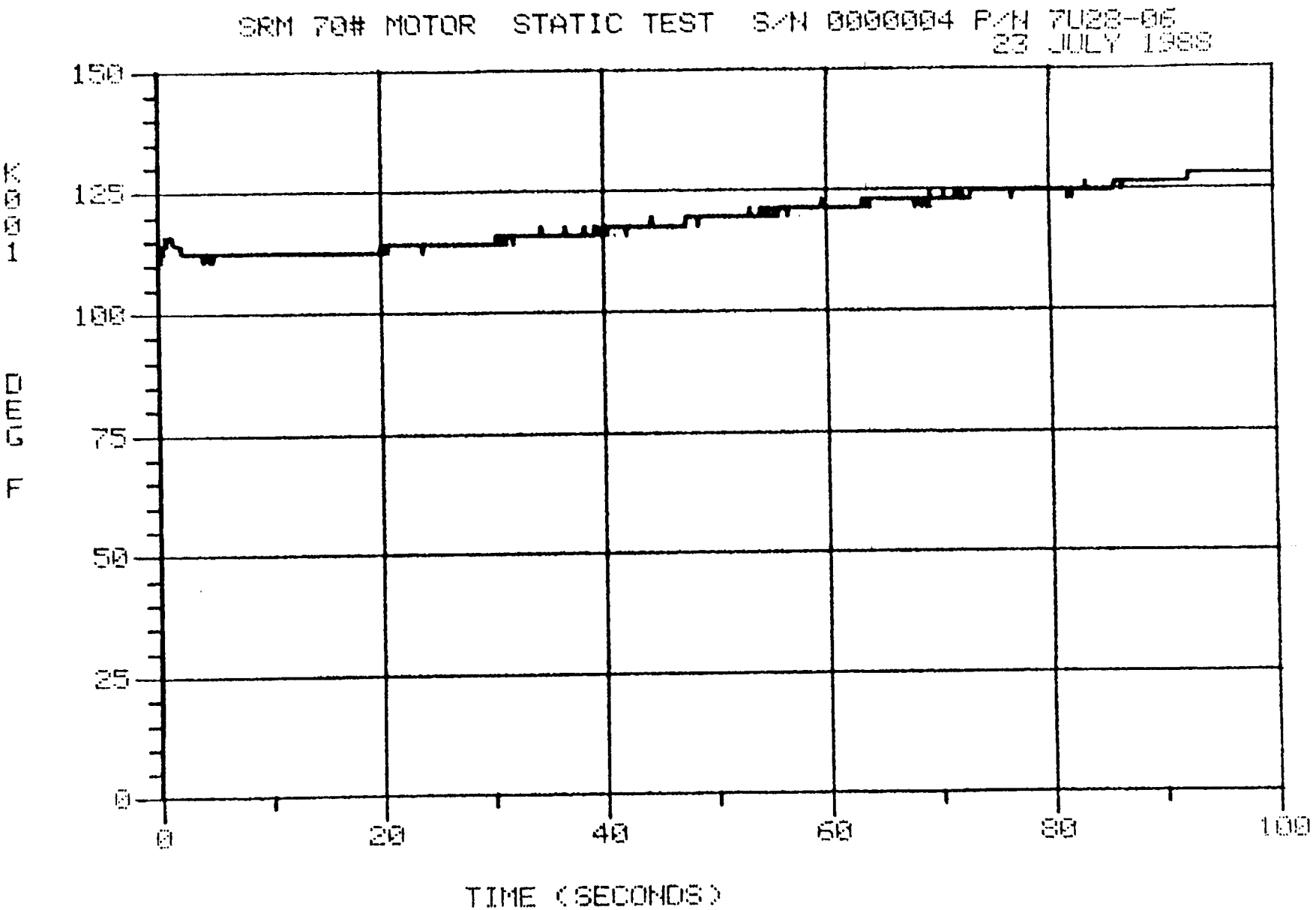
0
PSIA
0
20
40
60
80
100
TIME (SECONDS)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150
125
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75
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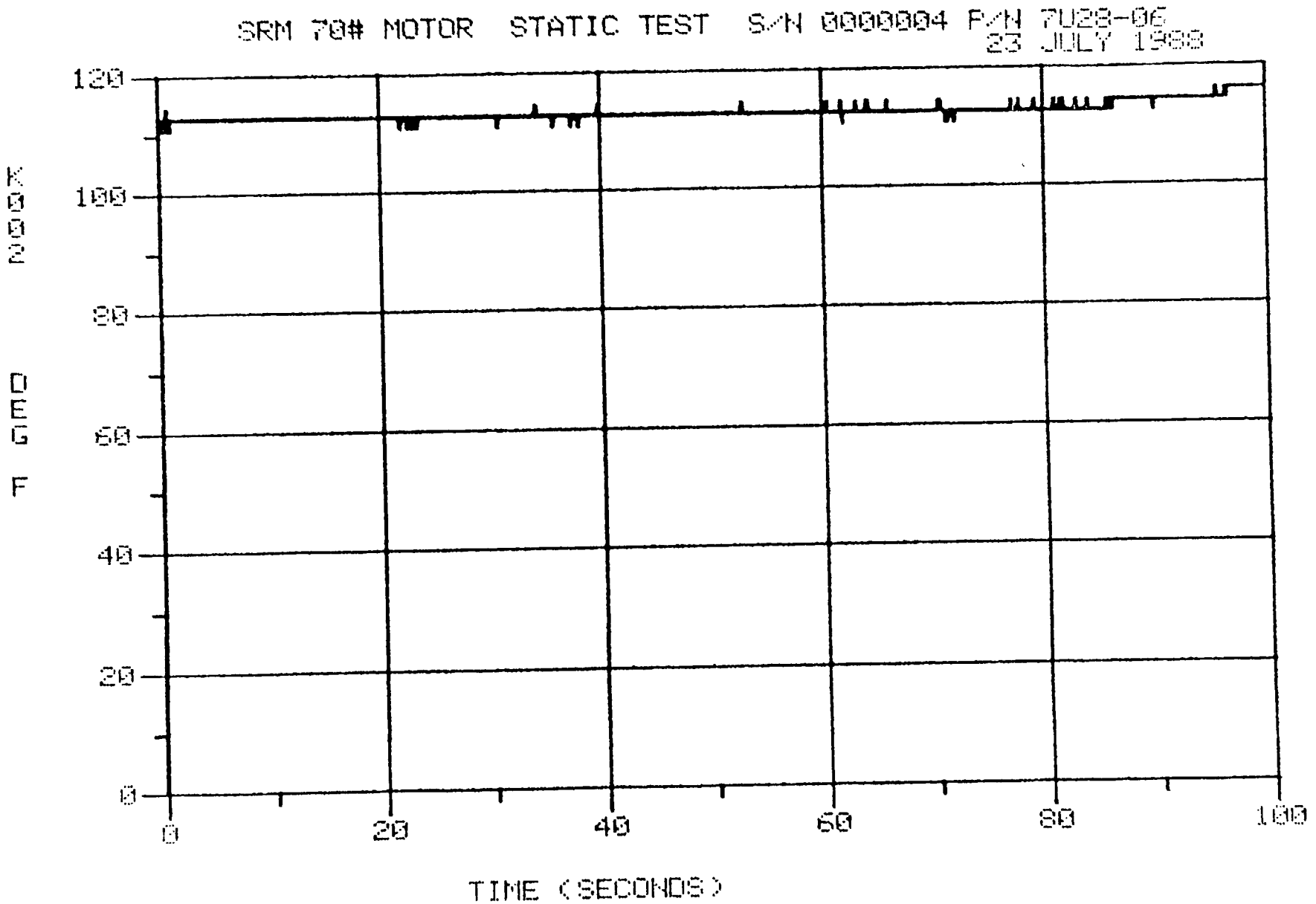
20
40
60
80
100
TIME (SECONDS)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120
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80
60
40
20
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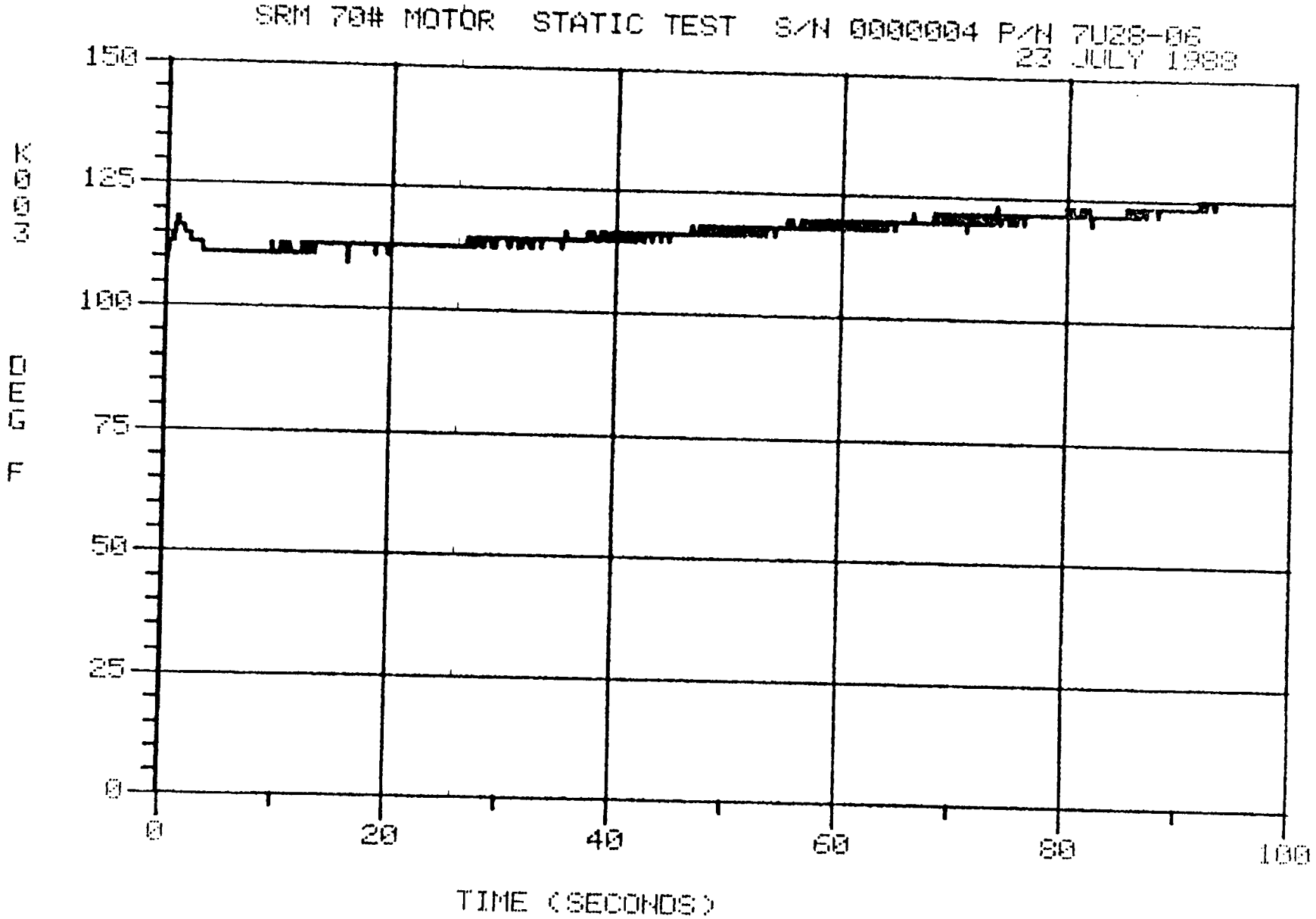
40
60
80
100
DEG F 200K
TIME (SECONDS)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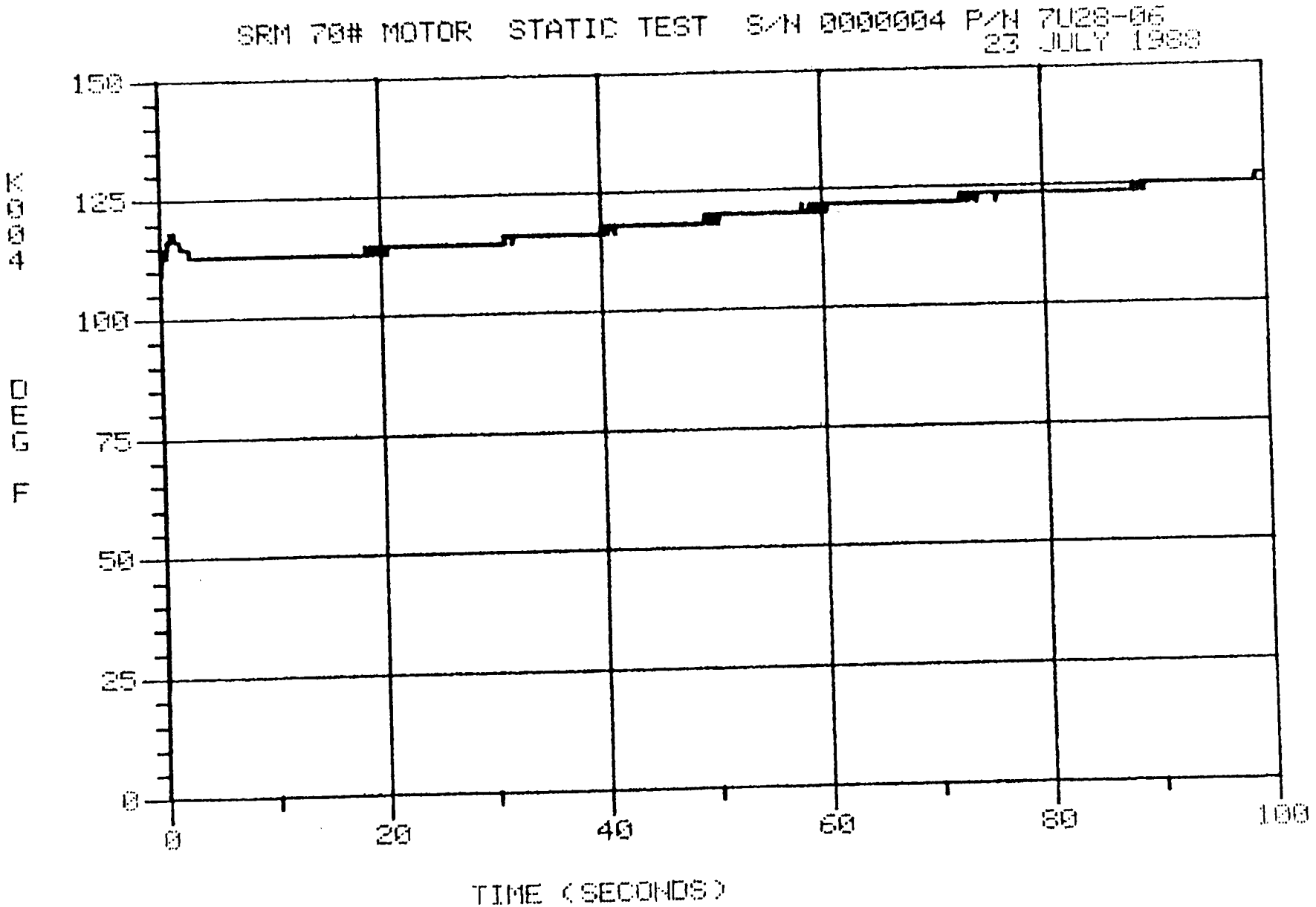
20
40
60
80
100
TIME (SECONDS)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125
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K
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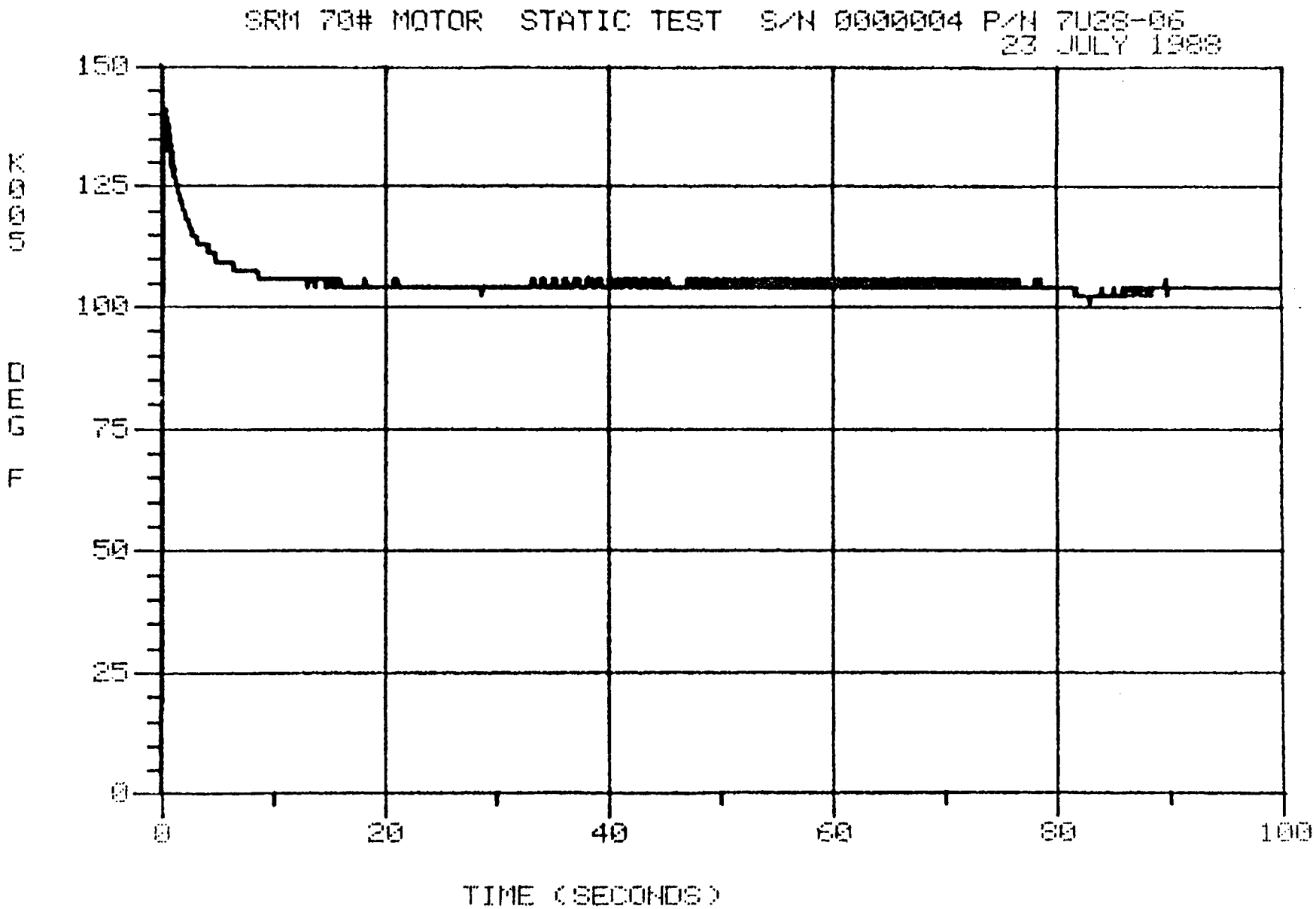
4
D
E
G
F
TIME (SECONDS)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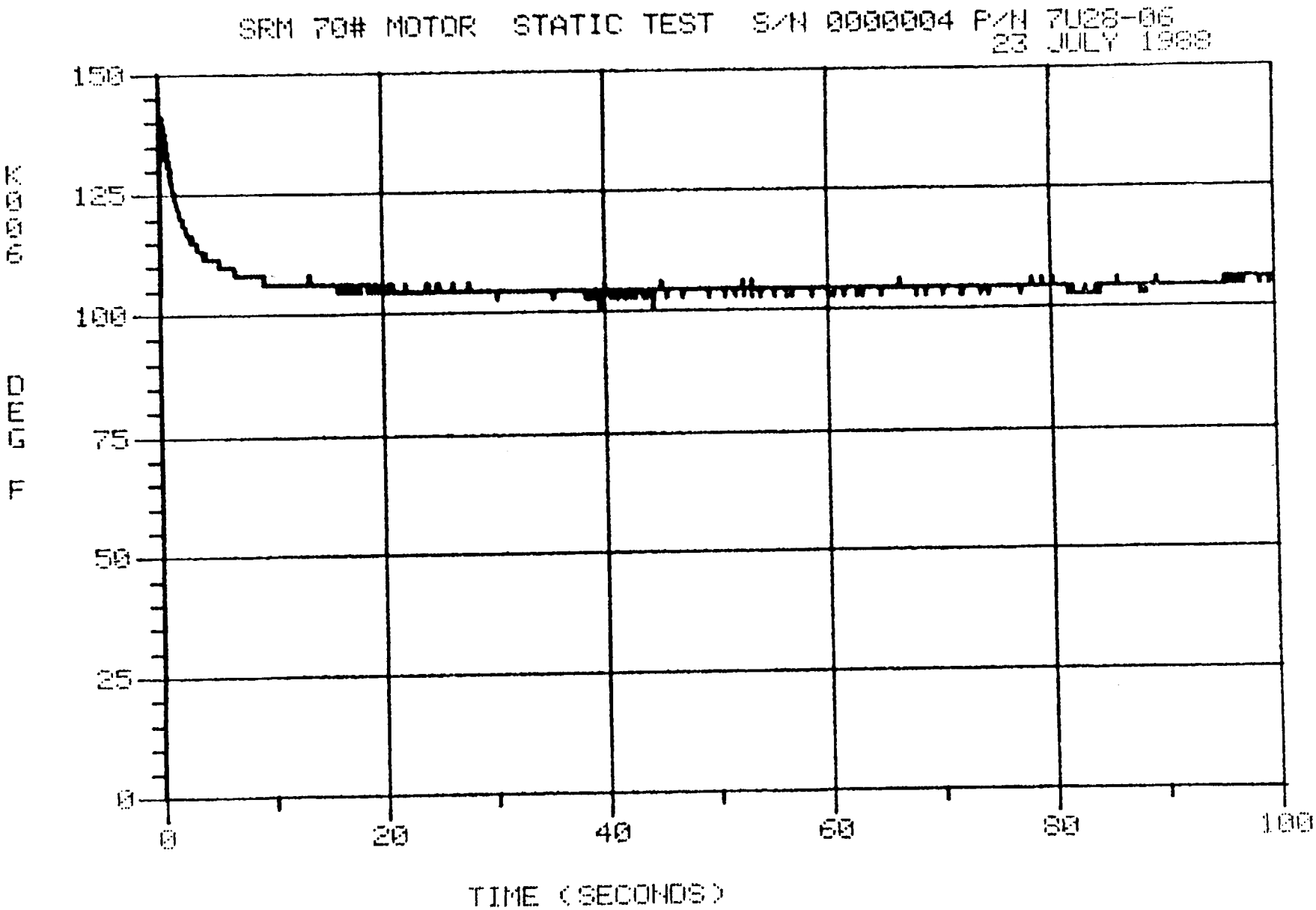
20
40
60
80
100
K
D
E
G
F
TIME (SECONDS)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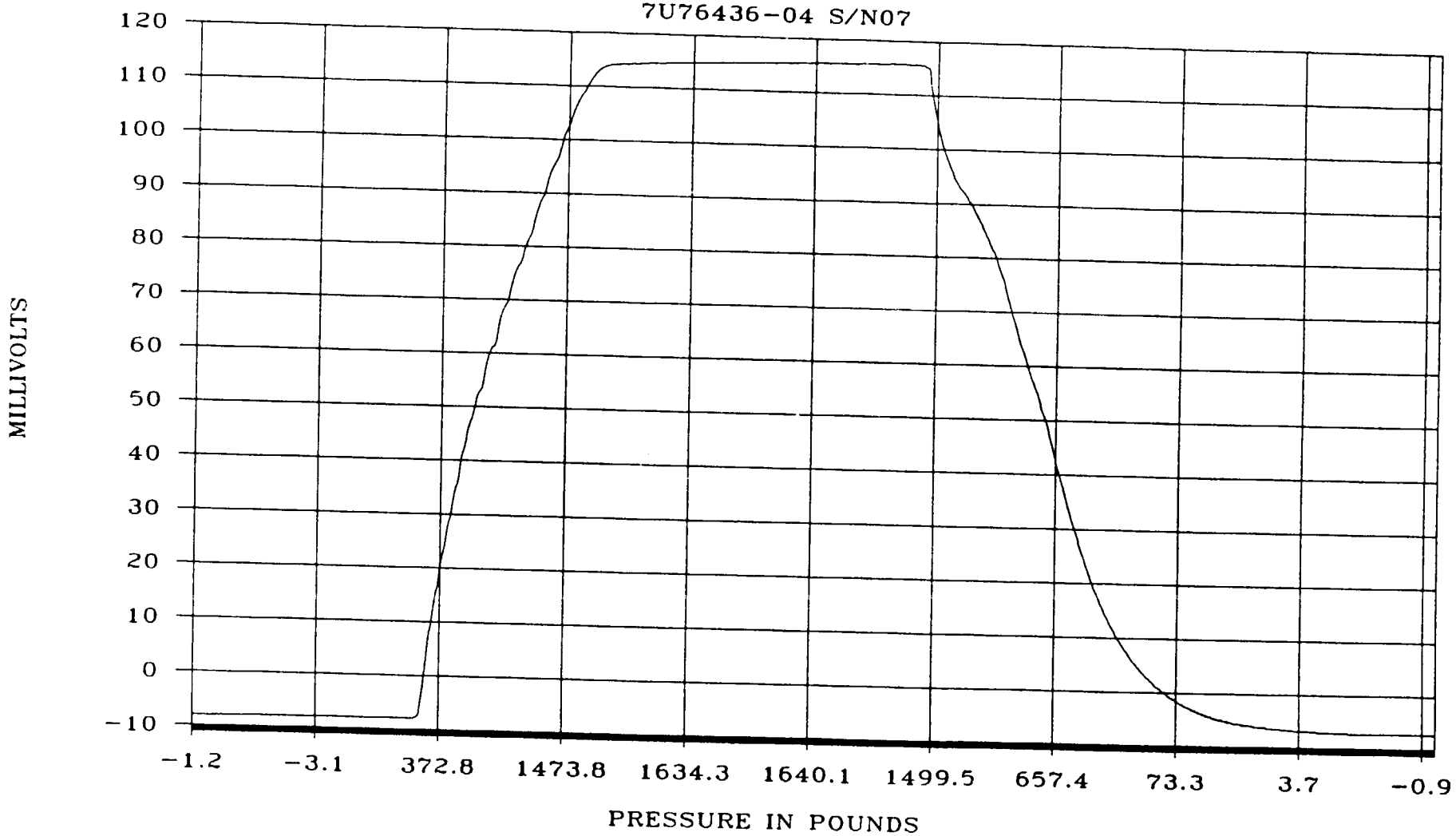
23 JULY 1988
F 0,00K
150
125
100
75
50
25
0
0
20
40
60
80
100
TIME (SECONDS)

OVERPRESSURE TEST

7U76436-04 S/N07



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B. Miles	1	E14
T. Morgan	1	L10
K. Sanofsky	1	851
L. Stevens	1	561E
M. Williams	1	L36
R. Papasian	45	EC5
Print Crib	5	282
Data Management	5	L23E
Library	1	K73