NUCLEAR ENVIRONMENTAL QUALIFICATION REPORT

BECHTEL POWER CORP.
RECEIVED
NOV 1 8 1982

of

HYDROGEN IGNITOR ASSEMBLIES

for

GRAND GULF NUCLEAR STATION UNIT 1

JOB NO. 9645

MISSISSIPPI POWER & LIGHT COMPANY

BECHTEL POWER COMPANY

Specification No. 9645-M-198.0, Rev. 6

Report Date: November 12, 1982
CCL Report Number: A-516-82
CCL Project Number: 81-1609
PSD P.O. No.: 45917-6043

VOLUME I

VENDOR'S DOCUMENT REVIEW
1 ☒ Approved—Mfg. may proceed.
2 ☐ Approved—Submit final dwg.—Mfg. may proceed
3 ☐ Approved except as noted—Make changes and submit final dwg.—Mfg. may proceed as approved.
4 ☐ Not Approved—Correct and resubmit.
5 ☐ Review not required—Mfg. may proceed.
Approval of this document does not relieve supplier from full compliance with contract or purchase order requirements.
By G. Ernst Date 1-10-83
BECHTEL
JOB NO. 9645 | BECHTEL POWER CORPORATION 15740 SHADY GROVE ROAD GAITHERSBURG, MD

By Douglas D. Greenwood
Douglas D. Greenwood, P.E.

NORTH CAROLINA PROFESSIONAL SEAL DOUGLAS DUFF GREENWOOD

Checked By Duna F. Hatmaker
Duna F. Hatmaker

Approved By J. Roland Yow
Dr. J. Roland Yow, P.E.
CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.

NORTH CAROLINA REGISTERED SEAL 7033 ENGINEER HARRY WILLIAM FALTER
11-17-82

Approved By Harry W. Falter
POWER SYSTEMS DIVISION
Harry W. Falter, P.E.

Prepared By

CORPORATE CONSULTING & DEVELOPMENT COMPANY, LTD.
Koger Executive Center
Raleigh, North Carolina

for

POWER SYSTEMS DIVISION

732675

9645-M-198.0-Q1-26.0-2-0
part 1 of 2
Part 2 - before Appendix I

8302160300 830214
PDR ADOCK 05000416
P PDR

Report Prepared By: Douglas D. Greenwood, P.E.

Technical Editor: Darlene Rachal

Technical Typist: Catherine A. Howard

Q.A. Review: C Blanton Jr

Original Issue: November 12, 1982

REVISION(S)

Number	Issue Date	Revision By	Checked By	Q.A. By	Description and Pages Revised

Copyright 1982
CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Raleigh, North Carolina

QA-004-01

TABLE OF CONTENTS

VOLUME I

TABLE OF CONTENTS (CONTINUED)

VOLUME II

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The Nuclear Environmental Qualification Report presented herein details the procedures and results providing Nuclear Environmental Qualification of the Hydrogen Ignitor Assemblies furnished by Power Systems Division (PSD) for use in the Grand Gulf Nuclear Station. Testing, analysis, and a combination of both were the methods used to verify the adequacy of the equipment design under normal, abnormal, seismic, and accident conditions. The tested equipment was shown to be able to perform its safety-related functions through all specified conditions when maintained in accordance with the maintenance schedules established as a result of this program. The test program satisfies the requirements of IEEE 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," including the November 21, 1975 Supplement, and IEEE Standard 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations." In addition, the equipment qualification meets the requirements of Bechtel Technical Specification No. 9645-M-198.0, Revision 6.

1. QUALIFICATION REPORT LOCATOR

The reviewer of this Nuclear Environmental Qualification Report (NEQR) will be primarily interested in determining how the Grand Gulf Nuclear Station requirements have been satisfied. Table 1.1 provides an index to the important documentation requirements of IEEE 323-1974 and the Bechtel specification.

Requirement	Location
Purchase Order Number	Title page of this report
List of Equipment Qualified	Table 4.1 of this report
Methods of Qualification	CCL Report A-409-81-01, NEQP for Hydrogen Ignitor Assemblies
Justification of Test Sequence	Section 3 of this report
Illustrations and Description of Equipment	Sections 4 and 7 of this report and Appendices F, I, and K of this report
Test facility description-CCL Test facility description-SDRC Test facility description-WYLE	Section 3 of this report and Appendices F, I, and K of this report
Functional & environmental test set-ups, instrumentation, and calibration records	Appendices B through K of this report
Seismic test set-ups, instrumentation, calibration records	SDRC Report No. 10824-3, contained in Appendix F of this report
Loss of Coolant Accident (LOCA) test set-ups, instrumentation, and calibration records	Wyle Report No. 45880-1 contained in Appendix I of this report
Hydrogen burn test set-ups, instrumentation and calibration	Wyle Report No. 57149 contained in Appendix K of this report
CCL instrumentation calibration traceability records	CCL Laboratory records (Permanent file at CCL)
Plan and objective	CCL Report A-409-81-01
Test data (test procedures and results)	Appendices B through K of this report
Statement of qualified life	Section 6 of this report

Table 1.1 Qualification Documentation Locator (Continued)

Requirement	Location
Conclusions and recommendations	Section 8 of this report
Supporting data and references	CCL Report A-409-81-01
Description of analytical method used	CCL Report A-409-81-01
Identification of specified tolerances	CCL Test Procedures contained in Appendices B through G, H, and J of this report
Recommended program to maintain qualification	This report
Statement that equipment shipped matches that which has been qualified	Provided separately by Power Systems Division

Table 1.1 Qualification Documentation Locator (Concluded)

2. INTRODUCTION

Nuclear environmental qualification of the Hydrogen Ignitors furnished by PSD was accomplished in accordance with the program described in Corporate Consulting and Development Company, Ltd. (CCL) Report A-409-81-01. The program was executed by CCL in conjunction with Structural Dynamics Research Corporation (SDRC), Wyle Laboratories, Georgia Institute of Technology, and PSD. This report summarizes the Nuclear Environmental Qualification Program results.

The CCL qualification program consisted of putting age-sensitive equipment in a simulated end-of-life condition and then subjecting it to Design Basis Event (DBE) (seismic and accident) testing. The final step in the program consisted of operating the aged ignitors while exposed to specified concentrations of hydrogen in air postulated to occur in the event of an accident during the plant life. This demonstrated that the equipment was capable of performing its safety-related function while in its "end-of-qualified-life" condition. A test program outline is provided in Section 3 of this report.

A brief summary of the Hydrogen Ignitors and a description of their safety-related function is provided in Section 4 to aid the reader in understanding the overall qualification.

Section 5 contains a description of the service conditions to which the components will be subjected and compares these to the service conditions on which the test program was based. In all cases, the test program conditions envelope the Grand Gulf requirements.

Section 6 contains a summary, in tabular form, of the results of the program and shows the qualified life of the ignitor along with margins on thermal and wear aging based on the Grand Gulf requirements. The qualified life of the Hydrogen Ignitors is 40 years plus seven days Post Design Basis Event (PDBE) operation.

Section 7 contains a summary of the seismic testing performed on the ignitors, and Section 8 contains summaries of the LOCA and Hydrogen Burn Testing.

Appendix A contains the Environmental Qualification Summary Sheets for the ignitors. These sheets show the test program phases to which the CCL test samples were subjected.

Appendix B contains the Functional Test Procedures and the results of each functional test.

Appendices C through E contain the test procedures and results for radiation, thermal aging, and wear aging, respectively.

Appendix F contains SDRC Report No. 10824-3, "Seismic Qualification Report on Two Hydrogen Ignitor Assemblies." This report documents the results of the triaxial seismic testing which was performed on the ignitors.

Appendix G contains the Submergence Test Procedure and results.

Appendix H contains the LOCA Test Procedure and results, followed by Wyle Report 45880-1 documenting the LOCA test, in Appendix I.

Appendix J contains the Hydrogen Burn Test Procedure and results, followed by Wyle Report 57149 documenting the Hydrogen Burn Test, in Appendix K.

Both a prime and spare test sample were tested by CCL for the majority of the program. The spare sample was aged (thermal and wear) to an equivalent life of 20 years (plus margin) while the prime was aged to a 40 year life (plus margin). The prime sample is identified by CCL Sample No. 1609-001-000-002. The spare sample is identified by CCL Sample No. 1609-001-000-001. The spare sample was tested with the prime for all test phases except LOCA testing and the Hydrogen Burn Test. Only the prime sample was tested during these last two phases. Therefore, qualification of the Hydrogen Ignitors is based on the success of the prime test sample. The reader will note that the data contained in the appendices refers to both test sample numbers. The data concerning the spare sample is included for completeness sake only.

3. TEST PROGRAM OUTLINE

Test samples received at CCL's laboratory were inspected, functionally tested and prepared for accelerated aging simulation. The samples were subjected to radiation exposure, thermal aging, and wear aging, as well as periodic functional tests to verify equipment operability. When the test samples reached their simulated qualified life, they were shipped to SDRC in Milford, Ohio, for seismic qualification.

Seismic testing consisted of an exploratory, low-level resonance search, followed by 30 minutes of simultaneous horizontal (in both principal axes) and vertical random multifrequency motion to simulate Safety Relief Valve (SRV) loads. The SRV load simulation was followed by triaxial seismic testing to simulate five Operating Basis Earthquakes (OBE). The samples were then subjected to the Design Basis Earthquake simulation. Triaxial seismic testing was performed using a Required Response Spectra (RRS) developed from Appendices Q, R, and S to Bechtel Specification 9645-M-198.0, as explained in Sections 3.2.3 and 3.3 of CCL Report A-409-81-01. The test samples were mounted in their worst case in-service configuration and the operability of the ignitors was verified during and after all seismic test series.

Following the seismic test, the assemblies were subjected to additional testing to simulate anticipated conditions resulting from a LOCA. These included a Submergence Test, a LOCA Test, and a Hydrogen Burn Test, as well as periodic functional tests. During the Submergence Test, the assembly was immersed in demineralized water, removed and energized. The ignitor was then submerged in water while energized. The LOCA simulation consisted of exposing the assembly to the temperature and pressure profile shown in CCL Report A-409-81-01. During the LOCA simulation, the assembly was subjected to negative pressure transient. The assembly was energized continuously during the LOCA Test. The final test phase consisted of a Hydrogen Burn Test. During this test, the assembly successfully ignited combustible mixtures of hydrogen and air, with concentrations varying from 4% to 12% hydrogen by volume.

The qualification test program sequence is presented in Figure 3.1. IEEE 323-1974 was used as the basis for the test sequence. That is, the equipment was aged to its "end of qualified life" point and then subjected to the DBE simulations. The same test sample was used throughout all test phases.

The Arrhenius methodology was used as the basis for thermal aging as discussed in CCL Report A-409-81-01. Activation energies of the materials in the components tested were derived from literature sources and through the use of thermal analysis methods. The use of the Arrhenius methodology and, specifically, the use of thermal analysis to determine material activation energies in nuclear environmental qualification programs is discussed and justified in CCL's paper, "Arrhenius Methodology of Aging for Nuclear Environmental Qualification."

Synergistic effects were considered in the testing program to the extent to which these effects are known. At present, the state-of-the-art of accelerated aging has not been developed to the extent that predictions of humidity effects on activation energies of materials can be included in defining aging programs. A measure of humidity stress was factored into the test program by subjecting the test samples to a [illegible]-hour humidity soak in excess of 90 percent RH at the maximum service temperature which the assembly is expected to experience. In addition the assembly was subjected to combined environments of pressure, temperature, and steam during the LOCA Test. Reference Test Procedures 1609-2, Appendix D and 1609-5, Appendix H for more specific discussion. No other known synergistic effects exist that would affect the testing sequences or overall test program. The actual test sequence is described in Figure 3.1.

These tests constitute complete qualification of the Hydrogen Ignitor Assemblies.

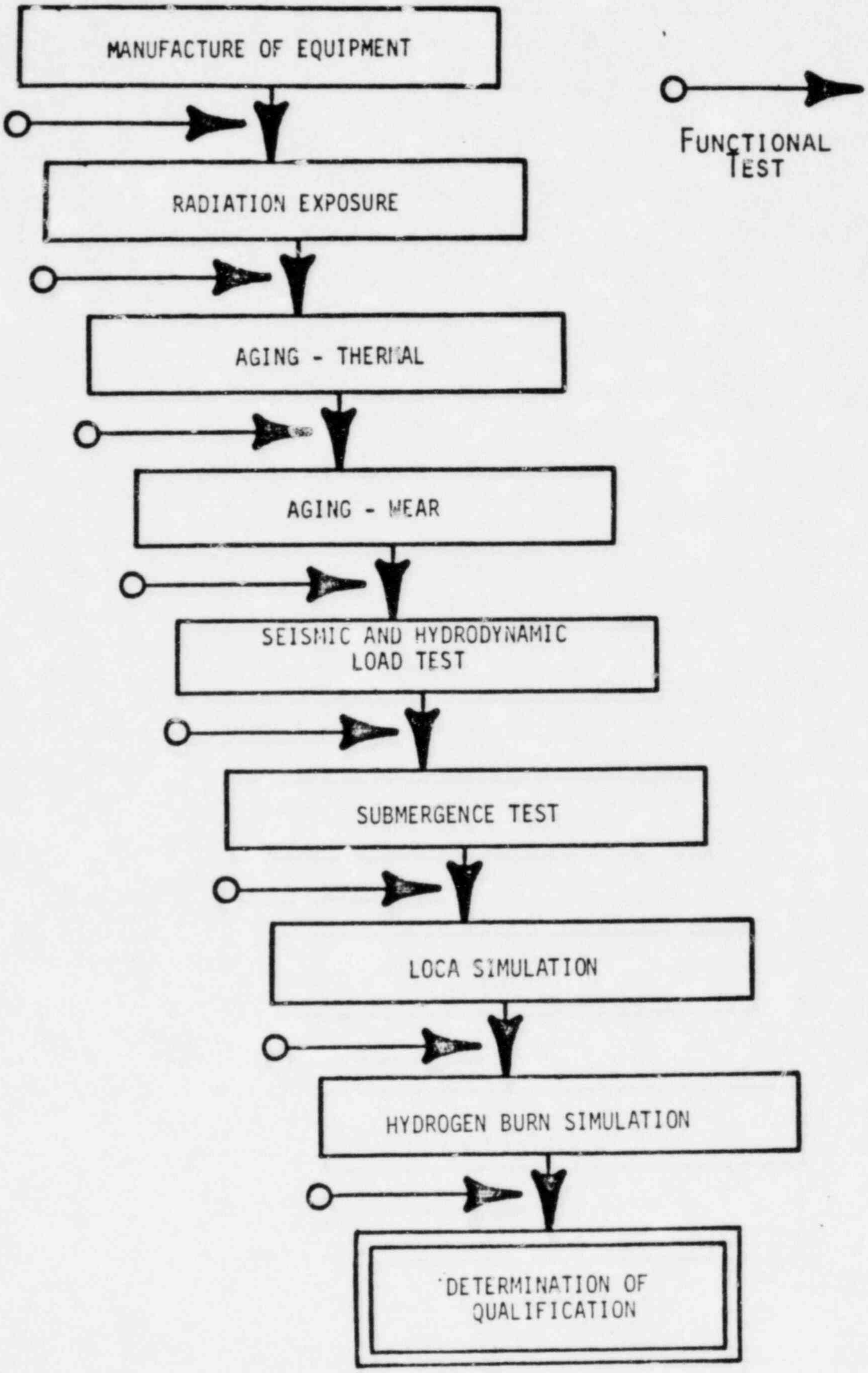


Figure 3.1 Flow Chart for Qualification Process

4. DESCRIPTION OF EQUIPMENT

The Hydrogen Ignitor Assemblies will be used to burn hydrogen at low concentrations as it is produced following a postulated design basis accident. The system will maintain hydrogen concentration in the containment within acceptable limits, thereby precluding hydrogen detonation at high concentrations. Figure 4.1 is the general assembly drawing for the Hydrogen Ignitor. The figure also lists the components from which the ignitors are assembled.

4.1 Safety-Related Functions

The specific safety-related function of the Hydrogen Ignitor is to maintain hydrogen concentration in the containment within acceptable limits by burning low-level concentrations as it is produced. The glow plug must maintain a minimum temperature of 1,500°F.

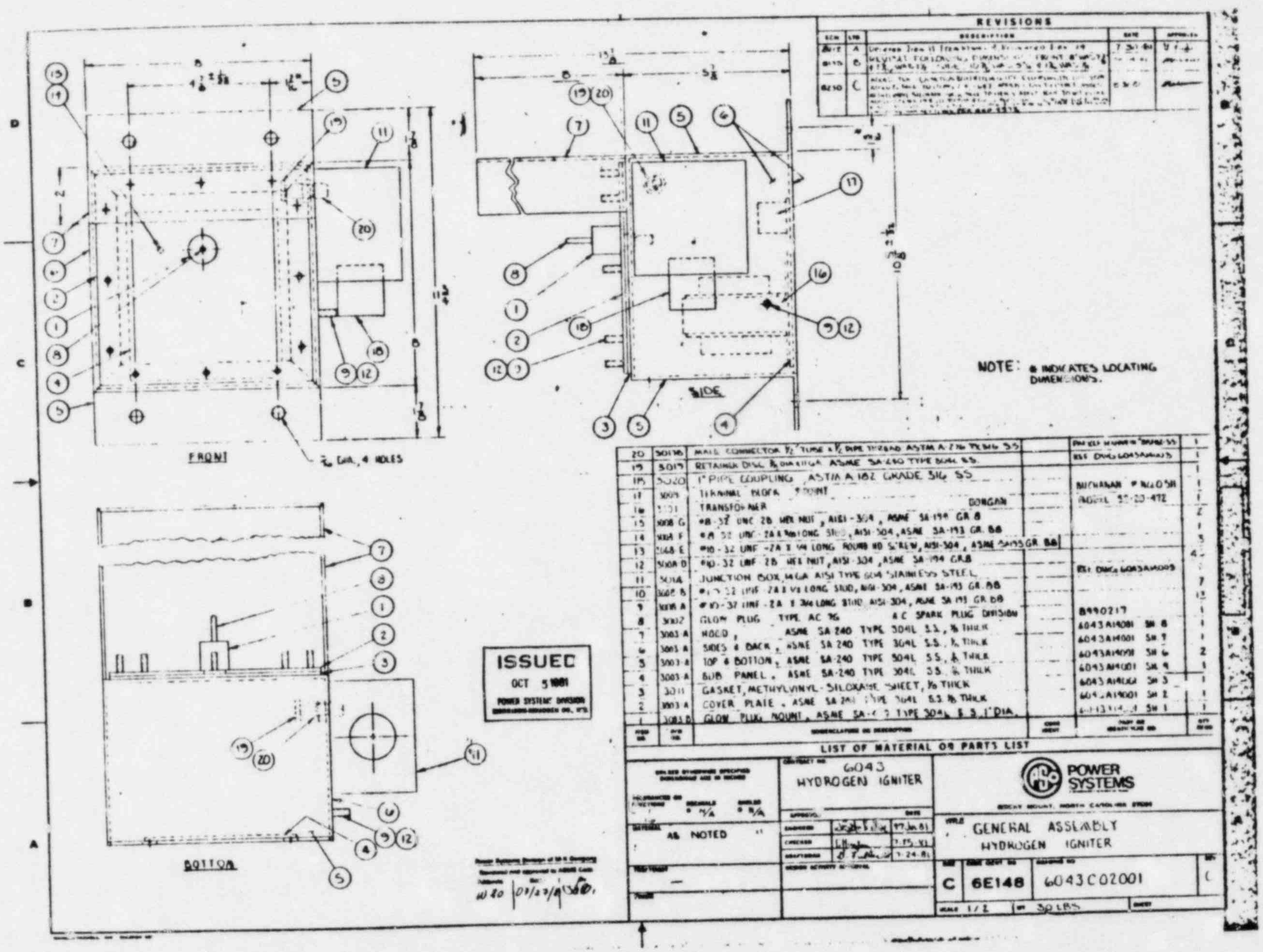


Figure 6.1 Hydrogen Ignitor General Assembly Drawing

5. SERVICE CONDITIONS

The service conditions upon which the qualification of the Hydrogen Ignitors is based are discussed in this section.

5.1 Normal Service Conditions

Equipment service conditions considered in this qualification program may be divided into two primary categories: environmental conditions and wear conditions.

5.1.1 Environmental Conditions

For the purpose of the qualification program, environmental service conditions are defined as those present at the equipment location during the generating station design life. Environmental conditions in the immediate area surrounding the equipment are as defined in Bechtel Specification No. 9645-M-198.0. The worst-case set of environmental conditions from the drywell and containment locations was chosen as the basis for qualification and is shown in Table 5.1. Table 5.2 shows the environmental conditions for inside the drywell. Table 5.3 shows the environmental conditions for outside the drywell but inside containments. Qualification test results have been evaluated on the basis on each location and included in this final qualification report.

5.1.2 Wear Conditions

Table 5.1 contains an estimate of the number of cycles the equipment will undergo over a 40-year period. The ignitors will not be energized during normal plant operation. However, they will be energized during periodic surveillance, specified to occur once per month. In addition, once per year during reactor shutdown, the ignitor operating temperatures will be verified. Bechtel has estimated that the ignitors could be energized for eight hours for each of the shutdown periods.

PARAMETER	NORMAL DUTY	SEISMIC	ACCIDENT
Temperature	Minimum 26.7°C (80°F) Maximum 57.2°C (135°F) Representative 57.2°C (135°F)	57.2°C (135°F)	See Figure 5.7
Pressure	-0.5 to 2.0 psig	-0.5 to 2.0 psig	See Figure 5.7
Relative Humidity	40% - 90%	40% to 90%	100%
Radiation	1.81×10^7 Rads gamma (air) 40 Year Total Integrated Dose	2.7×10^7 Rads gamma (air) 1.0×10^9 Rads beta (air) 7 Day Total Integrated Dosages	
Operational Cycles	520 cycles		Continuously Energized Maximum of 100 Ignitions of Combustible Hydrogen
Voltage	120 VAC ± 10% 60 Hz $^{+1.8}_{-3.0}$		
Seismic	SRV Loads Figures 5.1 and 5.2 Operating Basis Earthquake (OBE) Figures 5.3 and 5.4	Safe Shutdown Earthquake (SSE) Figures 5.5 and 5.6	

Table 5.1 Service Conditions for Hydrogen Ignitor Assembly Qualification

PARAMETER	NORMAL DUTY	SEISMIC	ACCIDENT
Temperature	Representative 57.2°C (135°F)	57.2°C (135°F)	See Figure 5.7
Pressure	-0.5 to 2.0 psig	-0.5 to 2.0 psig	See Figure 5.7
Relative Humidity	40% - 60%	40% to 60%	100%
Radiation	1.8×10^7 Rads gamma (air) 1.8×10^{14} Neutrons/cm^2 40 Year Total Integrated Dose	2.7×10^7 Rads gamma (air) 1.0×10^9 Rads beta (air) 7 Day Total Integrated Dosages	
Operational Cycles	520 cycles		Continuously Energized Maximum of 100 Ignitions of Combustible Hydrogen
Voltage	120 VAC ± 10% 60 Hz $^{+\,1.8}_{-\,3.0}$		
Seismic	SRV Loads Figures 5.1 and 5.2 Operating Basis Earthquake (OBE) Figures 5.3 and 5.4	Safe Shutdown Earthquake (SSE) Figures 5.5 and 5.6	

Table 5.2 Service Conditions for Inside Drywell

PARAMETER	NORMAL DUTY	SEISMIC	ACCIDENT
Temperature	Minimum 26.7°C (80°F) Maximum 40.6°C (105°F) Representative 40.6°C (105°F)	40.6°C (105°F)	See Figure 5.7
Pressure	-0.1 to 1.0 in H_2O	-0.1 to 1.0 in H_2O	See Figure 5.7
Relative Humidity	80% - 90%	80% to 90%	100%
Radiation	9.0×10^6 Rads gamma (air) 2.5×10^{11} Neutrons/cm^2 Total Integrated Dosages	1.0×10^7 Rads gamma (air) 2.0×10^8 Rads beta (air) Total Integrated Dosages	
Operational Cycles	520 cycles		Continuously Energized Maximum of 100 Ignitions of Combustible Hydrogen
Voltage	120 VAC ± 10% 60 Hz $\begin{matrix} +1.8 \\ -3.0 \end{matrix}$		
Seismic	SRV Loads Figures 5.1 and 5.2 Operating Basis Earthquake (OBE) Figures 5.3 and 5.4	Safe Shutdown Earthquake (SSE) Figures 5.5 and 5.6	

Table 5.3 Service Conditions for Outside Drywell/Inside Containment

This results in a total of 1 cycle/month x 12 months/year x 40 years periodic surveillance energize/de-energize cycles, plus 1 cycle/year x 40 years annual energize/de-energize cycles during the 40-year life of the plant. Therefore the total number of cycles is 520.

5.1.3 Safety Relief Valve and Operating Basis Earthquake Loads

During the 40-year plant design life, the assemblies will be subjected to dynamic loads associated with the main steam SRV discharge thermo-hydrodynamic phenomena in addition to seismic loads. The SRVs are postulated to actuate 1800 times during the life of the plant. The horizontal and vertical RRS due to the SRV actuation are shown in Figures 5.1 and 5.2. The OBE RRS are shown in Figures 5.3 and 5.4 for the horizontal and vertical directions. The RRS shown were taken from Appendix R, Rev. 1, to the Bechtel specifications and include a +10 percent margin added to the acceleration.

5.1.4 Radiation

The radiation levels to which the assemblies will be exposed during normal and accident conditions will be highest for assemblies located within the drywell. Therefore, radiation levels inside the drywell were the basis for qualification.

Normal radiation consists of gamma and neutron dosages. For the purposes of qualification, the neutron dose was converted to equivalent gamma radiation and added to the gamma dose. This resulted in a 40-year total integrated dose of 1.81 to 10^7 Rads gamma (air equivalent) as shown in Table 5.1.

Accident radiation consists of gamma and beta doses. The ignitor assembly components are sealed within an 0.125 inch (0.318 cm) thick type 304 stainless steel enclosure. Therefore, the components contained within the stainless steel box will be shielded from the effects of beta radiation and the effects of beta radiation were exempted from the qualification process. The glow plug and the cover plate gasket were not exempted from the beta radiation qualification process and were irradiated.

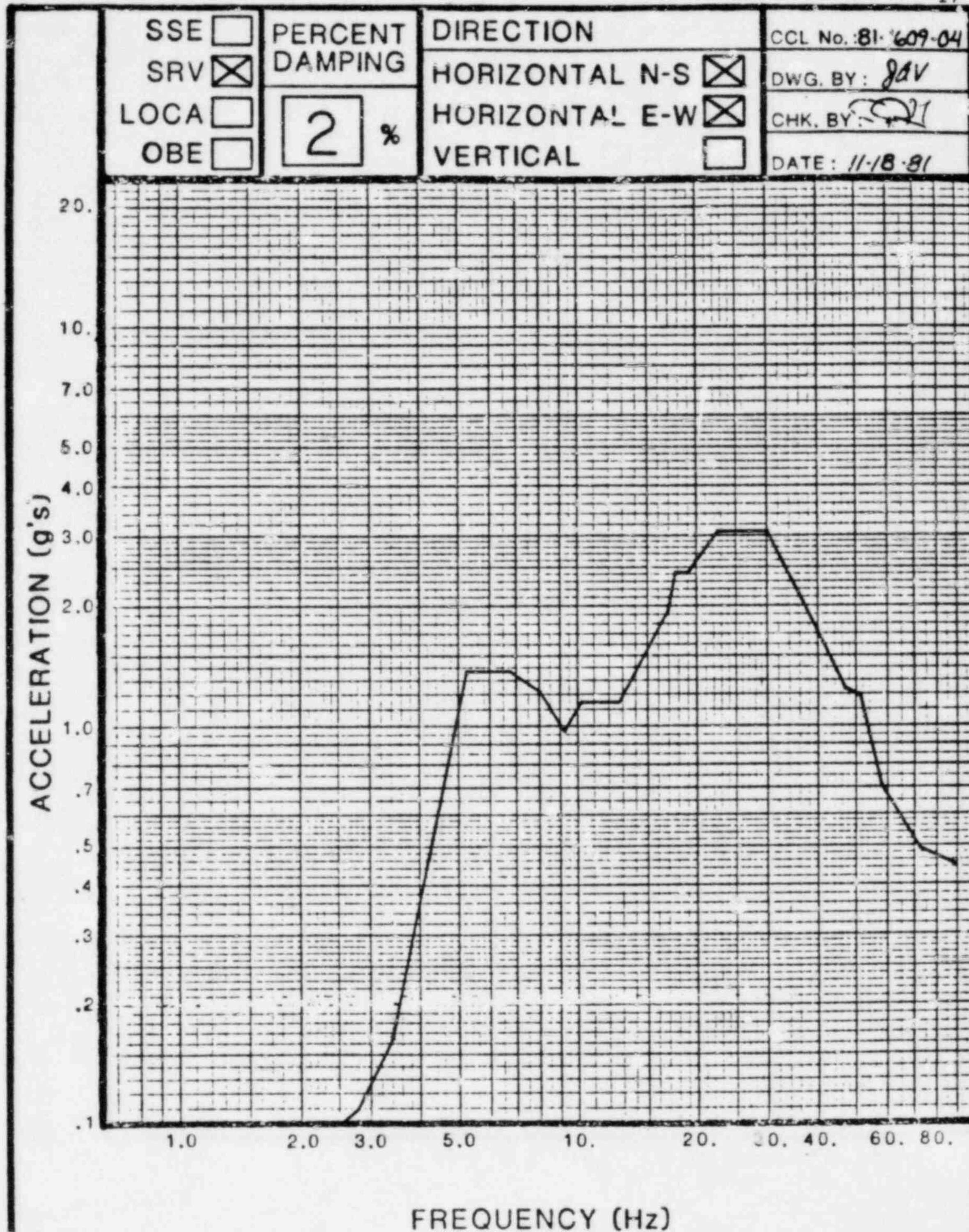


Figure 5.1 Horizontal RRS for SRV Loads

SSE ☐ SRV ☒ LOCA ☐ OBE ☐	PERCENT DAMPING 2 %	DIRECTION HORIZONTAL N-S ☐ HORIZONTAL E-W ☐ VERTICAL ☒	CCL No.: 81-1604-04 DWG. BY: JDV CHK. BY: DATE: 11-18-81

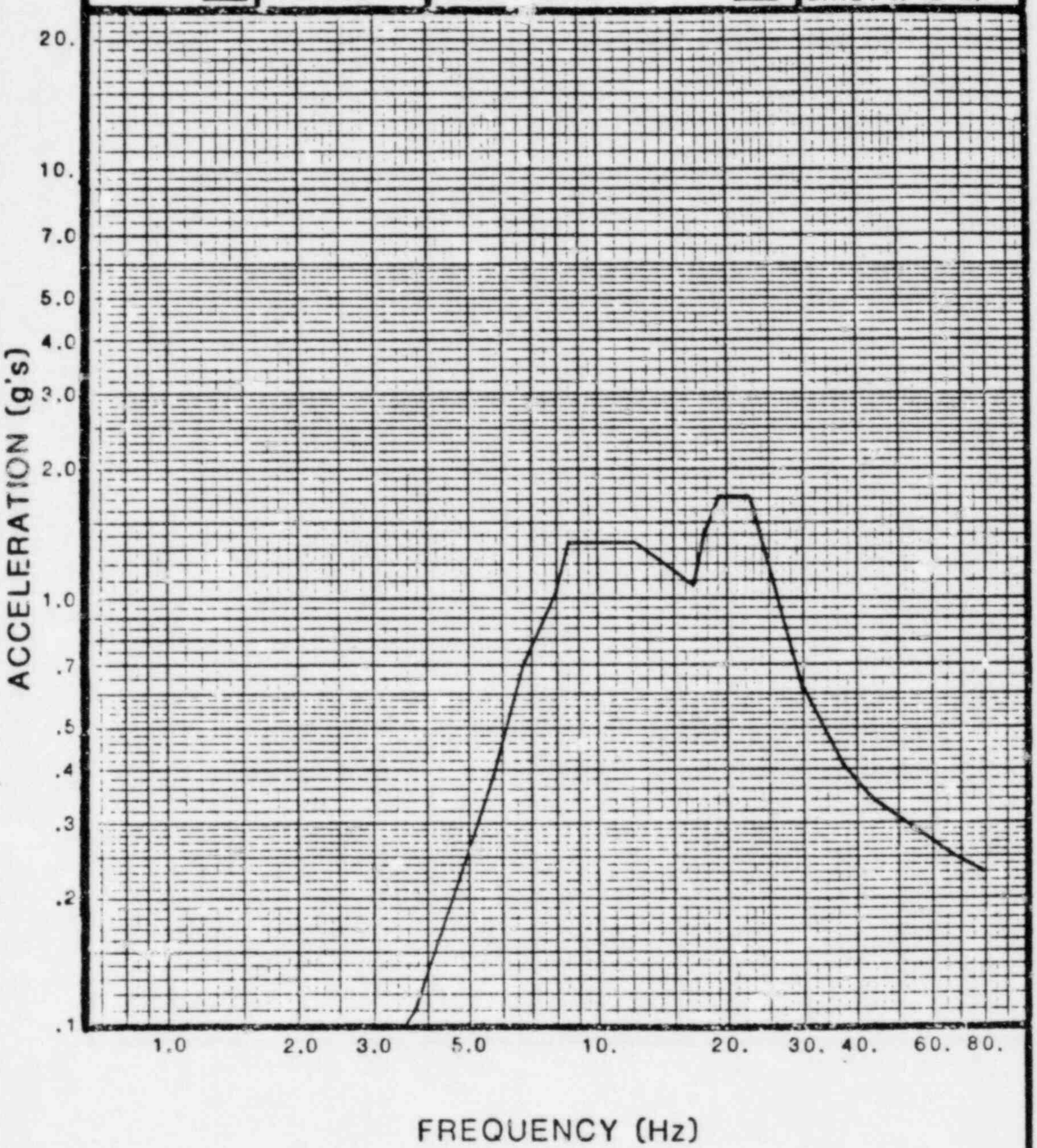


Figure 5.2 Vertical RRS for SRV Loads

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

SSE ☐ SRV ☐ LOCA ☐ OBE ☒	PERCENT DAMPING 2 %	DIRECTION HORIZONTAL N-S ☒ HORIZONTAL E-W ☒ VERTICAL ☐	CCL No.: 81-1609-04 DWG. BY: JAV CHK. BY: [illegible] DATE: 11-18-81

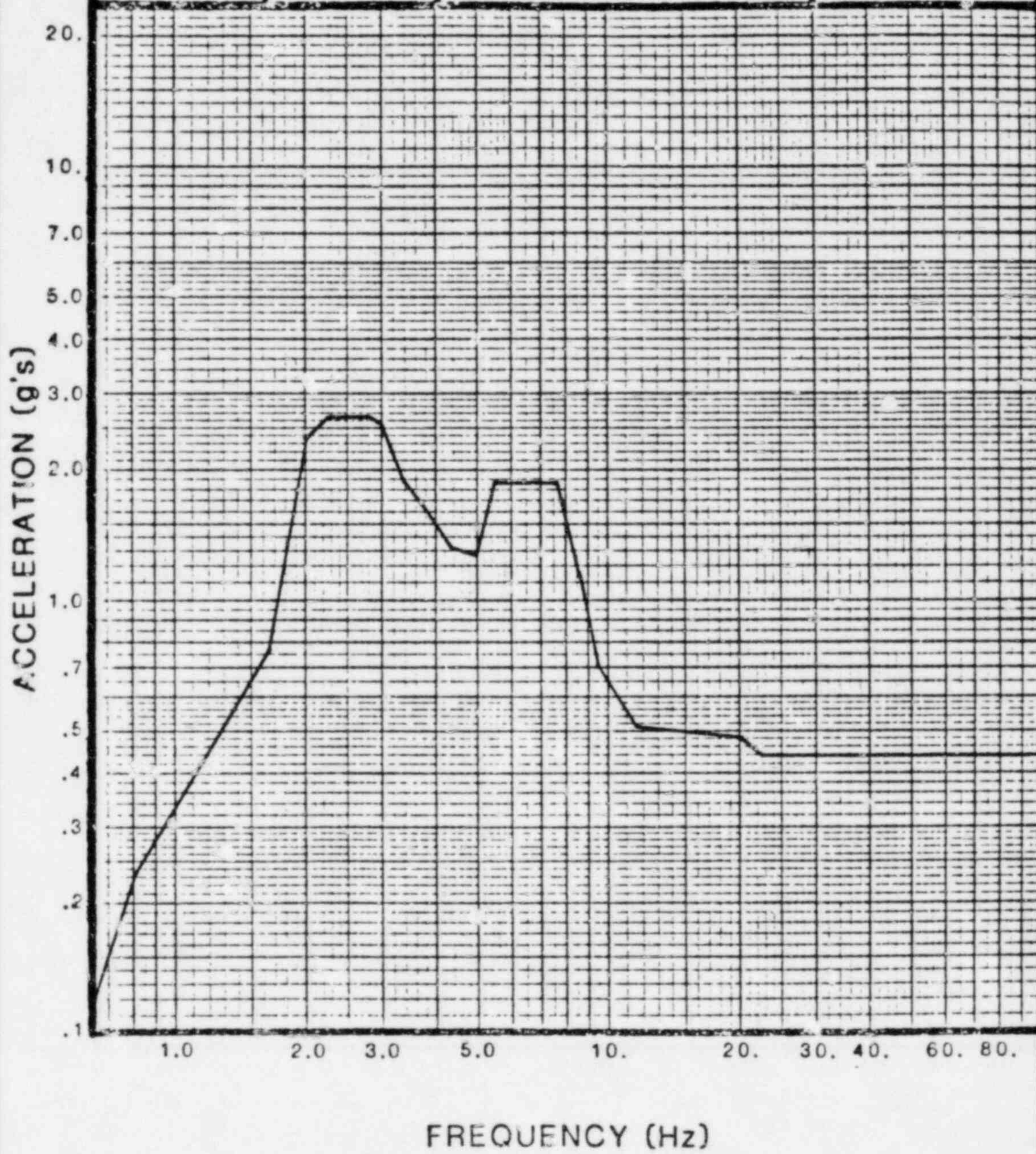


Figure 5.3 Horizontal RRS for OBE

Corporate Consulting & Development Company, Ltd.
consultants constructors
KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

TF004-G

SSE ☐ SRV ☐ LOCA ☐ OBE ☒	PERCENT DAMPING 2 %	DIRECTION HORIZONTAL N-S ☐ HORIZONTAL E-W ☐ VERTICAL ☒	CCL No.: 81-1609-04 DWG. BY: JAV CHK. BY: DATE: 11-18-81

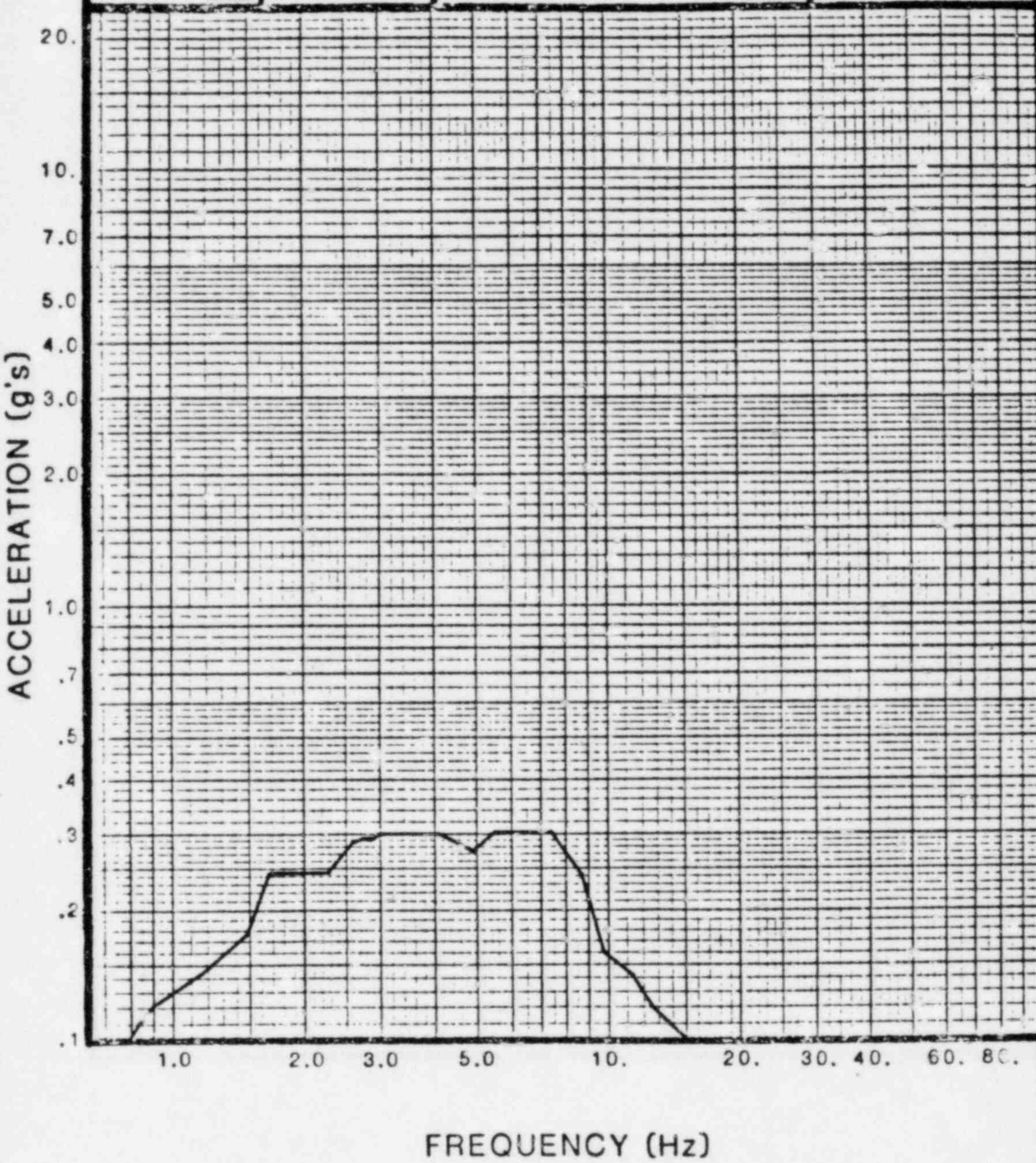


Figure 5.4 Vertical RRS for OBE

Corporate Consulting & Development Company, Ltd.
consultants constructors
KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

The maximum accident gamma dose specified is 2.7×10^7 Rads. The maximum accident beta dose specified is 1.0×10^9 Rads.

5.2 Conditions During Design Basis Events

The DBEs for the Ignitor Assemblies consist of an SSE and a LOCA. The horizontal and vertical RRS for the SSE condition are shown in Figures 5.5 and 5.6. The RRS for the SSE condition were combined, using the absolute sum method, with the SRV and LOCA RRS and a +10-percent margin added to the accelerations. The LOCA test temperature and pressure profile is shown in Figure 5.7. It is during the course of the LOCA that the ignitor will be energized continuously in order to burn combustible concentrations of hydrogen. It is also postulated that some of the assemblies may be submerged in suppression pool water as a result of pool swell and drywell negative pressure transients. The submergence may occur while the ignitor is de-energized or energized. Qualification requires demonstration of operability while exposed to the DBE conditions while the assembly is in its "end-of-qualified life" condition.

SSE ☒ SRV ☒ LOCA ☒ OBE ☐	PERCENT DAMPING 3 %	DIRECTION HORIZONTAL N-S ☒ HORIZONTAL E-W ☒ VERTICAL ☐	CCL No.: 81-1609-01 DWG. BY: JAV CHK. BY: [illegible] DATE: 11-20-81

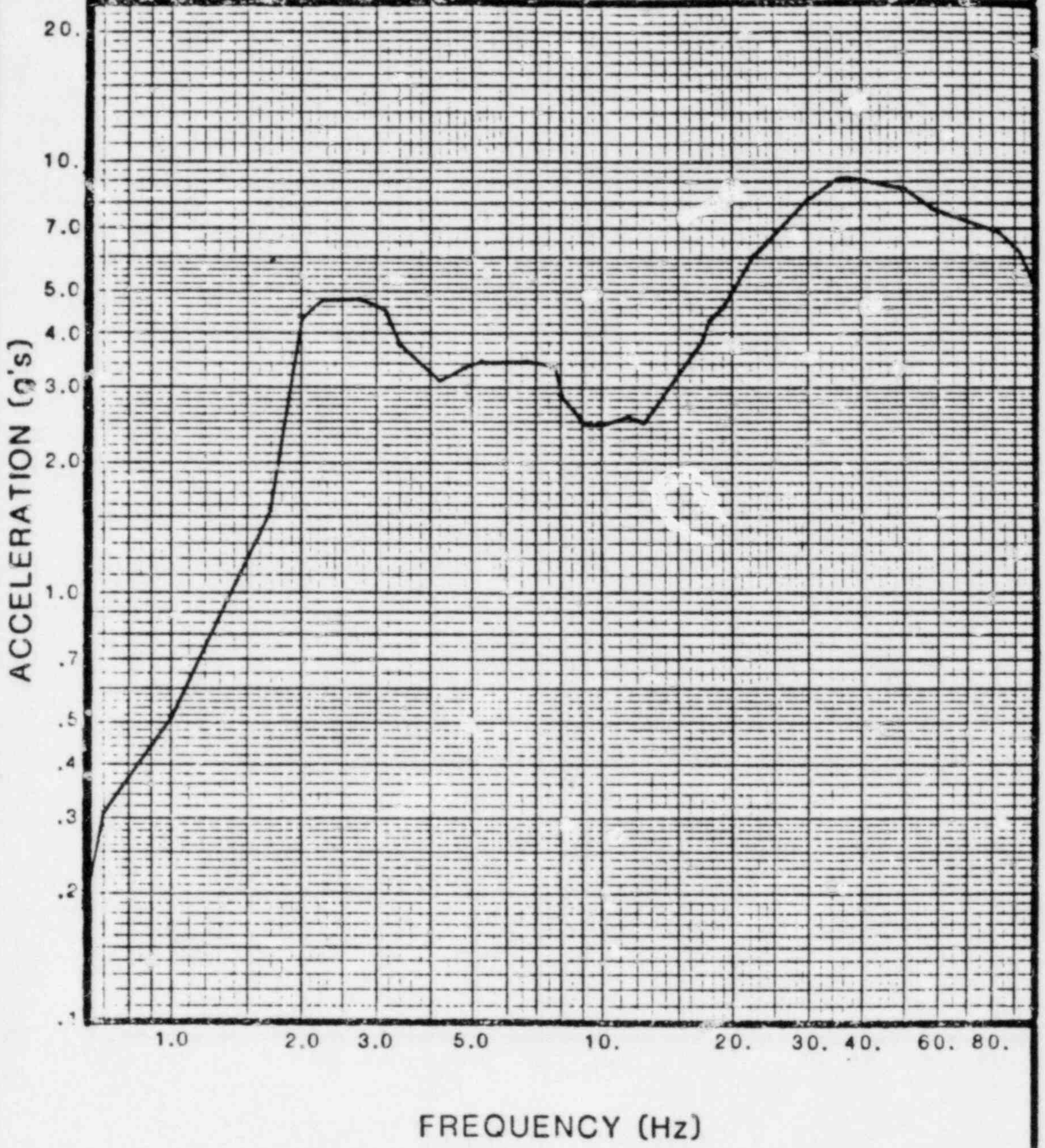


Figure 5.5 Horizontal RRS for Combined SSE, SRV, and LOCA Loads

Corporate Consulting & Development Company, Ltd.
consultants constructors
KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

SSE ☒	PERCENT DAMPING	DIRECTION	CCL No.: 81-1609-04
SRV ☒		HORIZONTAL N-S ☐	DWG. BY: JAV
LOCA ☒	3 %	HORIZONTAL E-W ☐	CHK. BY:
OBE ☐		VERTICAL ☒	DATE: 11-20-81

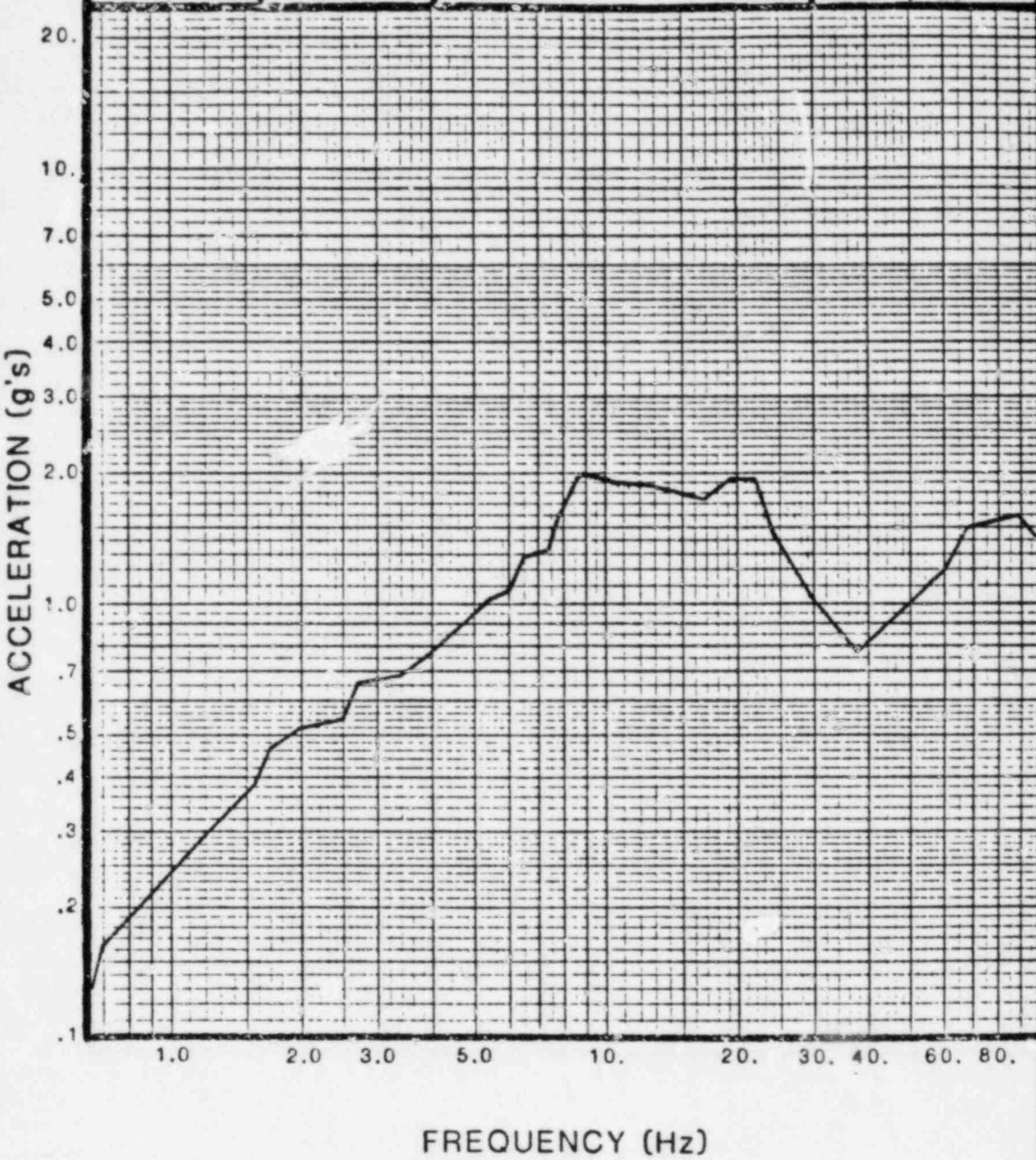


Figure 5.6 Vertical RRS for Combined SSE, SRV, and LOCA Loads

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

TF004-G

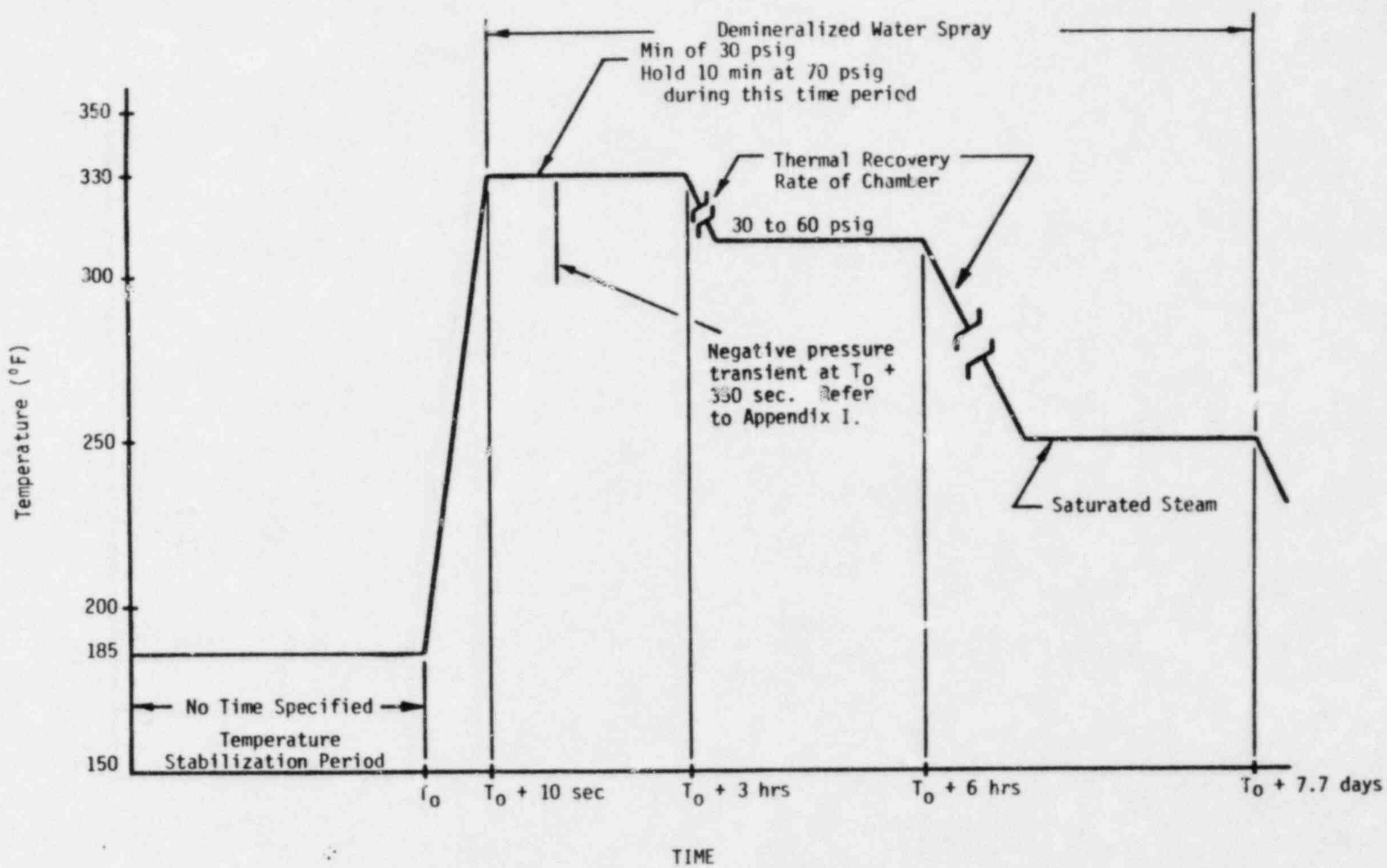


Figure 5.7 LOCA Test Temperature and Pressure Profile

6. COMPONENT QUALIFIED LIFE SUMMARY

Tables 6.1 and 6.2 provide a summary of the results of the qualification test program and show the qualified life of the ignitor, along with the appropriate margin on radiation, thermal and wear aging, and required maintenance. Table 6.1 is based on the environment inside the drywell and Table 6.2 is based on the environment outside the drywell, but inside the containment. The following is an explanation of the columns used in Tables 6.1 and 6.2.

1. CCL Sample Number - This number identifies the test sample used for qualification, in this case the prime test sample.
2. Qualified Life - The number of years in this column represents the period of time for which satisfactory performance has been demonstrated based on the Grand Gulf service requirements.
3. Radiation Exposure Margin - The percent margin in this column represents the amount of radiation to which the component has been exposed in excess of the specified dose. Margin is calculated based on the accident dose only.
4. Thermal Aging Margin - The percent margin in this column represents the amount of thermal aging induced on the component in excess of the qualified life, expressed as a percent of the qualified life based on the Grand Gulf service requirements.
5. Wear Aging Margin - The percent margin in this column represents the number of wear aging cycles through which the component was operated, in excess of the number of cycles expected during the qualified life, expressed as a percent of the qualified life cycles based on the Grand Gulf service requirements.
6. Maintenance/Replacement Interval - The maintenance/replacement interval contained in this column is the maintenance or the replacement interval required in order to maintain qualification of the hydrogen ignitors. This maintenance/replacement information should not replace PSD's recommended maintenance but should be combined with it.

CCL SAMPLE NUMBER 1609-	DESCRIPTION	QUALIFIED LIFE (Years)	RADIATION EXPOSURE MARGIN (Percent)	THERMAL AGING MARGIN (Percent)	WEAR AGING MARGIN (Percent)	MAINTENANCE/ REPLACEMENT INTERVAL
001-000-002	Hydrogen Ignitor Assembly	40	18 (gamma)[1] 18 (beta)	12	14	Replace junction box wire penetration seal after 20 years

[1]Radiation margin based on accident dose only.

Table 6.1 Qualified Life Summary - Inside Drywell

CCL SAMPLE NUMBER 1609-	DESCRIPTION	QUALIFIED LIFE (Years)	RADIATION EXPOSURE MARGIN (PERCENT)	THERMAL AGING MARGIN (Percent)	WEAR AGING MARGIN (Percent)	MAINTENANCE/ REPLACEMENT INTERVAL
001-000-002	Hydrogen Ignitor Assembly	40	410 (gamma)[1] 590 (beta)	>100	14	None

[1]Radiation margin based on accident dose only.

Table 6.2 Qualified Life Summary - Outside Drywell/Inside Containment

7. SEISMIC TESTING SUMMARY

The Hydrogen Ignitor samples were mounted on the shake table in a manner simulating the worst case in-service mounting condition. Figures 7.1 and 7.2 contain photographs illustrating the mounting arrangement. The testing was performed with the test specimen's principal horizontal axis positioned parallel with the test table motion.

The ignitors remained functional before, during, and after the entire test sequence. Table 7.1 is the CCL log of the glow plug temperatures monitored during the test. The glow plug temperatures during the seismic tests were approximately 1,600°F, or approximately 100°F below the required 1,700°F at 120 VAC. This was judged to be the result of two principal factors.

1. The Chromel-Alumel thermocouple was attached to the glow plug by wire. Although a smaller diameter thermocouple was used to reduce heat-sink effects, the attachment method prevented solid contact between the thermocouple and the plug. A ceramic binder was used in subsequent testing.
2. Air movement around the plugs as a result of table motion during the tests increased the heat transfer from the plugs to the environment, lowering the plug temperature.

See Appendix F of this report for the entire SDRC report on the seismic testing of the Hydrogen Ignitors.

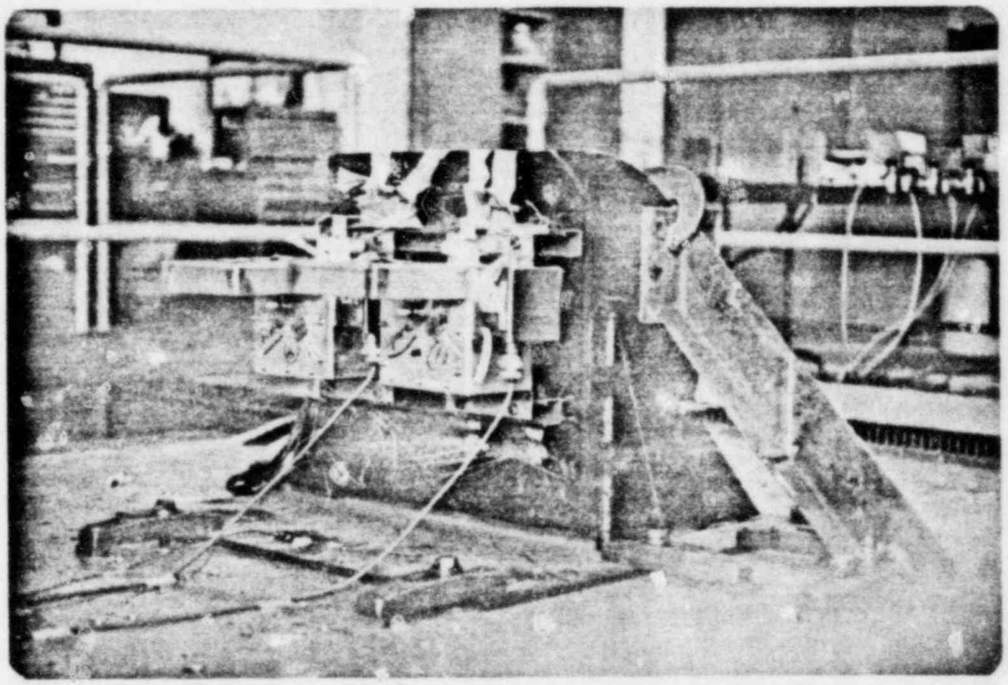


Figure 7.1 Hydrogen Ignitors Mounted on Seismic Table

Figure 7.2 Hydrogen Ignitor Mounting Detail

RUN NO.	DESCRIPTION AND COMMENTS	GLOW PLUG TEMPERATURE (°F)			
		TIME (PM)	1609-1-0-2 (PRIME)	1609-1-0-1 (SPARE)	NOMINAL VOLTAGE
	Bolts torqued to 21 ft-lbs				
--	Pretest	1:40	1670	1645	132
1	X axis resonance search	1:42	1688		132
		1:44	1692		132
		1:45		1682	132
		1:46		1582	120
		1:47	1576		120
		1:48	1580		120
	end	1:49		1578	120
	Between runs	1:55	1707	1705	132
		2:00	1455	1440	108
2	Y axis resonance search	2:15	1575	1585	120
	end	2:18	1577		120
		2:19	1685	1708	132
3	Z axis resonance search	2:28		1700	132
		2:29	1718		132
		2:30	1716		132
		2:33		1708	132
	end	2:35	1616		120

Table 7.1 CCL Seismic Test Log (Continued)

RUN NO.	DESCRIPTION AND COMMENTS	GLOW PLUG TEMPERATURE (°F) TIME (PM)	1609-1-0-2 (PRIME)	1609-1-0-1 (SPARE)	NOMINAL VOLTAGE
		2:40	1621		120
4	Start SRV aging	2:50	1616	1602	120
		2:53		1605	120
		2:55		1614	120
		3:05	1625	1623	120
		3:10	1616	1616	120
		3:15	1623	1628	120
	end	3:20	1632	1636	120
	Bolts torqued to 21 ft-lbs				
5	1st OBE	3:28		1620	120
6	2nd OBE	3:39	1622		120
7	3rd OBE	3:43		1623	120
8	4th OBE	3:45	1732		132
9	5th OBE	3:48		1727	132
	Bolts torqued to 21 ft-lbs				
10	1st SSE	3:57	1593		120
	post-SSE	4:00	1636	1638	120

Table 7.1 CCL Seismic Test Log (Continued)

RUN NO.	DESCRIPTION AND COMMENTS	GLOW PLUG TEMPERATURE (°F)			
		TIME (PM)	1609-1-0-2 (PRIME)	1609-1-0-1 (SPARE)	NOMINAL VOLTAGE
	1st SSE did not envelope bolts torqued to 21 ft-lbs				
11	2nd SSE	4:08		1587	120
	2nd SSE did not envelope bolts torqued to 21 ft-lbs				
12	3rd SSE	4:15	1586		120

Table 7.1 CCL Seismic Test Log (Concluded)

8. LOCA AND HYDROGEN BURN TESTING SUMMARY

The Hydrogen Ignitor prime test sample was subjected to LOCA and Hydrogen Burn Testing at Wyle laboratories, Huntsville, Alabama, and Norco, California, facilities.

During the LOCA Test, the test sample was installed inside a pressure chamber and subjected to a steam environment to simulate a LOCA. The ignitor was energized throughout the test with the glow plug and case temperature monitored. The input voltage and current to the sample were also monitored. During the latter part of the test, the measured glow plug temperature declined steadily from the required levels. However, the input current to the ignitor transformer remained constant, indicating proper operation of the ignitor (i.e., no short or open circuit). The temperature decline was therefore attributable to the thermocouple becoming detached from the glow plug. As proof of this, the thermocouple was reattached to the plug following completion of the LOCA Test. The required chamber conditions were then re-established and the ignitor energized. The glow plug temperature was above the required levels. During the saturated steam portion of the test, the chamber temperature fell below the required levels for short periods of time. The LOCA Test time was not extended to compensate for the total accumulated low temperature time. However, Wyle demonstrated by using the Arrhenius methodology, that due to overtemperature test conditions the equivalent degradation of the assemblies amounted to a +32% margin on the required 7 day LOCA period. The Wyle test report documenting the complete test is included as Appendix I to this report.

The Hydrogen Burn Test was composed of two parts. In the first part, the ignitor was exposed to known concentrations of hydrogen in air. The ignitor was then energized and ignition of hydrogen/air mixture verified. The concentrations of hydrogen was varied from 4% to 12% by volume. Concurrent with this, the voltage to the ignitor was varied from 108 VAC to 132 VAC. In all cases the ignitor successfully burned the hydrogen to which it was exposed. The second part of the test consisted of multiple burns of an 8% hydrogen concentration by volume in air. The known volumetric flow of hydrogen and air into the chamber was begun and the ingitor energized. The hydrogen ignited and was allowed to burn for approximately 3 to 8 seconds. The flow of hydrogen was then stopped and the ignitor de-energized. This process was repeated until the total number of ignitions from both parts of the test reached 100. The ignitor successfully completed the test and showed no signs of deterioration from the burn test. A section of conduit used in the actual in-service configuration was used in the installation of the ignitor in the test chamber. The conduit was in a like-new condition following the burn test. The Wyle test report documenting the Hydrogen Burn Test is included as Appendix K to this report.

9. CONCLUSIONS AND RECOMMENDATIONS

The work documented by this Nuclear Environmental Qualification Report demonstrates that the Hydrogen Ignitor Assemblies supplied for the Grand Gulf Nuclear Station are capable of performing their safety-related function through all specified conditions, when maintained in accordance with maintenance schedules specified herein. This qualification program satisfies the requirements of IEEE 323-1974 including the November 21, 1975 supplement, and Bechtel's Design Specification. No further work is required to demonstrate the capability of this equipment with regard to the specified environmental design criteria.

10. LIST OF REFERENCES

1. American Society for Testing and Materials. ASTM E698-79, "Standard Test Method for Arrhenius Kinetic Constants for Thermally Unstable Materials." Philadelphia: 1979.

2. Essex International, Inc., Magnet Wire Division, Fort Wayne, Indiana.

3. Glasstone, S. and A. Sesonske. Nuclear Reactor Engineering. New York: Van Nostrand Reinhold Company, 1967.

4. IEEE Standard 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." New York: The Institute of Electrical and Electronic Engineers, 1974.

5. IEEE Standard 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Equipment Stations." New York: The Institute of Electrical and Electronic Engineers, Inc., 1975.

6. Power Systems Division Purchase Order No. 45917-6043.

7. Siegmann A. and M. Narkis. "Thermal Analysis of Thermosetting Phenolic Compounds for Injection Molding." Journal of Applied Polymer Science, Vol. 21.

8. Specification 9645-M-198.0, Rev. 6, "Technical Specification for Hydrogen Ignitor Assemblies for Mississippi Power and Light Company, Grand Gulf Nuclear Station, Unit 1, Grand Gulf, Mississippi," Bechtel Power Corporation, Gaithersburg, Maryland.

9. Technical Bulletin NX-7, "Properties and Performance of Nomex Type 410 Aramid Paper." Wilmington, Delaware: E.I. DuPont de Nemours & Co., November, 1977.

10. Wendlandt, W. W. Thermal Methods of Analysis. New York: John Wiley & Sons, 1974.

APPENDIX A - ENVIRONMENTAL QUALIFICATION SUMMARY SHEETS

ENVIRONMENTAL QUALIFICATION PROCEDURE

COMPONENT Hydrogen Ignitor Assembly

QUALIFIED LIFE Forty years plus 12% margin

MAINTENANCE/REPLACEMENT SCHEDULE Replace junction box wire penetration seal after 20 years

CLIENT Power Systems Division

CCL PROJECT NUMBER 81-1609

CCL SAMPLE NUMBER 1609-001-000-002

ENVIRONMENTAL AGING

THERMAL AGING: ☒ REQUIRED ☐ EXEMPTED

COMMENT

LOCA SIMULATION: ☒ REQUIRED ☐ EXEMPTED

COMMENT:

CONDITION	TEMPERATURE		DURATION		MEDIA		QUALITY		PRESSURE	
	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING
Standby	57.2°C	115°C	44.83 years	57.62 days	Air	Air	40-90% RH	HS	2.0 psig max	atm

CRITICAL COMPONENT/MATERIAL Transformer Varnish

ACTIVATION ENERGY 1.08 ev

RADIATION AGING

RADIATION EXPOSURE: ☒ REQUIRED ☐ EXEMPTED

COMMENT Per CCL Test Procedure 1609-3

T.I.D. 5.0×10^7 Rads gamma
1.1×10^9 Rads beta

DURATION 40 years normal integrated dose plus 7 day accident integrated dose

WEAR AGING

CYCLING: ☒ REQUIRED ☐ EXEMPTED;

COMMENT Per CCL Test Procedure 1609-4

NO. CYCLES 592

VIBRATION AGING See SDRC Report 10824-3 in Appendix F.

SEISMIC QUALIFICATION

METHOD: ☐ ANALYSIS ☒ TEST ☐ EXEMPTED

COMMENT See SDRC Report 10824-3 in Appendix F.

NOTES:

1. Functionally test per CCL Test Procedure 1609-1.
2. Hydrogen Burn Test per CCL Test Procedure 1609-6.
3. Submergence Test per CCL Test Procedure 1609-7.
4. Thermal aging evaluation based on temperatures inside drywell.

ENVIRONMENTAL QUALIFICATION PROCEDURE

COMPONENT Hydrogen Ignitor Assembly

QUALIFIED LIFE Forty years plus >100% margin

MAINTENANCE/REPLACEMENT SCHEDULE None

CLIENT Power Systems Division

CCL PROJECT NUMBER 81-1609

CCL SAMPLE NUMBER 1609-001-000-002

ENVIRONMENTAL AGING

THERMAL AGING: ☒ REQUIRED ☐ EXEMPTED

COMMENT

LOCA SIMULATION: ☒ REQUIRED ☐ EXEMPTED

COMMENT:

CONDITION	TEMPERATURE		DURATION		MEDIA		QUALITY		PRESSURE	
	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING	SERVICE	AGING
Standby	40.6°C	115°C	333.77 years	57.62 days	Air	Air	40-90% RH	HS	2.0 psig max	atm

CRITICAL COMPONENT/MATERIAL Transformer Varnish

ACTIVATION ENERGY 1.08 ev

RADIATION AGING

RADIATION EXPOSURE: ☒ REQUIRED ☐ EXEMPTED

COMMENT Per CCL Test Procedure 1609-3

T.I.D. 5.0×10^7 Rads gamma
1.1×10^9 Rads beta

DURATION 40 years normal integrated dose plus 7 day accident integrated dose

WEAR AGING

CYCLING: ☒ REQUIRED ☐ EXEMPTED;

COMMENT Per CCL Test Procedure 1609-4

NO. CYCLES 592

VIBRATION AGING See SDRC Report 10824-3 in Appendix F.

SEISMIC QUALIFICATION

METHOD: ☐ ANALYSIS ☒ TEST ☐ EXEMPTED

COMMENT See SDRC Report 10824-3 in Appendix F.

NOTES:

1. Functionally test per CCL Test Procedure 1609-1.
2. Hydrogen Burn Test per CCL Test Procedure 1609-6.
3. Submergence Test per CCL Test Procedure 1609-7.
4. Thermal aging evaluation based on maximum temperature outside drywell/inside containment.

APPENDIX B - FUNCTIONAL TEST PROCEDURES AND RESULTS

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

FUNCTIONAL TEST

1.0 The requirements and procedures for the functional testing of the Hydrogen Ignitor Assembly are presented in the following subsections.

1.1 Test Requirements

The Hydrogen Ignitor Assembly shall be functionally tested in accordance with the procedure specified below. The test sample shall comply with the following requirements.

The Glow Plug of the assembly, when supplied with the following input power, shall achieve minimum temperatures as listed.

Input Power (VAC)	Phase	Frequency (Hertz)	Minimum Temperatures (°F)
120	1	60	1700
108	1	60	1500
132	1	60	1700
120	1	57	1700
108	1	57	1500
132	1	57	1700
120	1	63	1700
108	1	63	1500
132	1	63	1700

R1

The Hydrogen Ignitor Assembly shall be tested at the input power levels listed above during the initial baseline functional and final functional tests following the last test sequence. The Intermediate Functional Tests

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O.Box 30096 • Raleigh N.C 27622 • 919-782-3441

TEST PROCEDURE

shall be conducted at 120/1/60, 108/1/60 and 132/1/60 (± 10% of rated voltage conditions only). The glow plug temperature shall be a minimum of 1500°F at 108 VAC and a minimum of 1700°F at 120 & 132 VAC. The input power, frequency and current shall be recorded. The glow plug temperature and case temperature shall be measured and recorded. The insulation resistence between the electrical leads and base ground shall be a minimum of 50 megohms at 500 volts.

1.2 Test Procedure R2

The Hydrogen Ignitor Assembly shall be electrically connected and instrumented as shown in the attached schematic for the functional tests.

During the baseline functional test and the final functional test following the last test sequence, the test sample shall be energized with the following input power: 120/1/60, 108/1/60, 132/1/60, 120/1/57, R1
108/1/57, 132/1/57, 120/1/63, 108/1/63, and 132/1/63. The glow plug temperatures shall be as shown in Paragrph 1.1 above. The test results and data shall be recorded on the applicable data sheets.

During all intermediate functional tests the test sample shall be energized with the following input power: 120/1/60, 108/1/60 and 132/1/60. The glow plug temperature shall be a minimum of 1500°F at 108 VAC and a minimum of 1700°F at 120 and 132 VAC. The test results and data shall be recorded on the applicable data sheets. R1

The insulation resistance shall be measured between the inlet power lead and case ground during each functional test. The megohommeter (meggar) leads shall be attached to the power leads and case ground. The megger voltage selector shall be set at 500 volts. Turn megger switch to on position. Measure and record the insulation resistance.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

1.3 Test Results R2

The test samples were subjected to the functional tests in accordance with the requirements and procedure specified above. The functional test data sheets follow this Test Procedure.

The test samples complied with the functional test requirements.

The instrumentation and equipment used in the performance of the functional tests, along with their calibration due dates are shown on the data sheets.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ________ DATE ________
APPROVED BY ________ DATE ________
APPROVED BY ________ DATE ________
QA REVIEW BY ________ DATE ________

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR BASELINE AND FINAL FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609
Description Sample Hydrogen Ignitor Assembly Date of Test ________
CCL No. ________ Part No. ________

INSTRUMENT AND EQUIPMENT LIST

ITEM	CCL NO.	RANGE	CALIBRATION DUE DATE

Test Procedure	Record			Requirements	
• Energize with the Following:					
Voltage				120, 108, 132 VAC	R1
Frequency				60 Hertz	
Current				Record	
Record Glow Plug Temperature				See Para. 1.1	
Record Case Temperature				Record	
• Energize with the Following:					
Voltage				120, 108, 132 VAC	R1
Frequency				57 Hertz	
Current				Record	
Record Glow Plug Temperature				See Para. 1.1	
Record Case Temperature				Record	
• Energize with the Following:					
Voltage				120, 108, 132 VAC	R1
Frequency				63 Hertz	
Current				Record	
Record Glow Plug Temperature				See Para. 1.1	
Record Case Temperature				Record	
• Insulation Resistance					
Record Voltage Applied				500 Volts	
Record Insulation Resistance				> 50 Megohms	

Functional within Acceptable Limits Yes No Tested By ________
ROA No. ________ Reviewed By ________

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division ______ Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test ______

CCL No. ______ Part No. ______

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage				120, 108, 132 VAC
Frequency				60 Hertz
Record Current				Record
Record Glow Plug Temperature				1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature				Record
. Insulation Resistance				
Record Voltage Applied				500 volts
Record Insulation Resistance				> 50 megohms

Functional with Acceptable Limits ______ Yes No

ROA No. ______ Tested by ______

Reviewed by ______

CCL Corporate Consulting & Development Company, Ltd.

Koger Executive Center
P O Box [illegible] • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

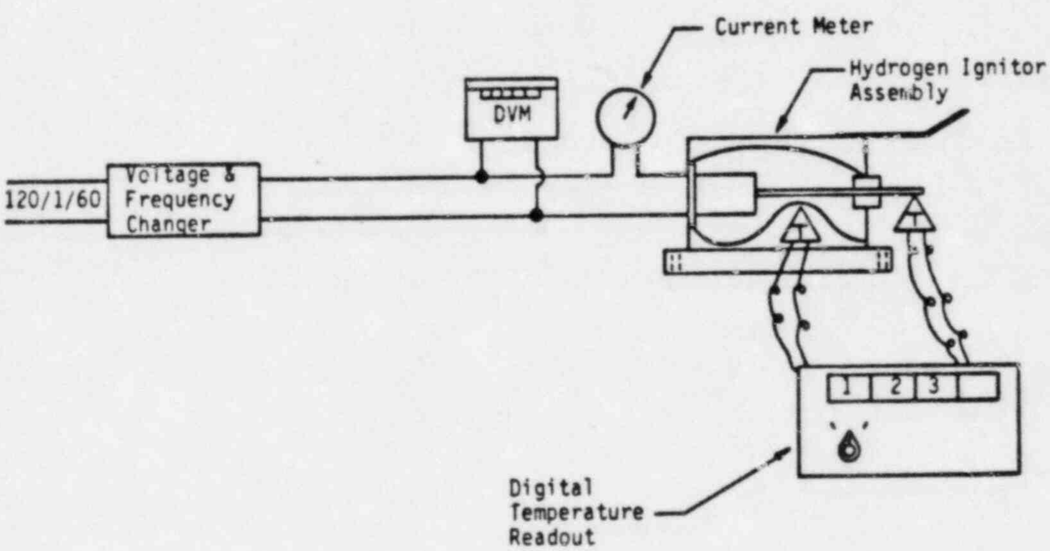


Figure 1609-1-1 Functional Test Setup

Test Procedure 1609-1

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR BASELINE AND FINAL FUNCTIONAL TEST

Client Power Systems Division — Project No. 81-1609
Description Sample Hydrogen Ignitor Assembly — Date of Test 02-09-82
CCL No. 1609-001-000-003 Part No. ____________

INSTRUMENT AND EQUIPMENT LIST

ITEM	CCL NO.	RANGE	CALIBRATION DUE DATE
179 DMM	6005	0-200V AC	06-11-82
179 DMM	6005	0-200MA AC	06-11-82
Wahl	8005	K	12-22-82
Megger	6007	500 MΩ	03-07-82

Test Procedure	Record			Requirements	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	60	60	60	60 Hertz	
Current	1.1	1.0	1.2	Record	
Record Glow Plug Temperature	1720	1568	1809	See Para. 1.1	
Record Case Temperature	80	75	80	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	57	57	57	57 Hertz	
Current	1.1	1.1	1.1	Record	
Record Glow Plug Temperature	1709	1592	1786	See Para. 1.1	
Record Case Temperature	73	73	73	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	63	63	63	63 Hertz	
Current	1.0	1.0	1.0	Record	
Record Glow Plug Temperature	1732	1612	1768	See Para. 1.1	
Record Case Temperature	74	75	75	Record	
• Insulation Resistance					
Record Voltage Applied				500 Volts	
Record Insulation Resistance	>1000			> 50 Megohms	

Functional within Acceptable Limits ✓ Yes No — Tested By [signature]
ROA No. N/A — Reviewed By [signature] 2/9/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR BASELINE AND FINAL FUNCTIONAL TEST

Client Power Systems Division — Project No. 81-1609
Description Sample Hydrogen Ignitor Assembly — Date of Test 02-09-82
CCL No. 1609-001-000-001 Part No. ____________

INSTRUMENT AND EQUIPMENT LIST

ITEM	CCL NO.	RANGE	CALIBRATION DUE DATE
179 DMM	6005	0-200V AC	06-11-82
179 DMM	6005	0-200mA AC	06-11-82
Wahl	8005	K	12-22-82
Megger	6007	500 MΩ	03-07-82

Test Procedure	Record			Requirements	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	60	60	60	60 Hertz	
Current	1.1	1.1	1.4	Record	
Record Glow Plug Temperature	1724	1610	1843	See Para. 1.1	
Record Case Temperature	82	82	83	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	57	57	57	57 Hertz	⊥
Current	1.1	1.1	1.1	Record	
Record Glow Plug Temperature	1700	1574	1747	See Para. 1.1	
Record Case Temperature	72	75	72	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	63	63	63	63 Hertz	⊥
Current	1.1	1.1	1.1	Record	
Record Glow Plug Temperature	1719	1576	1803	See Para. 1.1	
Record Case Temperature	72	75	72	Record	
• Insulation Resistance					
Record Voltage Applied				500 Volts	
Record Insulation Resistance	≥1000			> 50 Megohms	

Functional within Acceptable Limits ✓ Yes No — Tested By [signature]
ROA No. N/A — Reviewed By [signature] 2/9/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 3/3/82

CCL No. 1609-001-000-002 Part No. —

Post Radiation Functional Test

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Temperature Recorder	8005	-328 to 2501°F	12/22/82
Digital Multimeter	6005	0-200 VAC	6/11/82
Meggar	10007	500 Megohms	3/7/82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	4.1	4.1	4.1	Record
Record Glow Plug Temperature	1795	1575	1926	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	72°F	72°F	72°F	Record
• Insulation Resistance				
Record Voltage Applied	500			500 Volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. __________

Tested by [signature]

Reviewed by [signature] 3/3/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division   Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly   Date of Test 3/3/82

CCL No. 1609 001-000-001   Part No. —

Post Radiation Functional Test

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Temperature Recorder	8005	-328 to 2501°F	12/22/82
Digital Multimeter	6005	0 to 200 Volts	6/11/82
Megger	6007	500 Megohms	3/7/82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	1.1	1.1	1.1	Record
Record Glow Plug Temperature	1723	1603	1853	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	72°F	72°F	72°F	Record

. Insulation Resistance

	Record	Requirements
Record Voltage Applied	500	500 volts
Record Insulation Resistance	>1000	> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. ____

Tested by [signature]

Reviewed by [signature] McPherson 3/3/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 3-24-82

CCL No. 1609-001-000-002 Part No. ______ AFTER THERMAL AGING INTERVAL No. 1

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Wahl	8005	K -328 to +1501	12-22-82
DMM 129	6005	0-200 V AC	6-11-82
DMM 132	6011	0-20 A AC	8-4-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	0.94	0.81	1.08	Record
Record Glow Plug Temperature	1747	1620	1879	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	71	71	71	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by [signature]

Reviewed by [signature]

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 4-19-82

CCL No. 001-000-002 Part No. ____ AFTER THERMAL AGING INTERVAL No. 2

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Dmm 129	6005	0-200 VAC	6-11-82
Dmm 130	6011	0-10 A AC	8-4-82
FLUKE	8008	K -328 → +2472°F	10-14-82
megger	6007	> 1000 MΩ	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	0.95	0.83	1.08	Record
Record Glow Plug Temperature	1735	1670	1856	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	71	72	72	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by [signature]

Reviewed by [signature]

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 11-20-82

CCL No. 001-000-002 Part No. ____________ AFTER HUMIDITY SOAK

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 129	6005	0-200 VAC	6-11-82
DMM 130	6011	0-10 A AC	8-4-82
Fluke	8008	K -328 → +2472°F	10-14-82
Megger	6007	≥1000 MΩ	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	0.95	0.83	1.09	Record
Record Glow Plug Temperature	1712	1561	1824	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	79	79	83	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	≥1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by [signature]

Reviewed by [signature]

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 5-5-82

CCL No. 001-000-002 Part No. ________ AFTER THERMAL AGING INTERVAL No. 3

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 130	6011	0-10 A AC	8-4-82
DMM 175	6055	0-200 V AC	6-11-82
Fluke meter	8008	K	10-14-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	9.5	8.2	10.9	Record
Record Glow Plug Temperature	1720	1591	1808	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	76	76	76	Record
• Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by [signature]

Reviewed by [signature]

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 5-20-82

CCL No. 001-000-002 Part No. ____________ AFTER THERMAL AGING INTERVAL No. 4

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200 V AC	6-11-82
DMM 130	6011	0-10 A AC	8-4-82
Fluke	8008	K	10-14-82
Megger	6007	500 MΩ	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	0.95	0.85	1.1	Record
Record Glow Plug Temperature	1702	1559	1788	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	81	80	81	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>500			> 50 megohms

Functional with Acceptable Limits ✓ Yes ___ No

ROA No. N/A

Tested by [signature]

Reviewed by [signature] 5/20/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 5-20-82

CCL No. 001-000-001 Part No. ____________ AFTER THERMAL AGING INTERVAL No. 4.

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Dmm 179	6005	0-200 V AC	6-11-82
Dmm 130	6011	0-10 A AC	8-4-82
Fluke	8008	K	10-14-82
Megger	6007	500 M Ω	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	1.0	0.88	1.2	Record
Record Glow Plug Temperature	1706	1529	1828	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	79	79	80	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes ___ No

ROA No. N/A

Tested by Clarence E. Reh

Reviewed by K. McKeon 5/20/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 5-22-82

CCL No. 001-000-002 Part No. ____________

Post Wave Aging

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200 V AC	6-11-82
DMM 130	6011	0-10 A AC	8-4-82
megger	6007	500V MΩ	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	0.96	0.85	1.09	Record
Record Glow Plug Temperature	~~1882~~ 1705	1556	1802	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	88	88	88	Record

. Insulation Resistance

	Record	Requirements
Record Voltage Applied	500	500 volts
Record Insulation Resistance	>1000	> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by [signature]

Reviewed by K M[signature] 5/22/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division　　Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly　　Date of Test 5-22-82

CCL No. 001-000-001　　Part No. ____________

Post Wave Aging

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200 VAC	6-11-82
DMM 130	6011	0-10 AAC	8-4-82
Megger	6007	500V MΩ	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	1.02	0.89	1.22	Record
Record Glow Plug Temperature	1709	1522	1812	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	89	89	89	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000			> 50 megohms

Functional with Acceptable Limits ✓ Yes No

ROA No. N/A

Tested by Clarence E. Peh

Reviewed by K McPherson 5/22/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 6-2-82

CCL No. 001-060-002 Part No. ____________

POST SEISMIC TEST

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200 VAC	6-11-82
DMM 130	6011	0-10 A AC	8-4-82
MEGGER	6007	500 V MΩ	9-24-82
G.E. THERMOMETER	8008	THER. TYPE K	10-14-82
G.E. THERMOMETER	8009	THER. TYPE K	11-25-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	9.3	8.2	1.09	Record
Record Glow Plug Temperature	1710	1637	1850	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	89	89	89	Record
. Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>50			> 50 megohms

Functional with Acceptable Limits ✓ Yes ___ No

ROA No. N/A

Tested by S. F. Griffin

Reviewed by Clarence E. Rehs

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-I, Rev. 1

DATA SHEET FOR INTERMEDIATE FUNCTIONAL TEST

Client Power Systems Division Project No. 81-1609

Description of Sample Hydrogen Ignitor Assembly Date of Test 6-15-82

CCL No. 001-000-001 Part No. ____________ Post Seismic.

INSTRUMENT AND EQUIPMENT LIST

Item	CCL No.	Range	Calibration Due Date
Fluke meter	8009	K	11-25-82
DMM 179	6005	0-200 V AC	12-11-82
Amprobe	6008	0-6 A	5-5-83
Meggar	6007	0-50 MΩ 500V	9-24-82

Test Procedure	Record			Requirements
• Energize Test Sample with the following power.				
Voltage	120	108	132	120, 108, 132 VAC
Frequency	60	60	60	60 Hertz
Record Current	1.0	0.8	1.4	Record
Record Glow Plug Temperature	1840	1737	2031	1500°F Min @ 108, 1700°F Min @ 120 & 132 VAC
Record Case Temperature	89	89	89	Record
• Insulation Resistance				
Record Voltage Applied	500			500 volts
Record Insulation Resistance	>1000 MΩ			> 50 megohms

Functional with Acceptable Limits ✓ Yes ___ No

ROA No. N/A

Tested by [signature]

Reviewed by [signature] 6/15/82

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
Test Procedure No. 1609-1, Rev. 1

DATA SHEET FOR BASELINE AND FINAL FUNCTIONAL TEST

Client Power Systems Division   Project No. 81-1609
Description Sample Hydrogen Ignitor Assembly   Date of Test 11-2-82
CCL No. 1609-001-000-002 Part No. ________

INSTRUMENT AND EQUIPMENT LIST

ITEM	CCL NO.	RANGE	CALIBRATION DUE DATE
6011 DMM 130	6011	0-200 V AC	1-13-83
DMM 130	6016	0-2 A AC	1-13-83
5740	6014	1 sec.	7-19-83
Fluke	8009	K	11-25-82

Test Procedure	Record			Requirements	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	60	60	60	60 Hertz	
Current	0.94	0.82	1.06	Record	
Record Glow Plug Temperature	1866	1620	1978	See Para. 1.1	
Record Case Temperature	79	79	79	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	57	57	57	57 Hertz	
Current	0.95	0.85	1.11	Record	
Record Glow Plug Temperature	1826	1628	1981	See Para. 1.1	
Record Case Temperature	80	80	80	Record	
• Energize with the Following:					
Voltage	120	108	132	120, 108, 132 VAC	R1
Frequency	63	63	63	63 Hertz	
Current	0.91	0.81	1.03	Record	
Record Glow Plug Temperature	1825	1658	1974	See Para. 1.1	
Record Case Temperature	80	80	80	Record	
• Insulation Resistance					
Record Voltage Applied	>1000			500 Volts	
Record Insulation Resistance				> 50 Megohms	

Functional within Acceptable Limits ✓ Yes No   Tested By [signature]
ROA No. N/A   Reviewed By [signature]

CCL Corporate Consulting & Development Company, Ltd.
Koger Executive Center
P[illegible] 30096 • Raleigh, N.C. 27622 • 919-782-3441

JOB 1609 PSD
SHEET NO. 1 OF 1
CALCULATED BY [illegible] DATE 11-10-82
CHECKED BY [illegible] DATE 11/10/82
SCALE

Hydrogen Ignitor Assembly
1609-001-000-002

volts a.c.	temp °F
90	1341
93	1389
96	1440
99	1479
102	1528
105	1576
108	1610

APPENDIX C - RADIATION TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-3, Rev. 2
ISSUE DATE ______ PAGE 1 OF 2
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

RADIATION TEST

3.0 The requirements and procedures for irradiation of the Hydrogen Ignitor Assembly are described in the following paragraphs.

3.1 Test Requirement

The Hydrogen Ignitor test samples (1609-001-000-002 & 1609-001-000-001) shall be exposed to a Cobalt 60 source of gamma radiation to a total accumulated dose of 5.0×10^7 rads (air equivalent). The test samples shall also be exposed to a source of beta radiation to a total accumulated dose of 1.1×10^9 Rads (air equivalent). These doses are based upon the normally expected radiation exposure over the equipment qualified life, plus that associated with the Design Basis Accident, and include a 10-percent margin. R1

The radiation testing will be subcontracted to a CCL-approved radiation facility.

After completion of the Radiation Test, the Hydrogen Ignitor Assembly shall be functionally tested to verify operability in accordance with CCL Test Procedure 1609-1.

1.2 Test Procedure

The following information shall be supplied by the radiation facility:

a. Description of irradiation chamber or rooms and source, R1
b. Identification of the samples by sample number or other unique identification number,
c. Location of source and distance from test sample,

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

d. Type dosimetry used and its location from test sample, R1
e. Start and end date of test,
f. Signature of person performing the test,
g. Dose rate,
h. Total accumulated dose (air equivalent),
i. Calibration due date on dosimetry used, and
j. Certified test report or letter of certification.

3.3 Test Results

The test samples were subjected to the radiation test in accordance with the requirements and procedure specified above. The letters of certification from Georgia Institute of Technology follow this Test Procedure. R2

The test samples complied with the radiation test requirements.

Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
SCHOOL OF NUCLEAR ENGINEERING AND HEALTH PHYSICS
ATLANTA, GEORGIA 30332
March 2, 1982

NEELY NUCLEAR RESEARCH CENTER

(404) 894-3600

MAR 1982
RECEIVED
CCL
RALEIGH, N.C. 27612

Corporate Consulting and Development
P. O. Box 30096
Raleigh, North Carolina 27622

Attention: Mr. Doug Greenwood Reference: 1357
Ga. Tech 212013

Gentlemen:

The items covered by the above number have been irradiated in our hot cell facility using Cobalt 60 (gamma energies 1.173 Mev, 1.332 Mev) to a total dose of 5.0×10^7 rads (air) following an electron irradiation to a total dose of 1.18×10^9 rads.

We certify the specifics of the gamma irradiation as follows:

Irradiation periods:	Intervals on February 22-26, 1982 as shown on the enclosed Gamma Irradiation Log Sheet
Dose Rate:	7.146×10^5 rads/hour (air)
Total Dose:	5.0×10^7 rads (air)
Dosimetry:	Victoreen Radocon Model 550 Integrating/Rate Electrometer System with ionization chamber probe. Calibration by Victoreen traceable to NBS Cobalt-60.

Details concerning the electron irradiation are given in the enclosed memorandum from Dr. M. V. Davis.

Calculations, a sketch, and photographs of the arrangement are enclosed. Please let us know if any additional information is needed.

Yours truly,

T. F. Craft

T. F. Craft, PhD
Senior Research Scientist

TFC:lrm

Enclosures

AN EQUAL EDUCATION AND EMPLOYMENT OPPORTUNITY INSTITUTION

Georgia Institute of Technology
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
SCHOOL OF NUCLEAR ENGINEERING AND HEALTH PHYSICS
ATLANTA, GEORGIA 30332

NEELY NUCLEAR RESEARCH CENTER

(404) 894-3600

March 11, 1982

MEMORANDUM

TO: Dr. T. F. Craft

FROM: Dr. M. V. Davis M.V. Davis

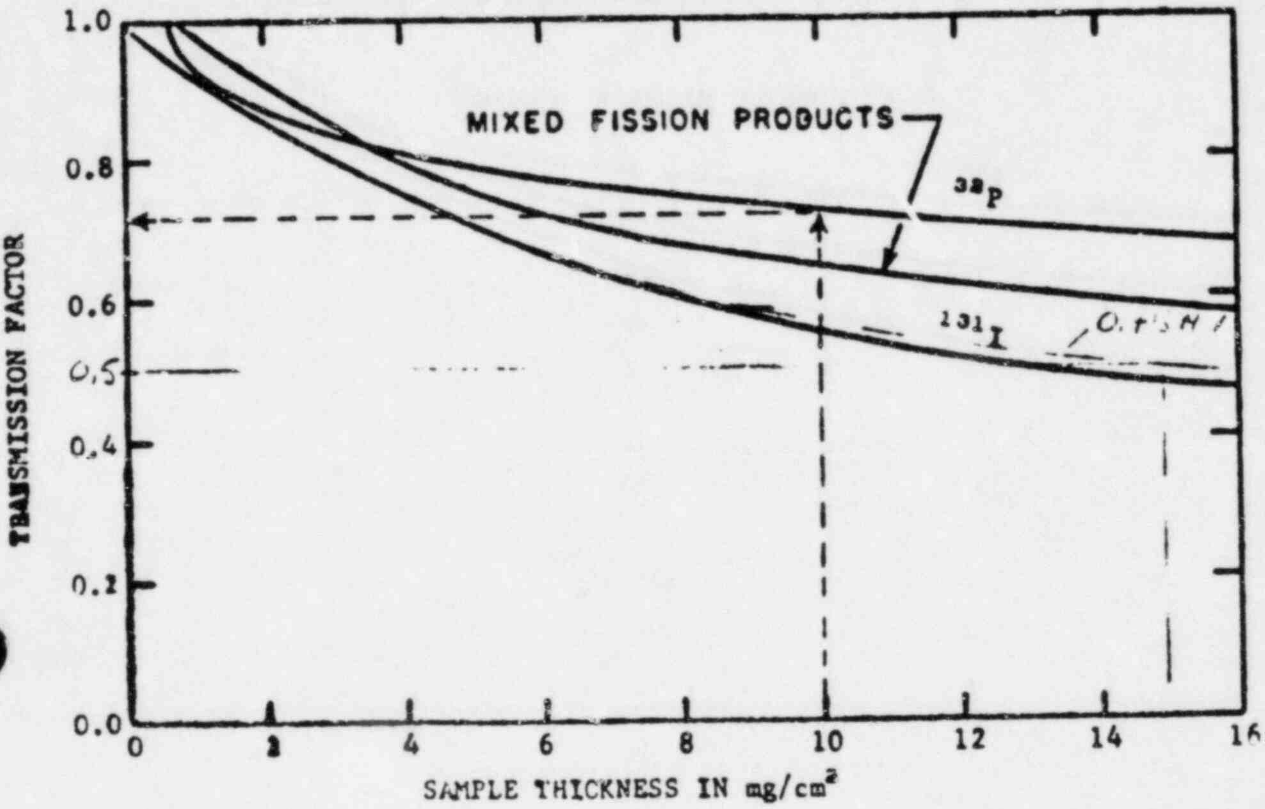
SUBJECT: Electron Irradiation of Hydrogen Igniters

The igniters were irradiated on all sides by the electron beam from the Dynamitron located in the Nuclear Engineering Department of the University of Arizona. The irradiations were performed at five milliamps with a beam power of 750 kV. This corresponds to an equivalent source at the horn of approximately one megacurie.

At a beam current of 5 ma there are 3.2 $(10)^{16}$ electrons/sec incident on the window. Between the inner side of the window and the geometrical center of the space occupied by the sample there is 15 mg/cm^2 of attenuating material so the beam intensity (of 0.75 MeV particles) is attenuated by 50%. At the sample 1.6 $(10)^6$ electrons/sec or 1.2 $(10)^{22}$ eV/sec is incident. The dose given to the sample is then calculated to be

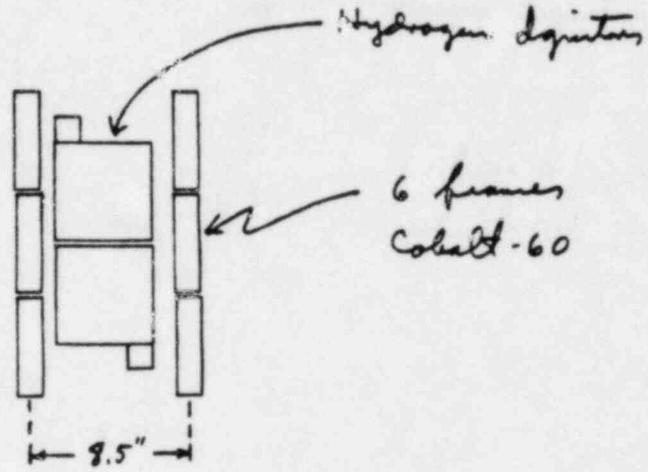
$$1.18\ (10)^9 \text{ rad.}$$

MVD:lrm



Data on this page obtained from: "Radioactivity Assay of Water and Industrial Wastes with Internal Proportional Counter," by L. R. Setter, A. S. Goldin, and J. S. Nader, Analytical Chemistry, Vol. 26, p. 1305, Aug. 1954.

CCL 1357 Ga. Tech 212013



Not to scale

Dosimetry at center:

$$\overset{\text{Radcon reading}}{1.88} \times \underset{\text{Probe factor}}{95.1} \times \overset{\text{Temperature factor}}{1.095} \times \underset{\text{Pressure factor}}{1.014} \times \overset{\text{Conversion factor}}{3.6} = 7.146 \times 10^{5} \text{ Rads/hr}$$

GEORGIA INSTITUTE OF TECHNOLOGY

Nuclear Research Center
900 Atlantic Drive, N.W.
Atlanta, Georgia 30332
(404) 894-3608

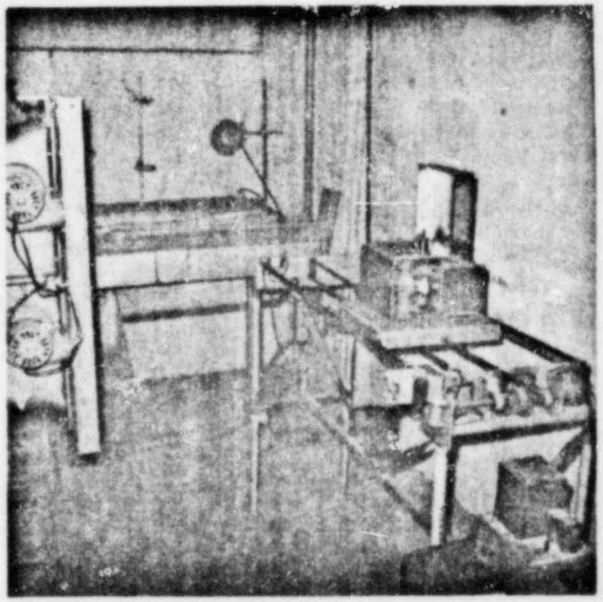
GAMMA IRRADIATION LOG

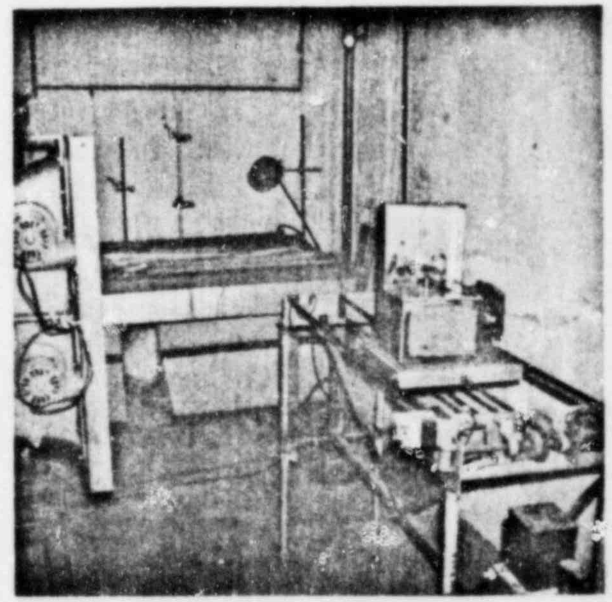
Client: Corporate Consulting NRC Reference: 212013

Reference: 1357 Total Dose: 5.0×10^7

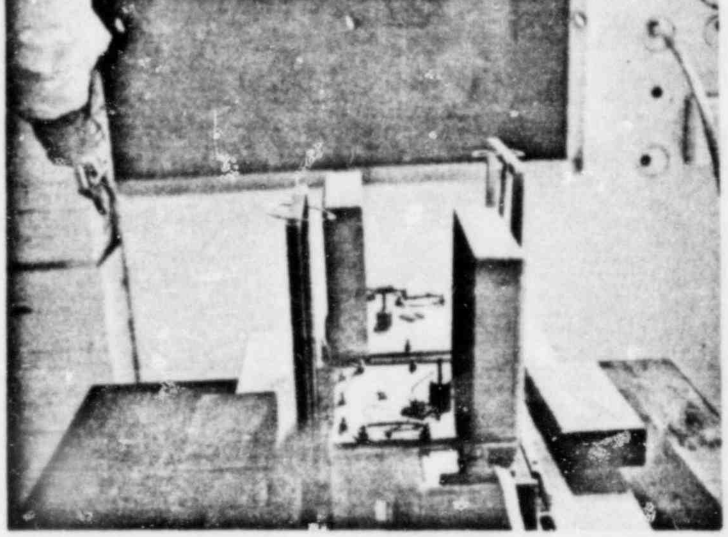
Item: (2) Hydrogen Ignitors Dose Rate:

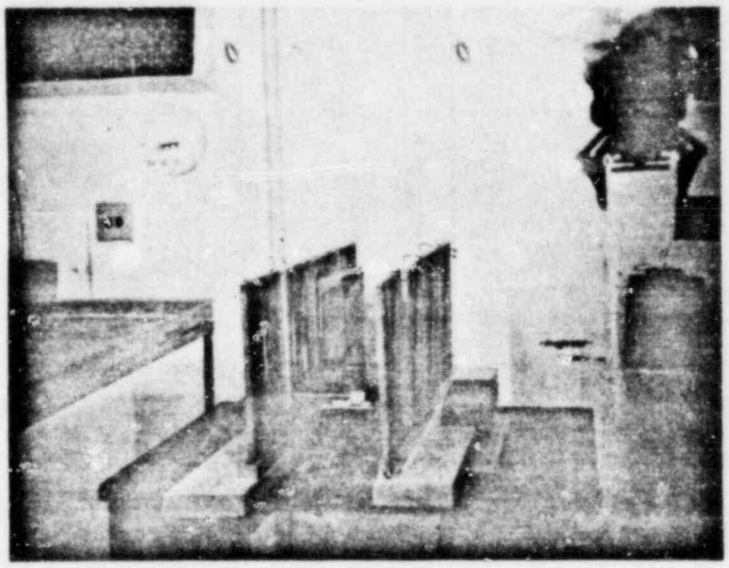
Start	Stop	Lapsed Hours	Dose Rate Rads/hour	Total Dose Rads	Cumulative Dose - Rads
2-22-82 1614	2-24-82 0930	41.2666	7.146×10^5	2.94×10^7	2.94×10^7
2-24-82 1626	2-25-82 1610	23.7333	7.146×10^5	1.69×10^7	4.63×10^7
2-26-82 0830	2-26-82 1340 and	5.1777	7.146×10^5	3.7×10^6	5.0×10^7
	39.7 hrs				





Positioning of Hydrogen Ignitors During Electron Irradiation





Positioning of Hydrogen Ignitors
During Gamma Irradiation

APPENDIX D - THERMAL AGING TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd.
Koger Executive Center
P.O Box 33096 • Raleigh N C 27622 • 919-782-3441

THERMAL AGING

2. The requirements and procedures for the Thermal Aging Test are presented in the following subsections.

2.1 Test Requirements

The sample shall be thermally aged to simulate the environmental aging effects that occur during its qualified life.

The thermal aging time required to simulate the test sample qualified life plus a 10% margin (minimum) shall be based upon the activation energy values of the age sensitive, nonmetallic materials which affect the safety-relayed function of the test sample.

The thermal aging temperature, duration of test, and aging condition of the test sample (energized or not energized) are shown in the attached appendix.

The temperature chambers used for this test shall comply with the following requirements.

a. The chamber shall be equipped with a primary and a redundant temperature controller.
b. The chamber control thermocouple shall be located at a position that measures the mean temperature inside the chamber. The chamber control thermocouple shall be located within 6" of the test samples. R1
c. Chamber heaters shall be baffled to prevent direct radiation of heat on the test sample.

d. The chambers shall be equipped with fans of adequate flow capacity to circulate the heated air.

After completion of the thermal aging test, the test sample shall be functionally tested in accordance with Test Procedure Number 1609-1.

2.2 Test Procedures

The primary test sample shall be installed in the temperature chamber. The test sample shall be positioned so air may circulate around and over each sample.

The specified aging temperature, test sample operating conditions, and duration of time required for each aging interval are listed in the attached Qualified Life Interval sheets.

The chamber temperature shall then be increased to and stablized at the required aging time temperature. This temperature shall be maintained until the specified aging time is obtained. The test sample shall then be removed from the chamber and a functional test shall be performed to verify that the test sample will function within its specified operating requirements. The functional requirement procedures are specified in the Test Procedure Number 1609-1.

After completion of the first aging interval, both the primary and the spare test sample shall be installed in the temperature chamber and procedure repeated.

The above procedure shall be repeated until the Aging Days Required as specified in the attached Qualified Life Interval sheets are completed.

The spare sample shall be functionally tested before and after thermal aging or in the event of the prime sample failure. Intermediate functional testing of the spare sample is not required.

The instrumentation and equipment, along with their ranges and calibration due dates used in the performance of the thermal aging test shall be recorded on the attached CCL TF-069-A, B, and C. Thermal aging times shall also be recorded on CCL TF-069-A, B, and C. R1

2.3 Test Results R2

The test samples were subjected to the Thermal Aging Test in accordance with the requirements and procedures specified above. The Thermal Aging Data Sheets for the samples follow this Test Procedure. The chambers used for thermal aging and the instrumentation used, range and calibration due dates are listed on the Thermal Aging Data Sheets.

The test samples complied with the requirements and procedures specified above.

CCL Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P[illegible] 30096 • Raleigh, N C 27622 • 919-782-3441

TEST PROCEDURE

Data Sheet for Thermal Aging

Client ______ Project Number ______

Oven Number ______ Date Test Started ______ Date Test Completed ______

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature ______ B. Chamber Humidity ______ %RH

o Wet Bulb Temp. ______

o Dry Bulb Temp. ______

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date

CCL Number	Required Days	IN Date	IN Time	IN By	OUT Date	OUT Time	OUT By

Remarks ______ Reviewed by ______

Page ___ of ___

TF-069 A

CCL Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh, N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Data Sheet for Thermal Aging

Oven Number ______ Project Number ______ Continued: Page ____ of ____

CCL Number	Required Days	IN Date	IN Time	IN By	OUT Date	OUT Time	OUT By

Remarks ______

TF-069 B

Reviewed By ______ ______

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
PO [illegible] 30096 • Raleigh, N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Data Sheet for Thermal Aging

Oven Number ______ Continued: Page ___ of ___

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb ( )	Wet Bulb ( )	Humidity (%RH)	By

Remarks ______

TF-069 C

Reviewed By ______

TF-067

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.[redacted]0096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No. 1609-2, Rev. 2
ISSUE DATE ____________ PAGE 7 OF 10
PREPARED BY ____________ DATE ____________
APPROVED BY ____________ DATE ____________
APPROVED BY ____________ DATE ____________
QA REVIEW BY ____________ DATE ____________

Test Procedure No. 1609-2 Rev. 1
Client PSD
Project Number 81-1609
Interval Number 1
Page 1 of 1

QUALIFIED LIFE INTERVAL

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___ C & >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
001-000-002	Hydrogen Ignitor	[illegible]	No	4.1[illegible]					N/C				
001-000-001	Hydrogen Ignitor	N/A											

TF-061-B

TF-067

CCL Corporate Consulting & Development Company, Ltd.

Koger Executive Center
P[illegible] 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-2, Rev. 2
ISSUE DATE ______ PAGE 8 OF 10
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Test Procedure No. 1609-2 Rev. 1
Client PSD
Project Number 81-1609
Interval Number 2
Page 1 of 1

QUALIFIED LIFE INTERVAL

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (57°C @ >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
001-000-002	Hydrogen Ignitor	1.5[illegible]	No	14.[illegible]					Y[illegible]				
001-000-001	Hydrogen Ignitor	1.5[illegible]	No	14.[illegible]					Y[illegible]				

TF-061-B

TF-067

CCL Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-2, Rev. 2
ISSUE DATE ______ PAGE 9 OF 10
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Test Procedure No. 1609-2 Rev. 1
Client PSD
Project Number 81-1609
Interval Number 3
Page 1 of 1

QUALIFIED LIFE INTERVAL

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___ C @ 90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
001-000-002	Hydrogen Ignitor	[illegible]	No	14.1					No				
001-000-001	Hydrogen Ignitor	[illegible]	No	14.1					No				

TF-061-B

Corporate Consulting & Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No. 1609-2, Rev. 2
ISSUE DATE ______ PAGE 10 OF 10
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Test Procedure No. 1609-2 Rev. 1
Client PSD
Project Number 81-1609
Interval Number 4
Page 1 of 1

QUALIFIED LIFE INTERVAL

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___C @ ___PERM)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, O-OBSERVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
001-000-002	Hydrogen Ignitor	115°C	No	14.14					No				
001-000-001	Hydrogen Ignitor	115°C	No	14.14					No				

TF-061-B

TF-067

Data Sheet for Thermal Aging

Client Power Systems Division Project Number 81-1609

Oven Number H007 Date Test Started 03-08-82 Date Test Completed 03-22-82

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature 115 °C B. Chamber Humidity Ambient %RH

o Wet Bulb Temp. N/A

o Dry Bulb Temp. N/A

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date
Wahl	8005	J	12-22-82

		IN			OUT		
CCL Number	Required Days	Date	Time	By	Date	Time	By
001-000-002	14-14	3-8-82	1000	[illegible]	3-22-82	1322	[illegible]

Remarks INTERVAL No. 1 Reviewed by [illegible]

Page 1 of 2

TF-069 A

Data Sheet for Thermal Aging

Oven Number H007 Continued: Page 2 of 2

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb (°C)	Wet Bulb ( )	Humidity (%RH)	By
3-8-82	1000	115	N/A	N/A	[illegible]
3-9-82	0850	115	N/A	N/A	[illegible]
3-10-82	0835	115	N/A	N/A	[illegible]
3-11-82	0900	114	N/A	N/A	[illegible]
3-12-82	0900	115	N/A	N/A	[illegible]
3-13-82	0900	115	N/A	N/A	[illegible]
3-15-82	2100	114	N/A	N/A	[illegible]
3-16-82	2000	114	N/A	N/A	[illegible]
3-17-82	2000	114	N/A	N/A	[illegible]
3-18-82	1015	114	N/A	N/A	[illegible]
3-19-82	1415	114	N/A	N/A	[illegible]
3-22-82	1145	113	N/A	N/A	[illegible]

Remarks 1609-001-000-002

INTERVAL No. 1

TF-069 C

Reviewed By [signature]

QUALIFIED LIFE INTERVAL

Test Procedure No. 1609-3
Client Power Systems Division
Project Number 81-1609
Interval Number 1

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___ C @ >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL.	RECORD OF ANOMALY (N/A OR NUMBER)	
1609 001-000-001	Hydrogen Ignitor	N/A											
1609 001-000-002	Hydrogen Ignitor	115°C	NO	14.14	3/8/82	3/22/82	Ø	14.14 / 14.14	NO	3-24-82 P		N/A	

Data Sheet for Thermal Aging

Client Power Systems Division Project Number 81-1609

Oven Number H007 Date Test Started 03-29-82 Date Test Completed 4-13-82

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature 115° C B. Chamber Humidity Ambient %RH

o Wet Bulb Temp. N/A

o Dry Bulb Temp. N/A

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date
Wahl	E005	J	12-22-82

		IN			OUT		
CCL Number	Required Days	Date	Time	By	Date	Time	By
001-000-002	14.14	03-29-82	1000	CC	04-13-82 ~~04-12-82~~	0850 ~~1322~~	CC
001-000-001	14.14	03-29-82	1000	CC	04-13-82 ~~04-12-82~~	0850 ~~1322~~	CC

Remarks INTERVAL No. 2 Reviewed by [signature]

TF-069 A

Data Sheet for Thermal Aging

Oven Number H007

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb (°C)	Wet Bulb ( )	Humidity (%RH)	By
03-29-82	1000	115	N/A	N/A	[illegible]
03-30-82	1200	114	N/A	N/A	[illegible]
03-31-82	1320	115	N/A	N/A	[illegible]
04-01-82	1403	115	N/A	N/A	[illegible]
04-02-82	1145	115	N/A	N/A	[illegible]
04-05-82	1625	115	N/A	N/A	[illegible]
04-06-82	1015	115	N/A	N/A	[illegible]
04-07-82	1400	115	N/A	N/A	[illegible]
04-08-82	1030	115	N/A	N/A	[illegible]
04-09-82	1410	115	N/A	N/A	[illegible]
04-13-82	0850	115	N/A	N/A	[illegible]

Removed from oven at 0850 04-13-82

Remarks 1609-001-000-002

1609-001-000-001

INTERVAL No. 2

TF-069 C

Reviewed By [illegible signature]

Data Sheet for Thermal Aging

Client Power Systems Division Project Number 81-1609

Oven Number 4002 Date Test Started 4-19-82 Date Test Completed 4-20-82

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature 57.2 °C B. Chamber Humidity > 90 %RH

o Wet Bulb Temp. 55.2

o Dry Bulb Temp. 57.2

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date
Fluke Meter	8008	J -200+ +770°C	10-14-82

CCL Number	Required Days	IN Date	IN Time	IN By	OUT Date	OUT Time	OUT By
001-000-001	1	4-19-82	1130	[illegible]	4-20-82	1130	[illegible]
001-000-002	1	4-19-82	1130	[illegible]	4-20-82	1130	[illegible]

Remarks HUMIDITY SOAK Reviewed by [signature]

TF-069 A

Data Sheet for Thermal Aging

Oven Number 4002 Continued: Page 2 of 2

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb (57-2) °C	Wet Bulb (55-2) °C	Humidity (%RH)	By
4-19-82	1130	57	55	90	[illegible]
4-20-82	0910	57	55	90	[illegible]
4-20-82	1130	57	55	90	[illegible]
4-20-82	1130	removed	samples	from oven	[illegible]

Remarks HUMIDITY SOAK

TF-069 C

Reviewed By [signature]

QUALIFIED LIFE INTERVAL

Test Procedure No. 1609-3
Client Power Systems Division
Project Number 81-1609
Interval Number 2

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (57.2C @ >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL.	RECORD OF ANOMALY (N/A OR NUMBER)	
1609 001-000-001	Hydrogen Ignitor	115°C	NO	14.14	3-29-83	4-12-83	Ø	14.95 / 14.95	yes				
1609 001-000-002	Hydrogen Ignitor	115°C	NO	14.14	3-29-83	4-12-83	Ø	14.95 / 29.09	yes	4-20-83 / P		N/A	

Data Sheet for Thermal Aging

Client Power Systems Division Project Number 81-1609

Oven Number 4007 Date Test Started 4-20-82 Date Test Completed 5-4-82

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature 115 °C B. Chamber Humidity N/A %RH

o Wet Bulb Temp. N/A

o Dry Bulb Temp. N/A

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date
Fluke	8008	J	10-14-82

		IN			OUT		
CCL Number	Required Days	Date	Time	By	Date	Time	By
001-000-001	14-14	4-20-82	1415	[illegible]	5-4-82	~~1739~~ 1537	[illegible]
001-000-002	14.14	4-20-82	1415	[illegible]	5-4-82	~~1737~~ 1537	[illegible]

Remarks 2 hrs. oven time lost due to time error

INTERVAL No. 3

Reviewed by [illegible signature]

Page 1 of 2

TF-069 A

Data Sheet for Thermal Aging

Oven Number H007 Continued: Page 2 of 2

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb (115 °C)	Wet Bulb ( )	Humidity (%RH)	By
4-20-82	1415	115	N/A	N/A	[illegible]
4-21-82	0850	116	N/A	N/A	[illegible]
4-22-82	0840	115	N/A	N/A	[illegible]
4-28-82	1713	115	N/A	N/A	WMJ
4-30-82	15:45	115	–	–	WMJ
5-3-82	9:18A	115	NA	NA	WMJ
5-4-82	2:25P	115	NA	NA	WMJ
5-4-82	3:37P	115	OVEN off		WMJ

Remarks 1609 - 001 - 000 - 001

1609 - 001 - 000 - 002

INTERVAL No. 3

TF-069 C

Reviewed By [illegible signature]

Test Procedure No. 1609-3
Client Power Systems Division
Project Number 81-1609
Interval Number 3

QUALIFIED LIFE INTERVAL

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___C @ >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
1609 001-000-001	Hydrogen Ignitor	115°C	NO	14.14	4-20-83	5-4-83	2 hrs.	14 / 38.4	NO			N/A	
1609 001-000-002	Hydrogen Ignitor	115°C	NO	14.14	4-20-83	5-4-83	2 hrs.	14 / 13.09	NO	5-5-83 / P		N/A	

Data Sheet for Thermal Aging

Client Power Systems Division   Project Number 81-1609

Oven Number 4007   Date Test Started 5-5-82   Date Test Completed 5-20-82

1. Test Conditions Required: The following test conditions shall be monitored and recorded each working day.

A. Chamber Temperature 115 °C   B. Chamber Humidity N/A %RH

o Wet Bulb Temp. N/A

o Dry Bulb Temp. N/A

Instrumentation and Equipment List

Item	CCL Number	Range	Calibration Due Date
Fluke meter	8008	J	10-14-82

CCL Number	Required Days	IN Date	IN Time	IN By	OUT Date	OUT Time	OUT By
001-000-001	14.14	5-5-82	1430	TC	5-20-82 ~~5-19-82~~	0830 ~~1952~~	TC
001-000-002	14.14	5-5-82	1430	TC	5-20-82 ~~5-19-82~~	0810 ~~1952~~	TC

Remarks INTERVAL No. 4   Reviewed by H F Hatmaker

TF-069 A

Data Sheet for Thermal Aging

Oven Number H007 Continued: Page 2 of 2

Chamber Temperature Monitoring Log

Date	Time	Dry Bulb (°C)	Wet Bulb ( )	Humidity (%RH)	By
5-5-82	1430	115	N/A	N/A	
5-6-82	0906	116	N/A	N/A	
5-7-82	0855	115	N/A	N/A	WMJ
5-10-82	10:55A	114°C	NA	NA	WMJ
5-11-82	0840	115 °C	N/A	N/A	
5-12-82	1310	115	N/A	N/A	
5-13-82	0840	115	N/A	N/A	
5-14-82	1440	115	N/A	N/A	
5-17-82	0930	115	N/A	N/A	
5-18-82	0928	114	N/A	N/A	
5-19-82	0900	114	N/A	N/A	
5-20-82	0830	Both items removed			

Remarks 1609 - 001 - 000 - 001

1605 - 001 - 000 - 002

INTERVAL No. 4

TF-069 C

Reviewed By [signature]

QUALIFIED LIFE INTERVAL

Test Procedure No. 1609-3
Client Power Systems Division
Project Number 81-1609
Interval Number 4

CCL SAMPLE NUMBER	DESCRIPTION	AGING TEMPERATURE AND CHAMBER NUMBER	SAMPLE ENERGIZED DURING AGING YES/NO	AGING DAYS REQUIRED	DATE STARTED AGING INTERVAL	DATE COMPLETED AGING INTERVAL	AGING TIME LOST DURING INTERVAL	TOTAL ACCUMULATED DAYS OF AGING/INTERVAL	24 HOUR HUMIDITY CYCLE (___C @ >90%RH)	FUNCTIONAL TEST DATE/P-PASSED, C-CALIBRATION, R-REMOVED	ACCUM. YEARS OF THERMAL AGING/INTERVAL	RECORD OF ANOMALY (N/A OR NUMBER)	
1609 001-000-001	Hydrogen Ignitor	115 °C	NO	14.14	5-5-82	5-20	Ø	14.53 / 4348	NO	5-20 / P		N/A	
1609 001-000-002	Hydrogen Ignitor	115 °C	NO	14.14	5-5-82	5-20	Ø	14.53 / 5262	NO	5-20 / P		N/A	

APPENDIX E - WEAR AGING TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd
Koger Executive Center
P.O. Box 30096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

WEAR AGING

4.0 The requirements and procedures for Wear Aging of the Hydrogen Ignitors are presented in the following subsections. R1

4.1 Test Requirements

4.1.1 The test samples shall be wear aged to simulate the number of operating cycles they will experience during their qualified life, plus a minimum margin of ten percent. R1

4.1.2 The prime test sample (1609-001-000-002) shall be cycled a total of 572 cycles (minimum). The spare test sample (1609-001-000-001) shall be cycled a total of 286 cycles (minimum). A Cycle shall consist of energizing the transformer with 120 VAC and allowing the glow plug temperature to increase to a minimum of 1700°F and then de-energizing the transformer and allowing the glow plug temperature to decrease to 100°F + 100°F, -0°F. R1

4.1.3 After completion of the wear aging cycling, the test samples shall be subjected to a functional test in accordance with the requirements and procedures specified in Test Procedure Number 1609-1.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

4.2 Test Procedures

R1

4.2.1 The test samples shall be electrically connected and instrumented as shown in the attached schematic. The timing device shown in the schematic shall be set to energize and de-energize the ignitor. The on/off times shall be adjusted so that the glow plug temperature cycles within the required values. The test samples shall be cycled to the number of cycles required in Section 4.1, with data recorded on the attached data sheets.

4.2.2 After completion of the wear aging test, the test samples shall be subjected to a functional test as specified in Test Procedure 1609-1. R1

4.3 Test Results R2

The test samples were electrically cycled in accordance with the requirements and procedures specified above. The Data Sheets for Wear Aging follow this test procedure.

The test samples complied with the requirements and procedures specified above.

Corporate Consulting & Development Company, Ltd.

Koger Executive Center
30096 • Raleigh N C 27622 • 919-782-3?41

TEST PROCEDURE

PROCEDURE No. 1609-4, Rev. 2
ISSUE DATE ______ PAGE 3 OF 4
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

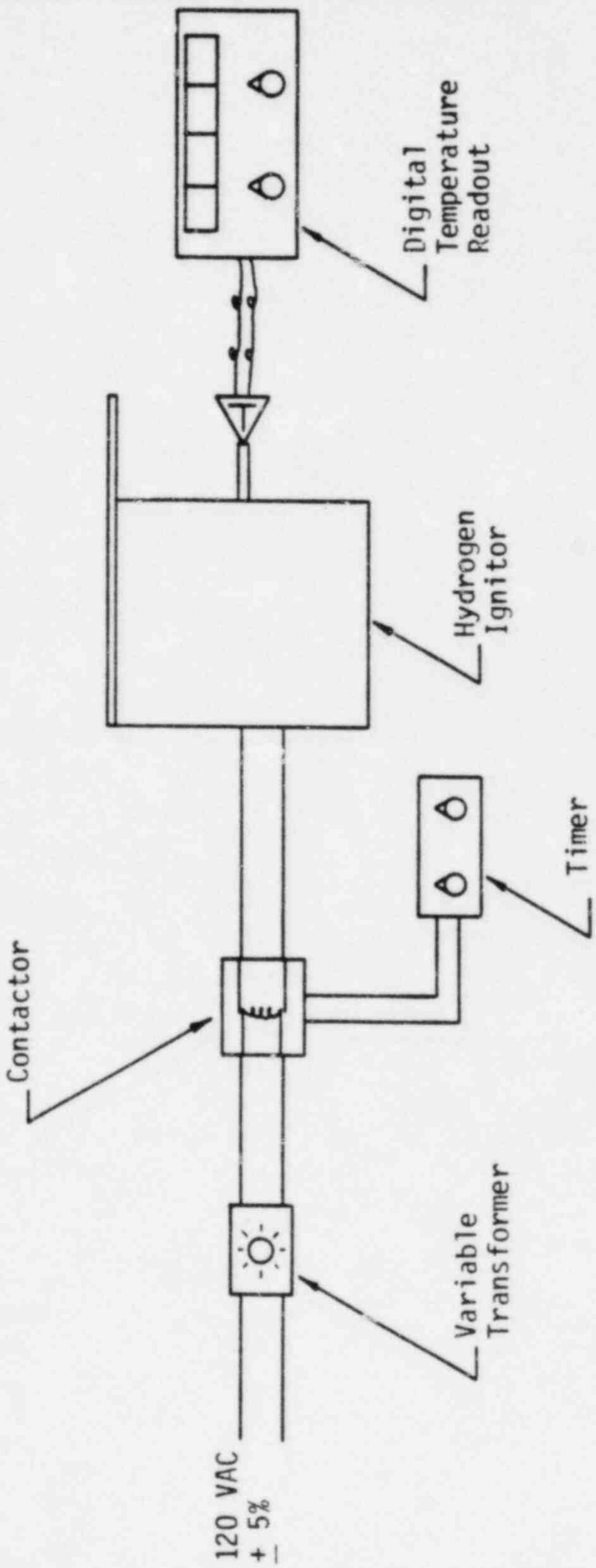


Figure 1609-4-1 Wear Aging Test Setup

CCL Corporate Consulting & Development Company, Ltd.

Koger Executive Center
Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

Test Procedure 1609-4

Data Sheets for Wear Aging of
Hydrogen Ignitor Assemblies

Client Power Systems Division Project No. 81-1609

Dates of Test ______

Instrument and Equipment List

Item	CCL No.	Range	Calibration Due Date

Test Parameter	Record Sample No. 1609- 001-000-002	Record Sample No. 1609- 001-000-001	Requirements
Input Voltage			120 VAC ± 5%
Maximum Temperature			1700°F minimum
Minimum Temperature			100°F + 100°F, -0°F
Record Counter reading			Zero or initial reading
Record number of cycles at end of 20 year equivalent cycling	N/A		Final counter reading
	N/A		286 cycles minimum
Record number of cycles at end of 40 year equivalent cycling		N/A	Final counter reading
		N/A	592 cycles minimum

Functional within Acceptable Limits

Sample 1609-001-000-002 Yes ___ No ___ ROA No. ______

Sample 1609-001-000-001 Yes ___ No ___ ROA No. ______

Tested by ______ Reviewed by ______

Test Procedure 1609-4

Data Sheets for Wear Aging of
Hydrogen Ignitor Assemblies

Client Power Systems Division Project No. 81-1609

Dates of Test 5-21-82

Instrument and Equipment List

Item	CCL No.	Range	Calibration Due Date
Fluke meter	8008	T	10-14-82
DMM 179	6005	0-200 V AC	12-11-82

Test Parameter	Record Sample No. 1609- 001-000-002	001-000-001	Requirements
Input Voltage	120	120	120 VAC ± 5%
Maximum Temperature	1745	1737	1700°F minimum
Minimum Temperature	120	118	100°F + 100°F, -0°F
Record Counter reading	358984	359270	Zero or initial reading
Record number of cycles at end of 20 year equivalent cycling	N/A	359576	Final counter reading
	N/A	306	286 cycles minimum
Record number of cycles at end of 40 year equivalent cycling	359576	N/A	Final counter reading
	592	N/A	592 cycles minimum

Functional within Acceptable Limits

Sample 1609-001-000-002 Yes ✓ No ___ ROA No. N/A

Sample 1609-001-000-001 Yes ✓ No ___ ROA No. N/A

Tested by [signature] Reviewed by K McPherson 5/21/82

APPENDIX F - SDRC SEISMIC TEST REPORT 10824-3

SDRC

Structural Dynamics Research Corporation

SDRC Report No. 10824-3

SEISMIC QUALIFICATION REPORT
ON
TWO HYDROGEN IGNITERS AND ASSEMBLIES

Prepared for

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
P.O. BOX 30096
RALEIGH, NORTH CAROLINA 27622

Prepared by

STRUCTURAL DYNAMICS RESEARCH CORPORATION
2000 EASTMAN DRIVE
MILFORD, OHIO 45150

JUNE 15, 1982

Contacts:

Corporate Consulting and Development
(919) 782-3441

Mr. Douglas Greenwood

SDRC (513) 576-2400

Mr. Gary Patrick
Mr. Thomas Zurmehly
Mr. Anthony Wolfer

RECORD OF REVISION

Rev. No.	Date	Pages Affected	By	Approvals Initials		
				Reviewed	Approved	QA Approved
0						

TABLE OF CONTENTS

I. QUALIFICATION RESULTS CERTIFICATION AND SUMMARY

SDRC Report No. 10824-3 Volume 1 of 1 Revision Number 0 Date 6/15/82

SDRC Project No. 10824-3 Dates from 5/26/82 to 5/26/82

Customer: Corporate Consulting & Development Company, Ltd.

Customer P.O. Number 1331

Address: P.O. BOX 30096
Raleigh, North Carolina 27622

Test Specimen(s) Two Hydrogen Igniter Assemblies

Manufacturer Power Systems – A Morrison-Knudsen Division
101 Gelo Road
P.O. Box 1928
Rocky Mount, North Carolina 27801

Summary

The test levels meet or exceed the Required Response Spectra. Both test items passed all structural acceptance criteria. Operability was performed by CCL personnel and will be reported by CCL under separate cover.

Prepared by: Anthony T. Wolfer
Anthony T. Wolfer, Test Engineer

Reviewed by: Gary B. Patrick
Gary B. Patrick, Senior Project Manager

Reviewed by: Gary T. Popp
Gary T. Popp, Q.A. Engineer

Approved by: Edward L. Peterson
Edward L. Peterson, PE, Technical Director–Testing

Certification of Results:

I hereby certify that the test specimen(s) have been qualified in full accordance with the Customers Purchase Order and is qualified to withstand without loss of those functions and/or structural integrity for the seismic condition provided in the Purchaser's Specification as presented to SDRC. The test has been supervised and reviewed by me.

Signature Edward L. Peterson

Registration P.E. Number E104507
State of Ohio

Date 16-July-82 P.E. Stamp

NAME AND LOCATION OF TEST FACILITY

STRUCTURAL DYNAMICS RESEARCH CORPORATION
2000 EASTMAN DRIVE
MILFORD, OHIO 45150
(513) 576-2400

1. Name of item:

   Item No. 1 – Hydrogen Igniter Assembly
   Item No. 2 – Hydrogen Igniter Assembly

2. Customer's part number:

   Item No. 1 – 1609-1-0-1
   Item No. 2 – 1609-1-0-2

3. Manufacturer's model number:

   Item No. 1 – PSD Ref. Drawing 6043C02001
   Item No. 2 – PSD Ref. Drawing 6043C02001

4. Manufacturer's serial number:

   N/A

5. Test date:

   5/26/82

6. Specification number and source:

   Supplied by CCL

7. Specification class or seismic category:

   Class 1E

8. Spectrum curves used (RRS's) and sources:

   See Section III.1

9. Number of orientations:

   1

10. Number of tests/orientations:

    1 SRV 30 min.
    5 OBE
    1 SSE plus SRV plus LOCA

11. Equipment is: stock ____, or special ✓

12. Equipment qualified by: analysis ____, test ✓, combination ____

13. Equipment is: mechanical ____, electrical ✓, other ____, instrumentation ____

14. Equipment is a: motor ____, pump ____, fan ____, panel ____, switchgear ____, instrument ____, other (specify) hydrogen igniter

15. Schematic and photographs of test setup:

    See Section III.3

16. Equipment is located in the N/S* building at elevation N/S*, and is attached to the: floor ____, wall ✓, ceiling ____, other (specify) ____

17. Summary of resonances located in equipment:

    See Section IV.1

18. Damping values used in TRS calculation:

    SRV 2%
    OBE 2%
    SSE 3%

19. Justification of use of damping values other than as allowed in Item 6:

    N/A

20. Description of the testing approach (such as biaxial, triaxial testing, simulated plant operation, testing frequency range, frequency interval, type of frequency wave from inputs, etc.):

    Triaxial random input 1 to 100 Hz

*Not Specified

21. Method of monitoring and location of monitors:

    Survey accelerometers placed on the hydrogen igniters at locations specified by CCL.

22. Statement of equipment function before and after tests:

    The igniters were operated and monitored by CCL personnel

23. Test levels shown to meet or exceed required response spectra:

    See Section IV.2

24. Mounting of test item as compared to actual mounting:

    The hydrogen igniters were mounted to duplicate in-service mounting as closely as was practical. See Section III.3.

25. Test observers (representatives from customer and/or supplier):

    CCL – Mr. Douglas Greenwood

26. Test logs:

    See Appendix VII.2

II. INTRODUCTION

This report documents a full scale tri-axis seismic qualification test performed by Structural Dynamics Research Corporation for Corporate Consulting and Development Company, Ltd. The items tested were Two Hydrogen Igniter Systems.

This test was conducted at the SDRC* testing laboratory in Milford, Ohio on May 26, 1982.

Participants in this project are:

Corporate Consulting & Development, Ltd.

Mr. Douglas Greenwood

SDRC

Mr. Gary Patrick
Mr. Thomas Zurmehly
Mr. Anthony Wolfer

*SDRC is a service mark of Structural Dynamics Research Corporation.

III. TEST DESCRIPTION

III.1 Required Response Spectrum (RRS)

The response spectrum was provided by CCL. The horizontal and vertical SRV spectra are shown in Figures III.1 and III.2. The horizontal and vertical OBE spectra are shown in Figures III.3 and III.4. The horizontal and vertical SSE curves are shown in Figures III.5 and III.6.

III.2 Test Signal Generation

The horizontal and vertical input signals were generated by three random noise signals shaped by one-third octave digital equalizers The resulting signals are tape recorded for playback to the table. The signals are 30 seconds in duration. Figure III.7 shows approximately 5 seconds of the horizontal and vertical time signals.

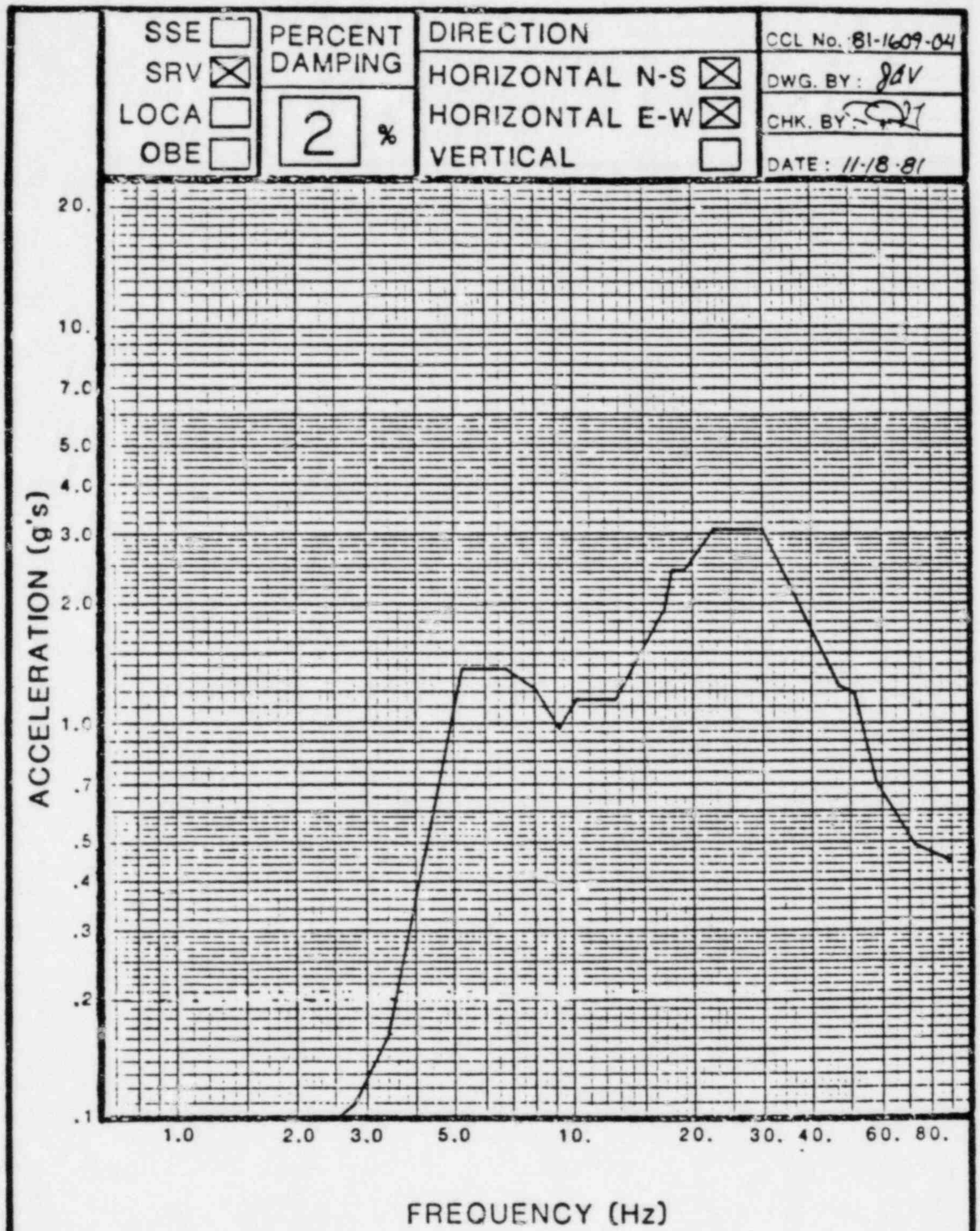


Figure III.1
Horizontal RRS for SRV Loads

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

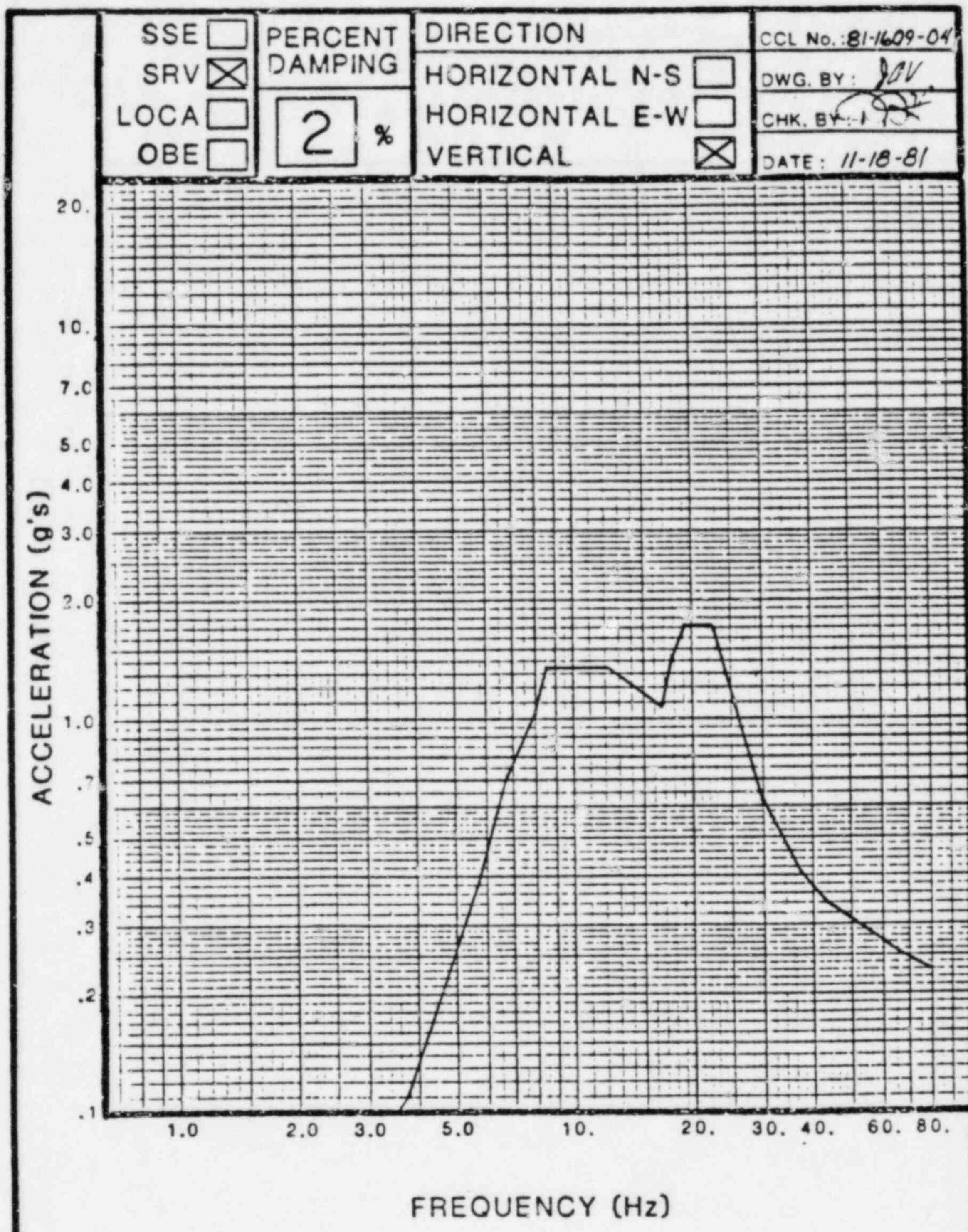


Figure III.2
Vertical RRS for SRV Loads

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

SSE ☐ SRV ☐ LOCA ☐ OBE ☒	PERCENT DAMPING 2 %	DIRECTION HORIZONTAL N-S ☒ HORIZONTAL E-W ☒ VERTICAL ☐	CCL No.: 81-1609-04 DWG. BY: JAV CHK. BY: [illegible] DATE: 11-18-81

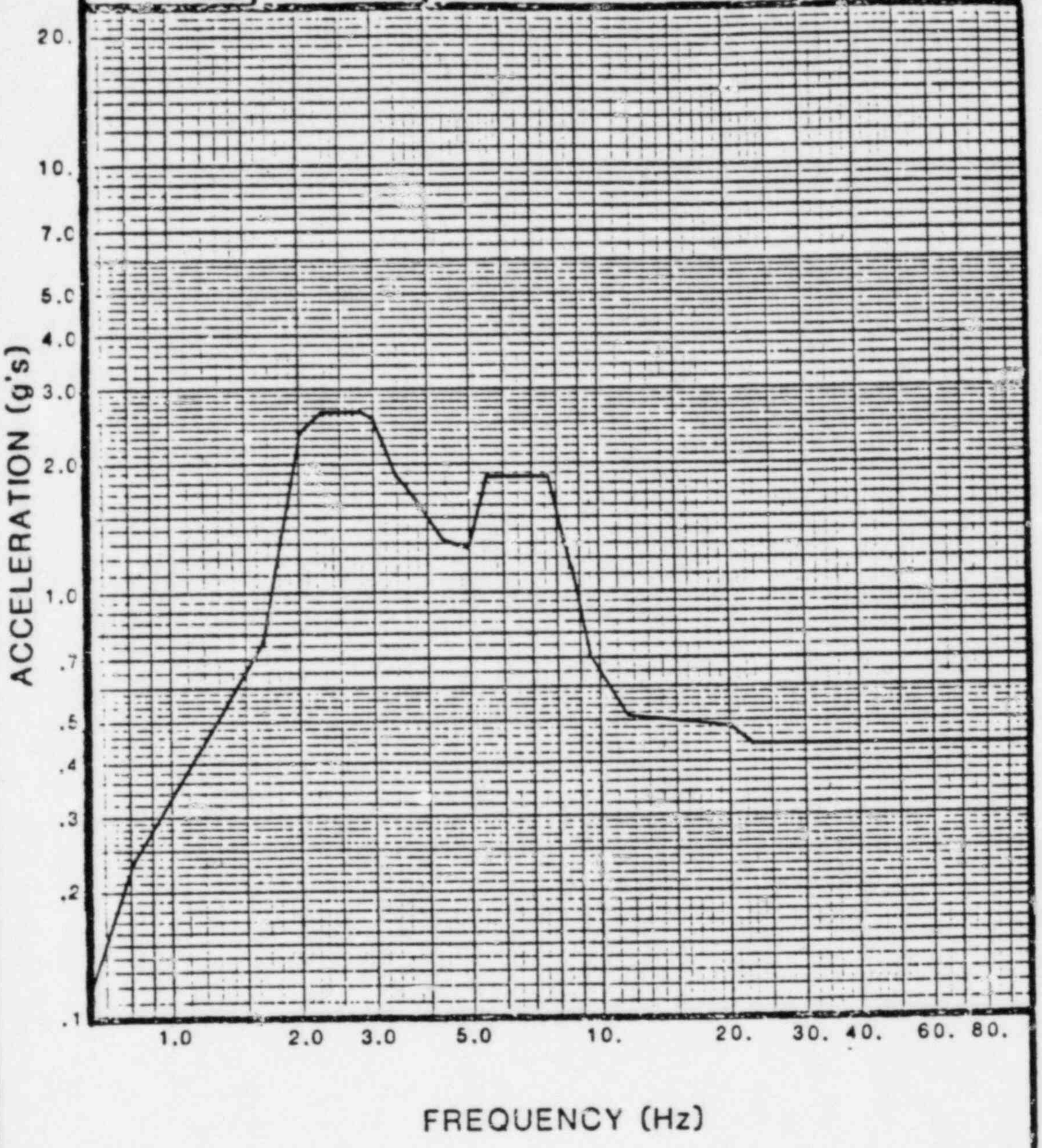


Figure III.3
Horizontal RRS for OBE

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

TF004-G

SSE ☐ SRV ☐ LOCA ☐ OBE ☒	PERCENT DAMPING 2 %	DIRECTION HORIZONTAL N-S ☐ HORIZONTAL E-W ☐ VERTICAL ☒	CCL No.: 81-1609-01 DWG. BY: JDV CHK. BY: DATE: 11-18-81

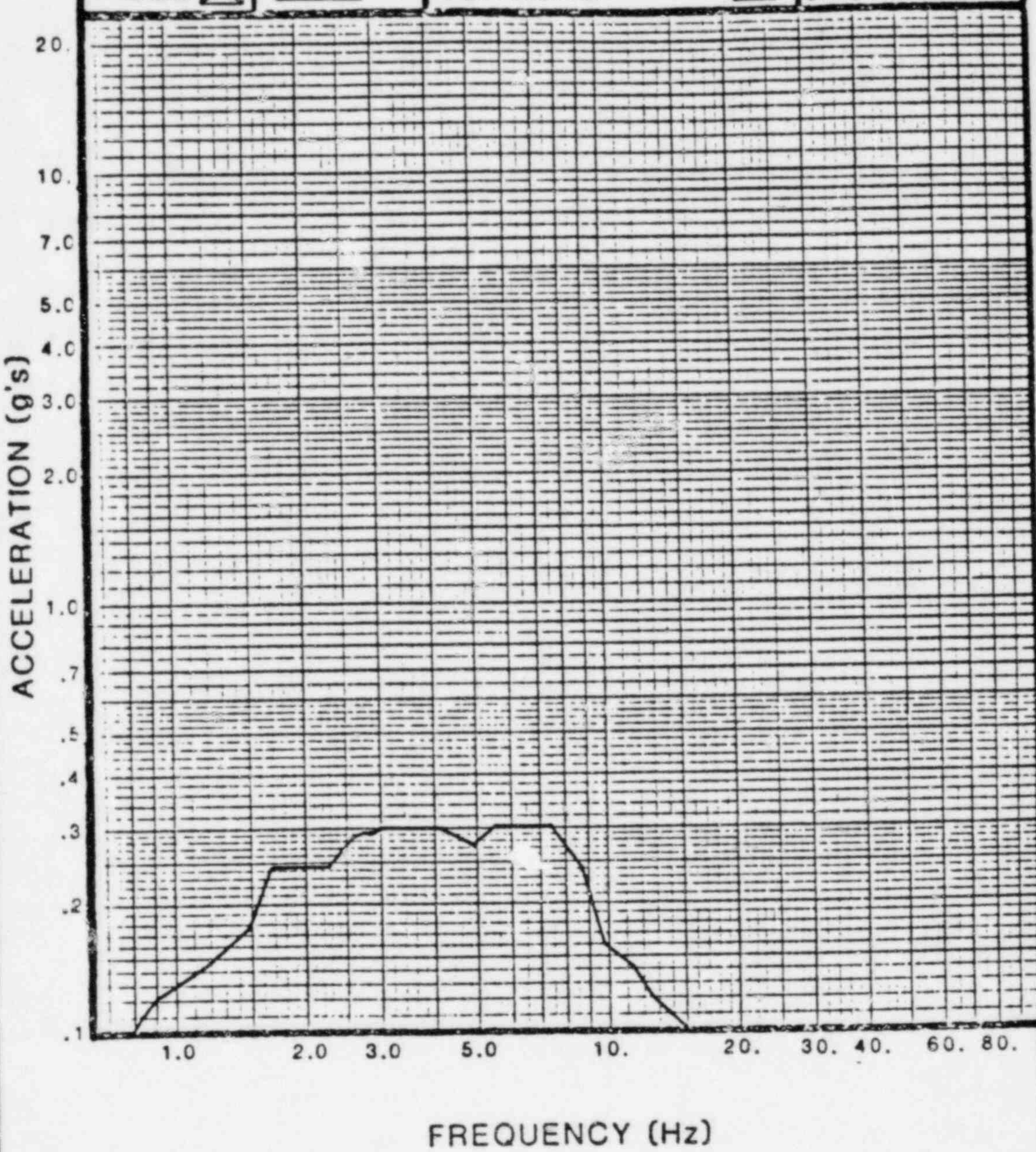


Figure III.4
Vertical RRS for OBE

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

SSE ☒	PERCENT DAMPING	DIRECTION	CCL No.: 81-1609-04
SRV ☒	3 %	HORIZONTAL N-S ☒	DWG. BY: JJV
LOCA ☒		HORIZONTAL E-W ☒	CHK. BY: [illegible]
OBE ☐		VERTICAL ☐	DATE: 11-20-81

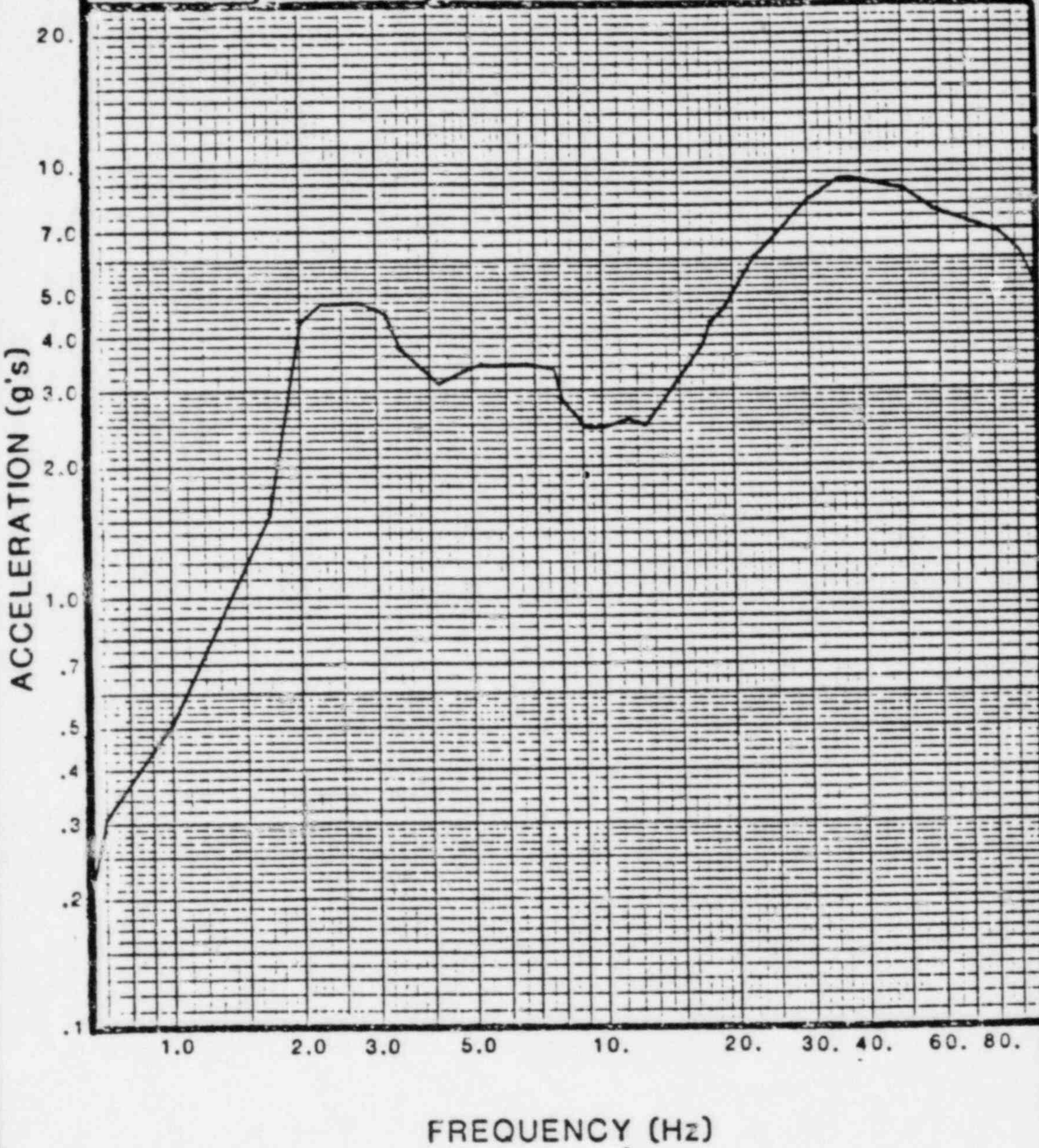


Figure III.5
Horizontal RRS for Combined SSE, SRV, and LOCA Loads

Corporate Consulting & Development Company, Ltd.
consultants constructors
KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

TF004-G

SSE ☒ SRV ☒ LOCA ☒ OBE ☐	PERCENT DAMPING 3 %	DIRECTION HORIZONTAL N-S ☐ HORIZONTAL E-W ☐ VERTICAL ☒	CCL No.: 81-K09-04 DWG. BY: JAV CHK. BY: [illegible] DATE: 11-20-81

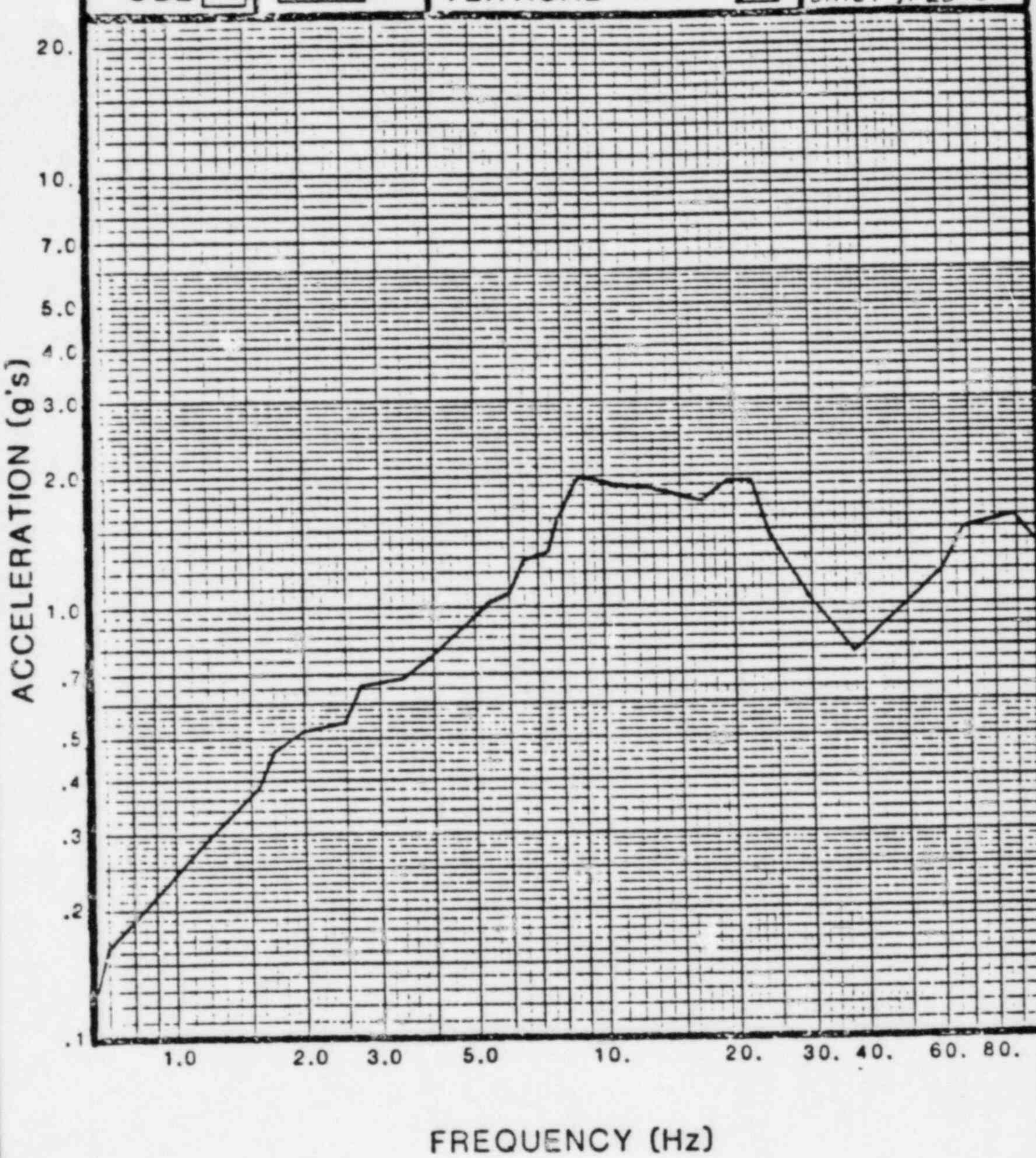


Figure III.6
Vertical RRS for Combined SSE, SRV, and LOCA Loads

Corporate Consulting & Development Company, Ltd.

consultants constructors

KOGER EXECUTIVE CENTER RALEIGH, NORTH CAROLINA

TF004-G

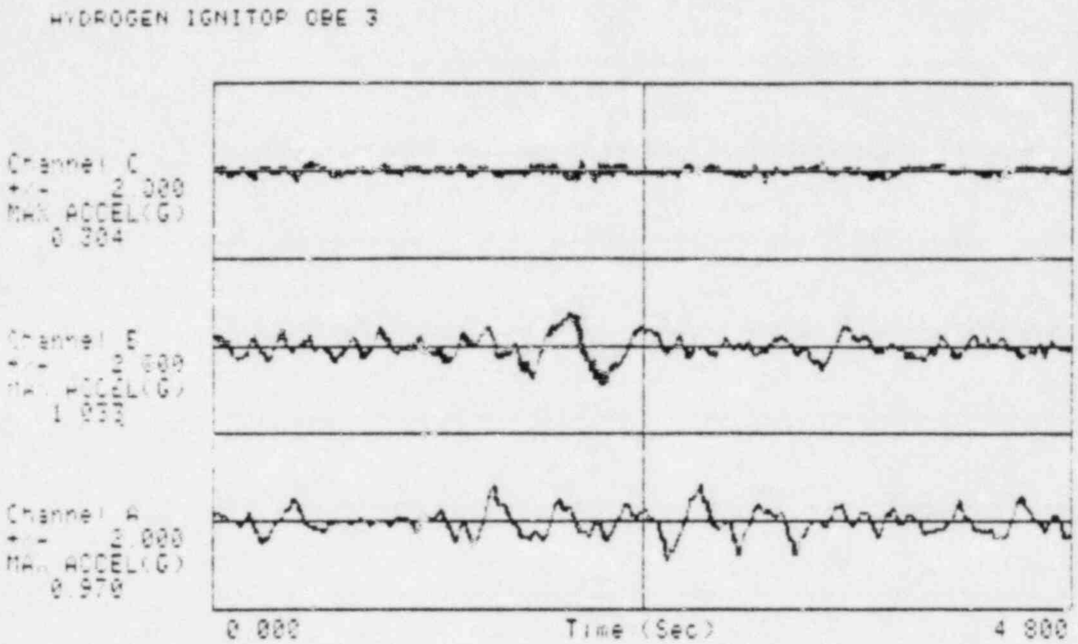


Figure III.7
Acceleration Time Histories
Channel A — N-S
Channel B — E-W
Channel C -- Vertical

III.3 Description and Mounting of Test Specimens

The mounting of the test specimen simulated the actual in-service mounting as closely as was practical. The hydrogen igniters were bolted to unistrut which was welded to the test fixture. The test fixture was rigidly clamped to the shake table. 1 5/8" x 1 5/8" x 1/4" square washers were placed between the igniters and the unistrut. Each igniter was mounted with four 3/8" – 16 ASTM A-307 bolts with lock washers. See Figure III.8.

III.4 Test Procedure

III.4.1 Exploratory Test

The frequency search was conducted in each principal axis prior to the full level qualification described in Section 2 below. This search was in the form of a single axis continuous frequency sweep using a sinusoidal steady state input at the lowest amplitude capable of determining resonance. This frequency search was conducted by developing transmissibility plots for point(s) on the test specimen. A transmissibility plot is defined as the ratio of motion of a point on the object divided by the input motion at the base of the item or the table on which the item is mounted. Peaks in the transmissibility plot represent the natural frequencies of the system. Phase angle of the output with respect to the input is also provided.

Transmissibility function(s) are calculated using Fourier analysis techniques on a GenRad test system. This technique ratio's the Fourier spectrum of the component response to the Fourier spectrum of the input motion.

The frequency of the input excitation was varied from 1.0 to 100 Hz.

The linear sweep rate was equivalent to two octaves per minute. The sine sweep was applied in the order of 0.2g to 0.4g.

Response accelerometers were mounted on the specimen as required to record natural frequencies up to 100 Hz.

Natural frequencies were determined by the peaks and the phase angle in the transmissibility plot.

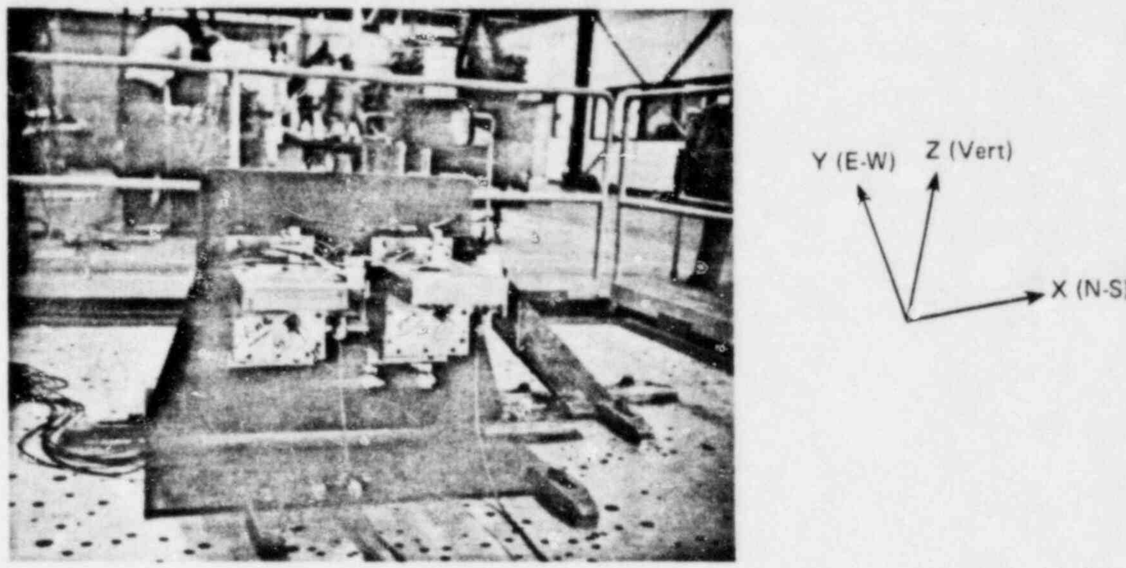


Figure III.8
Mounting of the Hydrogen Igniters on the
Triaxial Shake Table

III.4.2 Full Level Qualification Test

Simultaneous Excitation Technique

The seismic qualification for the subject equipment was performed by using an independent triaxial random motion simulator. Testing was performed with the test items' principal horizontal axis positioned parallel with the test table motion.

Thus, each horizontal axis was excited separately, but simultaneously with the vertical axis. The horizontal East-West, horizontal North-South and vertical input accelerations were independent (incoherent) of each other during the multi-frequency test.

Full Level Qualification Methodology

a. The number of tests performed simultaneously in three directions was one SRV 30 minute test, five operating basis earthquake basis (OBE) levels followed by one safe shutdown earthquake (SSE).

b. The specimen was subjected to a minimum test duration of 30 seconds. for the OBE and SSE tests.

c. The test consisted of simultaneous horizontal (N-S and E-W) and vertical inputs of continuous random waveform motion over the frequency range of 1.0 to 100 Hz.

d. The amplitude of each random waveform motion was independently adjusted at one-third octave frequency intervals in each axis until the TRS envelopes the RRS within the limitations of the test machine.

e. The resulting shake table motion was analyzed and plotted by a digital fourier analyzer using shock response software. This calculation was performed at the appropriate damping value and frequency interval:

Damping value(s): SRV 2%
OBE 2%
SSE 3%

Octave frequency interval: 1/3

III.5 Monitoring Instrumentation

SDRC calibrates all test equipment and instrumentation used in this test program in accordance with SDRC Quality Assurance Manual Section 12.001. This procedure is in compliance with 10CFR50 Appendix B, and ANSI/ASME N45.2-1977. Calibrations are traceable to the National Bureau of Standards.

III.5.1 Table Control

The three control accelerometers were mounted in the egg-crate designed shake table platform. These accelerometers are located in the approximate center of the horizontal planes and approximately 3 inches below the table top specimen interface plane.

The table control accelerometers were continuously monitored during the test using a brush recorder.

III.5.2 Survey Accelerometers

Three survey accelerometers (one triaxial location) were attached to each hydrogen igniter. See Section IV.1.

III.5.3 Electrical Monitoring

All operation and monitoring was performed and will be reported by CCL personnel.

III.6 Criteria for Test Acceptance

The criteria for seismic acceptance or failure of devices will include the following characteristics as applicable during and after testing:

1. No structural damage.
2. Igniters must function at specified temperature before, during and after seismic events.

IV. DATA PRESENTATION

IV.1 Transmissibility

This section reports the results of the low level swept sine tests. Horizontal and vertical sweeps were run at .2g peak acceleration table input for the three orientations. The linear sweep rate was equivalent to 2 octaves/minute. Transmissibility plots are generated by comparing the output of an accelerometer mounted on a test item to the output of a table reference accelerometer of the same direction.

Table IV.1 lists accelerometer locations, plot locations and resonant frequencies for the hydrogen igniters. SDRC documents significant resonances. Significant resonances are defined as those which have an amplification factor of 2 when the table motion is used as the reference.

Table IV.1

Accelerometer			Photo	Plot	Location	Summary of Major
Location	Number	Direction	Fig. No.	Fig. No.	Description	Resonances (Hz)*
1	1X	N-S	IV.1	V.1	Top of test item no. 1	78.5, 88.1
1	2Y	E-W	IV.1	V.2		33.9, 78.5, 88.1
1	3Z	Vert	IV.1	V.3		83.2, 92.3
2	4X	N-S	IV.1	V.4	Top of test item no. 2	78.5, 88.1
2	5Y	E-W	IV.1	V.5		33.9, 87.1
2	6Z	Vert	IV.1	V.6		82.2, 92.3

*These frequencies are cursored approximations at the equipment's resonant frequencies.

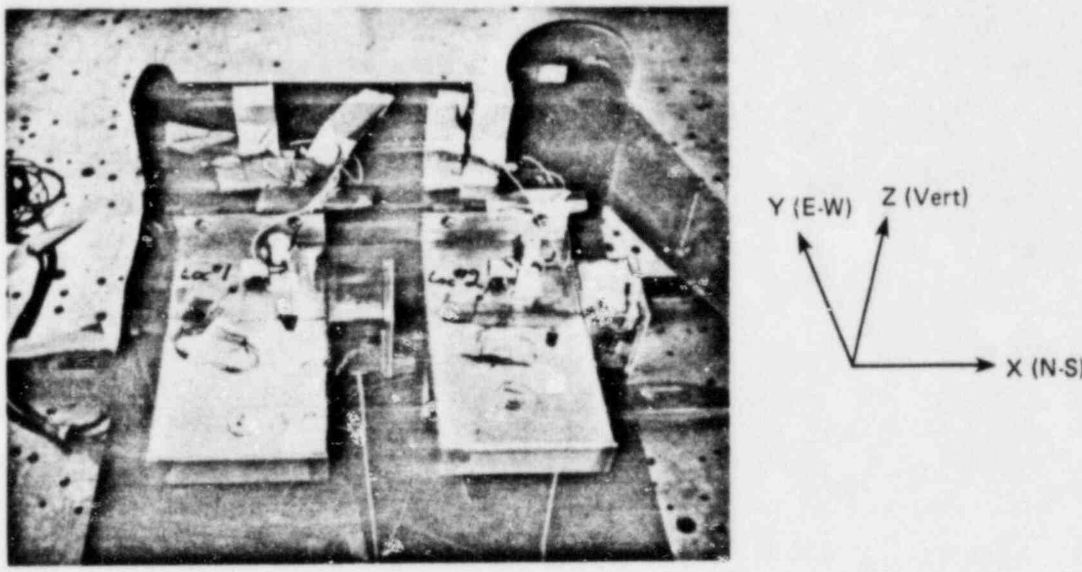


Figure IV.1
Accelerometer Mounting Locations

IV.2 Test Response Spectra (TRS)

The test response spectra for the various OBE levels and SSE levels are presented in Section VI.

Test no. 4 TRS enveloped the SRV RRS in all three axes.

Test nos. 5 through 9 TRS enveloped the OBE RRS in all three axes.

Test nos. 10 and 11 did not envelope.

Test no. 12 TRS enveloped the SSE plus SRV plus LOCA RRS in all three axes.

A representative TRS plot is provided in Figure VI.1 as a reference.

V. TRANSMISSIBILITY DATA

The data presented in this section is from the resonance search. See Section IV.1 for details.

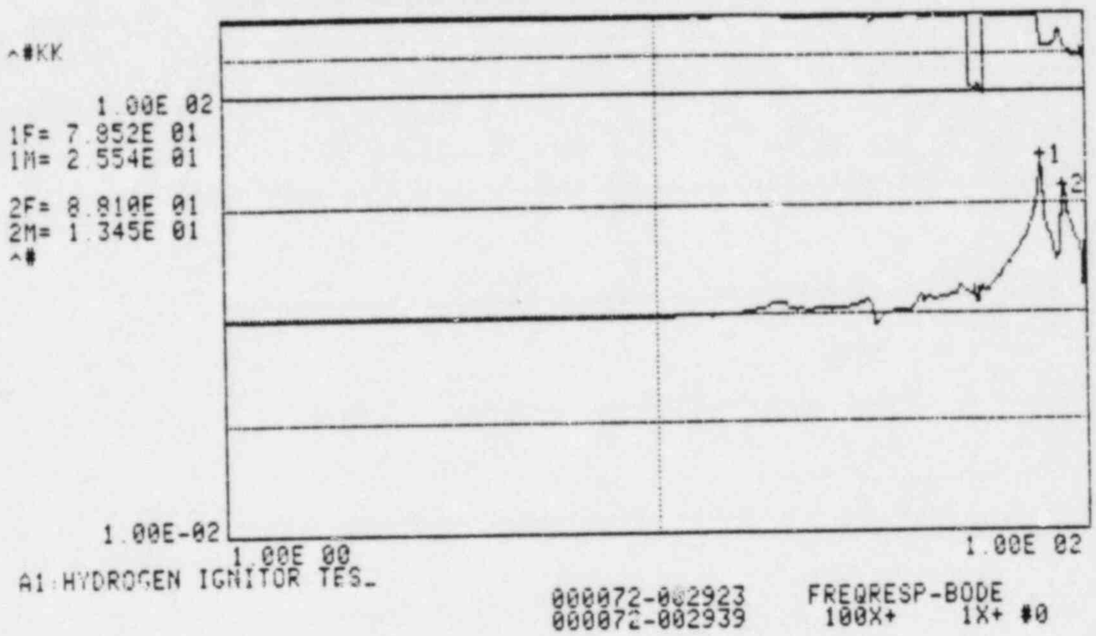


Figure V.1

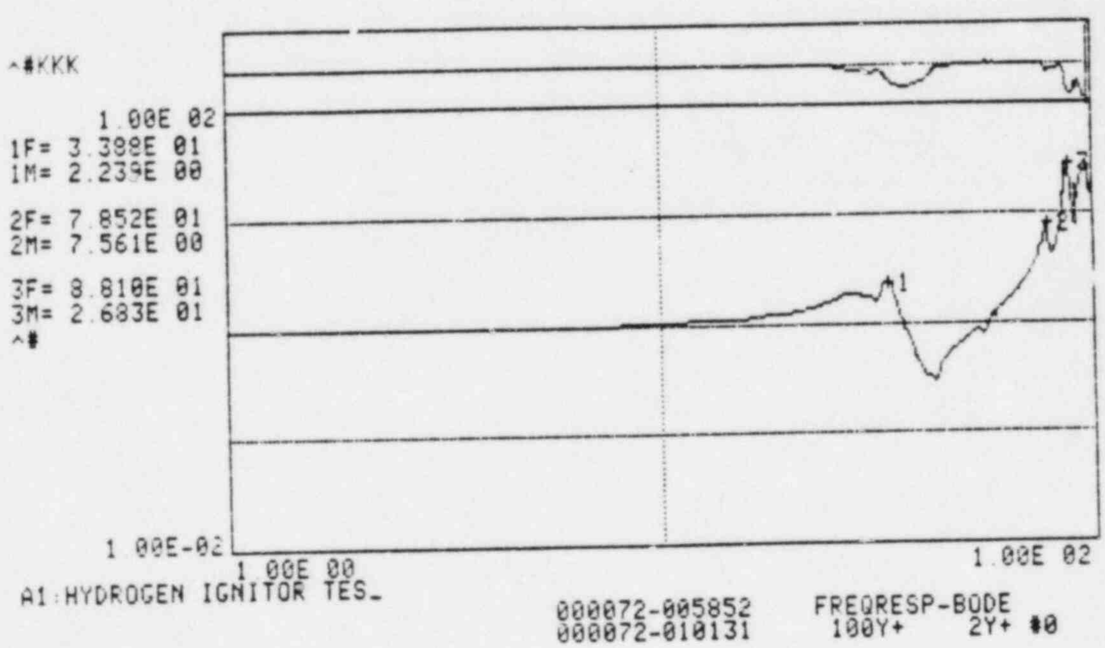


Figure V.2

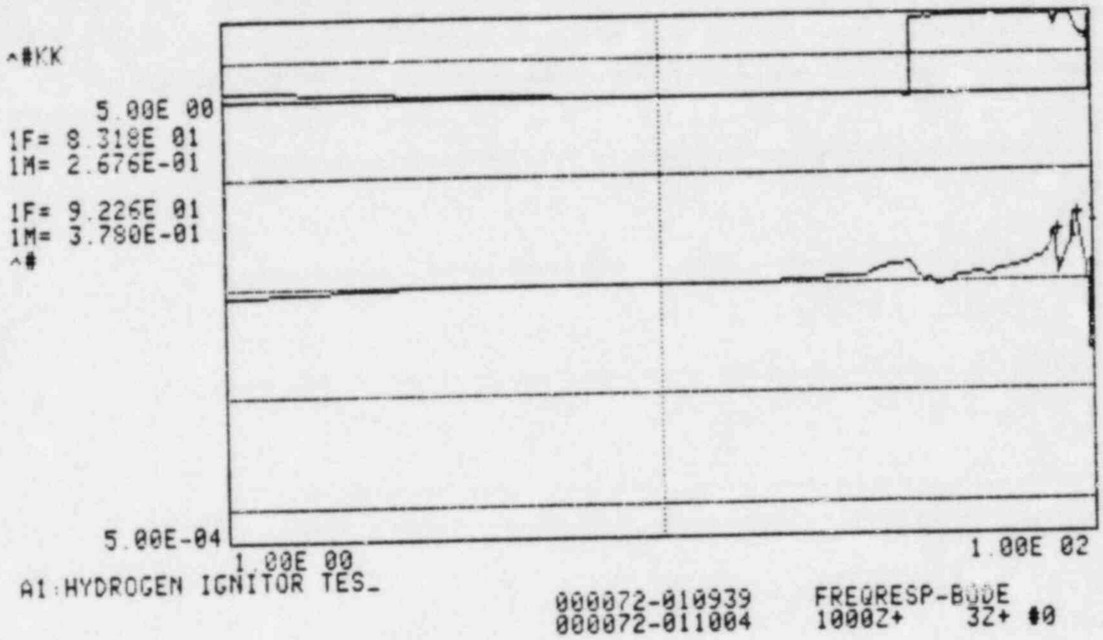


Figure V.3

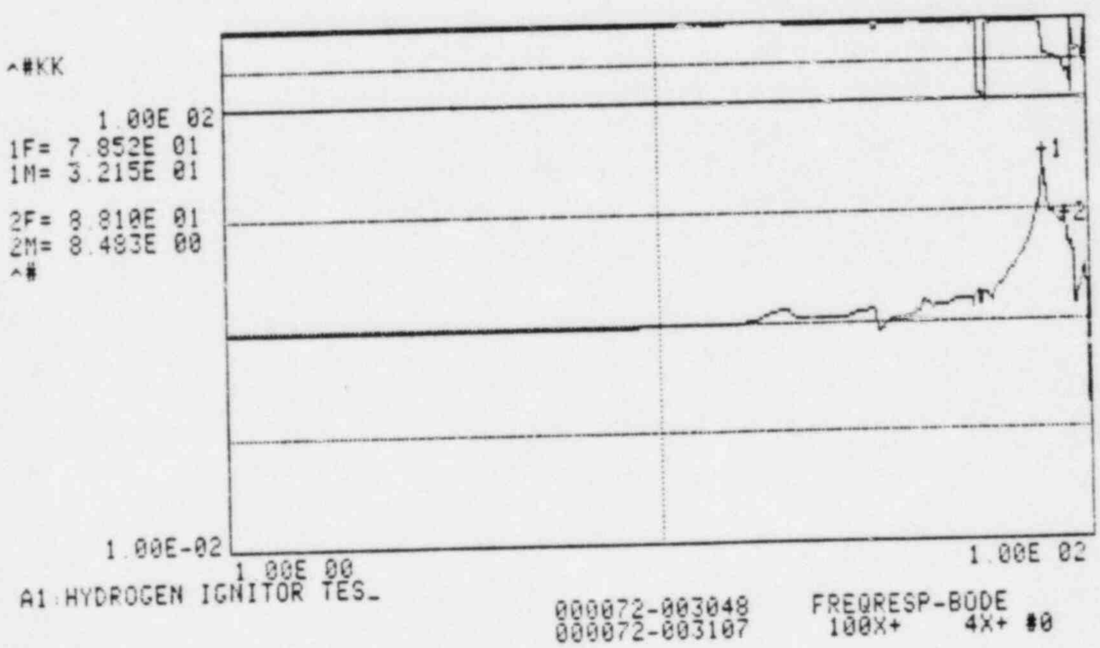


Figure V.4

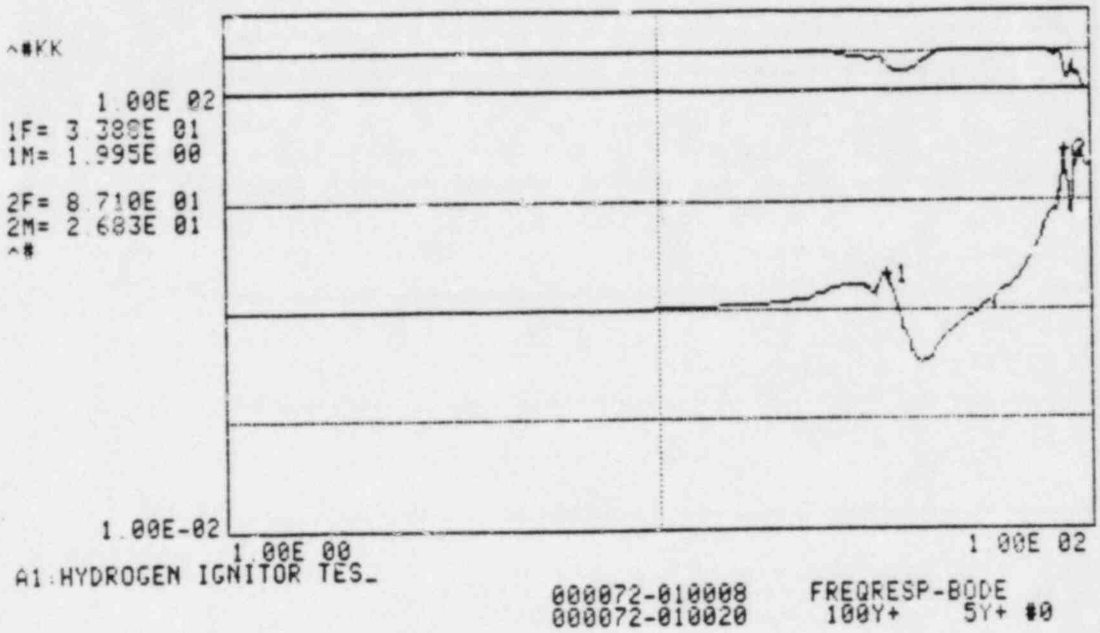


Figure V.5

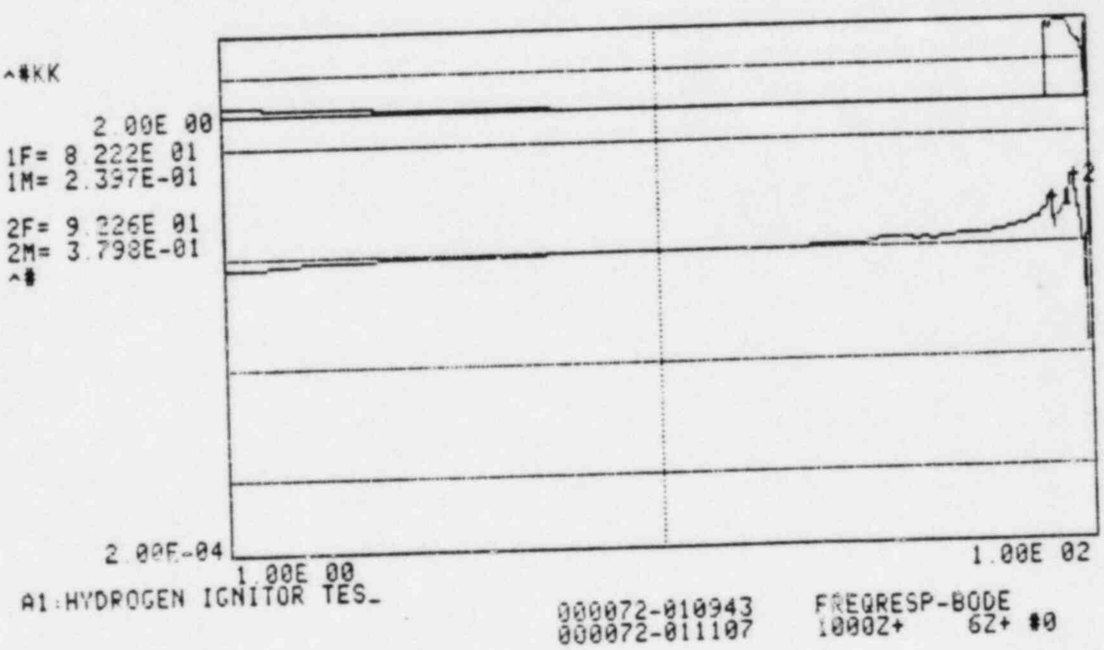


Figure V.6

VI. TEST RESPONSE SPECTRA PLOTS

VI.1 Table Controls

The table control TRS are presented as follows:

Test Number	Description	Pages
4	SRV 2%	27 – 29
5 – 9	OBE 1–5 2%	30 – 44
10 – 11	SSE 1–2 3%	45 – 50

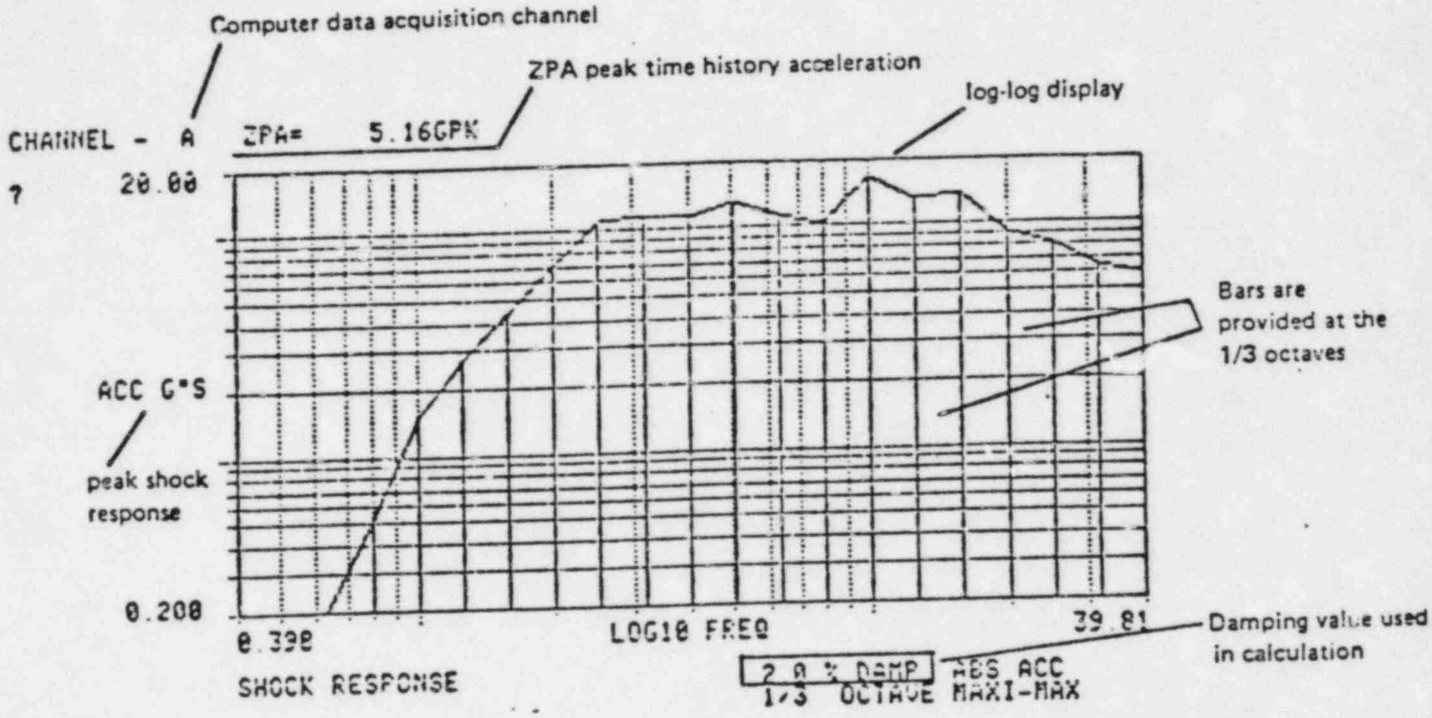
Tests nos. 10 and 11 TRS did not envelope the SSE plus SRV plus LOCA RRS

12	SSE 3 3%	51 – 53

VI.2 Survey Accelerometers

The TRS for the survey accelerometers are presented as follows:

Description	Pages
OBE 2%	54 – 59
SSE 3%	60 – 65



1/3 octave frequencies

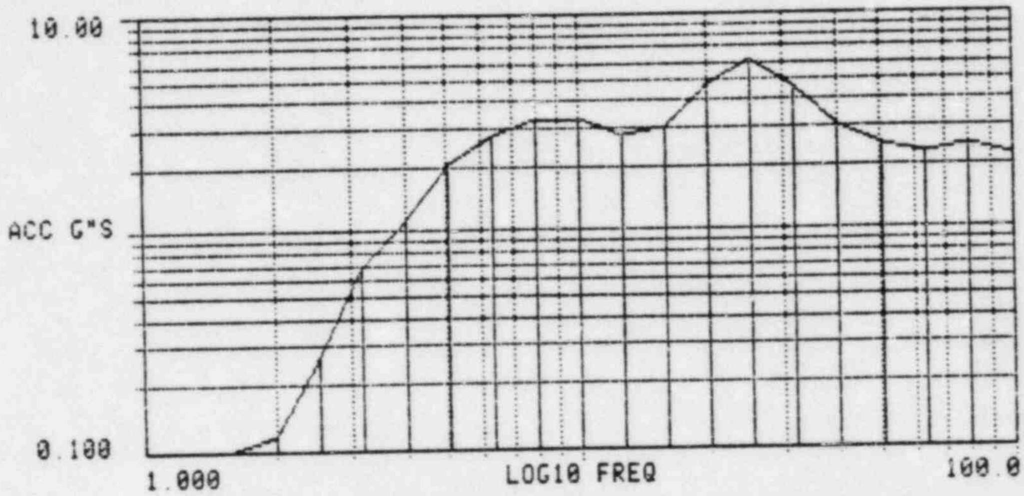
shock response (peak g's)

Freq	Ampl	Freq	Ampl	Freq	Ampl
0.50	0.11	2.51	10.76	12.59	12.76
0.63	0.19	3.16	11.44	15.85	13.88
0.79	0.51	3.98	11.19	19.95	8.94
1.00	1.47	5.01	12.77	25.12	8.86
1.26	2.76	6.31	11.26	31.62	6.30
1.58	4.30	7.94	10.33	39.81	5.76
2.00	6.89	10.00	16.05		

Figure VI.1
TRS Description

CHANNEL - A ZPA= 1.35GPK

?



26-MAY-82
00:12:20

SHOCK RESPONSE
HYDROGEN IGNITOR SRV TEST

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.09	5.01	2.06	25.12	6.01
1.26	0.08	6.31	2.73	31.62	4.54
1.58	0.08	7.94	3.27	39.81	2.99
2.00	0.11	10.00	3.23	50.12	2.46
2.51	0.26	12.59	2.71	63.10	2.25
3.16	0.67	15.85	2.99	79.43	2.47
3.98	1.11	19.95	4.72	100.00	2.19

ACCELEROMETER # __X__ DAMPING 2

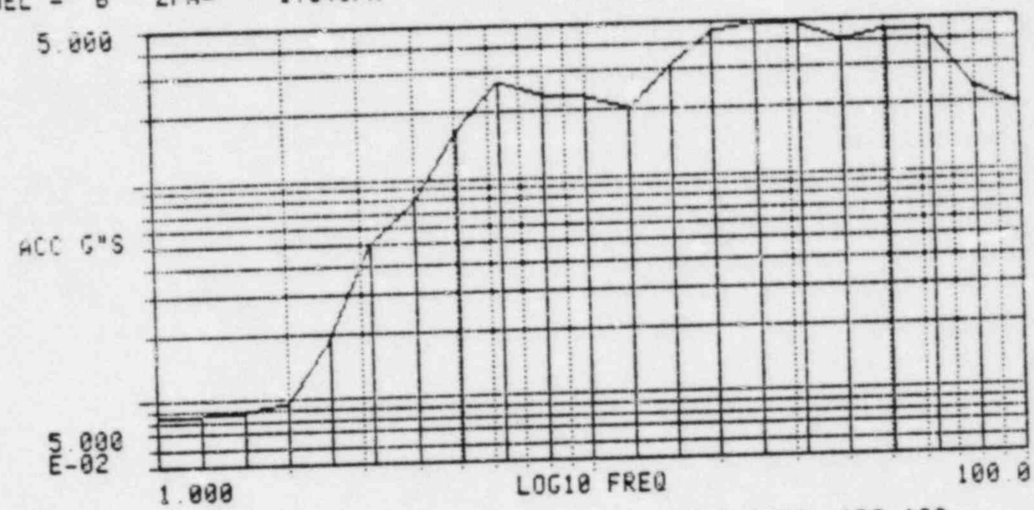
DIRECTION N-S_____ LOCATION ________

TEST # 4 OBE ____ SSE ____ SRV ✓

BIAX____ N-S____ E-W____ TRIAX ✓

CONTROL ___✓_____ SURVEY ________

CHANNEL - B ZPA= 1.04GPK



26-MAY-82
00:14:30

SHOCK RESPONSE
HYDROGEN IGNITOR SRV TEST

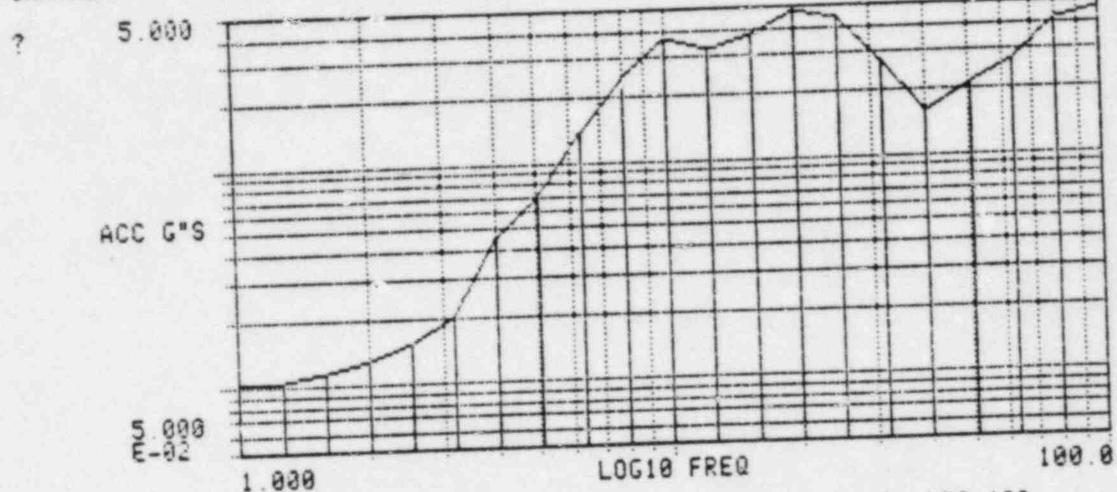
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.08	5.01	1.66	25.12	4.83
1.26	0.08	6.31	2.70	31.62	4.75
1.58	0.09	7.94	2.31	39.81	3.98
2.00	0.10	10.00	2.26	50.12	4.39
2.51	0.18	12.59	2.01	63.10	4.31
3.16	0.50	15.85	3.12	79.43	2.34
3.98	0.78	19.95	4.49	100.00	1.94

ACCELEROMETER # __Y___ DAMPING _2_
DIRECTION _E-W____ LOCATION _______
TEST # _4_OBE ____SSE ____ SRV _✓_
BIAX____ N-S____ E-W____ TRIAX_✓_
CONTROL ___✓____ SURVEY ________

CHANNEL - C ZPA= 1.02GPK



26-MAY-82
00:21:30

SHOCK RESPONSE
HYDROGEN IGNITOR SRV TEST

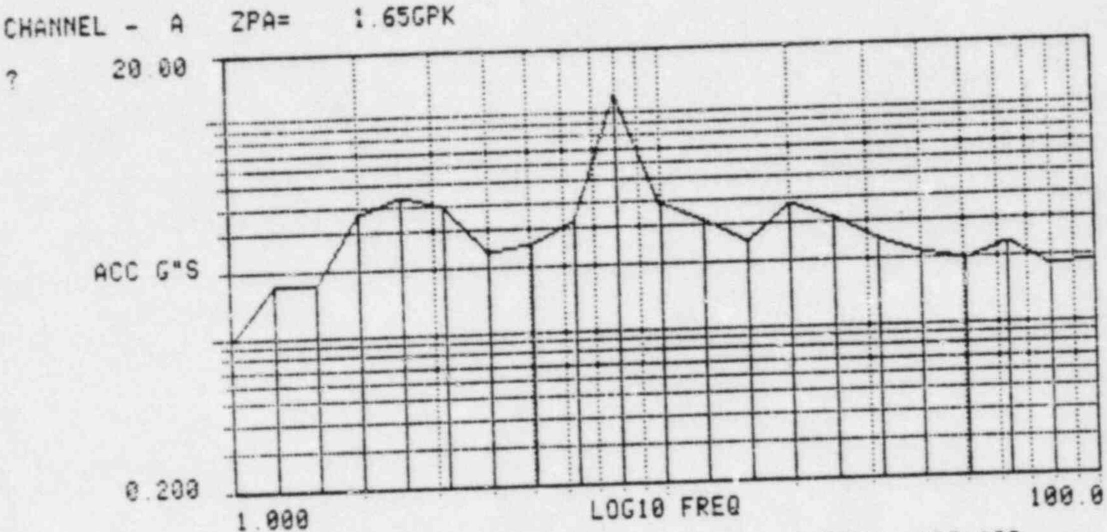
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.10	5.01	0.69	25.12	4.27
1.26	0.10	6.31	1.39	31.62	2.74
1.58	0.11	7.94	2.46	39.81	1.59
2.00	0.13	10.00	3.58	50.12	2.16
2.51	0.15	12.59	3.17	63.10	2.69
3.16	0.20	15.85	3.78	79.43	4.01
3.98	0.45	19.95	4.73	100.00	4.52

ACCELEROMETER # Z DAMPING 2
DIRECTION VerT LOCATION ✓
TEST # 4 OBE SSE SRV ✓
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - A ZPA= 1.65GPK



26-MAY-82
00:52:30

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 1

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

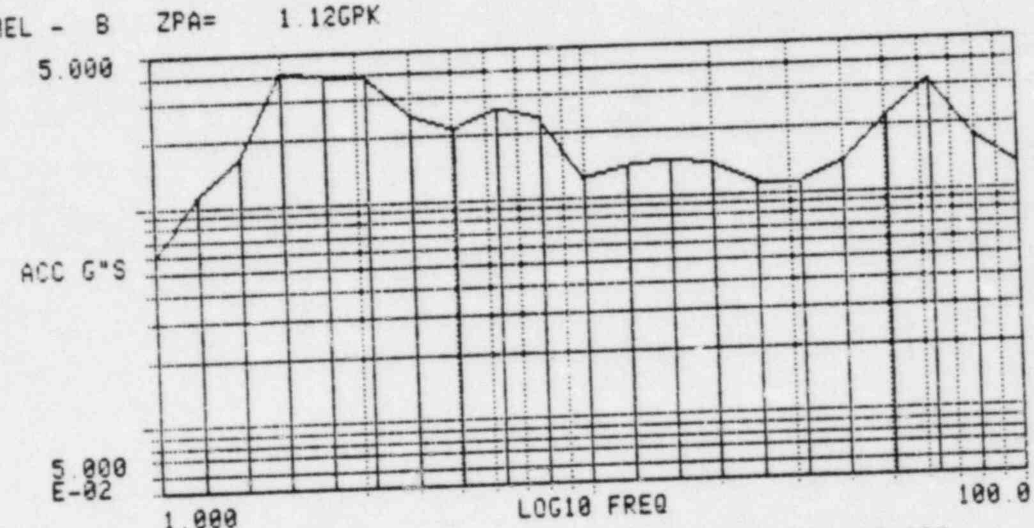
Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.96	5.01	2.53	25.12	3.17
1.26	1.72	6.31	3.21	31.62	2.46
1.58	1.69	7.94	12.32	39.81	2.13
2.00	3.70	10.00	3.91	50.12	1.98
2.51	4.30	12.59	3.13	63.10	2.30
3.16	3.80	15.85	2.48	79.43	1.79
3.98	2.34	19.95	3.74	100.00	1.92

?

ACCELEROMETER # __X__ DAMPING _2_
DIRECTION __N-S____ LOCATION _______
TEST # _5_OBE __✓__SSE ____ BRV ___
BIAX____ N-S____ E-W____ TRIAX_✓_
CONTROL _____✓___ SURVEY ________

CHANNEL - B ZPA= 1.12GPK

?



26-MAY-82
00:54:30

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 1

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

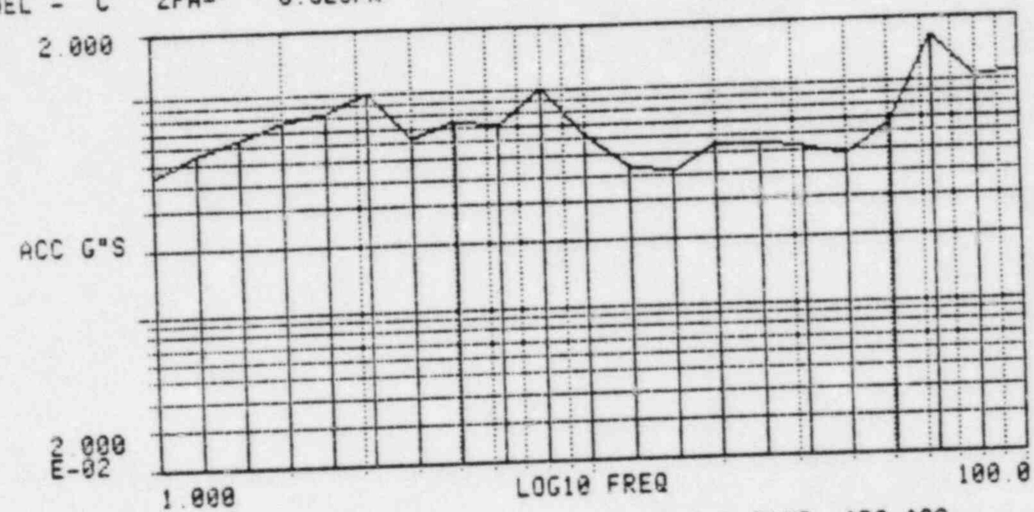
?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.59	5.01	2.15	25.12	1.12
1.25	1.11	6.31	2.61	31.62	1.13
1.58	1.61	7.94	2.36	39.81	1.38
2.00	4.10	10.00	1.21	50.12	2.20
2.51	3.81	12.59	1.37	63.10	3.20
3.16	3.77	15.85	1.46	79.43	1.72
3.98	2.46	19.95	1.37	100.00	1.31

ACCELEROMETER # __Y__ DAMPING __2__
DIRECTION __E-W__ LOCATION _______
TEST # __5__ OBE __✓__ SSE ____ SRV ___
BIAX____ N-S____ E-W____ TRIAX__✓__
CONTROL ___✓____ SURVEY ________

CHANNEL - C ZPA= 0.32GPK

?



26-MAY-82
00:58:10

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 1

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.43	5.01	0.75	25.12	0.56
1.26	0.56	6.31	0.70	31.62	0.51
1.58	0.63	7.94	1.01	39.81	0.47
2.00	0.77	10.00	0.62	50.12	0.66
2.51	0.82	12.59	0.43	63.10	1.66
3.16	1.01	15.85	0.40	79.43	1.06
3.98	0.62	19.95	0.54	100.00	1.10

ACCELEROMETER # __Z__ DAMPING 2

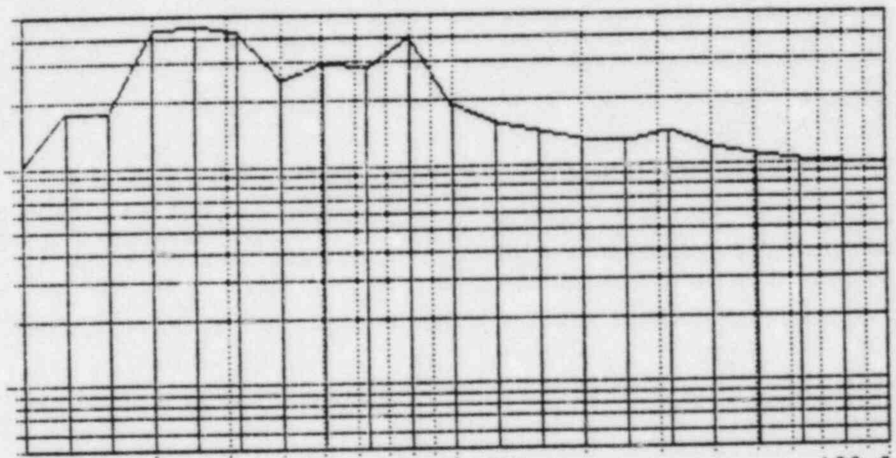
DIRECTION __VERT__ LOCATION _______

TEST # 5 OBE ✓ SSE ____ SRV ___

BIAX____ N-S____ E-W____ TRIAX ✓

CONTROL _____✓__ SURVEY ________

CHANNEL - A ZPA= 0.98GPK

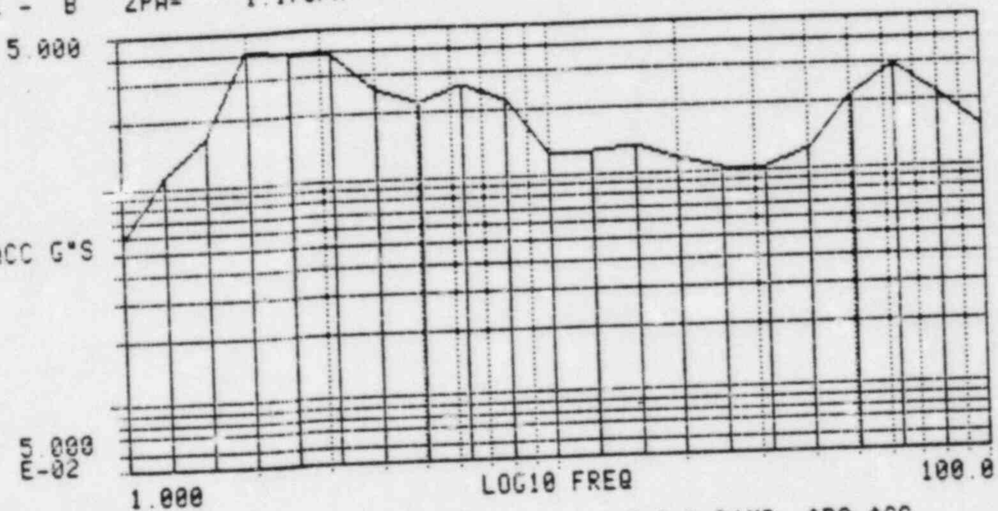


16-JUN-82 SHOCK RESPONSE 2.0 % DAMP ABS ACC
13:23:30 HYDROGEN IGNITOR TEST OBE 2 1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.02	5.01	2.94	25.12	1.26
1.26	1.77	6.31	2.80	31.62	1.40
1.58	1.75	7.94	3.98	39.81	1.17
2.00	4.16	10.00	1.87	50.12	1.08
2.51	4.40	12.59	1.54	63.10	1.04
3.16	4.04	15.85	1.43	79.43	0.99
3.98	2.48	19.95	1.30	100.00	0.98

ACCELEROMETER # X DAMPING 2
DIRECTION N-S LOCATION
TEST # 6 OBE ✓ SSE SRV
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - B ZPA= 1.17GPK



16-JUN-82
13:35:10

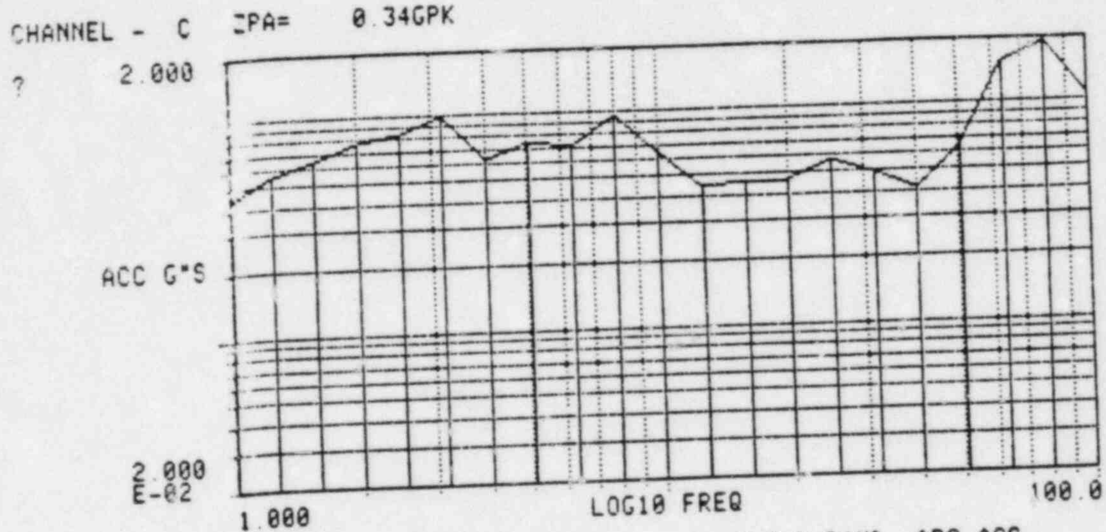
SHOCK RESPONSE
HYDROGEN IGNITOR TEST OBE 2

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.57	5.01	2.17	25.12	1.03
1.26	1.11	6.31	2.65	31.62	1.02
1.58	1.61	7.94	2.19	39.81	1.22
2.00	4.12	10.00	1.26	50.12	2.11
2.51	3.83	12.59	1.26	63.10	2.99
3.16	3.69	15.85	1.34	79.43	2.15
3.98	2.54	19.95	1.14	100.00	1.48

ACCELEROMETER # Y DAMPING 2
DIRECTION E-W LOCATION
TEST # 6 OBE ✓ SSE SRV
BIAX N-S ✓ E-W TRIAX ✓
CONTROL ✓ SURVEY



2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

16-JUN-82
13:37:20

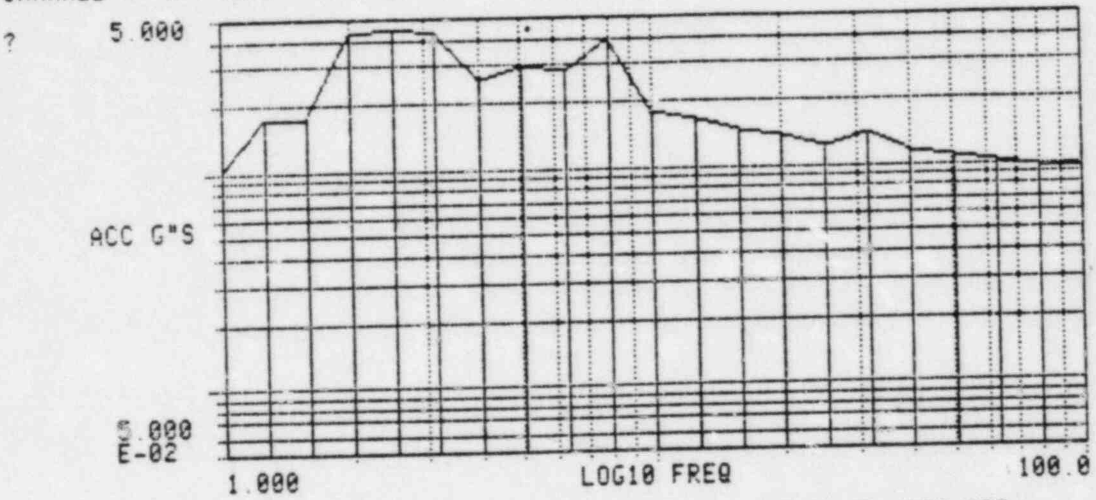
SHOCK RESPONSE
HYDROGEN IGNITOR TEST OBE 2

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.43	5.01	0.75	25.12	0.56
1.26	0.55	6.31	0.69	31.62	0.48
1.58	0.63	7.94	0.96	39.81	0.42
2.00	0.76	10.00	0.64	50.12	0.64
2.51	0.83	12.59	0.44	63.10	1.55
3.16	0.97	15.85	0.46	79.43	1.89
3.98	0.62	19.95	0.47	100.00	1.09

ACCELEROMETER # Z DAMPING 2
DIRECTION VERT LOCATION
TEST # 6 OBE ✓ SSE ---- ERV ✓
BIAX---- N-S---- E-W---- TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - A ZPA= 0.97GPK



16-JUN-82
13:41:30

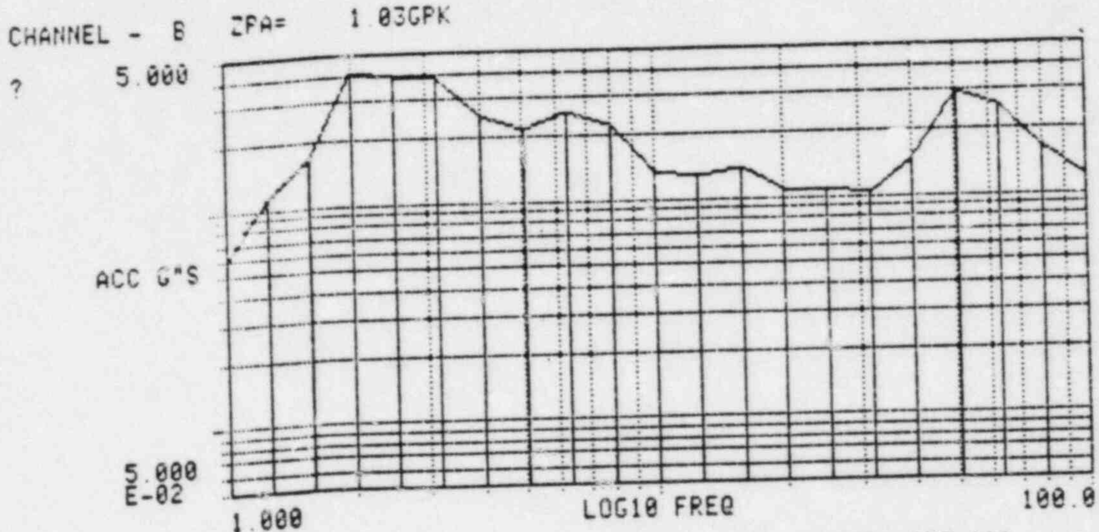
SHOCK RESPONSE
HYDROGEN IGNITOR OBE 3

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.03	5.01	2.94	25.12	1.22
1.26	1.74	6.31	2.78	31.62	1.41
1.58	1.73	7.94	3.98	39.81	1.15
2.00	4.15	10.00	1.80	50.12	1.08
2.51	4.41	12.59	1.61	63.10	1.02
3.16	4.14	15.85	1.43	79.43	0.98
3.98	2.53	19.95	1.35	100.00	0.97

?

ACCELEROMETER # X DAMPING 2
DIRECTION N-S LOCATION _______
TEST # 7 OBE ✓ SSE ____ SRV ___
BIAX____ N-S ___ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________



16-JUN-82
13:43:40

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 3

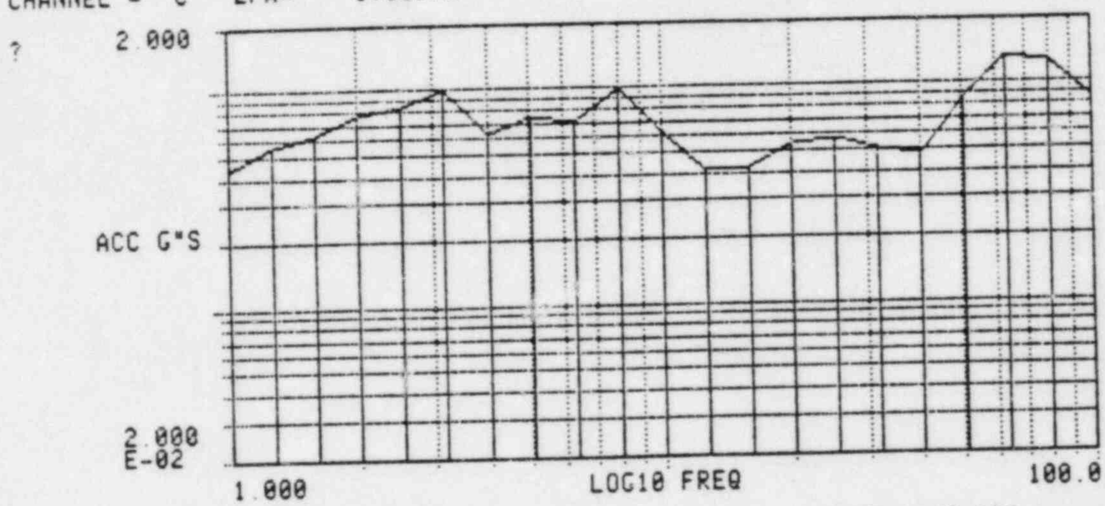
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.58	5.01	2.15	25.12	1.08
1.26	1.12	6.31	2.54	31.62	1.04
1.58	1.62	7.94	2.21	39.81	1.45
2.00	4.09	10.00	1.34	50.12	2.97
2.51	3.83	12.59	1.25	63.10	2.53
3.16	3.71	15.85	1.35	79.43	1.61
3.98	2.46	19.95	1.08	100.00	1.19

ACCELEROMETER # Y DAMPING 2
DIRECTION E-W LOCATION
TEST # 7 OBE ✓ SSE SRV
BIAX N-S ✓ E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - C ZPA= 0.30GPK



16-JUN-82
13:47:00

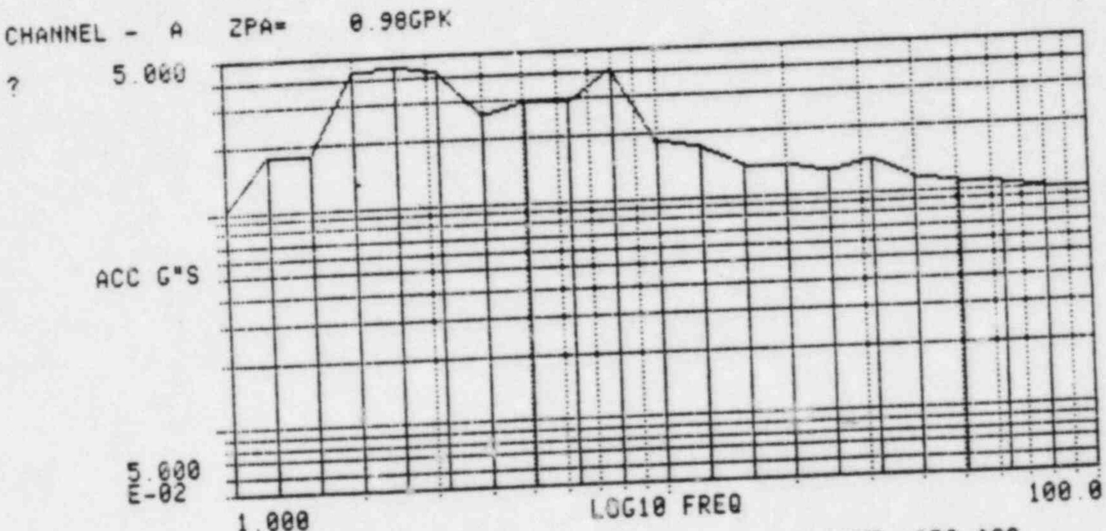
SHOCK RESPONSE
HYDROGEN IGNITOR OBE 3

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.43	5.01	0.74	25.12	0.57
1.26	0.55	6.31	0.69	31.62	0.50
1.58	0.62	7.94	0.99	39.81	0.48
2.00	0.76	10.00	0.61	50.12	0.85
2.51	0.82	12.59	0.41	63.10	1.32
3.16	0.98	15.85	0.42	79.43	1.24
3.98	0.61	19.95	0.54	100.00	0.85

?

ACCELEROMETER # Z DAMPING 2
DIRECTION VERT LOCATION ______
TEST # 7 OBE ✓ SSE ____ SRV ___
BIAX____ N-S ___ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________



16-JUN-82
13:51:00

SHOCK RESPONSE
HYDROGEN IGNITOR TEST OBE 4

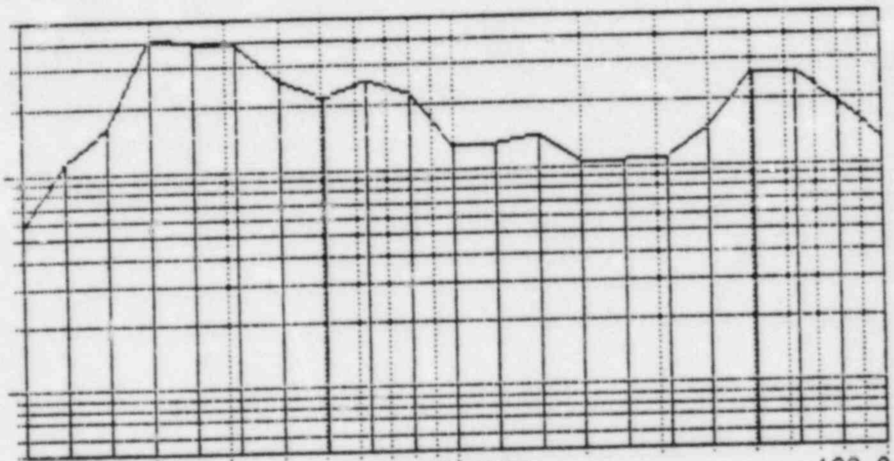
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.02	5.01	2.96	25.12	1.26
1.26	1.77	6.31	2.82	31.62	1.40
1.58	1.72	7.94	4.04	39.81	1.15
2.00	4.20	10.00	1.83	50.12	1.09
2.51	4.42	12.59	1.66	63.10	1.04
3.16	4.08	15.85	1.37	79.43	0.99
3.98	2.52	19.95	1.37	100.00	1.00

ACCELEROMETER # X DAMPING 2
DIRECTION N-S LOCATION
TEST # 8 OBE ✓ SSE ---- SRV
BIAX---- N-S ✓ E-W---- TRIAX ✓
CONTROL ✓ SURVEY --------

CHANNEL - B ZPA= 1.09GPK



16-JUN-82
13:53:10

SHOCK RESPONSE
HYDROGEN IGNITOR TEST OBE 4

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

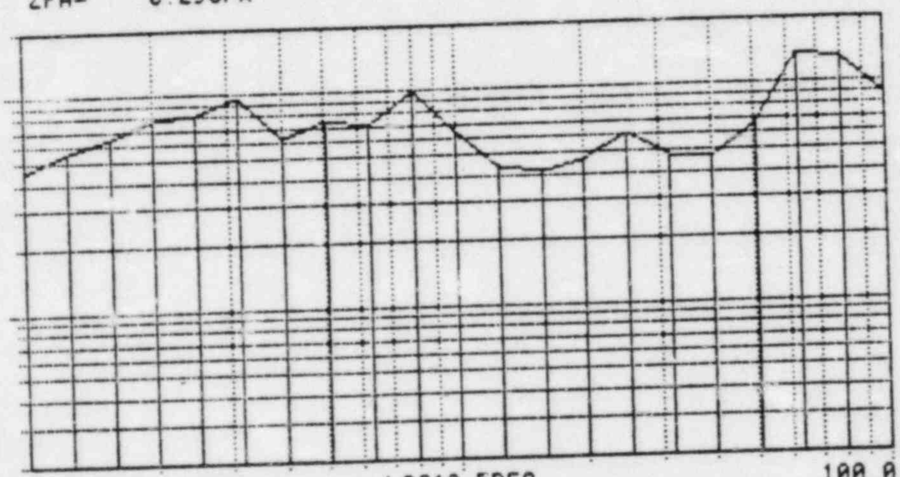
?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.57	5.01	2.15	25.12	1.05
1.26	1.10	6.31	2.56	31.62	1.07
1.58	1.60	7.94	2.20	39.81	1.48
2.00	4.10	10.00	1.24	50.12	2.59
2.51	3.80	12.59	1.30	63.10	2.63
3.16	3.70	15.85	1.42	79.43	1.87
3.98	2.52	19.95	1.05	100.00	1.30

ACCELEROMETER # Y DAMPING 2
DIRECTION E-W LOCATION
TEST # 8 OBE ✓ SSE SRV ✓
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - C ZPA= 0.29GPK

?



16-JUN-82
13 55 10

SHOCK RESPONSE
HYDROGEN IGNITOR TEST OBE 4

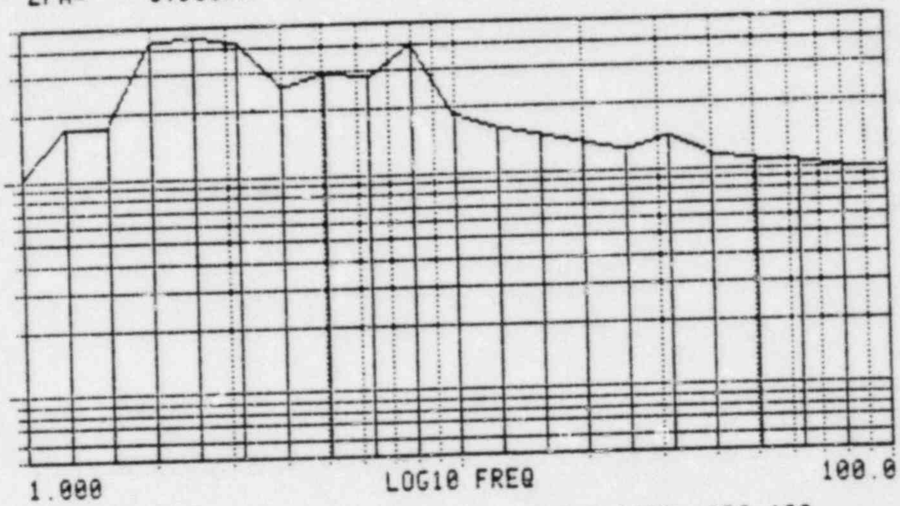
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.44	5.01	0.74	25.12	0.60
1.26	0.55	6.31	0.69	31.62	0.48
1.58	0.64	7.94	0.99	39.81	0.45
2.00	0.76	10.00	0.63	50.12	0.66
2.51	0.81	12.59	0.43	63.10	1.37
3.16	0.97	15.85	0.41	79.43	1.27
3.98	0.61	19.95	0.47	100.00	0.87

ACCELEROMETER # 2 DAMPING 2
DIRECTION VERT LOCATION ______
TEST # 8 OBE ✓ SSE ____ SRV ✓
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ______

CHANNEL - A ZPA= 0.98GPK



16-JUN-82
13:57:40

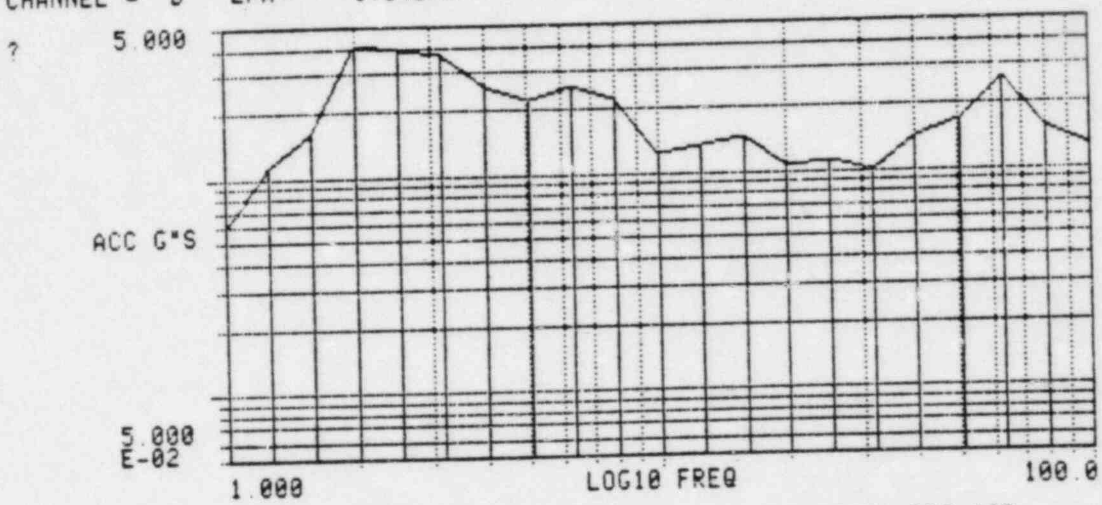
SHOCK RESPONSE
HYDROGEN IGNITOR OBE 5

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.02	5.01	2.95	25.12	1.23
1.26	1.76	6.31	2.81	31.62	1.42
1.58	1.74	7.94	1.00	39.81	1.15
2.00	4.21	10.00	1.85	50.12	1.09
2.51	4.45	12.59	1.59	63.10	1.04
3.16	4.04	15.85	1.43	79.43	1.00
3.98	2.51	19.95	1.34	100.00	0.99

ACCELEROMETER # X DAMPING 2
DIRECTION N-S LOCATION ______
TEST # 1 OBE ✓ SSE ____ SRV ___
BIAX____ N-S ✓ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - B   ZPA=   1.04GPK



16-JUN-82
13:59:40

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 5

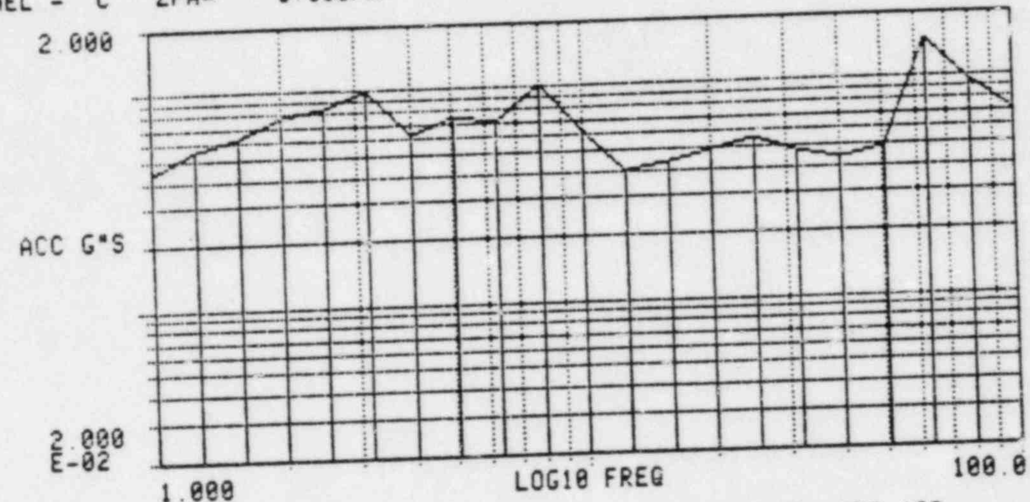
2.0 % DAMP   ABS ACC
1/3   OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.58	5.01	2.19	25.12	1.13
1.26	1.12	6.31	2.53	31.62	1.00
1.58	1.60	7.94	2.19	39.81	1.41
2.00	4.10	10.00	1.22	50.12	1.67
2.51	3.81	12.59	1.32	63.10	2.63
3.16	3.68	15.85	1.45	79.43	1.52
3.98	2.51	19.95	1.05	100.00	1.27

ACCELEROMETER # Y DAMPING 2
DIRECTION E-W LOCATION ______
TEST # 9 OBE ✓ SSE ____ SRV ____
BIAX ____ N-S ____ E-W ____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - C ZPA= 0.30GPK



16-JUN-82
14:01:40

SHOCK RESPONSE
HYDROGEN IGNITOR OBE 5

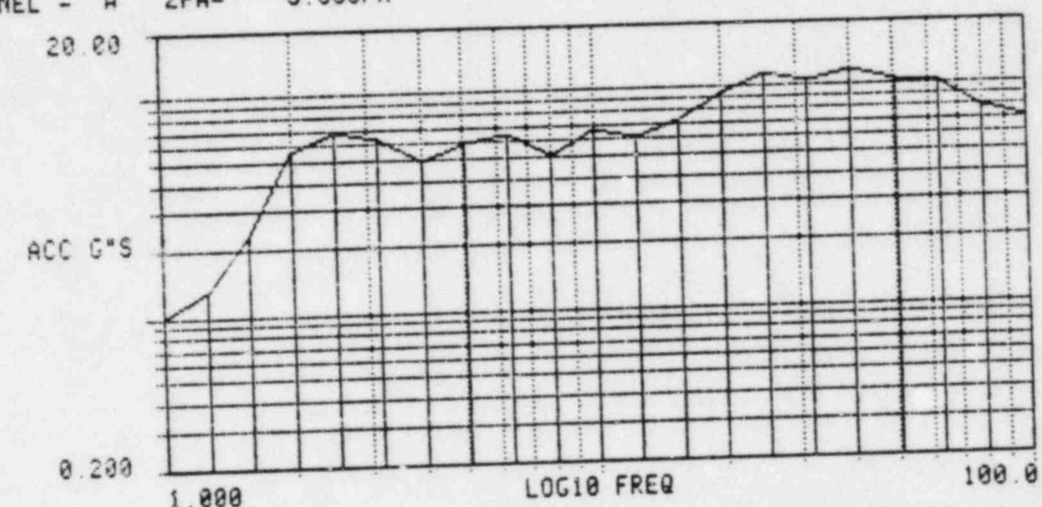
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.43	5.01	0.74	25.12	0.54
1.26	0.56	6.31	0.69	31.62	0.48
1.58	0.61	7.94	1.02	39.81	0.44
2.00	0.76	10.00	0.62	50.12	0.48
2.51	0.81	12.59	0.40	63.10	1.48
3.16	0.98	15.85	0.44	79.43	0.97
3.98	0.62	19.95	0.48	100.00	0.70

ACCELEROMETER # _Z___ DAMPING 2_
DIRECTION VERT___ LOCATION _______
TEST # 9_OBE ✓___SSE ____ SRV ___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ___✓____ SURVEY _______

CHANNEL - A ZPA= 3.66GPK



26-MAY-82
01:21:30

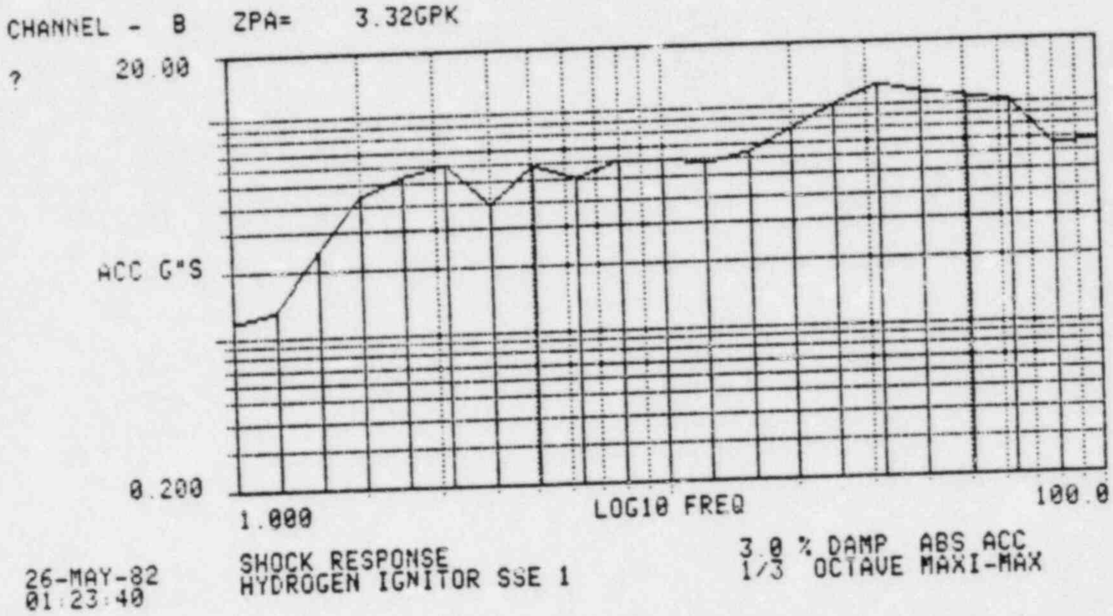
SHOCK RESPONSE
HYDROGEN IGNITOR SSE 1

3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.01	5.01	5.91	25.12	11.32
1.26	1.29	6.31	6.35	31.62	10.44
1.58	2.27	7.94	4.99	39.81	11.84
2.00	5.44	10.00	6.55	50.12	10.43
2.51	6.71	12.59	6.04	63.10	10.25
3.16	6.14	15.85	7.16	79.43	7.68
3.98	4.84	19.95	9.31	100.00	6.90

ACCELEROMETER # _X___ DAMPING 3
DIRECTION __N-S__ LOCATION _______
TEST # 10 OBE ____SSE _✓__ SRV ___
BIAX____ N-S____ E-W____ TRIAX_✓_
CONTROL ____✓____ SURVEY ________

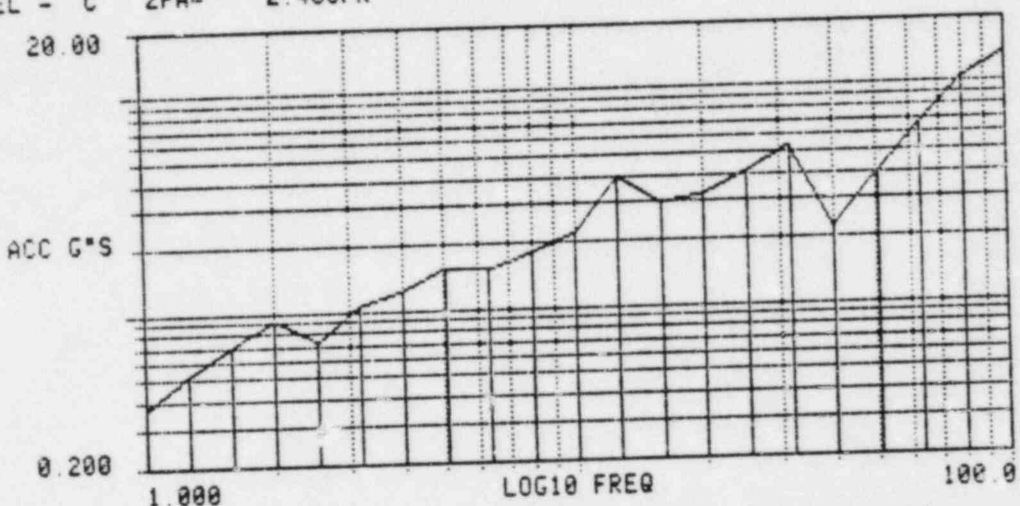


?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.15	5.01	5.86	25.12	10.14
1.26	1.29	6.31	5.03	31.62	12.61
1.58	2.48	7.94	5.99	39.81	11.47
2.00	4.31	10.00	5.95	50.12	10.67
2.51	5.28	12.59	5.65	63.10	10.25
3.16	5.94	15.85	6.34	79.43	6.35
3.98	3.80	19.95	8.07	100.00	6.71

ACCELEROMETER # Y DAMPING 3
DIRECTION E-W LOCATION
TEST # 10 OBE SSE ✓ SRV
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - C ZPA= 2.40GPK



26-MAY-82
01:25:50

SHOCK RESPONSE
HYDROGEN IGNITOR SSE 1

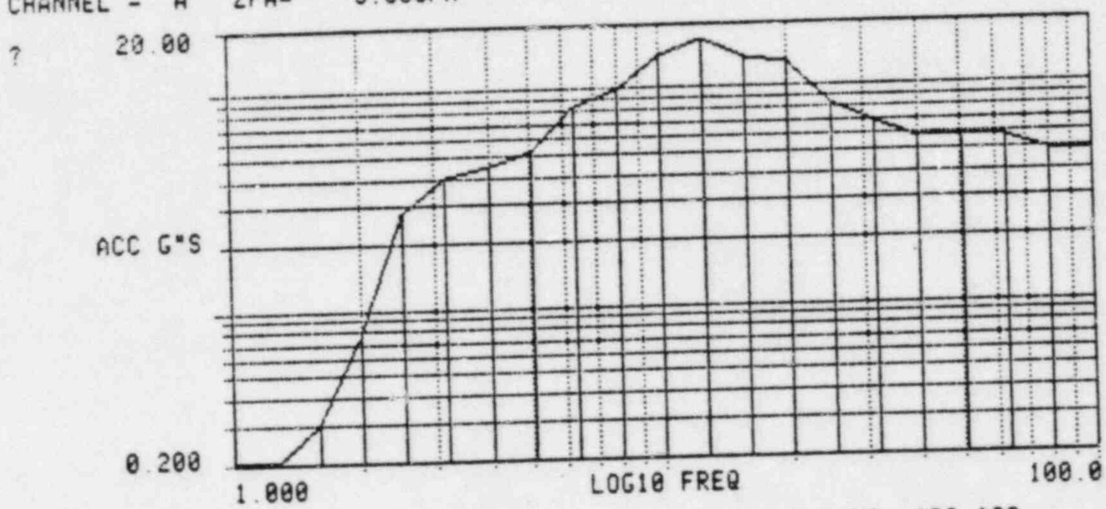
3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.37	5.01	1.53	25.12	4.13
1.26	0.52	6.31	1.51	31.62	5.28
1.58	0.71	7.94	1.80	39.81	2.27
2.00	0.93	10.00	2.23	50.12	4.02
2.51	0.73	12.59	3.99	63.10	6.53
3.16	1.06	15.85	2.94	79.43	10.44
3.98	1.24	19.95	3.22	100.00	13.65

ACCELEROMETER # Z DAMPING 3
DIRECTION VERT LOCATION
TEST # 10 OBE SSE ✓ SRV
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - A ZPA= 3.66GPK



16-JUN-82
14:04:00

SHOCK RESPONSE
HYDROGEN IGNITOR TEST SSE 2

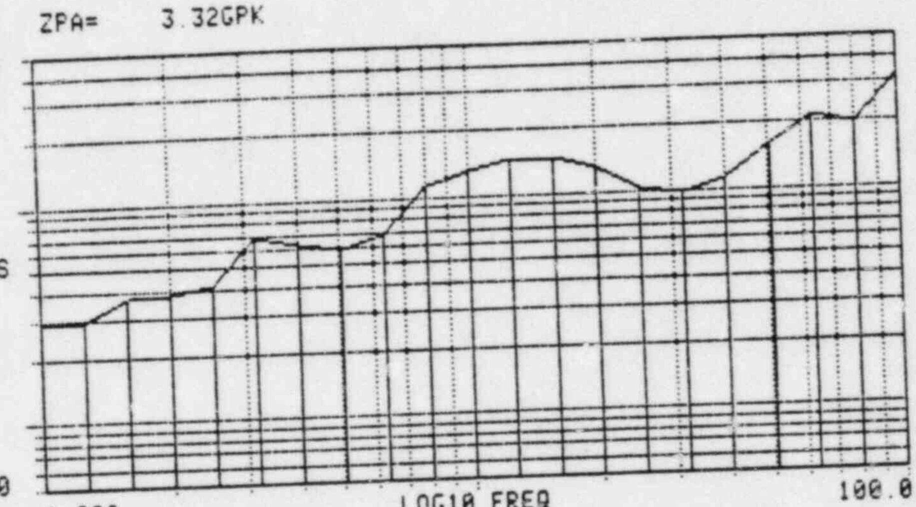
3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.21	5.01	5.14	25.12	8.17
1.26	0.20	6.31	8.29	31.62	6.77
1.58	0.30	7.94	9.75	39.81	5.68
2.00	0.76	10.00	14.19	50.12	5.90
2.51	2.82	12.59	16.75	63.10	5.61
3.16	3.96	15.85	13.60	79.43	4.86
3.98	4.44	19.95	12.84	100.00	4.77

?

ACCELEROMETER # X DAMPING 3
DIRECTION N-S LOCATION ______
TEST # 11 OBE ____ SSE ✓ SPV ___
BIAX____ N-S ✓ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - B ZPA= 3.32GPK



16-JUN-82
14:06:00

SHOCK RESPONSE
HYDROGEN IGNITOR TEST SSE 2

3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

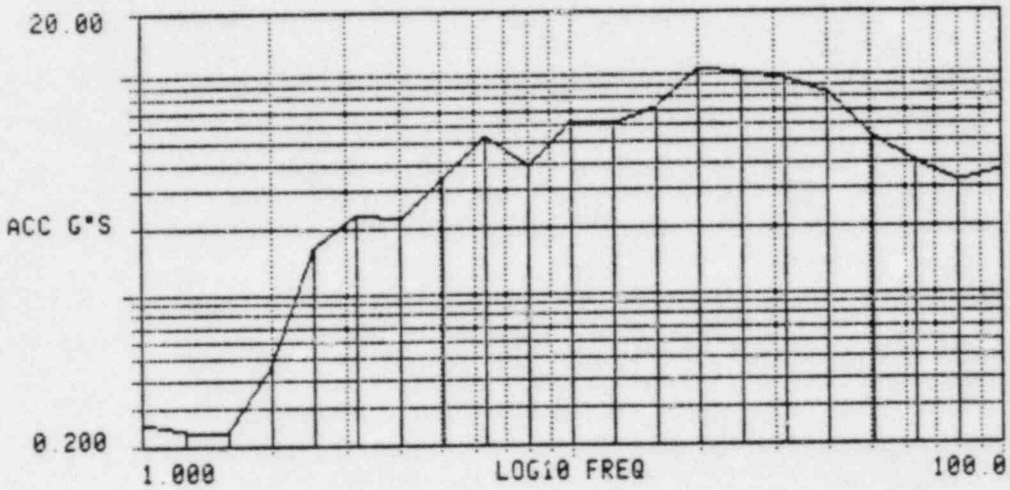
?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	2.85	5.01	5.85	25.12	10.29
1.26	2.90	6.31	6.87	31.62	9.66
1.58	3.66	7.94	11.08	39.81	11.11
2.00	3.73	10.00	12.84	50.12	15.90
2.51	4.09	12.59	14.79	63.10	21.24
3.16	6.78	15.85	14.62	79.43	19.45
3.98	6.17	19.95	12.80	100.00	32.11

ACCELEROMETER # _Y_ DAMPING _3_
DIRECTION _E-W_ LOCATION ______
TEST #11 OBE ____ SSE ✓ BRV ___
BIAX____ N-S ✓ E-W____ TRIAX ✓
CONTROL ___✓___ SURVEY ________

CHANNEL - C ZPA= 2.40GPK

?



16-JUN-82
14:07:50

SHOCK RESPONSE
HYDROGEN IGNITOR TEST SSE 2

3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

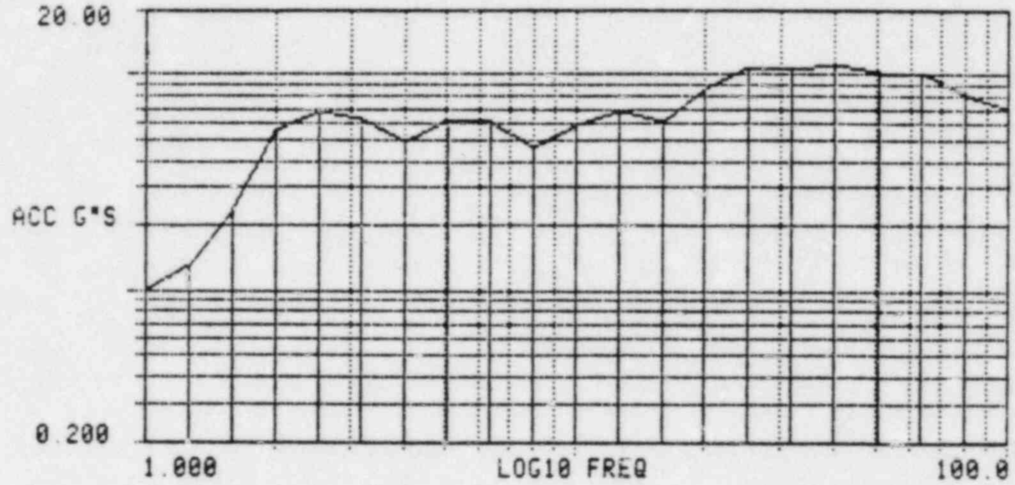
?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.25	5.01	3.44	25.12	10.23
1.26	0.23	6.31	5.28	31.62	9.53
1.58	0.23	7.94	3.81	39.81	8.37
2.00	0.46	10.00	6.10	50.12	5.12
2.51	1.66	12.59	5.98	63.10	4.02
3.16	2.30	15.85	7.23	79.43	3.26
3.98	2.17	19.95	10.63	100.00	3.66

ACCELEROMETER # Z DAMPING 3
DIRECTION VERT LOCATION ______
TEST # 11 OBE ____ SSE ✓ SRV ___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - A ZPA= 3.61GPK

?



16-JUN-82 SHOCK RESPONSE 3.0 % DAMP ABS ACC
14:10:10 HYDROGEN IGNITOR SSE 3 1/3 OCTAVE MAXI-MAX

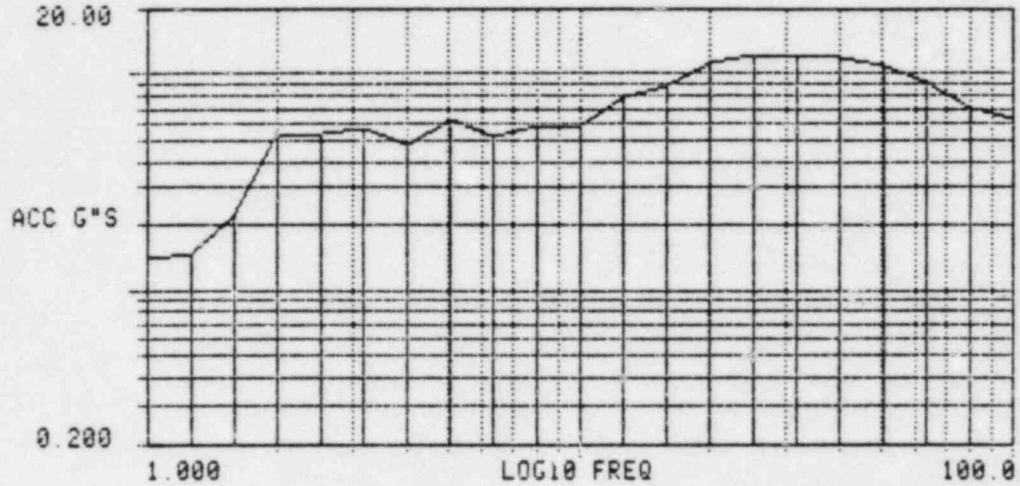
?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.01	5.01	6.13	25.12	10.69
1.26	1.30	6.31	6.06	31.62	10.47
1.58	2.32	7.94	4.60	39.81	11.01
2.00	5.40	10.00	5.86	50.12	10.18
2.51	6.77	12.59	6.80	63.10	10.10
3.16	6.07	15.85	5.98	79.43	7.96
3.98	4.91	19.95	8.57	100.00	6.93

ACCELEROMETER # X DAMPING 3
DIRECTION N-S LOCATION ______
TEST # 12 OBE ____ SSE ✓ SRV __
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - B ZPA= 3.55GPK

?



26-MAY-82
01:40:10

SHOCK RESPONSE
HYDROGEN IGNITOR SSE 3

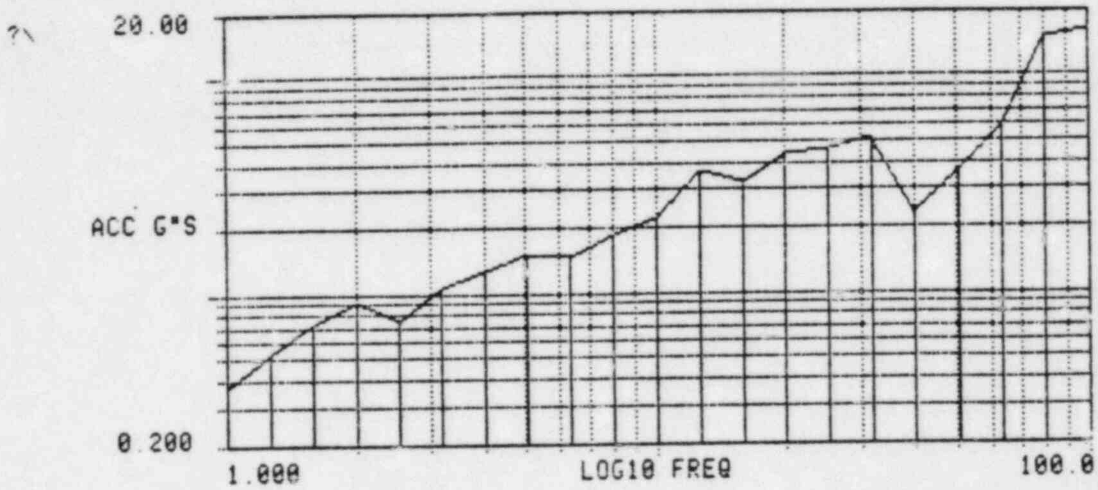
3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	1.37	5.01	6.11	25.12	12.14
1.26	1.48	6.31	5.25	31.62	12.28
1.58	2.20	7.94	5.91	39.81	11.80
2.00	5.31	10.00	5.91	50.12	10.85
2.51	5.35	12.59	7.92	63.10	9.11
3.16	5.72	15.85	8.81	79.43	7.04
3.98	4.72	19.95	11.06	100.00	6.16

?

ACCELEROMETER # Y DAMPING 3
DIRECTION E-W LOCATION
TEST # 12 OBE SSE ✓ SRV
BIAX N-S E-W TRIAX ✓
CONTROL ✓ SURVEY

CHANNEL - C ZPA= 2.41GPK



16-JUN-82
14:12:20

SHOCK RESPONSE
HYDROGEN IGNITOR SSE 3

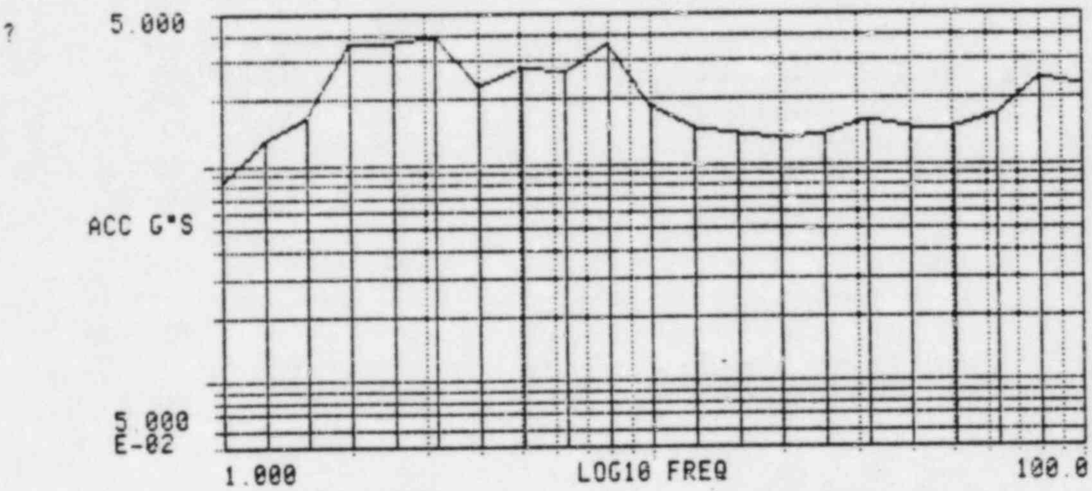
3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.37	5.01	1.50	25.12	4.57
1.26	0.53	6.31	1.47	31.62	5.20
1.58	0.72	7.94	1.84	39.81	2.34
2.00	0.93	10.00	2.20	50.12	3.68
2.51	0.75	12.59	3.66	63.10	5.79
3.16	1.06	15.85	3.19	79.43	15.00
3.98	1.25	19.95	4.31	100.00	16.45

?

ACCELEROMETER # 2 DAMPING 3
DIRECTION VERT LOCATION _______
TEST # 12 OBE ____ SSE ✓ SRV ___
BIAX____ N-S ✓ E-W____ TRIAX ✓
CONTROL ✓ SURVEY ________

CHANNEL - A ZPA= 1.23GPK



16-JUN-82 14:36:20

SHOCK RESPONSE
HYDRO IGNITOR OBE 5 SURVEY

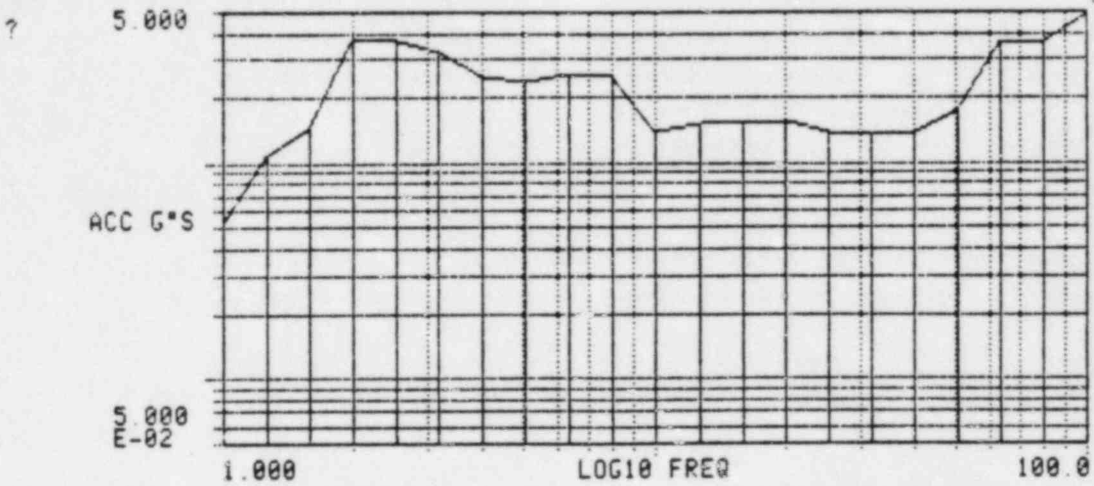
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.83	5.01	2.80	25.12	1.36
1.26	1.28	6.31	2.65	31.62	1.61
1.58	1.63	7.94	3.66	39.81	1.44
2.00	3.68	10.00	1.81	50.12	1.46
2.51	3.61	12.59	1.46	63.10	1.70
3.16	3.85	15.85	1.37	79.43	2.50
3.98	2.24	19.95	1.29	100.00	2.25

?

ACCELEROMETER # 1X DAMPING 2
DIRECTION N-S LOCATION 1
TEST # 9 OBE ✓ SSE ____ SRV ____
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - B ZPA= 1.56GPK



16-JUN-82
14:38:20

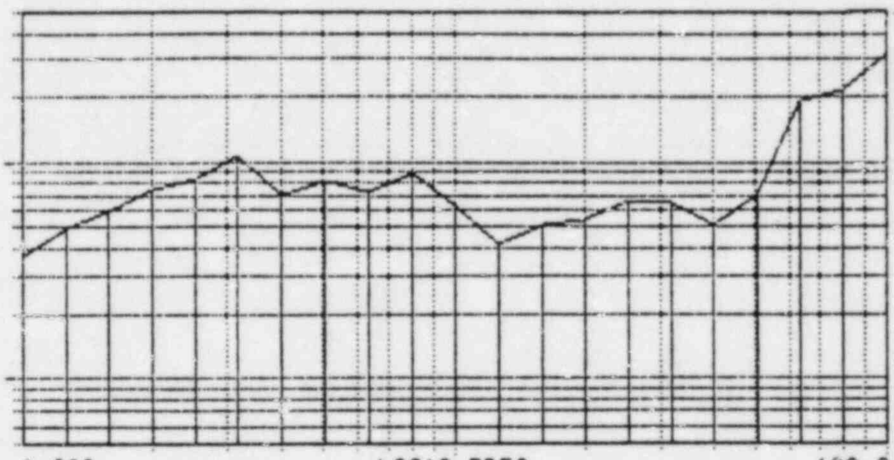
SHOCK RESPONSE
HYDRO IGNITOR OBE 5 SURVEY

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.52	5.01	2.35	25.12	1.36
1.26	1.09	6.31	2.55	31.62	1.36
1.58	1.44	7.94	2.43	39.81	1.38
2.00	3.75	10.00	1.39	59.12	1.76
2.51	3.59	12.59	1.48	63.10	3.65
3.16	3.24	15.85	1.52	79.43	3.61
3.98	2.46	19.95	1.54	100.00	4.83

ACCELEROMETER # 2Y DAMPING 2
DIRECTION E-W LOCATION 1
TEST# 9 OBE ✓ SSE ___ FRAG% ___
BIAX ___ N-S ___ E-W ___ TRIAX ✓
CONTROL ________ SURVEY ✓

CHANNEL - A ZPA= 0 50GPK



16-JUN-82
14:47:30

SHOCK RESPONSE
HYDRO IGNITOR OBE 5 SURVEY

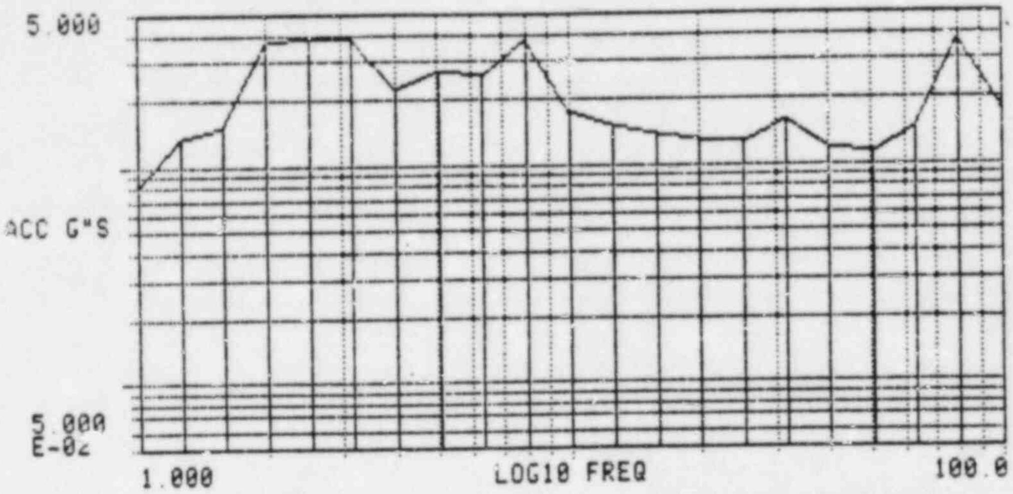
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

?\

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.37	5.01	0.80	25.12	0.66
1.26	0.49	6.31	0.71	31.62	0.63
1.58	0.59	7.94	0.89	39.81	0.50
2.00	0.74	10.00	0.62	50.12	0.71
2.51	0.84	12.59	0.42	63.10	1.90
3.16	1.05	15.85	0.50	79.43	2.14
3.98	0.69	19.95	0.54	100.00	3.13

ACCELEROMETER # 32 DAMPING 2
DIRECTION VERT LOCATION 1
TEST# 9 OBE ✓ SSE___ FRAG%___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - A ZPA= 0.97GPK



16-JUN-82
14:53:40

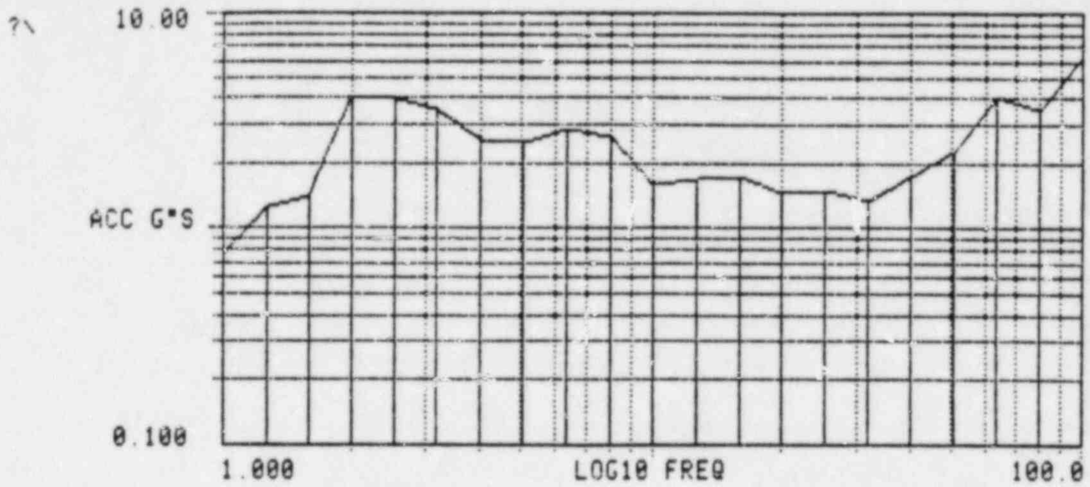
SHOCK RESPONSE
#2 HYDRO IGNITOR OBE 5 SURVEY

2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.82	5.01	2.73	25.12	1.24
1.26	1.33	6.31	2.57	31.62	1.59
1.58	1.51	7.94	3.70	39.81	1.18
2.00	3.61	10.00	1.76	50.12	1.13
2.51	3.86	12.59	1.50	63.10	1.47
3.16	3.71	15.85	1.37	79.43	3.74
3.98	2.18	19.95	1.28	100.00	1.80

ACCELEROMETER # 4X DAMPING 2
DIRECTION N-S LOCATION 2
TEST# 9 OBE ✓ SSE___ FRAG%___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - B ZPA= 2.03GPK



16-JUN-82
14:55:50

SHOCK RESPONSE
#2 HYDRO IGNITOR OBE 5 SURVEY

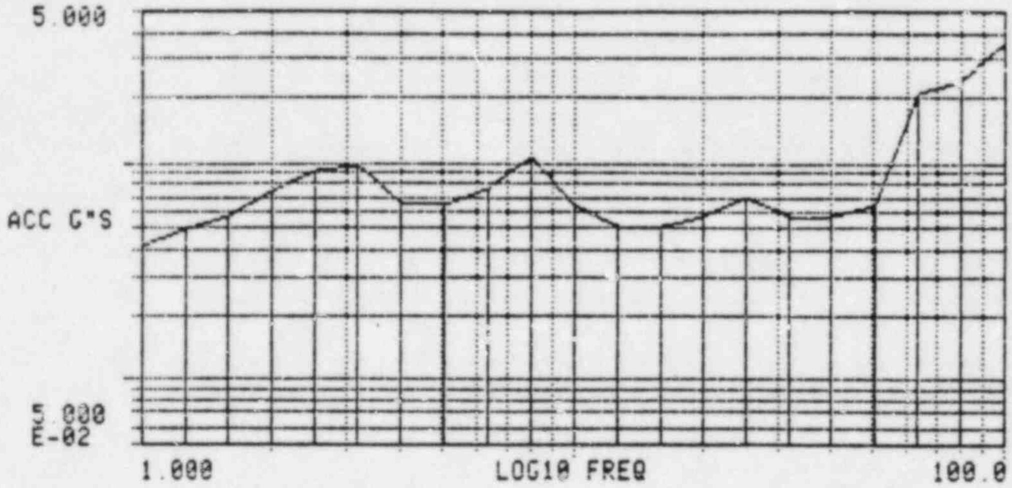
2.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.74	5.01	2.42	25.12	1.47
1.26	1.23	6.31	2.84	31.62	1.32
1.58	1.41	7.94	2.56	39.81	1.73
2.00	3.99	10.00	1.56	50.12	2.21
2.51	3.87	12.59	1.68	63.10	3.98
3.16	3.50	15.85	1.74	79.43	3.48
3.98	2.54	19.95	1.44	100.00	6.11

?

ACCELEROMETER # 5Y__ DAMPING 2__
DIRECTION E-W___ LOCATION 2____
TEST#_9__ OBE_✓_ SSE___ FRAG%___
BIAX____ N-S____ E-W____ TRIAX✓__
CONTROL _________ SURVEY ✓_______

CHANNEL - C ZPA= 0.59GPK



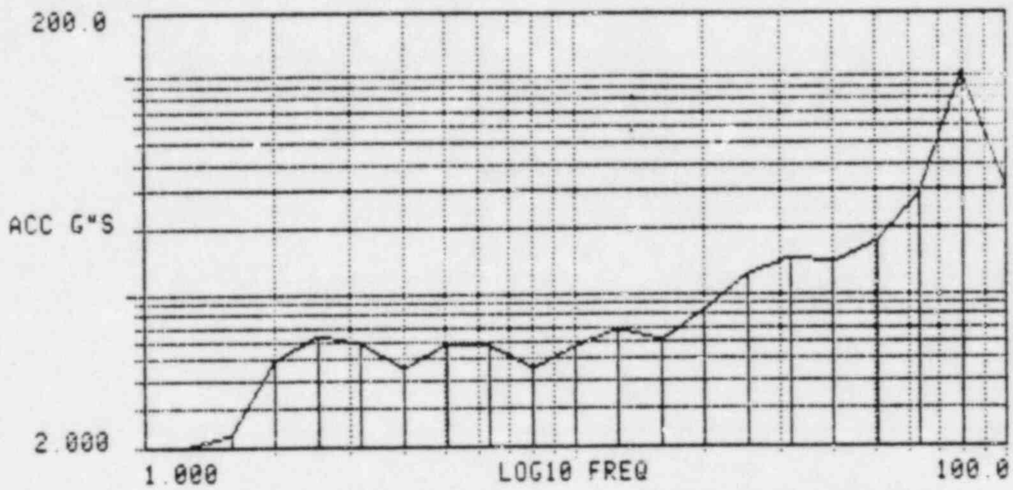
16-JUN-82 SHOCK RESPONSE 2.0 % DAMP ABS ACC
14:59:30 #2 HYDRO IGNITOR OBE 5 SURVEY 1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.41	5.01	0.65	25.12	0.70
1.26	0.49	6.31	0.75	31.62	0.57
1.58	0.57	7.94	1.06	39.81	0.56
2.00	0.74	10.00	0.65	50.12	0.63
2.51	0.92	12.59	0.50	63.10	2.07
3.16	0.96	15.85	0.51	79.43	2.41
3.98	0.67	19.95	0.57	100.00	3.52

ACCELEROMETER # 62 DAMPING 2
DIRECTION VERT LOCATION 2
TEST# 9 OBE ✓ SSE___ FRAGX___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - A ZPA= 11.51GPK

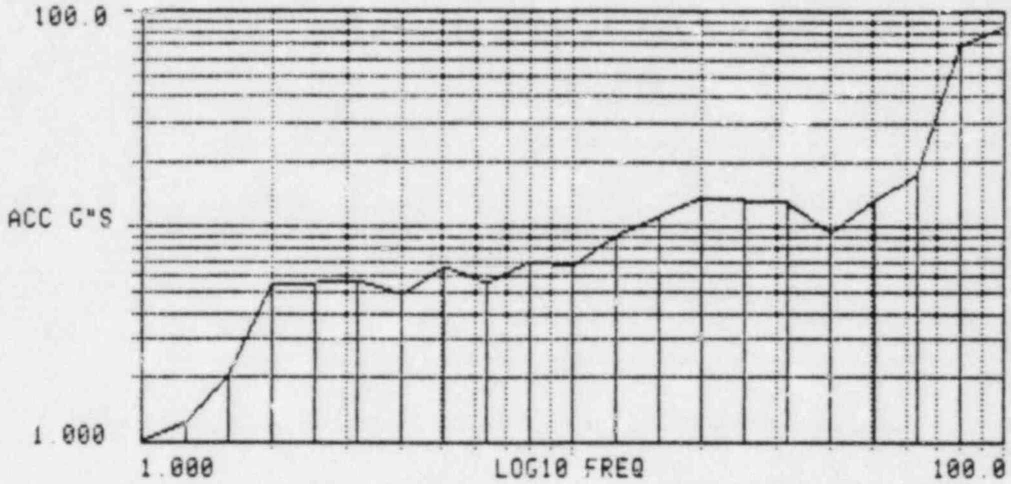


16-JUN-82 15:24:50 SHOCK RESPONSE HYDRO IGNITOR 3 SSE SURVEY 3.0 % DAMP ABS ACC 1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.96	5.01	5.91	25.12	12.12
1.26	1.36	6.31	5.67	31.62	14.63
1.58	2.24	7.94	4.47	39.81	13.94
2.00	4.93	10.00	5.69	50.12	17.31
2.51	6.39	12.59	6.91	63.10	29.17
3.16	5.78	15.85	6.05	79.43	104.63
3.98	4.47	19.95	8.34	100.00	31.33

ACCELEROMETER # 1X DAMPING 3
DIRECTION N-S LOCATION 1
TEST# 12 OBE___ SSE ✓ FRAG%___
BIAX___ N-S___ E-W___ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - B ZPA= 11.65GPK



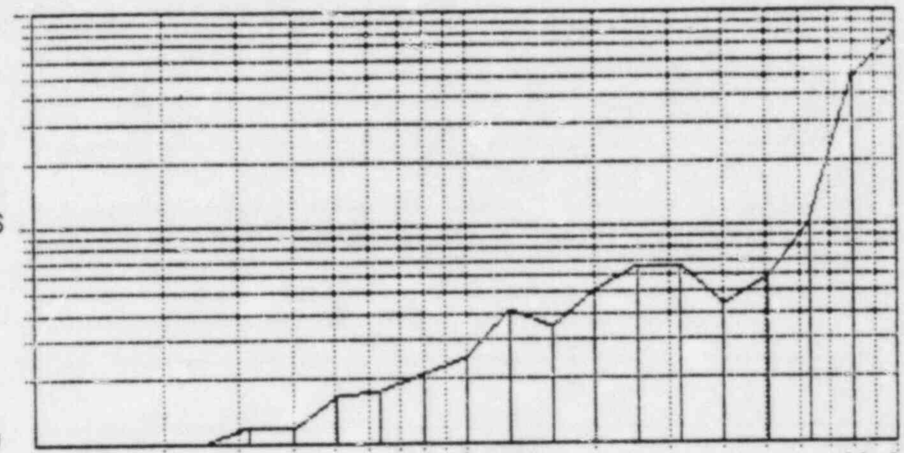
16-JUN-82 15:26:50 SHOCK RESPONSE HYDRO IGNITOR 3 SSE SURVEY 3.0 % DAMP ABS ACC 1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.74	5.01	6.59	25.12	13.29
1.26	1.23	6.31	5.53	31.62	12.72
1.58	2.00	7.94	6.99	39.81	9.11
2.00	5.23	10.00	6.45	50.12	13.12
2.51	5.49	12.59	8.86	63.10	17.08
3.16	5.64	15.85	11.08	79.43	67.92
3.98	4.85	19.95	13.40	100.00	84.82

ACCELEROMETER # 2Y DAMPING 3
DIRECTION E-W LOCATION 1
TEST# 12 OBE___ SSE ✓ FRAG%___
BIAX___ N-S___ E-W___ TRIAX ✓
CONTROL _________ SURVEY ✓

CHANNEL - A ZPA= 10.51GPK

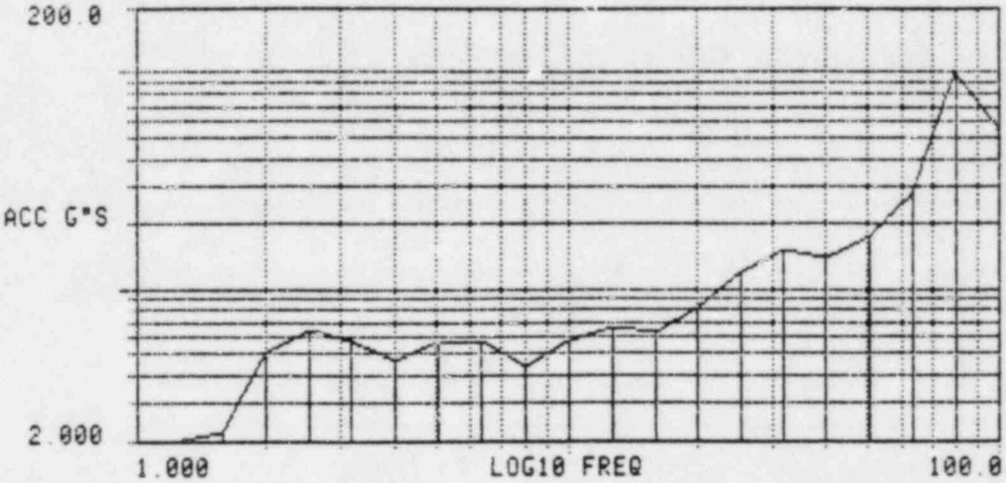


16-JUN-82 SHOCK RESPONSE 3.0 % DAMP ABS ACC
- 15:33:50 HYDRO IGNITOR 3 SSE SURVEY 1/3 OCTAVE MAXI MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.35	5.01	1.62	25.12	6.56
1.26	0.50	6.31	1.75	31.62	6.40
1.58	0.73	7.94	2.03	39.81	4.32
2.00	0.91	10.00	2.48	50.12	5.86
2.51	0.90	12.59	4.05	63.10	10.41
3.16	1.19	15.85	3.44	79.43	48.32
3.98	1.15	19.95	4.94	100.00	75.74

ACCELEROMETER # 32 DAMPING 3
DIRECTION VERT LOCATION 1
TEST# 12 OBE___ SSE ✓ FRAG%___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ________ SURVEY ✓

CHANNEL - A ZPA= 11.50GPK



16-JUN-82
15:13:16

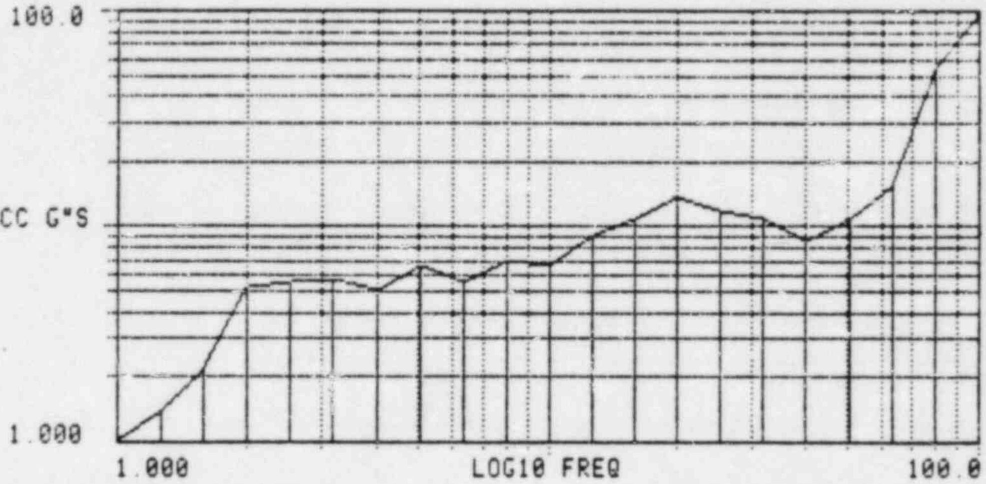
SHOCK RESPONSE
#2 HYDRO IGNITOR 3 SSE SURVEY

3.0 % DAMP ABS ACC
1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.86	5.01	5.76	25.12	11.89
1.26	1.26	6.31	5.72	31.62	15.00
1.58	2.14	7.94	4.34	39.81	13.61
2.00	5.01	10.00	5.66	50.12	17.70
2.51	6.47	12.59	6.66	63.10	28.27
3.16	5.64	15.85	6.21	79.43	102.46
3.98	4.67	19.95	8.26	100.00	54.12

ACCELEROMETER # 4X DAMPING 3
DIRECTION N-S LOCATION 2
TEST# 12 OBE___ SSE ✓ FRAG%___
BIAX____ N-S____ E-W____ TRIAX ✓
CONTROL ________ SURVEY ✓

CHANNEL - B ZPA= 11.06GPK



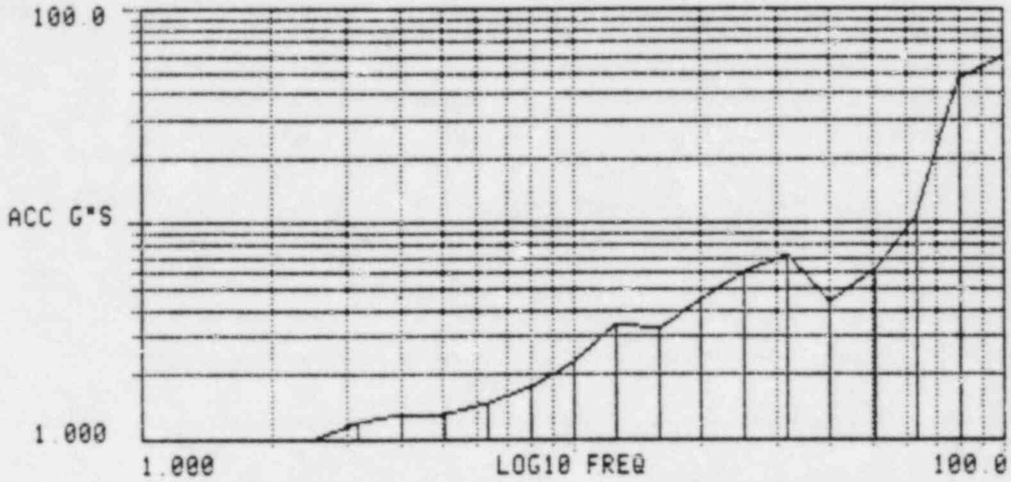
16-JUN-82 15:15:20 SHOCK RESPONSE 3.0 % DAMP ABS ACC
#2 HYDRO IGNITOR 3 SSE SURVEY 1/3 OCTAVE MAXI-MAX

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.90	5.01	6.52	25.12	11.66
1.26	1.36	6.31	5.44	31.62	10.81
1.58	2.13	7.94	6.85	39.81	8.39
2.00	5.19	10.00	6.52	50.12	10.67
2.51	5.50	12.59	9.01	63.10	15.41
3.16	5.54	15.85	10.71	79.43	52.49
3.98	4.99	19.95	13.45	100.00	95.95

ACCELEROMETER # 5Y DAMPING 3
DIRECTION E-W LOCATION 2
TEST# 12 OBE___ SSE ✓ FRAG%__
BIAX___ N-S___ E-W___ TRIAX ✓
CONTROL ________ SURVEY ✓

CHANNEL - C ZPA= 7.84GPK

?



16-JUN-82 15:17:30 SHOCK RESPONSE #2 HYDRO IGNITOR 3 SSE SURVEY 3.0 % DAMP ABS ACC 1/3 OCTAVE MAXI-MAX

?

Freq	Ampl	Freq	Ampl	Freq	Ampl
1.00	0.35	5.01	1.30	25.12	5.94
1.26	0.57	6.31	1.44	31.62	7.17
1.58	0.69	7.94	1.73	39.81	4.37
2.00	0.86	10.00	2.26	50.12	6.04
2.51	0.98	12.59	3.41	63.10	10.82
3.16	1.18	15.85	3.22	79.43	46.64
3.98	1.28	19.95	4.46	100.00	59.43

ACCELEROMETER # 62 DAMPING 3
DIRECTION VERT LOCATION 2
TEST# 12 OBE___ SSE ✓ FRAG%___
BIAX___ N-S___ E-W___ TRIAX ✓
CONTROL _________ SURVEY ✓

VII. APPENDICES

VII.1 Appendix A – Purchase Order and Seismic Test Plan

Purchase Order

67

CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.
POST OFFICE BOX 30096 • RALEIGH, NORTH CAROLINA 27612
PHONE 919/782-3441

Patrick

SELLER:

SDRC
2000 Eastman Drive
Milford, Ohio 45150

SHIP TO:

Corporate Consulting & Dev. Co., Ltd.
P. O. Box 30096
Raleigh, N.C. 27622

ATTENTION: DOUGLAS GREENWOOD

SELLER: By acceptance, seller agrees to conditions hereon. Invoice in triplicate unless otherwise specified.

THIS PURCHASE ORDER NUMBER MUST APPEAR ON ALL INVOICES, SHIPPING PAPERS, PACKAGES, AND CORRESPONDENCE. 1331

F.O.B.	DATE REQUIRED	SHIP VIA	TERMS	ORDER DATE
Shipping Point	*Week of 2/22/82	UPS	Net 30 days.	9/30/81

LINE NO.	QUANTITY	DESCRIPTION	NET UNIT PRICE AFTER DISCOUNT	AMOUNT/ EXTENDED PRICE
1	LS	Seismic Tri-Axial Qualification test, including SRV loads, of a Hydrogen Ignitor Assembly per SDRC Proposal 10824. Price valid for work implemented by 5/31/82 per SDRC proposal.		
		QUALITY ASSURANCE LEVEL I		
		REFERENCE: QA-043 Supplementary instructions attached.		
		*-true date to be advised		

AUTHORIZED SIGNATURE: J. Roland Yow

☐ NOT FOR RESALE

☐ FOR RESALE ______ TAX NUMBER

NET TOTAL

REQUESTED BY	CHARGE TO ACCT. NO.	SERVICE ORDER NO.	JOB NUMBER	PROJECT NO.	DATE RECEIVED
Doug Greenwood	5080			1609	

Form # P-8723

© The Drawing Board, Inc. • Box 505 • Dallas, Texas

ORIGINAL

SDRC PROPOSAL NUMBER 10824

PROPOSAL

FOR

SEISMIC TRI-AXIAL TEST QUALIFICATION PLAN
OF A HYDROGEN IGNITER SYSTEM

Prepared

for

CONSOLIDATED CONTROLS CORPORATION
KOGER EXECUTIVE CENTER
P.O. BOX 30096
RALEIGH, NORTH CAROLINA 27612

Submitted

by

STRUCTURAL DYNAMICS RESEARCH CORPORATION
2000 EASTMAN DRIVE
MILFORD, OHIO 45150

JULY 14, 1981

Approved by: John R Hendricks
John R. Hendricks, P.E.
Program Manager
Seismic Qualification

Prepared by: John R Hendricks

Customer Contact: Mr. Gary Hugh

Reviewed by: Gary B Patrick
Gary Patrick
Manager, Seismic Testing Service

Phone number: 919-782-3441

REVISIONS

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES

1.0: TEST PLAN

This plan is for the seismic qualification of a Hydrogen Igniter System.

The test specimen is defined in Table 1.

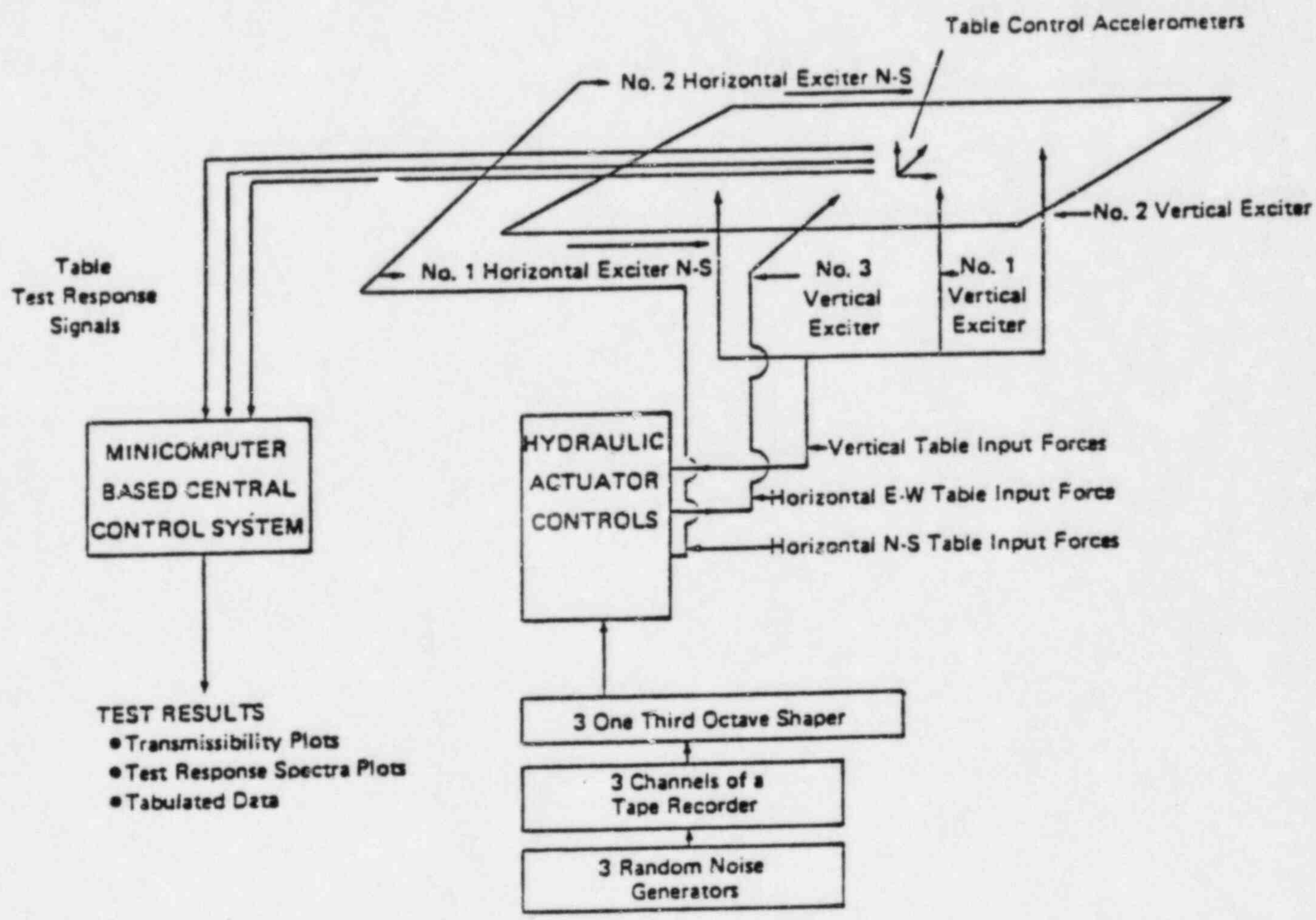
The test specimen will be qualified by seismic testing using the Tri-Axis Seismic Simulator Shake Table described in Figure 1. This table is located at the Structural Dynamics Research Corporation Laboratory in Milford, Ohio, a suburb of Cincinnati. Figure 2 is a description of the laboratory.

The control system for each of the six (3 vertical, 2 horizontal N-S and 1 horizontal E-W) actuators is made up of a dual loop analog controller. The controller provides a dynamic drive signal proportional to the command for force. This proportional system controls directly the variable of interest (acceleration). Conventional integral systems must process and track control data through two system orders (displacement and velocity), thereby making system stability much more difficult. The table's geometric design inherently has less table rocking because of the longer ram-actuator system which provides less pivot angle. The mechanical constraints eliminate the need for cross axis control feedback loops that typically compensate for test specimen shake table dynamic interaction, and out of necessity simultaneously reduce system response.

TABLE 1
Test Specimen Description

Items weight is less than 100 pounds. SRV is 30 minutes; 5 OBE followed by a summary of SRV + LOCA + SSE with the curve provided by CCL.

Figure 1
Description of Test Equipment
Schematic Diagram of the Test Instrumentation



SDRC Cincinnati Testing Services

Structural Dynamics Research Corporation, Milford, Ohio, offers sophisticated electromechanical testing capabilities for the study of complex mechanical and structural problems. These Testing Services are provided through the SDRC home office and several branch offices for problem solving in the following general areas:

- Telemetry transmitters and recievers for measurements on moving or rotating systems.
- A ten foot triaxial shaker table.
- Numerous recorders, transducers and amplifiers for the measurement of acceleration, strain, velocity, displacement, rotary motion and force.
- Fast Fourier Analyzers-Minicomputer based signal processing and modal testing systems.
- Hydraulic and electromechanical exciter systems.
- Real time analyzors for single channel or dual channel spectrum analysis.

Total Lab Area
11,280 Sq. Ft.

High Bay Area
5,760 Sq. Ft. x 20 Ft. Height

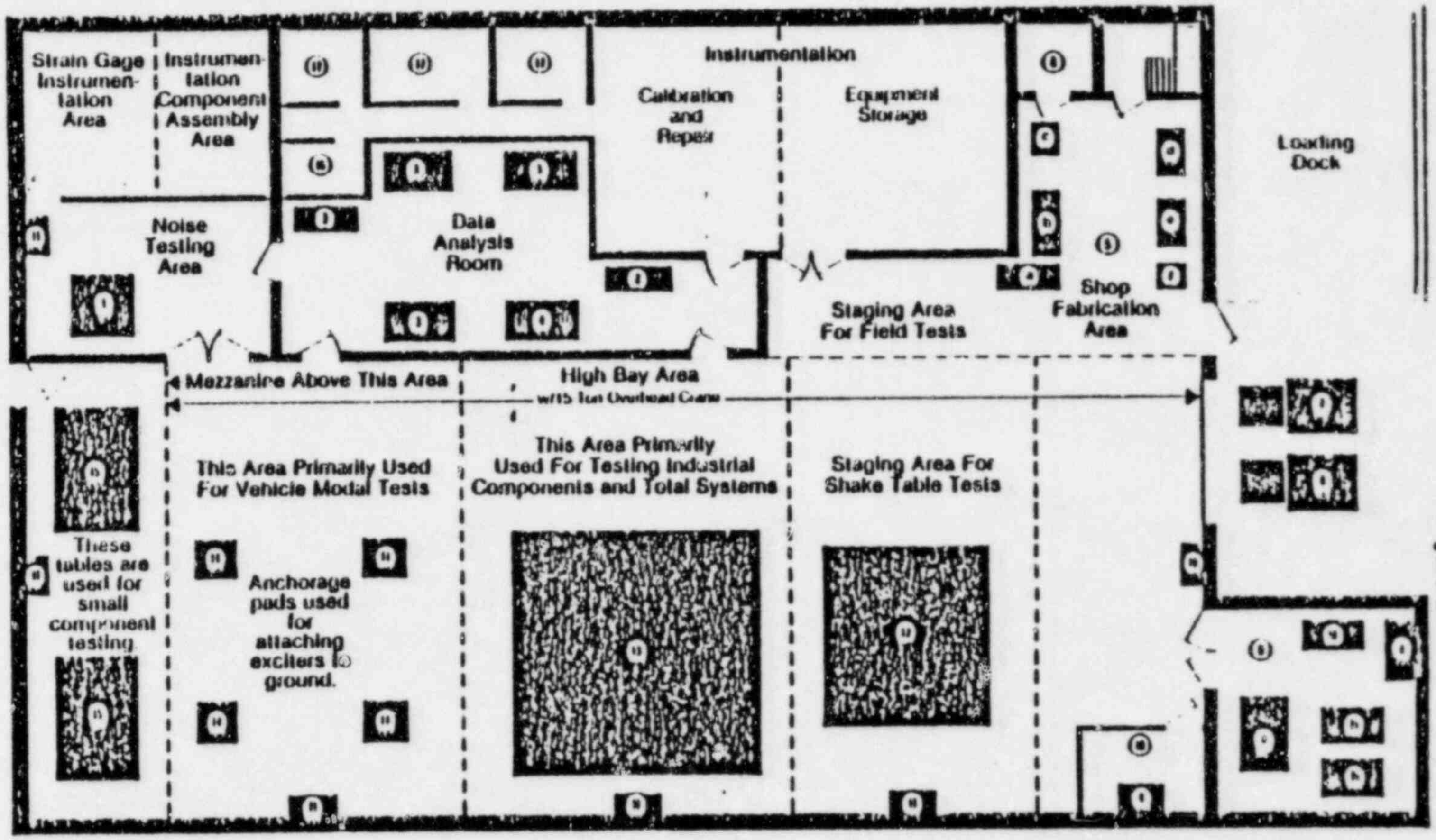


Figure 2

1. Sub-Zero & High Temperature Chamber
2. Real Time Analyzer
3. GenRad PDP 11/34 Minicomputer
4. HP 2100s Minicomputer
5. Shop Fabrication Area
   - a Kalamazoo Band Saw
   - b Boice Crane Band Saw
   - c Clausing Drill Press
   - d 18" LeBlond Regal Lathe
   - e Bridgeport Mill
   - f Miller Constant Welder
6. Telemetry Storage Area
7. Test Van No. 1
8. Test Van No. 2
9. Hydraulic Pump Room
   - g 10 GPM @ 3000 PSI
   - h 45 GPM @ 3000 PSI
   - i 90 GPM @ 3000 PSI
   - j 20 SCFM @ 100 PSI Air Compressor
10. Shake Table Control Room
11. Hydraulic Outlet
12. Shake Table
    Three axes simultaneously
    30,000 lbs. Force Vertical
    20,000 lbs. Force Horizontal
    20,000 lbs. Force Lateral
    Table 10'x10'
    Max. Spec. 15'x15'x12' High
    Max. Payload 10,000 lbs. @ 2 g's
    Max. Disp. 8" P.P all directions
    Max. Freq. 400 Hertz
13. Isolation Pad with Tie Down Inserts
    Used for testing components which need to be tied to ground or isolated from external vibrations. 30'x30'x3' Reinforced Concrete.
14. Anchorage Pad
15. "T" Slot Table
16. PCB Board Design and Fabrication
17. Office
18. Electric Outlets
    100 AMP 480V 3φ 60 Hz
    28 AMP 0-560V 3φ 60 Hz

2.0: TEST PROCEDURE

2.1: Specimen Mounting

2.1.1: The mounting of the test specimen will simulate the actual in-service mounting as closely as practical or as provided by the customer.

2.1.2: A visual inspection of the specimen shall be made prior to, during, and after the test. Any failure or abnormalities in the structural integrity of the specimen or mounting will be recorded.

2.1.3: The specimen will be rigidly connected to the shake table's surface with customer specified commercially available bolts, nuts and washers.

2.2: Exploratory Test

2.2.1: The frequency search is conducted in each principal axis prior to the full level qualification described in Section 2.3 below. This search is in the form of a single axis continuous frequency sweep using a sinusoidal steady-state input at the lowest possible amplitude capable of determining resonance. This frequency search is conducted by developing transmissibility plots for point(s) on the test specimen. A transmissibility plot is defined as the ratio of motion of a point on the object divided by the input motion at the base of the item or the table on which the item is mounted. Peaks in the transmissibility plot as well as a corresponding phase shift represent the natural frequency of the structure.

2.2.2: Transmissibility function(s) are calculated using Digital Fourier Analysis techniques which employ Digital Signal Processing Theory. This technique ratio's the Fourier spectrum of the component response to the Fourier spectrum of the input motion.

2.3.3: The frequency of the input excitation shall vary from 1.0 to 100 Hz.

2.3.4: The sweep rate shall be linear with the rate not to exceed two octaves per minute. The sine sweep shall be applied in the order of .02 g to 0.4 g.

2.2.5: Response accelerometers will be mounted on the specimen as required to record any natural frequencies.

2.2.6: It should be noted that due to either the complexity or the inaccessibility of critical parts (sealed relays, etc.), the exploratory test may not ascertain all the critical frequencies. Also because of nonlinearities the resonant response at high acceleration levels may differ in frequency and damping from that at low acceleration levels. Further, resonant response may not be excited at all low acceleration levels. Therefore, a low level exploratory test may not be conclusive as an indication of either equipment dynamic response or lack of resonances. Generally speaking higher accelerations, such as the SSE time signal, will shift the resonance frequencies lower than the indicated values from a .2 to 4 "g" acceleration sweep level.

Thus, it is recommended that the results of a low level exploratory search be used for an approximate determination of resonances and not be used for dwell tests, etc.

2.3: Full Level Qualification Test

2.3.1: Simultaneous Excitation Technique

The seismic qualification for the subject equipment will be performed by using an independent tri-axial random motion simulator. Testing will be performed with the test items' principal horizontal axes positioned parallel with the test table motion.

Thus, each horizontal axis will be excited separately, but simultaneously with the vertical axis. The Horizontal East-West, Horizontal North-South; and Vertical input accelerations will be independent (incoherent) of each other during the multi-frequency test.

2.3.2: Full Level Qualification Methodology

2.3.2.1: The SRV load will be applied for a total of 30 minutes.

2.3.2.2: Thereafter, the number of the tests performed simultaneously in three directions will be five operating basis earthquake (OBE')[1] levels followed by one safe shutdown earthquake (SSE')[2]. In addition to these required tests there may be a need for additional tests, if the test response spectra (TRS) does not envelope the required response spectra (RRS).

2.3.2.3: The specimen will be subjected to a minimum test duration of 30 seconds.

2.3.2.4: The test will consist of simultaneous horizontals (N-S and E-W) and vertical inputs of a continuous random motion over the frequency range of 1.0 to 100 Hz.

2.3.2.5: The amplitude of each random waveform motion will be independently adjusted at one-third octave frequency intervals in each axis until the TRS envelops the RRS within the limitations of the test machine.

2.3.2.6: The resulting shake table motion is analyzed and plotted by a digital Fourier analyzer using shock response software. This calculation is performed at the appropriate damping value and frequency interval:

damping value(s) 2
octave frequency interval: 1/3

The zero period acceleration (ZPA) of the RRS will probably be exceeded to meet the spectra peaks.

2.3.2.7: The required response spectra provided by the customer is attached.

NOTES:

(1) OBE[1] refer to OBE only.

(2) SSE' refers to a summary of the attached envelope of SSE, SRV, LOCA, etc., response spectra, see attachment.

3.0: MONITORING INSTRUMENTATION

SDRC calibrates all test equipment and instrumentation used in this test program in accordance with SDRC Quality Assurance and Operations Manual. This procedure is in compliance with 10CFR50 Appendix B, and ANSI/ASME N45.2-1977. Calibrations are traceable to the Natural Bureau of Standards.

3.1: Table Control

The three control accelerometers are mounted in the egg-crate designed shake table platform. These accelerometers are located in the approximate center of the horizontal planes and approximately 3 inches below the table top specimen interface plane.

The table control accelerometers are brushed recorded. The control accelerometers are calculated for the TRS at the following damping values: 2

3.2: Others

SDRC will provide 6 channels of Brush Recording for CCL use.

4.0: ACCEPTANCE CRITERIA

CCL to provide acceptance criteria.

5.0: FINAL REPORT

SDRC will certify that the testing was done in accordance with the accepted test program, IEEE-344-1975, etc. This report contains:

- QUALIFICATION RESULTS CERTIFICATION AND SUMMARY
- INTRODUCTION
- TEST DESCRIPTION
  - III.1: Required Response Spectrum (RRS)
  - III.2: Test Signal Generation
  - III.3: Description and Mounting of Test Specimens
  - III.4: Test Procedure
  - III.5: Monitoring of Specimen Response
  - III.6: Criteria for Test Acceptance
- DATA PRESENTATION
  - IV.1: Transmissibility
  - IV.2: Test Response Spectra (TRS)
- APPENDICES
  - V.1: Appendix A - Seismic Test Plan
  - V.2: Appendix B - SDRC Log Sheet
  - V.3: Appendix C - Calibration Records of Test Equipment
  - V.4: Appendix D - Description of SDRC Facility

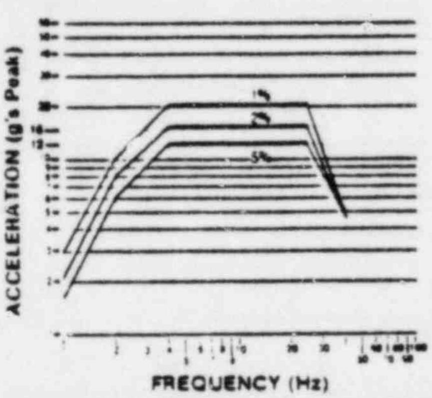
Photographs of the test setup and monitoring equipment are included.

SDRC will provide 10 copies of the final report.

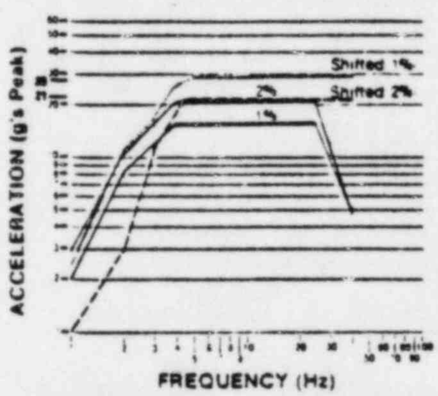
ATTACHMENTS

Customer's Requirement

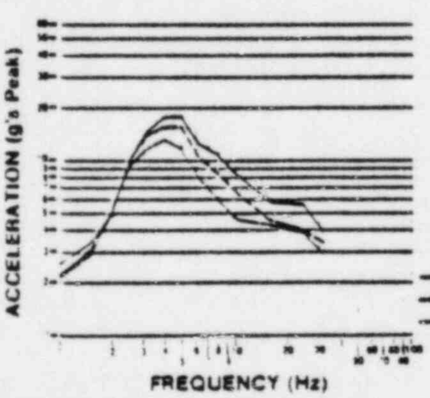
SDRC Broadband and shifted shake table limits; etc., using random noise as the signal source follows:



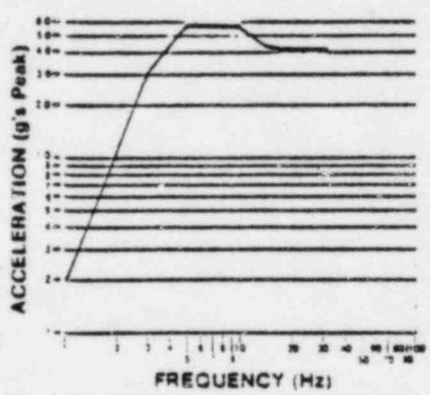
Approximate Broadband Limits Horizontal E-W. The horizontal N-S and vertical TRS are greater than the horizontal E-W.
(1, 2, & 5% damping is presented)



Variable TRS Curves. Can be obtained by modifying the test signal energy content at the 1/3 octave frequencies. Note the significantly increased TRS at 1 and 2% damping above 4 Hz by lowering the test signal energy below 4 Hz. This data is from two different qualifications tests.



Test Specimen Weight Effects On System Performance. Note the parallel TRS shifting with identical input signals. This shows the shake table controls are independent of the test article mounted on the table. RRS curves for larger items are enveloped merely by increasing system gain.

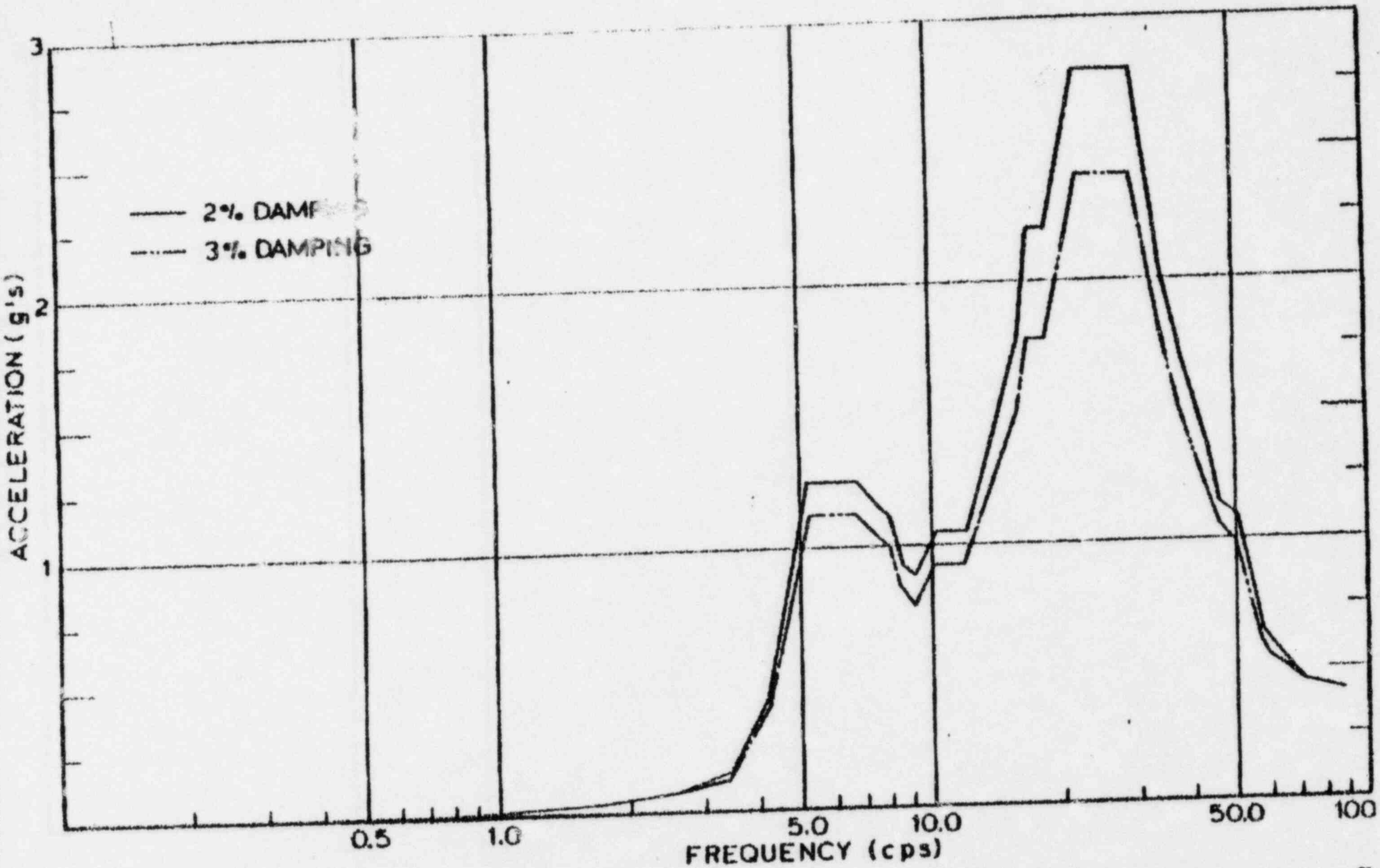


Maximum Acceleration In g's for the Horizontal E-W. The maximum g's for the horizontal N-S and vertical are equal to or greater than the horizontal E-W.

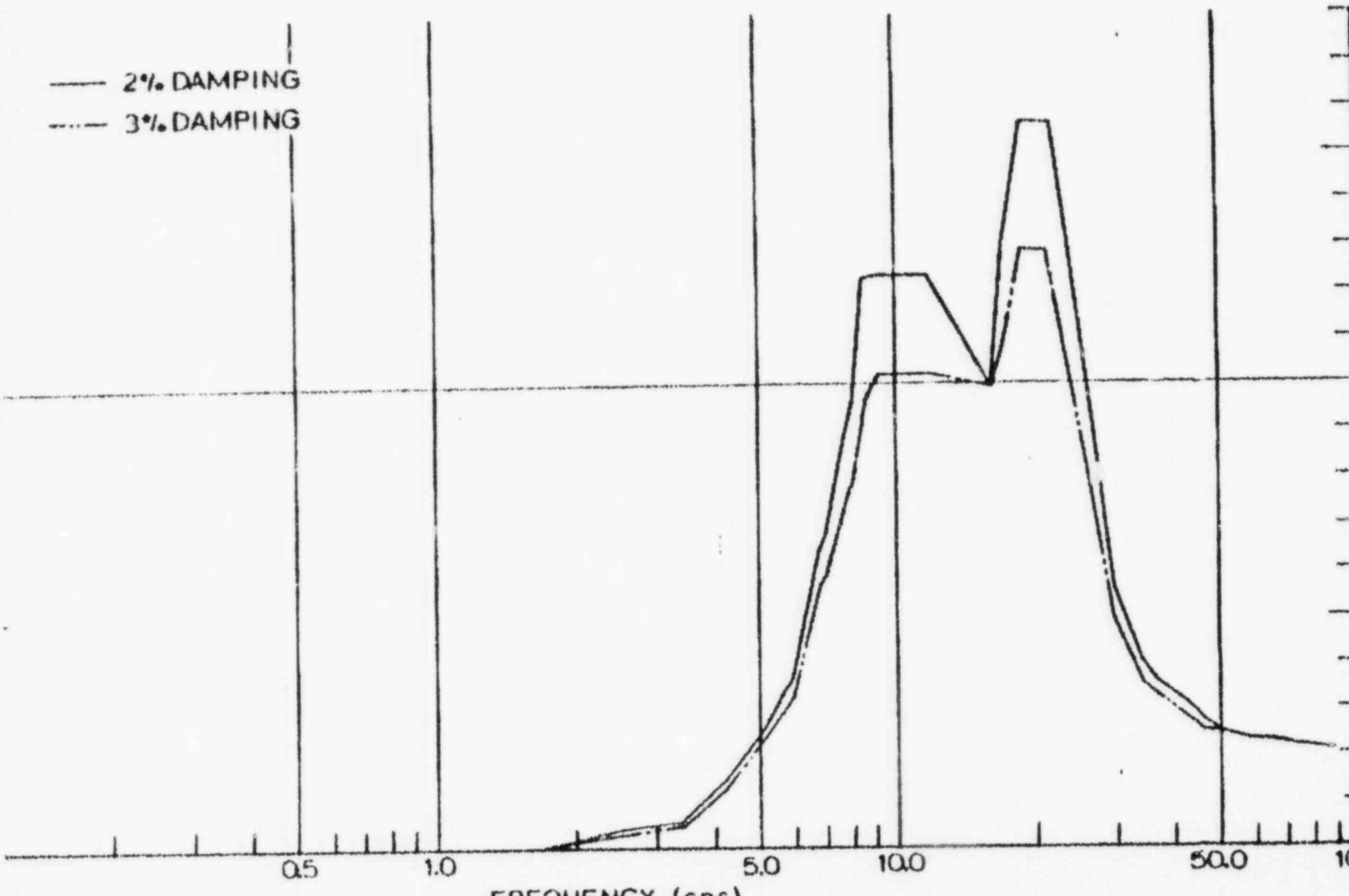
CUSTOMER RRS

Customer to provide a composite curve

TO: JOHN HENDRICKS, SDRC



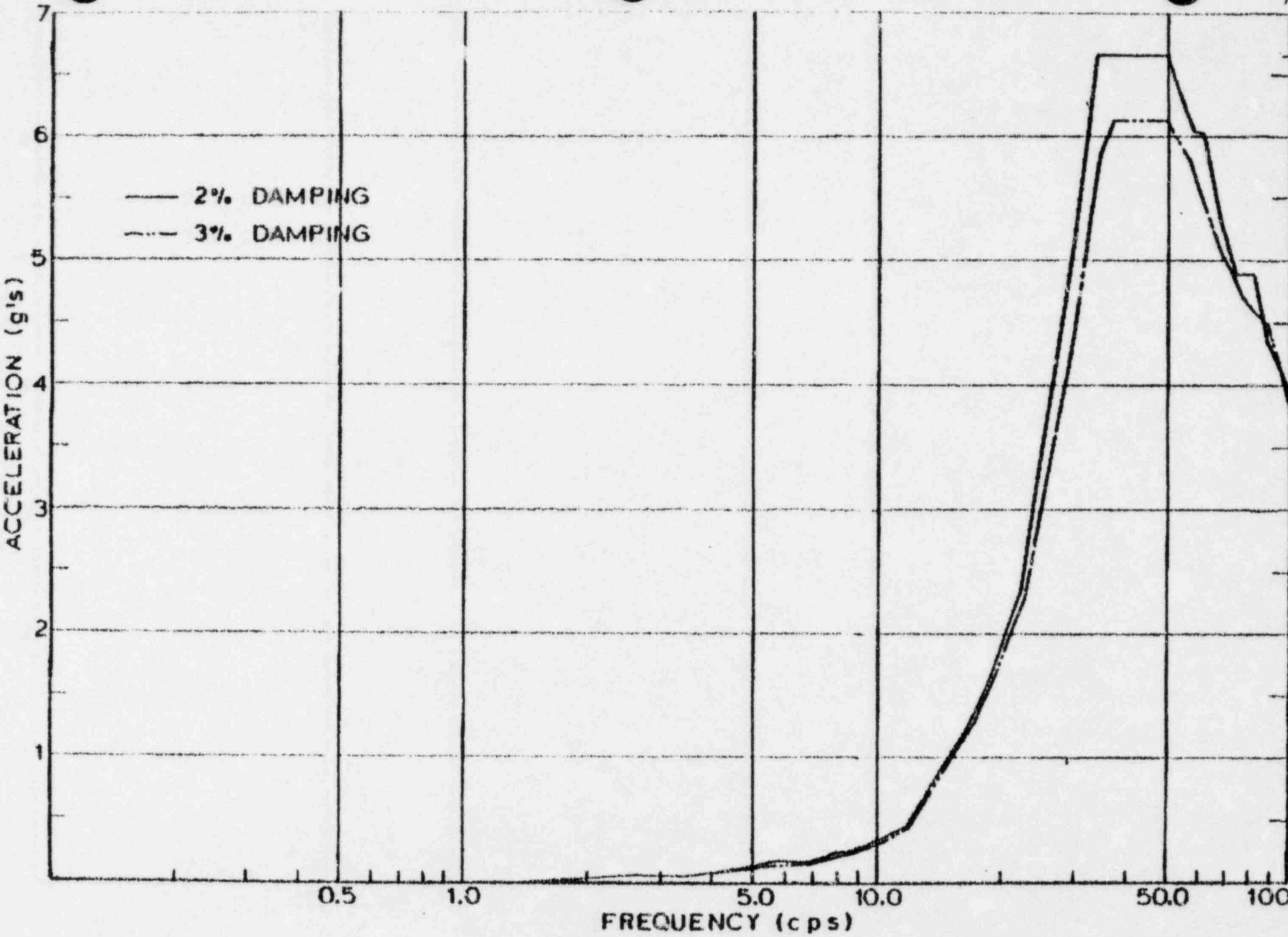
SRVA ALL CASES
HORIZONTAL ACCELERATION



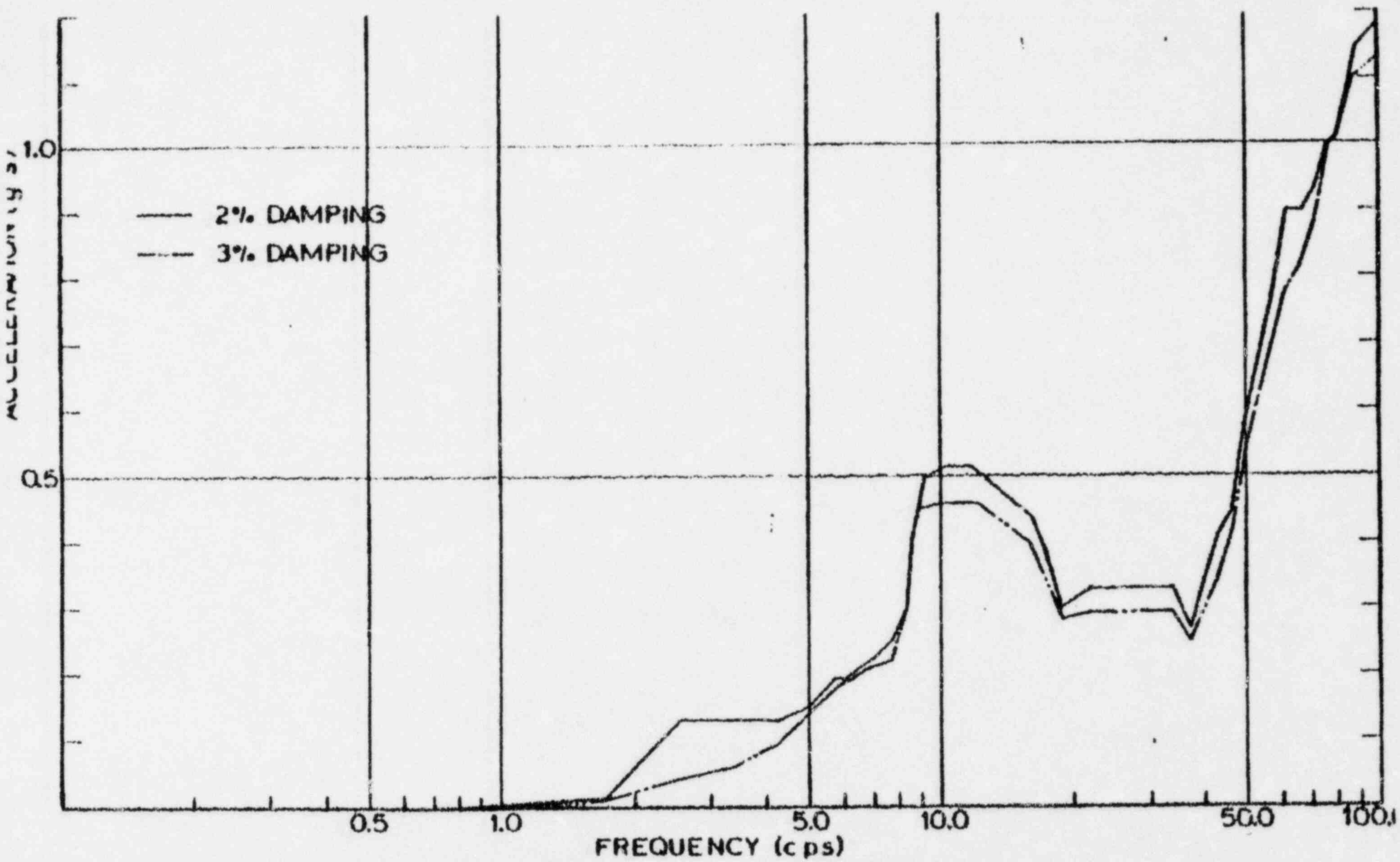
SRVA ALL CASES
VERTICAL ACCELERATION

1

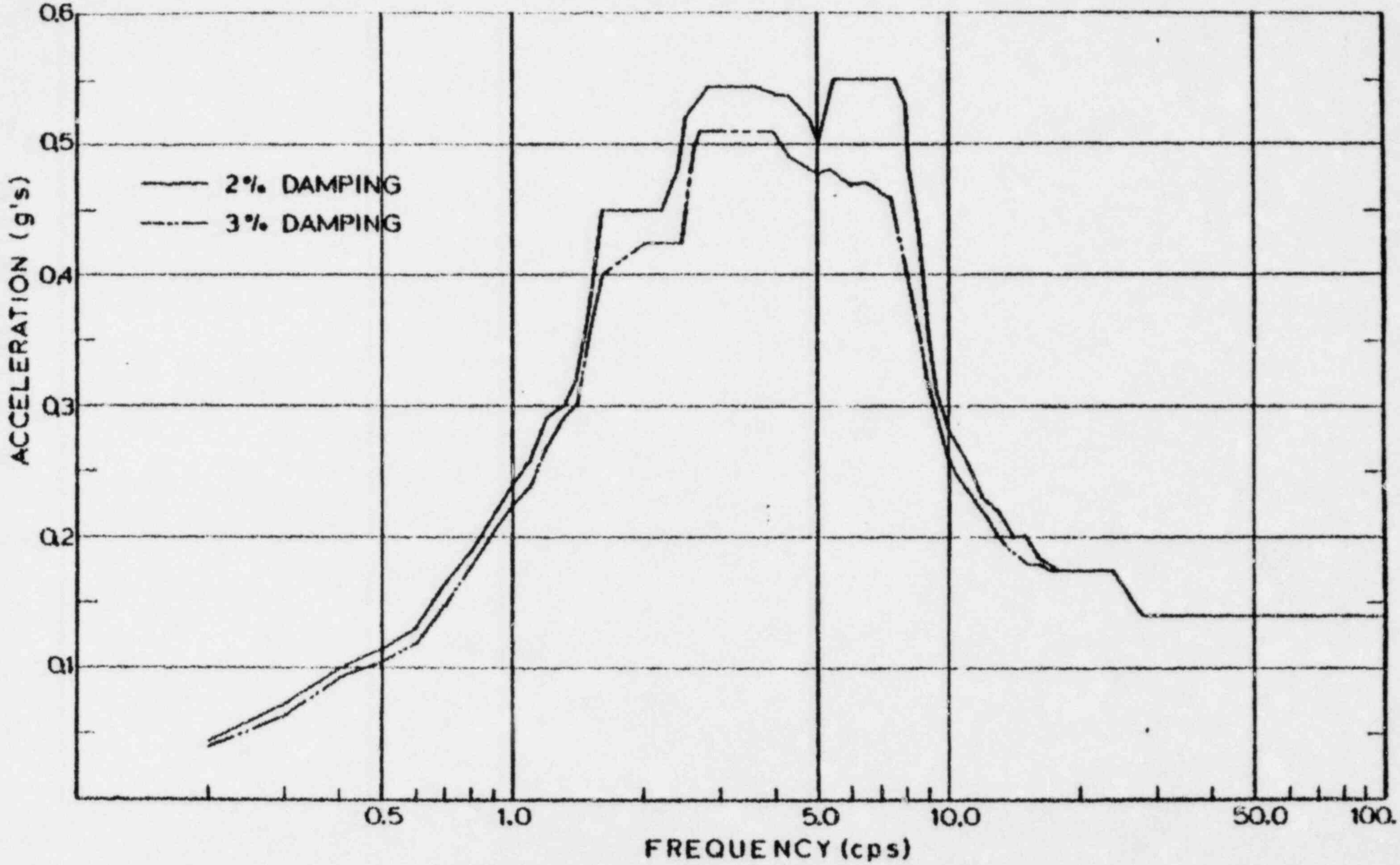
83



LOCA ALL CASES
HORIZONTAL ACCELERATION

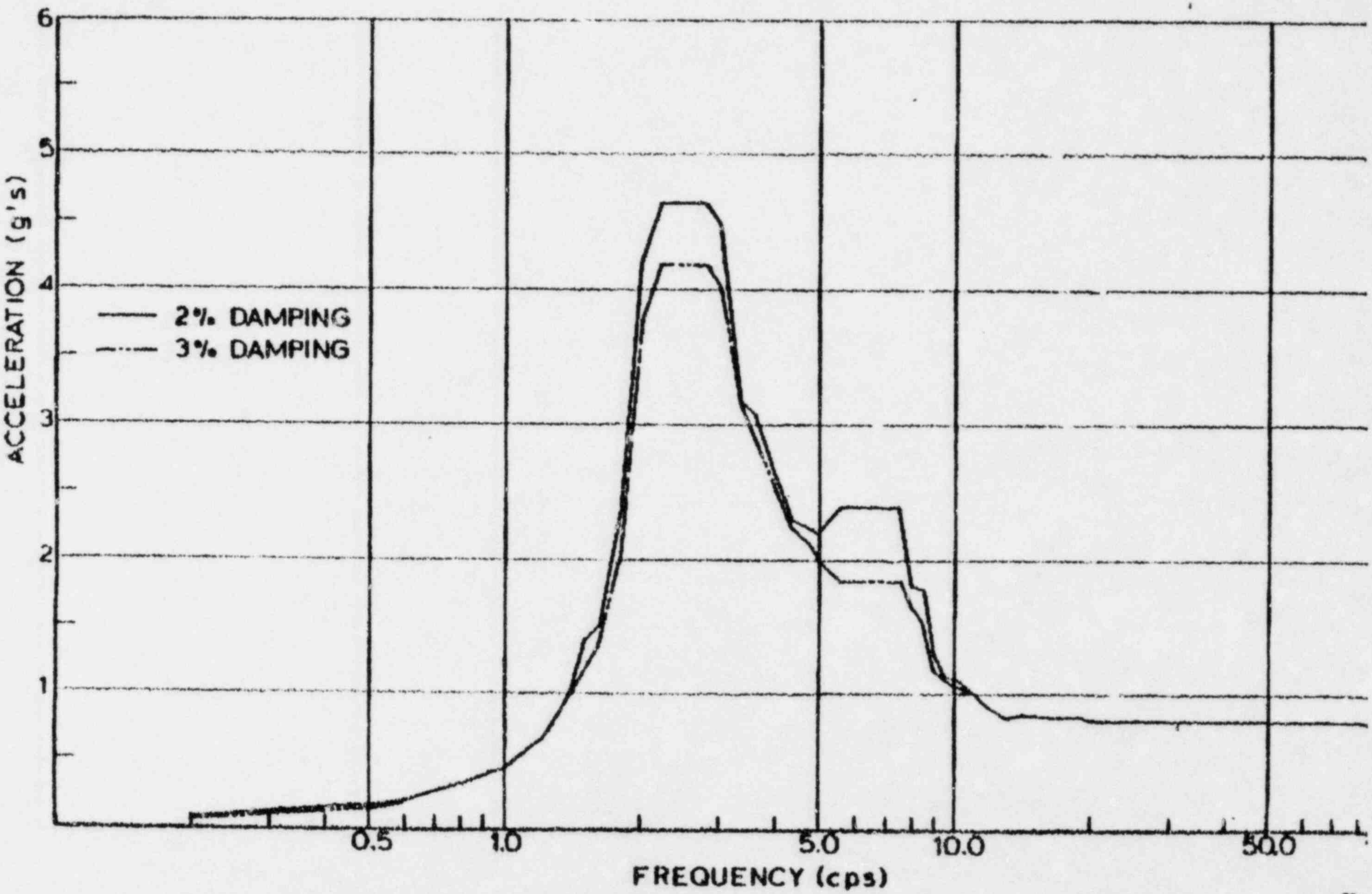


LOCA ALL CASES
VERTICAL ACCELERATION

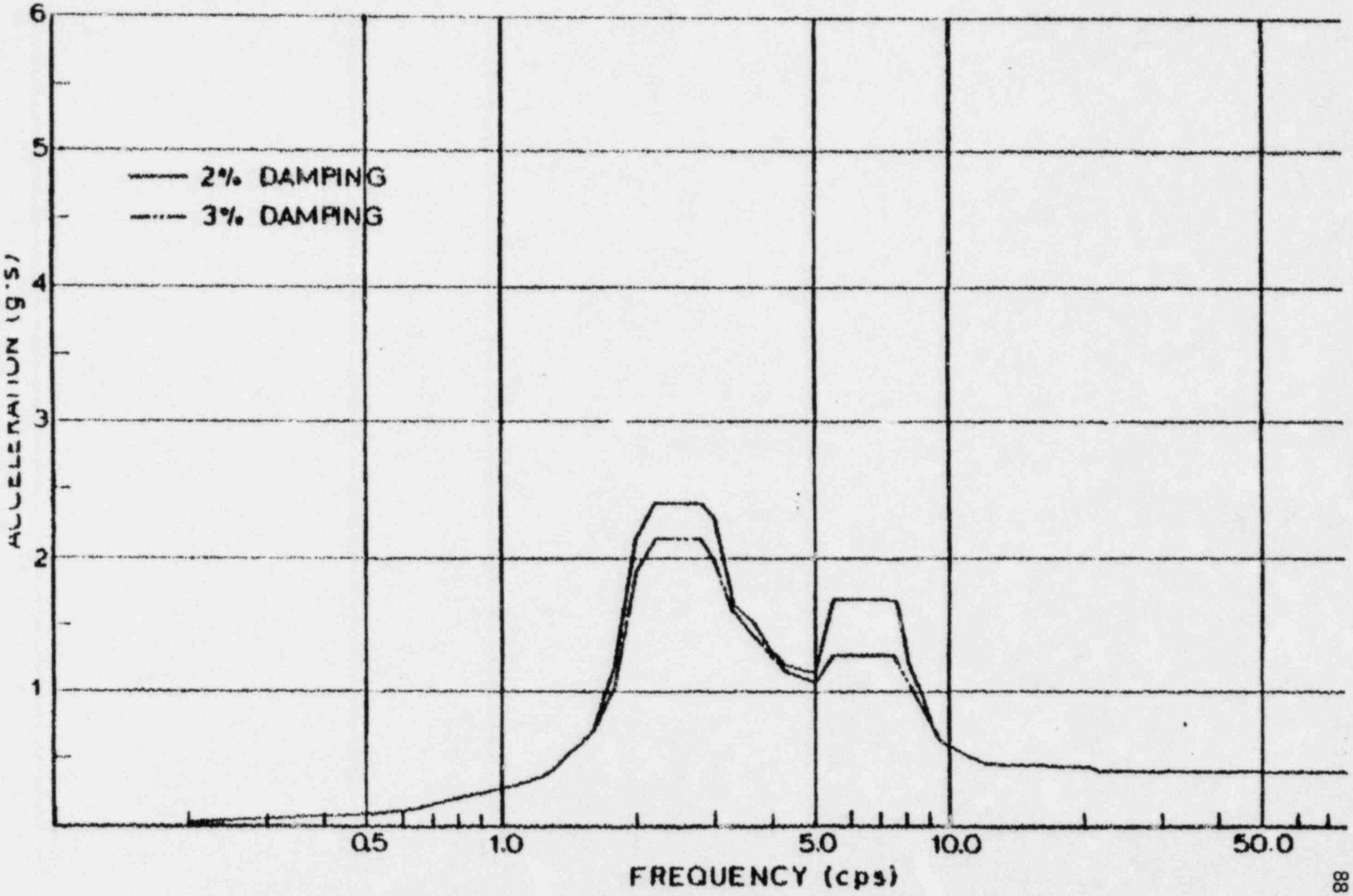


SEISMIC SSE
VERTICAL ACCELERATION

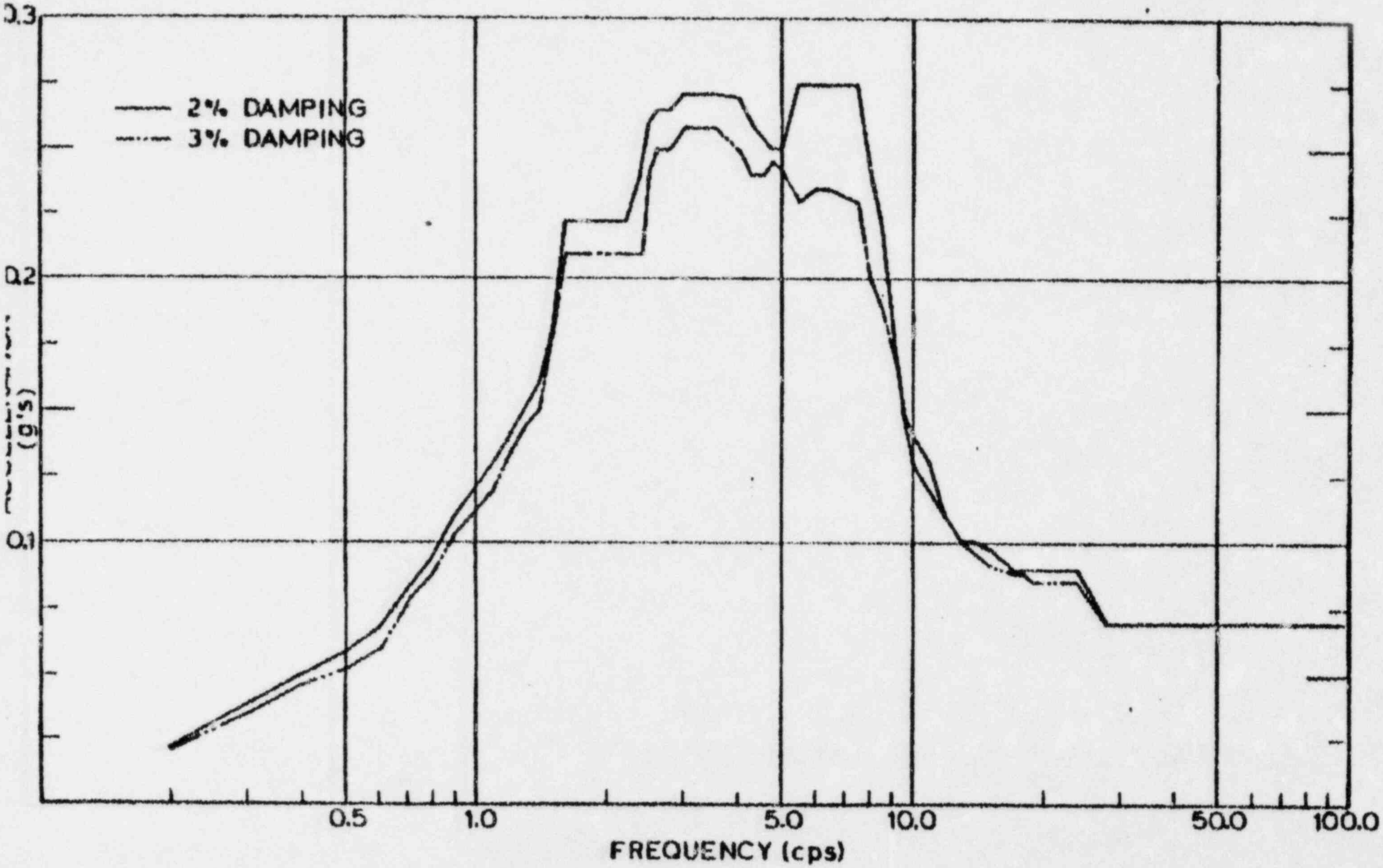
98



SEISMIC SSE
HORIZONTAL ACCELERATION



SEISMIC OBE
HORIZONTAL ACCELERATION



SEISMIC OBE
VERTICAL ACCELERATION

68

VII.2 Appendix B – SDRC Log Sheet

SDRC SEISMIC TEST LOG

Customer: [illegible]

P.O. No.: 1331

Project No.: [illegible]

Log Page 1 of [illegible]

Engineer: [illegible]

DATE	TIME	TEST NO.	TEST DESCRIPTION	COMMENTS
5/26/82	14:00	1	4" [illegible]	
5/26/82	14:15	2	Y [illegible]	
5/26/82	14:[illegible]	3	2" [illegible]	
5/26/82	14:[illegible]	4	SRV [illegible]	
5/26/82	15:21	5	1st [illegible]	
5/26/82	15:35	6	2nd [illegible]	
5/26/82	15:45	7	3rd [illegible]	
5/26/82	15:[illegible]	8	4th [illegible]	
5/26/82	15:[illegible]	9	5th [illegible]	
5/26/82	16:[illegible]	10	1st [illegible]	
5/26/82	16:[illegible]	11	2nd [illegible]	
5/26/82	16:[illegible]	12	3rd [illegible]	

VII.3 Appendix C – Calibration Records of Test Equipment

MINICOMPUTER BASED CENTRAL CONTROL SYSTEM

SDRC
Structural Dynamics Research Corporation

Instrumentation Services

000141

Cert. No.
Date 4/2/82
Due 7/2/82

Certificate of Calibration

Manufacturer GenRad Model 25Ø1-3ØØ7 ADS
Asset No: S/N ØØ47

This is to certify that the ADS unit described above has been calibrated by SDRC Instrumentation Services per procedure GenRad ADS Align using the references listed below and has been found to be within the tolerance specified.

Certified References Used			Last Cal Date
SDRC PC-2	S/N	ØØ3	
Data Precision 936	S/N	2551	3/19/82

Channel	Frequency	Ref. Input		Output	% Error
A		+.12Ø1		+.12ØØ	-Ø.Ø8
		-.12Ø1		-.12ØØ	-Ø.Ø8
		+1.8		+1.8Ø3	+Ø.17
		-1.8		-1.8Ø1	+Ø.Ø6
B		+.12Ø1		+.12ØØ	-Ø.Ø8
		-.12Ø1		-.12Ø3	+Ø.17
		+1.8		+1.799	-Ø.Ø6
		-1.8		-1.799	-Ø.Ø6
C		+.12Ø1		+.12ØØ	-Ø.Ø8
		-.12Ø1		-.12Ø1	Ø
		+1.8		+1.8Ø3	+Ø.17
		-1.8		-1.8Ø1	+Ø.Ø6
D		+.12Ø1		+.12Ø4	+Ø.25
		-.12Ø1		-.12Ø1	Ø
		+1.8		+1.8Ø1	+Ø.Ø6
		-1.8		-1.793	-Ø.39

Comments Within spec

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By [signature]

SDRC
Structural Dynamics Research Corporation

Instrumentation Services

Cert. No. 000140
Date 4-2-82
Due 7-2-82

Certificate of Calibration

Manufacturer GenRad Model (2503) 2501-3027 ADS
Asset No: E0132 S/N 008

This is to certify that the ADS unit described above has been calibrated by SDRC Instrumentation Services per procedure ADS GenRad Align using the references listed below and has been found to be within the tolerance specified.

Certified References Used		Last Cal Date
SDRC PC-2	s/n 003	4/1/82
Data Precision 936	s/n 2551	3/19/82

Channel	Frequency	Ref. Input		Output	% Error
A		+.1201		+.1203	+0.17
		-.1201		-.1198	-0.25
		+1.8		+1.805	+0.28
		-1.8		-1.799	-0.06
B		+.1201		+.1201	0
		-.1201		-.1198	-0.25
		+1.8		+1.801	+0.06
		-1.8		-1.801	+0.06
C		+.1201		+.1200	-0.08
		-.1201		-.1204	+0.25
		+1.8		+1.803	+0.17
		-1.8		-1.801	+0.06
D		+.1201		+.1199	-0.17
		-.1201		-.1201	0
		+1.8		+1.799	-0.06
		-1.8		-1.801	+0.06

Comments Within spec

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Bill [signature]

TABLE CONTROL ACCELEROMETERS

SDRC
Structural Dynamics Research Corporation

Instrumentation Services

Cert. No. 000050 1816123081
Date 12-30-81
Due 6/30/82

Certificate of Calibration

Manufacturer PCB Model 483M33
Asset No: S/N 316

This is to certify that the AMPLIFIER described above has been calibrated by SDRC Instrumentation Services per procedure AMPL1 PCB 483M33 using the references listed below and has been found to be within the tolerance specified.
DEDICATED TO SHAKE TABLE

*Certified References Used	Last Cal Date
FLUKE 5100A CALIBRATOR	12-7-81
FLUKE 8600A DVM	12-11-81

*TRACEABLE TO NBS THROUGH CERTIFICATE # 32792

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV)		X 1 AS FOUND / AFTER CAL	%
1	100	100.00		99.98 / 100.00	-0-
2				100.00 / 100.03	+ .03
3				100.04 / 100.05	+ .05
4				100.05 / 100.06	+ .06
5				100.04 / 100.05	+ .05
6				100.04 / 100.05	+ .05
7				100.06 / 100.05	+ .05
8				100.04 / 100.08	+ .08
9				100.06 / 100.06	+ .06
X				100.06 / 100.08	+ .08
Y				100.04 / 100.06	+ .06
Z				100.05 / 100.05	+ .05

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 1417123081
Date 12-30-81

Certificate of Calibration

Manufacturer PCB Model 483M33
Asset No: S/N 316

This is to certify that the AMPLIFIER described above has been calibrated by SDRC Instrumentation Services per procedure ______ using the references listed below and has been found to be within the tolerance specified.

DEDICATED TO SHAKE TABLE

*Certified References Used			Last Cal Date
FLUKE	5100A	CALIBRATOR	12-7-81
FLUKE	8600A	DVM	12-11-81

*TRACEABLE TO NBS THROUGH CERTIFICATE # 32792

Channel	Frequency	Ref. Input		Output	% Error
	(HZ)	(mV)		x 10 AS FOUND AFTER CAL	%
1	100	100.00		1.0002 1.0000	-0-
2				.9979 1.0000	-0-
3				1.0001 1.0000	-0-
4				.9996 1.0000	-0-
5				.9995 1.0000	-0-
6				.9997 1.0000	-0-
7				.9996 1.0000	-0-
8				1.0000 1.0000	-0-
9				.9998 1.0000	-0-
X				.9994 1.0000	-0-
Y				.9975 1.0000	-0-
Z	↓	↓		.9994 1.0000	-0-

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 1418123081
Date 12-30-81

Certificate of Calibration

Manufacturer PCB Model 483M33
Asset No: S/N 316

This is to certify that the AMPLIFIER described above has been calibrated by SDRC Instrumentation Services per procedure ______ using the references listed below and has been found to be within the tolerance specified. DEDICATED TO SHAKE TABLE

*Certified References Used	Last Cal Date
FLUKE 5100A CALIBRATOR	12-7-81
FLUKE 8600A DVM	12-11-81

*TRACEABLE TO NBS THROUGH CERTIFICATE #32792

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV)		x 100	%
				AS FOUND AFTER CAL	
1	100	100.00		9.997 10.000	-0-
2				9.979 10.000	-0-
3				9.996 10.000	-0-
4				9.992 10.000	-0-
5				9.989 10.000	-0-
6				9.993 10.000	-0-
7				9.996 10.000	-0-
8				9.960 9.960	-.4
9				9.998 10.000	-0-
X				9.993 10.000	-0-
Y				9.995 10.000	-0-
Z	↓	↓		9.989 10.000	-0-

SDRC
Structural Dynamics Research Corporation

2000 Eastman Drive
Milford, Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

000030
Cert. No. 1115123181
Date 12-31-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 5377

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified.

DEDICATED TO SHAKE TABLE - X AXIS

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

* TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV/g)		(mV/g)	%
	10	100.00		104.85	+ 4.85
	30			103.50	+ 3.5
	50			103.70	+ 3.7
	100			103.50	+ 3.5
	300			103.65	+ 3.7
	500			104.15	+ 4.1
	1K			104.50	+ 4.5
	3K			108.10	+ 8.1

ACCELEROMETER SENS. = 100.0 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

000061
Cert. No. 1116123181
Date 12-31-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 5378

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 ______ using the references listed below and has been found to be within the tolerance specified. DEDICATED TO SHAKE TABLE - Y AXIS

*Certified References Used	Last Cal Date
FLUKE 1953A COUNTER-TIMER	12-7-81
FLUKE 8600A DVM	12-11-81
KROHN-HITE 5400B GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE #32793

Channel	Frequency	Ref. Input		Output	% Error
	(HZ)	(mV/g)		(mV/g)	%
	10	100.00		102.90	+ 3.7
	30			102.15	+ 3.0
	50			102.60	+ 3.4
	100			102.55	+ 3.4
	300			102.40	+ 3.2
	500			102.30	+ 3.1
	1K			103.15	+ 4.0
	3K	↓		105.60	+ 6.5

ACCELEROMETER SENS. = 99.2 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Calibrated By Pat Griffiths

000062

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 117123181
Date 12-31-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 5379

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified.
DEDICATED TO SHAKE TABLE - Z AXIS

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE #32793

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV/g)		(mV/g)	%
	10	100.00		104.80	+ 4.7
	30			103.40	+ 3.3
	50			103.35	+ 3.2
	100			103.40	+ 3.3
	300			103.60	+ 3.5
	500			103.45	+ 3.3
	1K			104.00	+ 3.9
	3K			109.80	+ 9.7

ACCELEROMETER SENS. = 100.1 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffith

SURVEY ACCELEROMETERS

000051

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 1300123081
Date 12-30-81
Due 6/30/82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 2767

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified. DEDICATED TO SHAKE TABLE - #1

*Certified References Used	Last Cal Date
FLUKE 1953A COUNTER-TIMER	12-7-81
FLUKE 8600A DVM	12-11-81
KROHN-HITE 5400B GENERATOR	12-28-81

* TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV/g)		(mV/g)	%
	10	100.00		101.40	+ 1.5
	30			101.00	+ 1.1
	50			101.30	+ 1.4
	100			101.70	+ 1.8
	300			101.90	+ 2.0
	500			101.90	+ 2.0
	1K			102.50	+ 2.6
	3K	↓		105.60	+ 5.7

ACCELEROMETER SENS. = 99.9 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Calibrated By Pat Griffiths

000052

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 1310123081
Date 12-30-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308 B
Asset No: ________ S/N 2768

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 ________ using the references listed below and has been found to be within the tolerance specified.
DEDICATED TO SHAKE TABLE - #2

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

* TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Ref. Input		Output	% Error
	(HZ)	(mV/g)		(mV/g)	%
	10	100.00		103.05	+ 3.4
	30			102.15	+ 2.5
	50			102.45	+ 2.8
	100			102.20	+ 2.5
	300			102.50	+ 2.8
	500			102.20	+ 2.5
	1K			102.55	+ 2.6
	3K			107.60	+ 7.9

ACCELEROMETER SENS. = 99.7 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

000053

SDRC
Structural Dynamics Research Corporation

Instrumentation Services

Cert. No. 1320123081
Date 12-30-81
DUE 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308 B
Asset No: S/N 2769

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACC PCB06 using the references listed below and has been found to be within the tolerance specified. DEDICATED TO SHAKE TABLE - #3

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Rel. Input		Output	% Error
	(HZ)	(mV/g)		(mV/g)	%
	10	100.00		105.50	+ 4.9
	30			104.35	+ 3.7
	50			103.85	+ 3.2
	100			103.40	+ 2.8
	300			103.70	+ 3.1
	500			103.65	+ 3.0
	1K			104.40	+ 3.8
	3K			107.90	+ 7.3

ACCELEROMETER SENSITIVITY = 100.6 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

000054

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 133012308I
Date 12-30-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 2770

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified.

DEDICATED TO SHAKE TABLE - #4

*Certified References Used			Last Cal Date
FLUKE -	1953A	COUNTER-TIMER	12-7-81
FLUKE -	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV/g)		(mV/g)	%
	10	100.00		101.90	+ 1.5
	30			101.85	+ 1.4
	50			102.05	+ 1.6
	100			102.40	+ 2.0
	300			102.35	+ 1.9
	500			103.20	+ 2.8
	1K			103.80	+ 3.4
	3K			106.55	+ 6.1

ACCELEROMETER SENS. = 100.4 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

000055
Cert. No. 134012308I
Date 12-30-81
Due 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 2771

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified.

DEDICATED TO SHAKE TABLE - #5

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE # 32793

Channel	Frequency	Ref. Input		Output	% Error
	(Hz)	(mV/g)		(mV/g)	%
	10	100.00		102.10	+ 1.3
	30			102.40	+ 1.6
	50			103.20	+ 2.4
	100			103.25	+ 2.4
	300			103.50	+ 2.7
	500			103.70	+ 2.9
	1K			104.30	+ 3.5
	3K			108.75	+ 7.9

ACCELEROMETER SENSITIVITY = 100.8 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

Instrumentation Services

000056

SDRC
Structural Dynamics Research Corporation

Cert. No. 1350123081
Date 12-30-81
DUE 6-30-82

Certificate of Calibration

Manufacturer PCB Model 308B
Asset No: S/N 2772

This is to certify that the ACCELEROMETER described above has been calibrated by SDRC Instrumentation Services per procedure ACCPCB06 using the references listed below and has been found to be within the tolerance specified.

DEDICATED TO SHAKE TABLE - #6

*Certified References Used			Last Cal Date
FLUKE	1953A	COUNTER-TIMER	12-7-81
FLUKE	8600A	DVM	12-11-81
KROHN-HITE	5400B	GENERATOR	12-28-81

*TRACEABLE TO NBS THROUGH CERTIFICATE #32793

Channel	Frequency	Ref. Input		Output	% Error
	(HZ)	(mV/g)		(mV/g)	%
	10	100.00		103.00	+ 2.2
	30			103.60	+ 2.8
	50			104.20	+ 3.4
	100			104.70	+ 3.9
	300			105.15	+ 4.3
	500			105.40	+ 4.6
	1K			105.00	+ 4.2
	3K			109.20	+ 8.3

ACCELEROMETER SENS. = 100.8 mV/g

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford Ohio 45150

Calibrated By Pat Griffiths

TAPE RECORDER, BRUSH RECORDER

SDRC
Structural Dynamics Research Corporation

Instrumentation Services

Cert. No. 000?49
Date 11-21-81
Due 11-21-82

Certificate of Calibration

Manufacturer AMPEX Model PR2200
Asset No: S/N 6140363

This is to certify that the RECORDER described above has been calibrated by SDRC Instrumentation Services per procedure RECOR AMPEX PR2200 using the references listed below and has been found to be within the tolerance specified.

Certified References Used	Last Cal Date
FLUKE 5100A S/N 2096008	4-29-81
FLUKE 8600A S/N 0820225	7-17-81
FLUKE 1953A S/N 2315063	5-6-81

3% DEV. FULL SCALE

Channel	Frequency	Ref. Input		Output	% Error
	CARRIER (KHz)	VOUT (mV)	CARRIER (KHz)	VOUT (VOLTS)	
1	108.025	-0.30	151.280	1.414	
2	.012	+0.15	.257	"	
3	.015	+0.20	.230	"	
4	.013	+0.08	.242	"	
5	.001	-0.05	.233	"	
6	.050	-0.04	.255	"	
7	.048	+0.30	.232	"	
8	.025	+0.10	.290	"	
9	.030	+0.04	.236	"	
10	.037	-0.20	.213	"	
11	.029	+0.20	.203	"	
12	.016	+0.60	.210	"	
13	.050	+0.20	.241	"	
14	.012	-0.30	.246	"	

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Comments SPEED = 3 3/4 IPS, 14 x 14, 2.828 IN 1.414 OUT. COPY OF ORIGINAL DATA BY PAT GRIFFITHS.

Calibrated By VIA Bill [signature]

Instrumentation Services

SDRC
Structural Dynamics Research Corporation

Cert. No. 000182
Date 82/05/12
Due - 83/05/12

Certificate of Calibration

Manufacturer Gould Model MK 260
Asset N S/N 4107

This is to certify that the Brush Recorder described above has been calibrated by SDRC Instrumentation Services per procedure Record Brush MK 260 using the references listed below and has been found to be within the tolerance specified.

Certified References Used	Last Cal Date
Fluke 5100A Calibrator	12/7/81
Krohn-Hite 5400B Generator	

Channel	Frequency	Ref. Input	Output	% Error
Channels 1-6 calibrated as follows:				
ICO BAL adjusted for minimum pen movement.				
ZERO adjusted to center pen.				
PEN POSITION control adjusted to center pen.				
Preamplifier BALANCE adjusted for zero pen deflection				
when SENSITIVITY X1 control is rotated.				
SPAN adjusted for exactly 25 divisions when ±2.5 V.d-c				
applied to input terminals.				
DAMPING control adjusted for sine-wave 25 divisions				
p-p when 1 Hz signal applied to input terminals.				
Amplitude response checked at 10 divisions(10-100Hz)				
and 50 divisions(4-40Hz)				
RT and LEFT LIMITS adjusted to 2 divisions outside				
chart edge when ±3V.d-c applied to input terminals.				

Speed = 5 mm/sec
Sensitivity = 100 mV/div.

SDRC
Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150

Calibrated By [signature]

APPENDIX G - SUBMERGENCE TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd.
Koger Executive Center
: ...2096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

SUBMERGENCE TEST

7.0 The requirements and procedure for the Submergence Test of the Hydrogen Ignitor Assembly are described in the following paragraphs.

7.1 <u>Requirements</u>

The Ignitor Assembly shall be tested in accordance with the procedures specified below. The Ignitor Assembly shall comply with the following requirements.

The Ignitor Assembly shall be capable of operating during and after being submerged in demineralized water with the following quality:

a.	Conductivity @ 77°F	$<$	10 µmho/CM
b.	Chlorides	$<$	0.5
c.	pH @ 77°F	$>$	5.3, but $<$ 8.3

The Ignitor Assembly glow plug temperature shall be a minimum 1700°F at 120 VAC, and 132 VAC and 1500°F at 108 VAC.

7.2 <u>Procedure</u>

The Ignitor Assembly shall be installed in the test setup shown in Figure 1 of this procedure.

The water temperature shall be increased to and stabilized at 95°F + 10°, -0°F. With the Ignitor Assembly de-energized, actuate the air cylinder and submerge the assembly. The assembly shall remain

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P. [illegible] 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY DATE
APPROVED BY DATE
APPROVED BY DATE
QA REVIEW BY DATE

submerged for a minimum of 30 seconds. Actuate the air cylinder to retract the assembly from the water. The Ignitor Assembly shall be energized at the following voltages: 120/1/60, 108/1/60 and 132/1/60. The glow plug temperature shall be measured and recorded at each voltage level. The glow plug temperature shall be a minimum of 1700°F at 120 VAC and 132 VAC and 1500°F at 108 VAC. The test results shall be recorded on data sheets shown in this procedure.

The water temperature shall then be increased to and stabilized at 181°F + 10; -0°F. The Ignitor Assembly shall be energized with 120/1/60 power. The glow plug temperature shall be a minimum of 1700°F. The air cylinder shall then be extended to submerge the Ignitor Assembly. The assembly shall remain submerged for a minimum of 30 seconds. Retract the air cylinder to remove the assembly from the water. Measure and record the glow plug temperature after its temperature has stabilized. Adjust the input voltage to 108 VAC and record the glow plug temperature. Adjust the input voltage to 132 VAC and record the glow plug temperature after it has stabilized. The test results shall be recorded on the data sheets shown in this procedure. R1

7.3 Test Results

R2

The test samples were subjected to the submergence test in accordance with the requirements and procedure specified above. The submergence test data sheets follow this test procedure.

The test samples complied with the submergence test requirements.

The instrumentation and equipment used in the performance of the submergence tests, along with their calibration due dates are shown on the data sheets.

CCL Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PREPARED BY DATE
APPROVED BY DATE
APPROVED BY DATE
QA REVIEW BY DATE

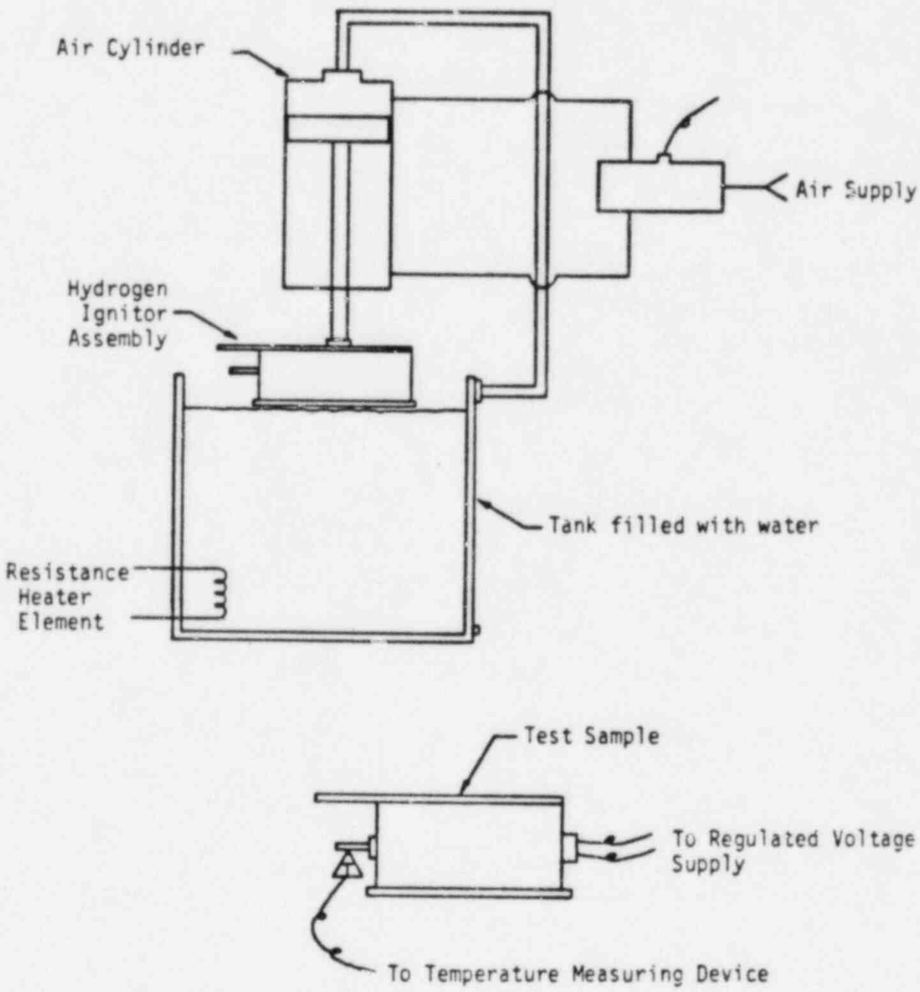


Figure 1609-7-1 Submergence Test Setup

Test Procedure 1609-7

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
x 30096 • Raleigh N C 27622 • 919-782-3441

PROCEDURE No 1609-7, Rev. 2

ISSUE DATE ______ PAGE 4 OF 5

PREPARED BY ______ DATE ______

APPROVED BY ______ DATE ______

APPROVED BY ______ DATE ______

QA REVIEW BY ______ DATE ______

TEST PROCEDURE

Test Procedure 1609-08 Page 1 of 2

DATA SHEET
FOR
SUBMERGENCE TEST

Client: Power System Division Date of Test: ______

Test Sample: Hydrogen Ignitor Assembly

CCL No.: ______

Instrument and Equipment List

Item	CCL No.	Range	Calibration Due Date

Test Parameters	Record	Requirements
1. Record the following water quality conditions.		
o Conductivity @ 77°F	______	< 10 μmho/cm
o Chlorides	______	< 0.5
o pH @ 77°F	______	> 5.3, but < 8.3
2. Condition Number 1		
o Record Water Temp	______	95°F + 10°F, -0°F
o Submerge test sample in water and then remove. Record time submerged.	______	30 seconds, minimum
o Record Input Voltage	______	120 VAC
o Record Glow Plug Temp	______	1700°F Minimum

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
... 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-7, Rev. 2
ISSUE DATE ________ PAGE 5 OF 5
PREPARED BY ________ DATE ________
APPROVED BY ________ DATE ________
APPROVED BY ________ DATE ________
QA REVIEW BY ________ DATE ________

DATA SHEET
FOR
SUBMERGENCE TEST

Client: Power System Division Date of Test: ________

Test Sample: Hydrogen Ignitor Assembly Drawing No.: 6043602001, Rev. "C"

CCL No.: ________ Test Procedure: ________

Test Parameters	Record	Requirements	
o Record Input Voltage	________	108 VAC	
o Record Glow Plug Temperature	________	1500°F Minimum	
o Record Input Voltage	________	132 VAC	
o Record Glow Plug Temperature	________	1700°F Minimum	
3. Condition Number 2			
o Record Water Temperature	________	181°F + 10°F, -0°F	
o Record Input Voltage	________	120 VAC	
o Record Glow Plug Temperature	________	1700°F Minimum	
o Submerge Test Sample in Water and Remove. Record time submerged.	________	30 seconds, minimum	
o Record Glow Plug Temperature	________	1700°F Minimum	
o Record Input Voltage	________	108 VAC	
o Record Glow Plug Temperature	________	1500°F Minimum	
o Record Input Voltage	________	132 VAC	
o Record Glow Plug Temperature	________	1700°F Minimum	R1

Functional within Acceptable Limits ____ Yes ____ No Tested by: ________

ROA Number ________ Reviewed by: ________

DATA SHEET
FOR
SUBMERGENCE TEST

Client: Power System Division

Date of Test: 6-14-82

Test Sample: Hydrogen Ignitor Assembly

CCL No.: 1609 001-000-002

Instrument and Equipment List

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200V AC	12-11-82
Fluke meter	8008	J	10-14-82
Fluke meter	8009	K	11-25-82

Test Parameters	Record	Requirements
1. Record the following water quality conditions.		
o Conductivity @ 77°F	< 10 µmho/cm	< 10 µmho/cm
o Chlorides	< .5 ppm	< 0.5
o pH @ 77°F	5.5	> 5.3, but < 8.3
2. Condition Number 1		
o Record Water Temp	97	95°F + 10°F, -0°F
o Submerge test sample in water and then remove. Record time submerged.	30	30 seconds, minimum
o Record Input Voltage	122	120 VAC
o Record Glow Plug Temp	1700	1700°F Minimum

DATA SHEET FOR SUBMERGENCE TEST

Client: Power System Division

Date of Test: 6-14-82 6-15-82

Test Sample: Hydrogen Ignitor Assembly

Drawing No.: 6043602001, Rev. "C"

CCL No.: 1609-001-000-002

Test Procedure: 1609-7 Rev. 1

Test Parameters	Record	Requirements	
o Record Input Voltage	108	108 VAC	
o Record Glow Plug Temperature	1506	1500°F Minimum	
o Record Input Voltage	132	132 VAC	
o Record Glow Plug Temperature	1773	1700°F Minimum	
3. Condition Number 2			
o Record Water Temperature	190	181°F + 10°F, -0°F	
o Record Input Voltage	120	120 VAC	
o Record Glow Plug Temperature	1712	1700°F Minimum	
o Submerge Test Sample in Water and Remove. Record time submerged.	38	30 seconds, minimum	
o Record Glow Plug Temperature	1870	1700°F Minimum	
o Record Input Voltage	108	108 VAC	
o Record Glow Plug Temperature	1731	1500°F Minimum	
o Record Input Voltage	132	132 VAC	
o Record Glow Plug Temperature	2018	1700°F Minimum	R1

Functional within Acceptable Limits ✓ Yes ___ No

Tested by: [signature]

ROA Number N/A

Reviewed by: [signature] 6/16/82

DELIVERY OF PURE BOTTLED WATERS OASIS COOLERS

Rainbow Water service

~~P.O. Box 1302, Durham, N.C. 27702 919/688-9064~~

~~Warehouse 802 D. Ramseur St.~~

Rt. 1, Box 280-A, Durham, N.C. 27705
919/888-4000 © Hwy. 70 West

the fresh taste

June 8, 1982

To Whom It May Concern:

We hereby certify that Huckleberry Springs Deionized Water has the following tolerences:

less than .5 ppm chlorides

and

less than 10 micro ohms/centimeter conductivity

Test Procedure 1609-08

DATA SHEET
FOR
SUBMERGENCE TEST

Client: Power System Division

Date of Test: 6-15-82

Test Sample: Hydrogen Ignitor Assembly

CCL No.: 1609 0001 -000 -001

Instrument and Equipment List

Item	CCL No.	Range	Calibration Due Date
DMM 179	6005	0-200 VAC	12-11-82
Fluke meter	8008	J	10-14-82
Fluke meter	8009	K	11-25-82

Test Parameters	Record	Requirements
1. Record the following water quality conditions.		
o Conductivity @ 77°F	< 10 μmho/cm	< 10 μmho/cm
o Chlorides	< .5 ppm	< 0.5
o pH @ 77°F		> 5.3, but < 8.3
2. Condition Number 1		
o Record Water Temp	105	95°F + 10°F, -0°F
o Submerge test sample in water and then remove. Record time submerged.	34	30 seconds, minimum
o Record Input Voltage	120	120 VAC
o Record Glow Plug Temp	1802	1700°F Minimum

DATA SHEET
FOR
SUBMERGENCE TEST

Client: Power System Division — Date of Test: 6-15-82

Test Sample: Hydrogen Ignitor Assembly — Drawing No.: 6043602001, Rev. "C"

CCL No.: 001-000-001 — Test Procedure: 1609-7 Rev. 1

Test Parameters	Record	Requirements
o Record Input Voltage	108	108 VAC
o Record Glow Plug Temperature	1617	1500°F Minimum
o Record Input Voltage	132	132 VAC
o Record Glow Plug Temperature	2007	1700°F Minimum
3. Condition Number 2		
o Record Water Temperature	182	181°F + 10°F, -0°F
o Record Input Voltage	120	120 VAC
o Record Glow Plug Temperature	1830	1700°F Minimum
o Submerge Test Sample in Water and Remove. Record time submerged.	37	30 seconds, minimum
o Record Glow Plug Temperature	1817	1700°F Minimum
o Record Input Voltage	108	108 VAC
o Record Glow Plug Temperature	1633	1500°F Minimum
o Record Input Voltage	132	132 VAC
o Record Glow Plug Temperature	2008	1700°F Minimum R1

Functional within Acceptable Limits ✓ Yes ___ No

Tested by: [signature]

ROA Number N/A

Reviewed by: [signature] 6/15/82

DELIVERY OF PURE BOTTLED WATERS   OASIS COOLERS

Rainbow Water service

the fresh taste

Rt. 1, Box 280-'A', Durham, N.C. 27705
919/383-4000 ○ Hwy. 70 West

June 8, 1982

To Whom It May Concern:

We hereby certify that Huckleberry Springs Deionized Water has the following tolerences:

less than .5 ppm chlorides
and
less than 10 micro ohms/centimeter conductivity

APPENDIX H - LOCA SIMULATION TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-5, Rev. 2
ISSUE DATE ______ PAGE 1 OF 11
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

ACCIDENT TEST (LOCA & HELB)

5.0 The requirements and procedures for accident testing of the Hydrogen Ignitor Assembly are presented in the following paragraphs.

5.1 Test and Requirements

5.1.1 The Hydrogen Ignitor Assembly shall be subjected to a postulated Design Basis Accident (LOCA & HELB) to determine if the test sample will perform its safety-related function during the environmental conditions specified below. R1

5.1.2 The accident conditions (temperature, pressure, time profile and spray rate) shall be in accordance with Figure 1609-5-1 of this procedure. The test medium for the containment spray shall be demineralized water. The spray rate shall be 1GPM/ft^2 of test sample surface area. R1

5.1.3 The Hydrogen Ignitor Assembly shall be energized with 120/1/60 VAC throughout the accident test. The glow plug temperature shall be a minimum of 1700°F. The Ignitor Assembly shall also be tested at 108 VAC and 132 VAC and the glow plug temperature shall be a minimum of 1500°F and 1700°F, respectively, at 108 VAC and 132 VAC. R1

5.1.4 The following test parameters shall be recorded during the accident test. R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O.Box 30096 • Raleigh N.C 27622 • 919 782 3441

TEST PROCEDURE

a. Test chamber pressure, temperature and time profile
b. Chamber spray rate (demineralized water)
c. Input power and current to test sample
d. Glow plug assembly temperature
e. Test sample case temperature

5.1.5 The Ignitor Assembly shall be subjected to a negative pressure transient during the accident test. R1

5.1.6 The Ignitor Assembly shall be subjected to a Post-Accident Functional Test. R1

5.2 Test Procedure

5.2.1 Test Setup

5.2.1.1 The Hydrogen Ignitor Assembly shall be installed in the test chamber as shown in Figure 1609-5-2. The ignitor assembly shall be connected to a regulated power source. A thermocouple shall be attached to the ignitor glow plug to measure the glow plug temperature. One additional thermocouple shall be attached to the Ignitor Assembly Case to monitor the case temperature. The thermocouple(s) used to monitor and control the test chamber temperature shall be located within six inches of the test sample. R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
Box 10096 • Raleigh N C 27622 • 919 782-3441

TEST PROCEDURE

5.2.1.2 A steam spraying/water system shall be set up inside the chamber for use during the portion of the test requiring saturated conditions. R1

5.2.1.3 A second chamber shall be setup in order to provide a negative pressure transient within the LOCA chamber. R1

5.2.1.4 After completion of the test setup and prior to the start of the accident test, the test sample shall be energized with a 120/1/60-VAC power source. The glow plug temperature shall be a minimum of 1700°F. Record the glow plug temperature, voltage and current. De-energize the electrical power to the Ignitor Assembly. R1

5.2.2 Instrumentation and Recording Equipment

5.2.2.1 The following test parameters shall be recorded on a Fluke Model 2240 Datalogger: R1

a. Test chamber temperature
b. Test chamber pressure
c. Glow plug temperature
d. Ignitor Assembly case temperature
e. Time

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
Box 30096 • Raleigh, N.C. 27622 • 919 782 3441

5.2.2.2 The following test parameters shall be manually monitored as required: R1

a. Input voltage
b. Input current

5.2.2.3 The parameters listed in Paragraph 5.2.2.1 above shall be recorded at the time intervals listed below. R1

a. The test data shall be continuously recorded during the initial temperature transient from 185°F to 330°F.
b. Test data shall be recorded at 5-minute intervals at the temperature of 330°F.
c. Test data shall be recorded at 15-minute intervals for the remaining portion of the test profile.

5.2.3 <u>LOCA and HELB Test</u>

5.2.3.1 The test chamber temperature shall be increased to and stabilized at 185°F. The test medium shall be saturated steam. The Ignitor Assembly shall then be energized with a 120-VAC, single-phase, 60-Hertz power source. Allow the glow plug temperature to stabilize and record its temperature. Also, record case temperature, input voltage, and current. De-energize the electrical power to the Ignitor Assembly. R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
Box 30096 • Raleigh, N.C. 27622 • 919 782 3441

TEST PROCEDURE

5.2.3.2 The Ignitor Assembly shall then be subjected to the temperature, pressure, time profile shown in Figure 1609-5-1 of this procedure. The test media shall be superheated and/or saturated steam. The following test parameters shall be recorded at the intervals specified in Paragraph 5.2.2 above: R1 R1

a. chamber pressure R1
b. chamber temperature
c. glow plug temperature
d. case temperature
e. input voltage
f. input current.

R1

5.2.3.3 After the chamber and test sample temperatures have stabilized at 185°F, superheated and saturated steam shall be injected into the test chamber to increase the chamber temperature to 330°F. The time required to increase the temperature from 185°F to 330°F shall be 10 seconds. The chamber pressure shall be a minimum of R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

30 psig and shall not exceed 70 psig. After the temperature and pressure conditions have been obtained, the demineralized water spray shall be initiated. The spray rate shall be 1GPM/ft^2 of the test sample surface area. The Ignitor Assembly shall be energized with a 120-VAC potential. The glow plug assembly temperature shall be measured and recorded. This test shall be repeated at 108 VAC and 132 VAC after completion of the negative pressure transient described in paragraph 5.2.3.4. The glow plug temperature shall be 1700°F minimum at 120 VAC and 132 VAC and 1500°F minimum at 108 VAC. After these operational tests are completed, the Ignitor Assembly shall be energized with a 120-VAC potential. This voltage shall remain applied for the remainder of the 7.7-day test. The 330°F and 30 to 70 psig condition specified above shall be maintained for a three-hour time period. A chamber pressure of 70 psig shall be maintained for 10 minutes during this time period to simulate a hydrogen ignition. R2 R1 R1

5.2.3.4 At T_O + 350 seconds, the Ignitor Assembly shall be subjected to a negative pressure transient as shown in Figure 1609-5-3. The Transient shall be accomplished by the use of a second chamber (Chamber No.2) of a suitable size in which a suitable vacuum has been established. Through the use of a control valve between Chamber No. 2 and the LOCA chamber, the R1 R2 pressure in the LOCA chamber shall be reduced as shown in Figure 1609-5-3 to a pressure of -14.0 psig ±10%. The rate of depressurization and pressurization shall not exceed the maximum values shown in Figure 1609-5-3. Note that during the negative pressure transient the demineralized water spray and steam inlet valves shall be closed. R1

5.2.3.5 After three hours at 330°F, the chamber temperature shall be decreased to 310°F. The chamber pressure shall be a minimum of 30 psig and shall not exceed 60 psig. These conditions shall be maintained for three hours. R1 R2 R1

5.2.3.6 After completion of the three hours at 310°F, the chamber temperature shall be reduced to 250°F. The chamber pressure shall be 15 psig. These conditions shall be maintained for 7 days and 11 hours. During this time period a steam spray/water system shall be in operation to insure saturated conditions inside the chamber. R1 R1

5.2.3.7 After completion of the Accident Test, the test chamber shall be opened and a Functional Test performed. The Functional Test shall consist of measuring the glow plug temperature with an electrical potential of 120/1/60, 108/1/60 and 132/1/60 applied. During each R1 of the above tests the voltage, current, case temperature, and glow plug temperature shall be recorded. The glow plug temperature shall be a minimum of 1700°F at 120 VAC and 132 VAC and 1500°F at 108 VAC. The Ignitor Assembly shall then be removed from test chamber and visually inspected. Any deleterious effect noted shall be recorded.

5.3 Test Results R2

The prime test sample was subjected to the accident test in accordance with the requirements and procedure specified above. Wyle Test Report 45880-1, documenting the results of the test, is included in Appendix I to this report.

The test sample complied with the accident test requirements. The instrumentation and equipment used in the performance of the accident test, along with their calibration due dates, are shown in the Wyle report in Appendix I.

Figure 1609-5-1 was revised to correct the location of the negative pressure transient test. As a consequence of this, Paragraphs 5.2.3.3, 5.2.3.4, and 5.2.3.5 of this procedure were revised to clarify the actual test sequence.

Several Wyle test equipment anomalies occurred during the course of the test. These are discussed in detail and resolved in Wyle Test Report 45880-1.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
Box 30096 • Raleigh N.C. 27622 • 919 782 3431

TEST PROCEDURE

PREPARED BY ________ DATE ________
APPROVED BY ________ DATE ________
APPROVED BY ________ DATE ________
QA REVIEW BY ________ DATE ________

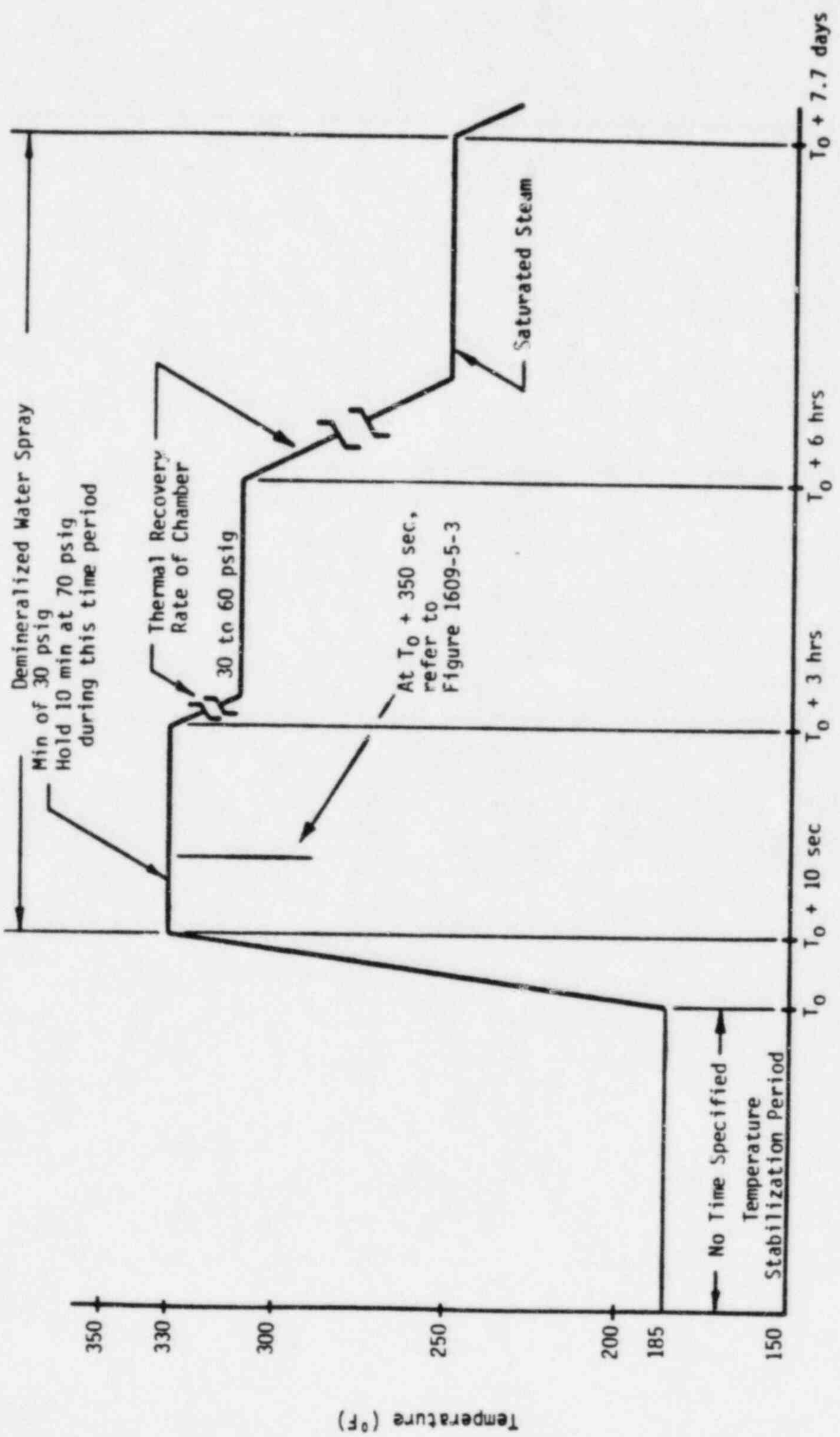


Figure 1609-5-1 Accident Test Profile (LOCA and HELB)

Test Procedure 1609-5

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
POB [illegible]96 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

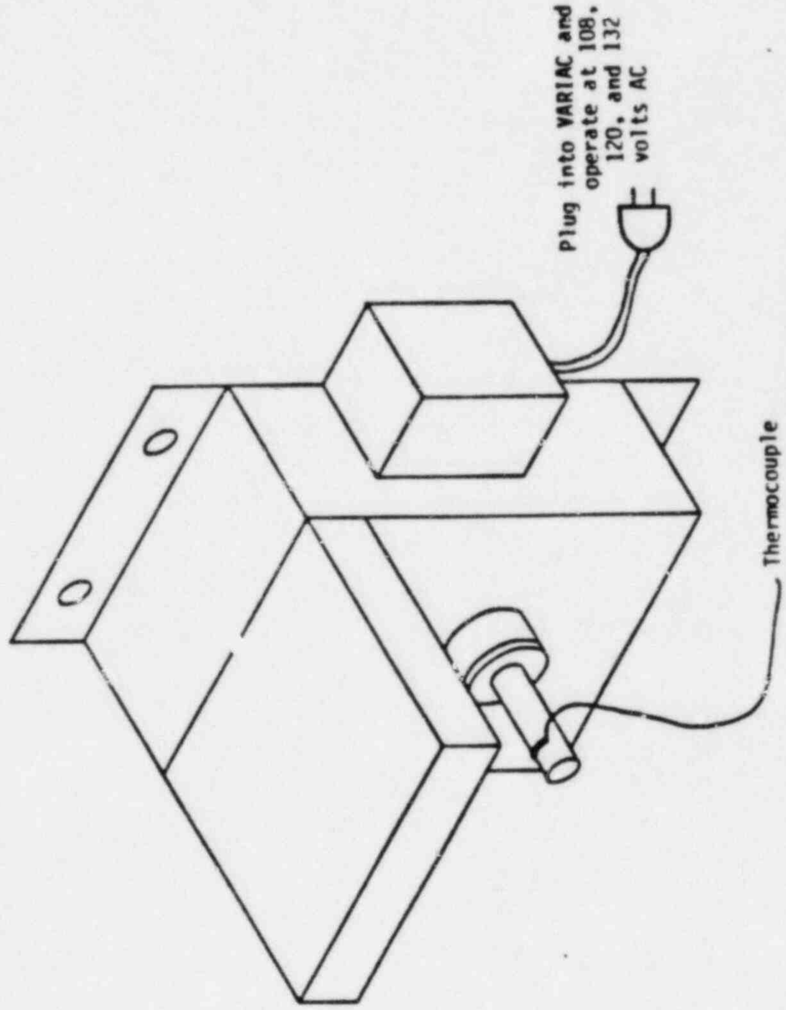


Figure 1609-5-2 Installation of Hydrogen Ignitor Assembly in Test Chamber

Test Procedure 1609-5

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh N.C. 27622 • 919 782 3441

TEST PROCEDURE

PREPARED BY ________ DATE ________
APPROVED BY ________ DATE ________
APPROVED BY ________ DATE ________
QA REVIEW BY ________ DATE ________

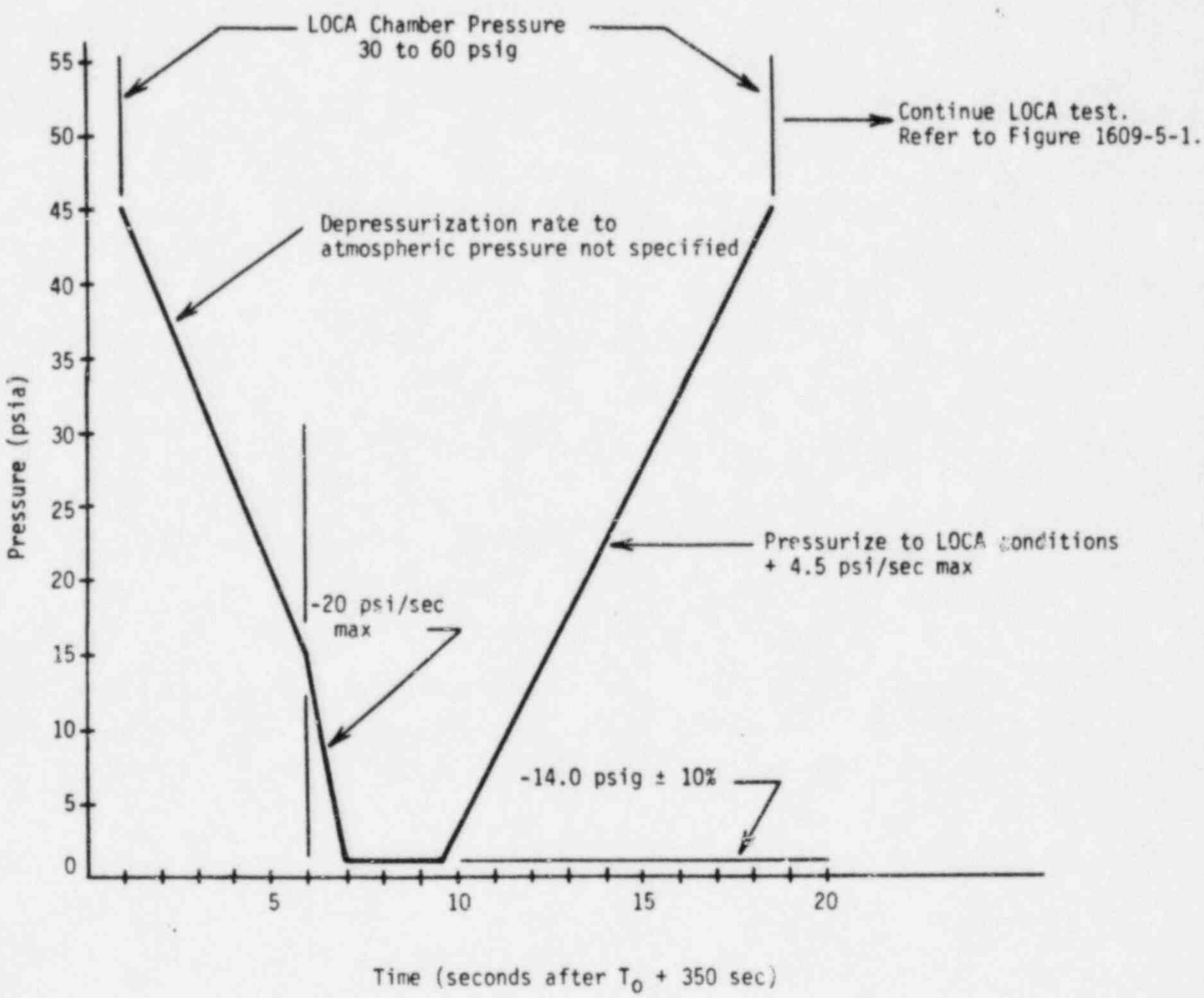


Figure 1609-5-3 Negative Pressure Transient
Test Procedure 1609-5

APPENDIX J - HYDROGEN BURN TEST PROCEDURE AND RESULTS

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No	1309-6, Rev. 2
ISSUE DATE	PAGE 1 OF 4
PREPARED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE
QA REVIEW BY	DATE

HYDROGEN BURN TEST

6.0 The requirements and procedures for the Hydrogen Burn Test of the Hydrogen Ignitor Assembly are described in the following paragraphs.

6.1 Test Requirements

6.1.1 The Hydrogen Ignitor Assembly shall be capable of igniting a combustible concentration of hydrogen and air. The Ignitor Assembly shall ignite mixtures of 4 to 12 percent hydrogen by volume. R1

6.1.2 The Ignitor Assembly shall remain operational after being subjected to multi-ignition of the combustible concentration of hydrogen and air mixtures. R1

6.1.3 The Ignitor Assembly shall be tested at the specified extremes of the power supply voltage to demonstrate it will ignite the combustible concentration of hydrogen and air. The test voltage shall be 120/1/60 VAC, 108/1/60 VAC, 132/1/60 VAC. R1

6.1.4 The Ignitor Assembly shall be subjected to a minimum of 100 ignitions of the hydrogen and air mixture specified below. R1

6.1.5 A spare test sample will be used to calibrate the test system and to verify ignitor assembly operation prior to installing the actual test sample in the system. R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
:096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

6.1.6 The data obtained from this test will be used to establish a known operating procedure for each test condition specified below. The intent of this test is to prevent over or under testing on the actual test sample. R1

6.2 Test Procedure

6.2.1 The Hydrogen Ignitor Assembly shall be placed in a test chamber that has a known volume. The Ignitor Assembly shall be instrumented and electrically connected to a power supply as shown in Figure 1 of this procedure. The Hydrogen Ignitor Assembly shall be tested in each of the conditions specified in the table below. R1

Number of Ignitions Required	Input Voltage (VAC)	H_2/Air Mixture (% by Volume)	
			R2
4	120	4 ±5%	
4	108	4 ±5%	
4	132	4 ±5%	
4	120	8 ±5%	
4	132	8 ±5%	
4	108	8 ±5%	
4	108	12 ±5%	
4	120	12 ±5%	
4	132	12 ±5%	
*70	120	as required to obtain multiple burns.	R1

*multiple burns shall consist of one ignition followed by another ignition. Flow of H_2/air mixture shall be interrupted between ignitions. R2

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
.. 2096 • Raleigh N C 27622 • 919-782-344

TEST PROCEDURE

6.2.2 The following test parameters shall be measured and recorded during each of the ignition tests specified above: R1

a. input voltage
b. current
c. glow plug assembly temperature
d. test sample case temperature
e. hydrogen/air burn temperature
f. hydrogen/air mixture (percent by volume)
g. chamber pressure R1

The parameters shall be recorded with a computer data acquisition system.

6.3 <u>Test Results</u> R2

The prime test sample was subjected to the Hydrogen Burn Test in accordance with the requirements and procedure specified above. Wyle Test Report 57149, documenting the results of the test, is included in Appendix K to this report.

The test sample complied with the Hydrogen Burn test requirements. The instrumentation and equipment used in the performance of the functional tests, along with their calibration due dates, are shown in the Wyle report in Appendix K.

Paragraph 6.2.1, above, was revised to show that, during the multiple burn portion of the test, the H_2/air mixture was manually interrupted for each ignition.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-6, Rev. 2
ISSUE DATE ______ PAGE 4 OF 4
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

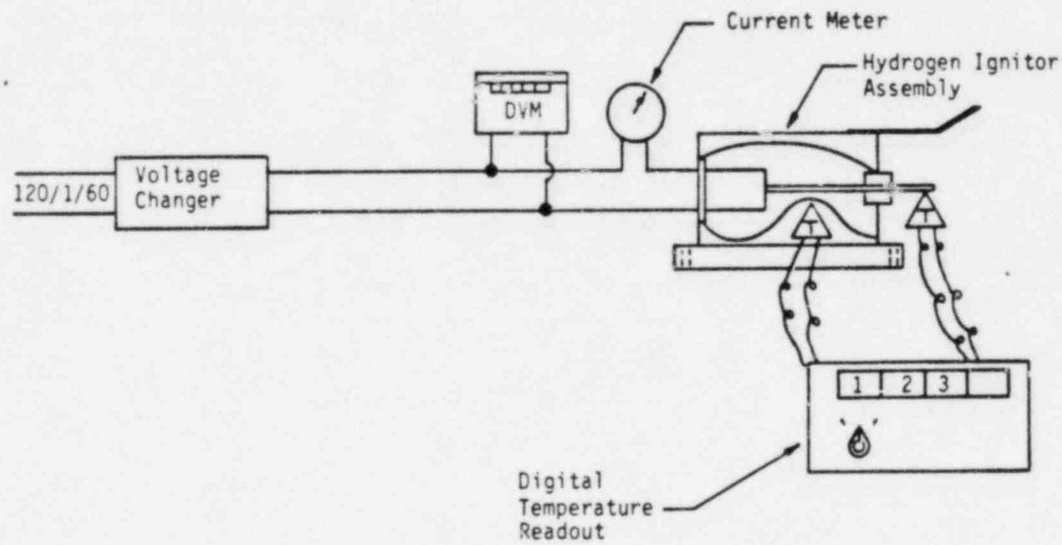


Figure 1609-6-1 Hydrogen Burn Test Setup

Test Procedure 1609-6

NUCLEAR ENVIRONMENTAL QUALIFICATION REPORT

of

HYDROGEN IGNITOR ASSEMBLIES

for

GRAND GULF NUCLEAR STATION UNIT 1

MISSISSIPPI POWER & LIGHT COMPANY

BECHTEL POWER COMPANY
Specification No. 9645-M-198.0, Rev. 6

VOLUME II

Report Date: November 12, 1982
CCL Report Number: A-516-82
CCL Project Number: 81-1609
PSD P.O. No.: 45917-6043

NORTH CAROLINA PROFESSIONAL SEAL 7081 ENGINEER DOUGLAS DUFF GREENWOOD

By Douglas D. Greenwood
Douglas D. Greenwood, P.E.

Checked By Duna F. Hatmaker
Duna F. Hatmaker

NORTH CAROLINA PROFESSIONAL SEAL

Approved By J. Roland Yow
Dr. J. Roland Yow, P.E.
CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.

NORTH CAROLINA REGISTERED SEAL 7033 ENGINEER HARRY WILLIAM FALTER
11-15-82

Approved By Harry W. Falter
POWER SYSTEMS DIVISION

Harry W. Falter, P.E.

Prepared By

CORPORATE CONSULTING & DEVELOPMENT COMPANY, LTD.
Koger Executive Center Raleigh, North Carolina

for

POWER SYSTEMS DIVISION

Part 2 of 2

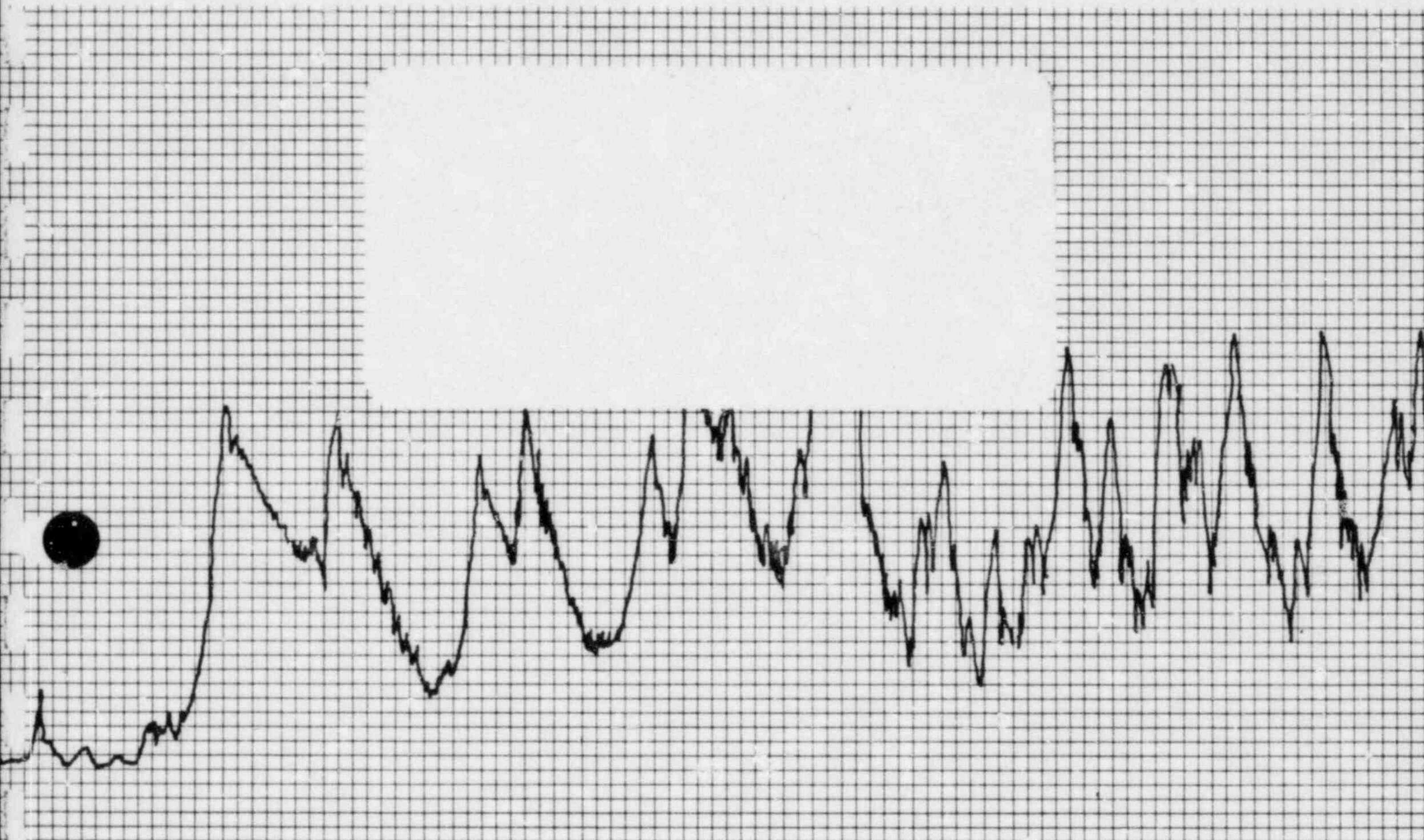
9645-M-198.0-Q1-26.0-2-0

APPENDIX I - WYLE LOCA TEST REPORT 45880-1

SDRC
Structural Dynamics Research Corporation

2000 Eastman Drive
Milford, Ohio 45150
513-576-2400

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP



NEQ
NUCLEAR ENVIRONMENTAL QUALIFICATION

test REPORT

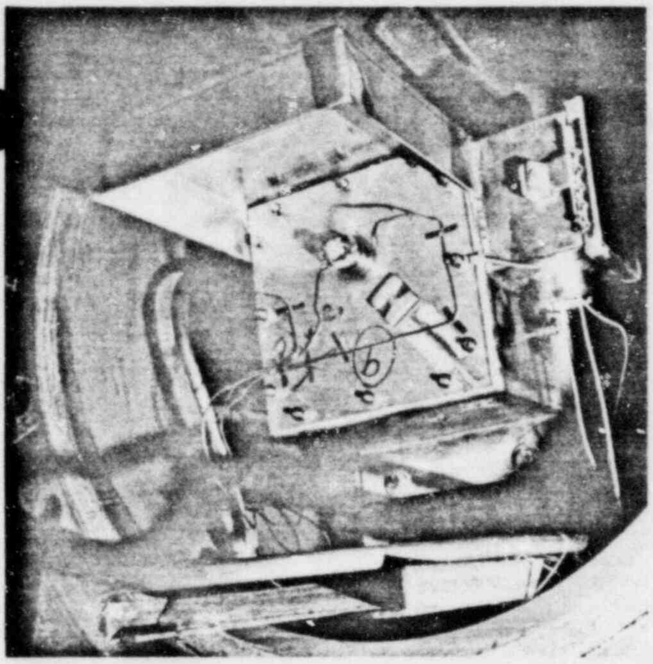
NUCLEAR ENVIRONMENTAL TEST

ON

ONE (1) HYDROGEN IGNITOR ASSEMBLY

FOR

CORPORATE CONSULTING AND DEVELOPMENT CO., LTD.
P. O. BOX 30096
RALEIGH, N.C. 27622



NEQ

Nuclear Environmental Qualification

Test Report

REPORT NO. 45880-1

WYLE JOB NO. 45880

CUSTOMER P. O. NO. 1334

PAGE 1 OF 64 PAGE REPORT

DATE October 5, 1982

SPECIFICATION (S) CCL Procedure No. 1609-5, Rev. 1

1.0 CUSTOMER Corporate Consulting and Development Co., LTD. (CCL)

ADDRESS P. O. Box 30096, Raleigh, NC 27622

2.0 TEST SPECIMEN One (1) Hydrogen Ignitor Assembly

3.0 MANUFACTURER N/A

4.0 SUMMARY

One (1) Hydrogen Ignitor Assembly was subjected to a Nuclear Environmental Test Program to verify its adequacy to maintain a high glow plug temperature during and after exposure to a Design Basis Event Accident (LOCA and HELB). The test procedure used was CCL Procedure No. 1609-5, Rev. 1.

STATE OF ALABAMA } ss.
COUNTY OF MADISON

Alabama Professional Eng. Reg. No. 8256

Flavous R. Johnson, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SEAL Flavous R. Johnson

SUBSCRIBED and sworn to before me this 18th day of October, 1982

Virginia K. Dent

Notary Public in and for the State of Alabama at large.

My Commission expires June 13, 1983

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report.

PREPARED BY G. Carbonneau
G. Carbonneau

APPROVED BY Flavous R. Johnson
Flavous R. Johnson

WYLE Q. A. T. Stinson
T. Stinson

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

4.0 SUMMARY (Continued)

This report contains the following sections:

- Section I - Pre-LOCA Baseline Functional
- Section II - Accident (LOCA) Test
- Section III - Post-LOCA Functional
- Section IV - CCL Procedure 1609-5, Rev. 1

The qualification program was conducted in the sequence indicated by Sections I through III above. During the program, three (3) anomalies were noted. The anomalies are discussed briefly below and in more detail in Section II of this report.

Notices of Anomaly (NOA)

NOA No. 1 - The hydrogen ignitor glow plug thermocouple was out of tolerance due to corrosion of the tie-down band which gave an indicated temperature lower than the actual probe temperature.

NOA No. 2 - Documents out-of-tolerance chamber temperature conditions caused by facility power outages and boiler control system anomalies during LOCA/HELB test.

NOA No. 3 - During the LOCA/HELB test, the required time at 250°F was 178.8 hours (162 hours + 16.8 hour margin). The actual time at 250°F or above was 171.3 hours (162 hours + 9.3 hours margin). Analysis is provided which demonstrates that the test profile margin envelops the required margin because of the time durations above the required temperature of 250°F.

Based upon the test results contained in this report, it is the opinion of Wyle Laboratories that the Hydrogen Ignitor Assembly successfully met all requirements of CCL procedure 1609-5, Rev. 1.

Additional rationale is provided in Wyle's letter to CCL, dated October 11, 1982 and is contained in Appendix I of this section.

5.0 REFERENCES

5.1 Corporate Consulting Purchase Order No. 1334

5.2 Corporate Consulting Test Procedure No. 1609-5, Rev. 1

5.3 Wyle Laboratories letter, Change of Scope No. 3, dated May 3, 1982

5.4 Wyle Laboratories letter, Change of Scope No. 2, dated April 21, 1982

5.5 Wyle Laboratories letter, Change of Scope No. 1, dated October 26, 1981

5.6 Wyle Laboratories letter, Quote No. 543/6149-1/DK, dated August 18, 1981

6.0 TEST SPECIMEN DESCRIPTION

The test specimen was a Hydrogen Ignitor Assembly, P/N 1609-001-000-002, 11-1/2" H x 8" W x 13-7/8" L, with a glow plug powered by a 120 VAC transformer.

7.0 TEST EQUIPMENT DESCRIPTION

The test equipment used for this Test Program is shown on Instrumentation Equipment Sheets included in the appropriate sections of this report.

8.0 QUALITY ASSURANCE

All instrumentation used in the performance of this Test Program was calibrated in accordance with Wyle Laboratories' (Eastern Operations) Quality Assurance Policies and Procedures Manual, which conforms to the applicable portions of ANSI N 45.2, 10 CFR 50 Appendix B, and Military Specification MIL-STD-45662. Standards used in performing all calibrations are traceable the the National Bureau of Standards.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

WYLE LETTER OF TRANSMITTAL, OCTOBER 11, 1982
NOTICES OF ANOMALY NOS. 2 AND 3

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

October 11, 1982 IN RESPONSE REFERENCE: 45880B-007C

Corporate Consulting & Development Company, Ltd.
Post Office Box 30096
Raleigh, NC 27612

Attention: Mr. Doug Greenwood

Subject: Purchase Order No. 1334

Reference: Wyle Job No. 45880

Gentlemen:

Enclosed are three (3) copies each of Notice of Anomaly Nos. 2 and 3.

In addition to the above transmittal, the purpose of this letter is:

1. To affirm that the test of the hydrogen igniter does qualify it for the required environment.
2. To address the fact that test anomalies occur and that test extension is the industry standard practice for satisfying the requirements with extrapolation by analysis, consistent with NRC requirements.
3. To address the question of a continuous duration test versus inadvertent outages.
4. To guarantee Wyle's support at Wyle's expense of our test report conclusions in any official communications between our customer and the NRC should these conclusions be questioned.

The following text addresses each one of these points individually.

1. Wyle is firm in its commitment to meet the governing standard requirements. It is, and always has been, our understanding, that the purpose of any qualification program is to satisfy these requirements. In conferring with NRC representatives, and as clearly stated in NUREG 0588, Sections 2.4 and 4, and IEEE 323-1974, Section 5.4, Combined Qualification and Section 6.5, analysis (including Arrhenius methodology) combined with testing, is a valid qualification method. Our test was conducted in full compliance with these standards and the equipment successfully met its acceptance criteria. Therefore, the conclusion is that the equipment is qualified to the required environmental parameters.

Corporate Consulting & Development Company, Ltd.
Page 2
October 11, 1982

2. It is understood and accepted by industry and regulatory agencies that anomalies occur. Every attempt is made to minimize anomalies. However, these occurrences cannot be eliminated. They can only be minimized. As a result, standard practices have evolved concerning the accident duration. Interruptions in the accident simulation (either planned or unplanned) do not effect the results. The cumulative duration at temperature is the critical paramater. For instance, some programs include planned interruptions such as any program conducted per IEEE 323-1974, Figures 1, A1, B1, B2, and NUREG-0588, Figure C1. For all of these programs the time at temperature is added to yield the cumulative time which is compared to the requirement duration. These standard practices are common knowledge and are acceptable in all cases to the regulatory agencies. The requirement is to demonstrate that the safety-related equipment perform properly while under the conditions of temperature and pressure for the required period of time. While every attempt is made to meet the environmental conditions continuously, the test is not rejected because of a discontinuous test. Instead, adjustments are made, as was done here and extrapolation is provided consistent with IEEE 323-1974 Paragraph 5.4. It is Wyle's opinion that the inadvertent outages resulted in below temperature conditions for only a minimal amount of the time. The thermal shock on the equipment under test resulted in a more conservative program and provides greater assurance of equipment operability.

3. The test requirement was for a 7 day LOCA exposure plus 10% time margin. The test was conducted for the full 7 days plus 6% margin on time. Additional margin is demonstrated by applying the industry accepted and regulatory agency recommended practice of applying Arrhenius techniques to determine equivalent degradation of the material. Using this technique an equivalent margin of 32% is demonstrated by using the overtest of the "envelope" profile during the final steady state portion of the LOCA test.

   The full 7 day withstandability requirement was met. The required margin was exceeded by the acceptable combination of test and analysis consistent with IEEE 323-1974 Paragraph 5.4. All initial test temperature peaks, pressure peaks and durations, prior to the final steady state temperature, were met by testing.

4. Our test reports are designed in accordance with IEEE 323-1974 and provide our customer with evidence of qualification which will allow verification by competent personnel other than the

qualifiers as defined by this standard. Should the NRC question the test report, Wyle accepts the responsibility to clarify those items in question at our expense. Wyle will support our test report should the need arise as the result of any official communication between our customer and the NRC.

Should you have any questions regarding this subject, please contact the undersigned.

Sincerely,

WYLE LABORATORIES
Eastern Operations

Edward W. Smith
Director, Contracts & Purchasing

EWS/paw

Enclosures

SECTION I

BASELINE FUNCTIONAL TEST

1.0 REQUIREMENTS

1.1 The test specimen shall be visually inspected prior to testing to assure that there has been no damage due to shipping or handling.

1.2 The test specimen shall be energized with 120 VAC, 60 Hz, 1 phase power supplied by a Variac. The glow plug temperature shall be measured and recorded following stabilization. The input voltage and current shall also be recorded.

1.3 The above test shall be repeated at 108 VAC and 132 VAC. The glow plug temperature, input voltage and current shall be recorded.

1.4 Acceptance Criteria

a) With 108 VAC applied, the minimum allowable glow plug temperature shall be 1500°F.

b) With 120 VAC and 132 VAC applied, the minimum allowable glow plug temperature shall be 1700°F.

2.0 PROCEDURES

2.1 The test specimen was installed in the LOCA test chamber and connected to a variable AC power supply.

2.2 A K-type thermocouple was placed on the tip of the glow plug and tied down with three (3) stainless steel bands. The thermocouple and bands were then covered with a layer of high temperature ceramic. Details of the test setup are presented in Appendices II and III of Section III.

2.3 A pre-test functional was performed in accordance with Paragraphs 1.2 and 1.3 above and the results recorded.

3.0 RESULTS

3.1 The test specimen showed no signs of damage when inspected.

3.2 The results of the functional voltage test are presented in the Data Sheet, Appendix I of this section.

3.0 RESULTS (Continued)

3.3 The equipment used to perform the pre-LOCA functional are presented in the Instrumentation Equipment Sheet of Appendix II of this section.

APPENDIX I

DATA SHEET

DATA SHEET

Customer Corporate Consulting
Specimen Hydrogen Ignitor Assy
Part No. N/A
Spec. CCL TP 1609-5 Rev 1
Para. 5.1.3
S/N 1609-001-000-002
GSI N/A

Amb. Temp. 80°F
Photo See Section II
Test Med. AIR
Specimen Temp. See Below

WYLE LABORATORIES

Job No. 45880
Report No. 45880-01
Start Date 7/8/82

Test Title Pre LOCA / Baseline Functional

DATE	TIME	POWER SOURCE	VOLTAGE	CURRENT	PLUG TEMP
7-8-82	1030	~~[illegible]~~ DAP 1 Phase 60Hz.	120VAC	0.94 Amps.	1810°F
7-8-82	1032	1 Phase 60Hz	108VAC	0.84 Amps	1640°F
7-8-82	1035	1 Phase 60 Hz.	132VAC	1.08 Amps	1900°F

Specimen Failed —
Specimen Passed Passed
NOA Written N/A

Tested By James K Pease Date: 7-8-82
Witness D. Greenwood Date: 7-8-82
Sheet No. 1 of 1
Approved D.L. Carton

WH-614A

APPENDIX II

INSTRUMENTATION EQUIPMENT SHEET

INSTRUMENTATION EQUIPMENT SHEET

Date 7-8-82 Job No. 45880 Test Area LOCA

Technician Perdue Customer CCL Type Test PRE-LOCA/Baseline Functional

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	A.C. Ampmeter	Weston	433	131333	3361	0-2 Amps	±.75%	7-2-82	10-2-82
2	A.C. Voltmeter	Weston	433	146032	81390	0-150VAC	±.2%	6-29-82	9-29-82
3	A.C. Watt Meter	Weston	432	18833	80136	0-800 Watts	±.5%	7-2-82	10-2-82
4	Datalogger	Fluke	2240C	2675019	0343	MULTI	MFG. Spec.	5-5-82	11-5-82

WYLE 307

Instrument Test Engineer [signature] WYLE 307 Checked & Received By [signature]

WH-1029

SECTION II

ACCIDENT (LOCA) TEST

1.0 REQUIREMENTS

1.1 The Hydrogen Ignitor Assembly shall be subjected to a postulated Design Basis Accident (LOCA and HELB) to determine if the test sample will perform its safety-related function during the environmental condition specified below.

1.2 The accident conditions (temperature, pressure, time profile and spray rate) shall be as shown in Figure II-1, Appendix II, of this section. The containment spray shall be demineralized water sprayed at a rate of 1 gm/ft^2 of specimen horizontal surface area.

1.3 The test specimen shall be subjected to a negative pressure transient during the accident test. This negative pressure transient shall be as shown in Figure II-2 of Appendix II of this section.

1.4 During the accident test, the test specimen shall be energized with 120/1/60 VAC. The glow plug temperature shall be a minimum of 1700°F.

1.5 The following test parameters shall be monitored during the accident test.

a) Chamber pressure, temperature and time profile.

b) Chamber spray rate.

c) Input power and current to test specimen.

d) Glow plug temperature.

e) Test specimen case temperature.

2.0 PROCEDURE

2.1 The Hydrogen Ignitor Assembly was installed in the test chamber as shown in Photograph II-1 in Appendix III of this section. The ignitor assembly was connected to a regulated power source. A thermocouple was attached to the ignitor glow plug to measure the glow plug temperature. A second thermocouple was attached to the ignitor assembly case to monitor the case temperature. Two additional thermocouples were used to monitor and control the test chamber ambient temperature and were located within 6 inches of the test specimen.

2.0 PROCEDURES (Continued)

2.2 A steam spraying/water system was set up inside the chamber for use during the portion of the test requiring saturated conditions. This system consisted of injecting saturated steam through a tube immersed in saturated water in the chamber. To assure proper water level, a glass sight gage and electric water level controller were provided. Figure II-3 presents a schematic of the test setup used to conduct this test.

2.3 The following test parameters were recorded on a Fluke Model 2240 datalogger:

a. Test chamber temperature (two thermocouples)

b. Test chamber pressure

c. Glow plug temperature

d. Ignitor Assembly case temperature

e. Time

2.4 The following test parameters were manually recorded on a data sheet:

a. Input voltage

b. Input current

2.5 The parameters listed in Paragraph 2.3 above were recorded at the time intervals listed below.

a. The test data were continuously recorded during the initial temperature transient from 185°F to 330°F

b. Test data were recorded at 5-minute intervals at the temperature of 330°F.

c. Test data were recorded at 15-minute intervals for the remaining portion of the test profile.

2.6 The test chamber temperature was stabilized at 185°F with saturated steam. The Ignitor Assembly was energized with a 120 VAC, single-phase, 60 Hz source. After allowing the glow plug temperature to stabilize, its temperature was recorded. Also recorded were case temperature, input voltage and current. The electrical power to the Ignitor Assembly was then de-energized.

2.0 PROCEDURES (Continued)

2.7 The Ignitor Assembly was then subjected to the temperature, pressure, time profile shown in Figure II-1 in Appendix II of this section. The test media was superheated steam followed by saturated steam.

2.8 After the temperature and pressure conditions were obtained, the demineralized water spray was initiated. The Ignitor Assembly was energized with a 120 VAC potential. The glow plug assembly temperature was measured and recorded. This test was repeated at 108 VAC and 132 VAC. After these operational tests were completed, the Ignitor Assembly was energized with a 120 VAC potential. This voltage remained applied for the remainder of the test.

2.9 At T_o + 350 seconds, the Ignitor Assembly was subjected to a negative pressure transient. The transient was accomplished by the use of a large vacuum chamber in which a vacuum of 1 psia was established. Through the use of a control valve placed between the vacuum chamber and the LOCA chamber, the pressure in the LOCA chamber was reduced. Prior to the negative pressure transient, the demineralized water spray and steam inlet valves were closed and the chamber was drained of all condensate.

2.10 Following the negative pressure transient and after the LOCA chamber was restored to the 330°F condition, the chamber pressure was raised to 70 psig for 10 minutes.

2.11 After three hours at 330°F, the chamber temperature was decreased to 310°F.

2.12 After three hours at 310°F, the chamber temperature was reduced to 250°F. This condition was maintained for the remainder of the test during which daily recording of input current and voltage was conducted.

3.0 RESULTS

3.1 The Hydrogen Ignitor Assembly was subjected to the required accident test profiles of Figures II-1 and II-2 in Appendix II of this section.

3.2 The test setup utilized is presented in the schematic of Figures II-3 of Appendix II and the photographs of Appendix III of this section.

3.0 RESULTS (Continued)

3.3 The actual recorded pressure, temperatures, and time profiles are presented in Figures II-4 through II-7 of Appendix II of this section.

a) Figure II-4 presents the chamber temperature profile which is the average temperatures of the two thermocouples mounted within 6 inches of the test specimen.

b) Figure II-5 presents the LOCA chamber pressure profile throughout the test. Figure II-6 presents the pressure profile during the negative pressure transient in more detail.

c) Figure II-7 presents the specimen glow plug temperature throughout the test.

d) Figure II-8 presents the specimen case temperature.

3.4 The data sheet section of Appendix IV presents the voltage and current readings taken during the test. The first data sheet presents measurements of the current, voltage and temperatures prior to and during the DBE. The second data sheet list measurements made daily during the post-LOCA period.

3.5 The required chemical spray flow rate was calculated to be 0.8 gpm based on 1.0 gpm per foot-square surface area of test specimen. Following stabilization at 330°F, the chemical spray was initiated. The 0.8 gpm had to be reduced to 0.4 gpm during the superheat region of the LOCA profile. Due to the small size of the LOCA chamber and proximity of the specimen to the chemical spray nozzle, thermocouples were saturated with DI water resulting in an out of spec chamber temperature indication.

3.6 The chemical spray flow rate established using an automatic flow rate controller manufactured by the W. A. Kates Company. A calibration curve is provided in Appendix V.

3.7 Throughout the test, a steady decrease in indicated glow plug temperature was noted (see NOA No. 1, Appendix I of this section). Following the test and prior to the post-LOCA functional, the glow plug thermocouple was removed and examined. Examination revealed that the stainless steel tie-down bands used to secure the thermocouple were highly corroded. The same thermocouple was reattached using new bands and the temperature reading at 120 VAC was 1725°F indicating that the low temperature readings were not due to specimen failure.

3.0 RESULTS (Continued)

3.8 During the post-LOCA period there were approximately twelve (12) significant periods totaling 11 hours, 42 minutes during which the chamber dropped below the required 250°F temperature (see NOA No. 2, Appendix I). This was due to unplanned boiler and controller shutdowns. The test was extended by 4 hours, 8 minutes. The test period of 250°F fell short of the required 7 days, 11 hours by 7 hours, 36 minutes (see NOA No. 3, Appendix I).

3.9 Appendix V presents the test instrumentation equipment used in this test.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

NOTICES OF ANOMALY

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: 10/22/82

NOTICE NO: 1A P.O. NUMBER: 1334 CONTRACT NO: N/A

CUSTOMER: Corporate Consulting Limited WYLE JOB NO: 45880

NOTIFICATION MADE TO: Doug Greenwood NOTIFICATION DATE: 7/9/82

NOTIFICATION MADE BY: F. Johnson VIA: Telephone

CATEGORY: ☐ SPECIMEN ☐ PROCEDURE ☒ TEST EQUIPMENT DATE OF ANOMALY: 7/9/82

PART NAME: Hydrogen Igniter PART NO. N/A

TEST: Accident Test (LOCA and HELB) I.D. NO. 1609-001-000-002

SPECIFICATION: CCL Spec 1609-5, Rev. 1 PARA. NO. 5.1.3

REQUIREMENTS:

The hydrogen igniter assembly shall be energized with 120/1/60 VAC throughout the accident test. The glow plug temperature shall be minimum of 1700°F.

DESCRIPTION OF ANOMALY:

The glow plug temperature dropped below 1700°F at 20 hours into the test. Throughout the test, there had been a steady decrease in glow plug temperature. There was no change in specimen power supply voltage and current.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The customer recommended that the test be continued. Following the seven (7) day 11-hour test period, the specimen and instrumentation will be examined in order to determine the cause of the low temperature readings.

Following the test, the thermocouple was examined. The stainless steel tiedown bonds which held the thermocouple to the glow plug were almost entirely consumed by corrosion. The the mocouple was reattached to the glow plug and the indicated temperature returned to the required value.

Revision A - Change category from specimen anomaly to test equipment anomaly to reflect that the anomaly was due to corrosion of thermocouple tiedown straps.

VERIFICATION:

PROJECT ENGINEER: G. R. Coloma 10/22/82

TEST WITNESS: N/A

PROJECT MANAGER: Herschel Jordan 10/22/82

REPRESENTING: N/A

INTERDEPARTMENTAL COORDINATION: [illegible]

QUALITY ASSURANCE: B. N. Hollingsworth 10/22/82

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: 10-4-82

NOTICE NO: 2 P.O. NUMBER: 1334 CONTRACT NO: N/A

CUSTOMER: Corporate Consulting Limited WYLE JOB NO: 45880

NOTIFICATION MADE TO: Don Hatmaker NOTIFICATION DATE: 7-12-82

NOTIFICATION MADE BY: G. R. Carbonneau VIA: Telephone

CATEGORY: ☐ SPECIMEN ☐ PROCEDURE ☒ TEST EQUIPMENT DATE OF ANOMALY: 7/10-15/82

PART NAME: Hydrogen Igniter PART NO. N/A

TEST: Accident (LOCA and HELB) I.D. NO. 1609-001-000-002

SPECIFICATION: CCL Spec 1609-5, Revision 1 PARA. NO. 5.2.3.6

REQUIREMENTS:

After completion of the three (3) hours at 310°F, the chamber temperature shall be reduced to 250°F. The chamber pressure shall be 15 psig. These conditions shall be maintained for seven (7) days and 11 hours.

DESCRIPTION OF ANOMALY:

The chamber temperature fell below the required temperature of 250°F several times due to facility power outages and boiler control system anomalies.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The Customer was notified and with his concurrence the total time below the required temperature of 250°F shall be added to the required seven (7) days and eleven (11) hours.

VERIFICATION:

PROJECT ENGINEER: [signature]

TEST WITNESS: N/A PROJECT MANAGER: Herschel Jordan

REPRESENTING: N/A INTERDEPARTMENTAL COORDINATION: [signature]

QUALITY ASSURANCE: [signatures]

WYLE Form WH 1066, Rev. Jan. 81

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: 10-4-82

NOTICE NO: 3 P.O. NUMBER: 1334 CONTRACT NO: N/A

CUSTOMER: Corporate Consulting Limited WYLE JOB NO: 45880

NOTIFICATION MADE TO: Doug Greenwood NOTIFICATION DATE: 9-13-82

NOTIFICATION MADE BY: G. R. Carbonneau VIA: Telephone

CATEGORY: ☐ SPECIMEN ☒ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 7-16-82

PART NAME: Hydrogen Igniter PART NO. N/A

TEST: Accident (LOCA) I.D. NO. 1609-001-000-002

SPECIFICATION: CCL Spec 1609-5, Rev. 1 PARA. NO. 5.2.3.6

REQUIREMENTS:

After completion of the three (3) hours at 310°F, the chamber temperature shall be reduced to 250°F. The chamber pressure shall be 15 psig. These conditions shall be maintained for seven (7) days and 11 hours.

DESCRIPTION OF ANOMALY:

The actual conditions were maintained for seven (7) days, three (3) hours, and 26 minutes. This occurred because a calculation error was made while determining the amount of time to extend the test to cover the twelve periods that the chamber temperature was below the required 250°F (see Notice of Anomaly No. 2).

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The LOCA requirement was to extend for a duration of 7.7 days (7 days +10% margin). The time requirement at the final temperature of 250°F was 178.8 hours (162 hours +16.8 hours margin). All temperature peaks, pressure peaks and steam requirements were met during the LOCA test. The 7-day test requirement was met.

Power outages and boiler control system anomalies caused the time margin at 250°F to fall short of the required 10% margin. Actual test time was 7 days +6% margin at or above the temperature requirements. Additional time was added onto the end of the test; however, an insufficient amount of time was included to provide for a one-to-one time ratio between the test profile margin and the required profile margin. Since the test temperature exceeded the requirements, a certain amount of margin was demonstrated by this overtest. The purpose of this analysis is to

VERIFICATION:

TEST WITNESS: ______

REPRESENTING: ______

QUALITY ASSURANCE: R.L. Sizemore WB Roberts

PROJECT ENGINEER: G.R. Carbon

PROJECT MANAGER: Herschel Jordan

INTERDEPARTMENTAL COORDINATION: MJ EDS

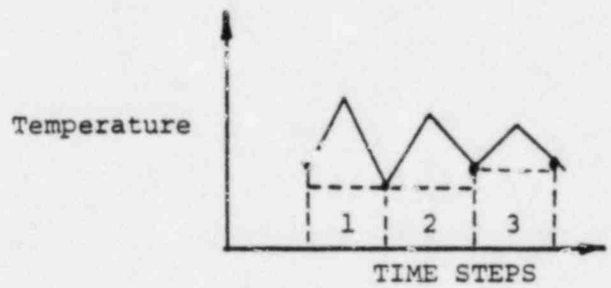
NOTICE OF ANOMALY

No. 3
Corporate Consulting Limited
Wyle J/N 45880
10-4-82

DISPOSITION - COMMENTS - RECOMMENDATIONS: (Continued)

demonstrate that the test profile margin envelops the required margin because of time durations at higher than required temperatures.

Arrhenius methodology was used to compare the 250°F portion of the requirement to the corresponding portion of the test profile. This was accomplished by equating the test profile to a time duration at a baseline temperature of 250°F (121.1°C). An activation energy of 0.95 eV was used (obtained from CCL as the lowest activation energy in the H_2 Igniter). Conservatism was introduced into the degradation equivalency by considering the time step durations to be at the lower temperature of step ends.



A sample calculation is as follows:

Time duration = 1 minute to 2 minutes = 1 minute

Temperature = 255°F to 257°F; therefore, 255°F utilized.

$t_1 = t_2\ [\exp(Ea/k_b)(1/T_1 - 1/T_2)]$

where

t_1 = equivalent time at baseline temperature

t_2 = 60 seconds, duration of test step

Ea = 0.95 eV

k_b = Boltzmann's Constant

T_1 = 250°F (394.1°K), baseline temperature

T_2 = 255°F (396.9°K), test step temperature

Solving for t_1,

t_1 = 73 seconds equivalent degradation at 250°F.

NOTICE OF ANOMALY

No. 3
Corporate Consulting Limited
Wyle J/N 45880
10-4-82

DISPOSITION - COMMENTS - RECOMMENDATIONS: (Continued)

The following table summarizes the equivalency data of the test profile to the baseline temperature of 250°F.

Requirements		Time		
Temperature °F	Time at 250°F Hours	Temperature °F	Actual Time Hours	250°F Time Hours
250	162.0	260	18.0	26.6
250	16.8 (margin)	258	24.0	32.9
		257	42.0	55.2
		256	24.0	30.3
		255	12.0	14.6
		253	30.0	33.8
		251	18.0	18.8
		250	3.3	3.3
		<250	11.7	0.0
Total	178.8		183.0	215.5

Subtracting the test requirement without margin gives

$$215.5 - 162 = 53.5 \text{ hours margin.}$$

Therefore, the LOCA test was equal to the required 7 days +32% margin (53.5/168 = 32%). It is concluded that the test requirement of 7 days +10% margin was enveloped by the test profile of 7 days +32% margin.

APPENDIX II

FIGURES

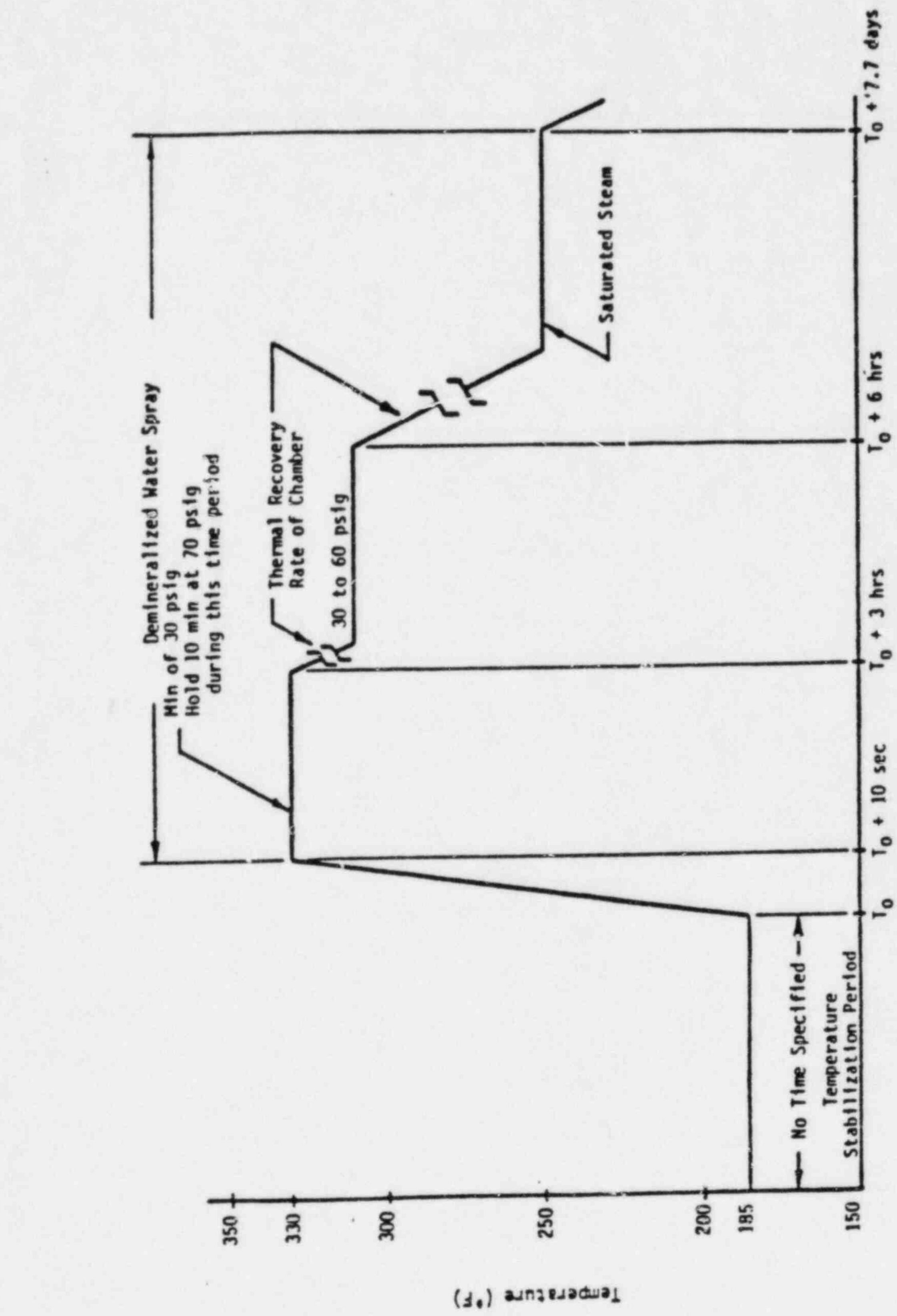


FIGURE II-1. TEMPERATURE PROFILE ACCIDENT TEST

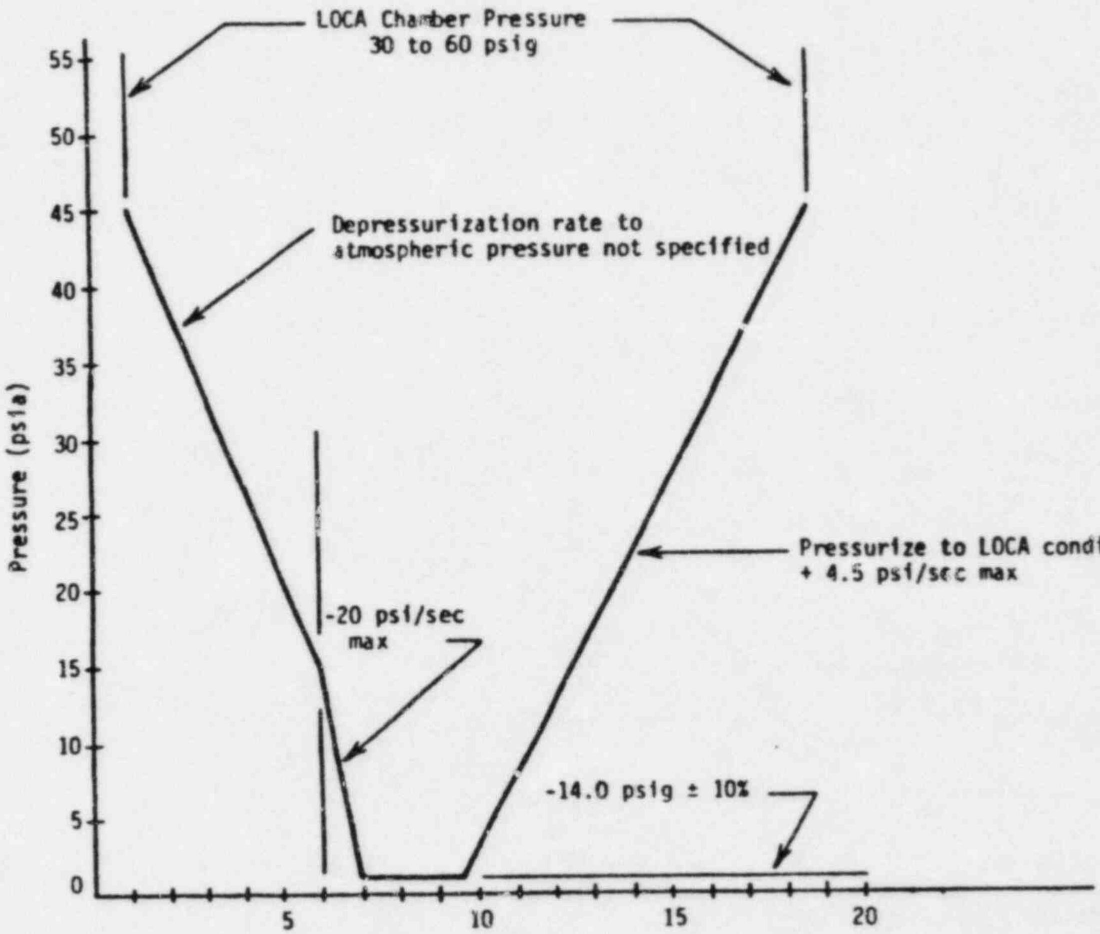


FIGURE II-2. NEGATIVE PRESSURE TRANSIENT

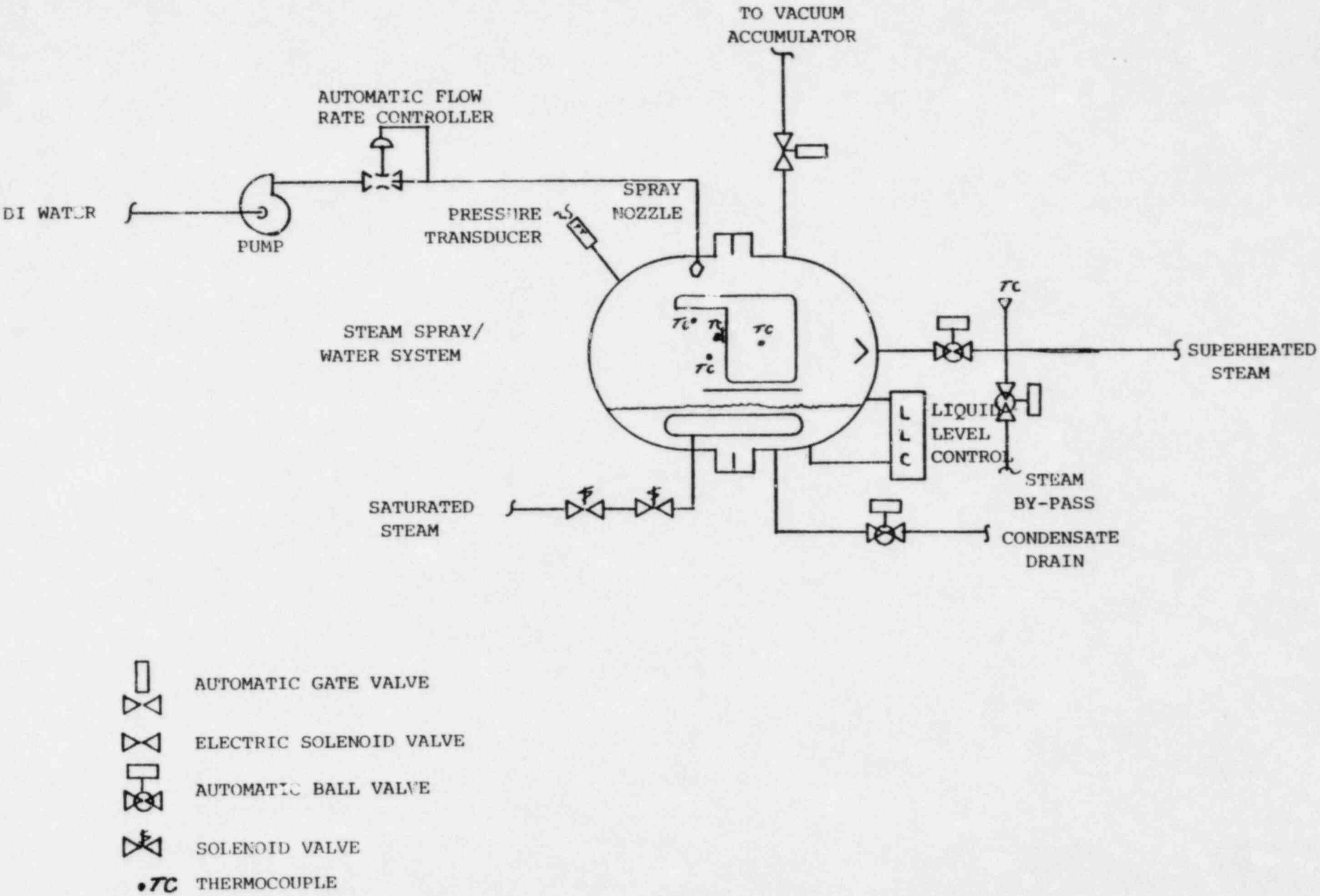


FIGURE II-3. TEST SETUP SCHEMATIC

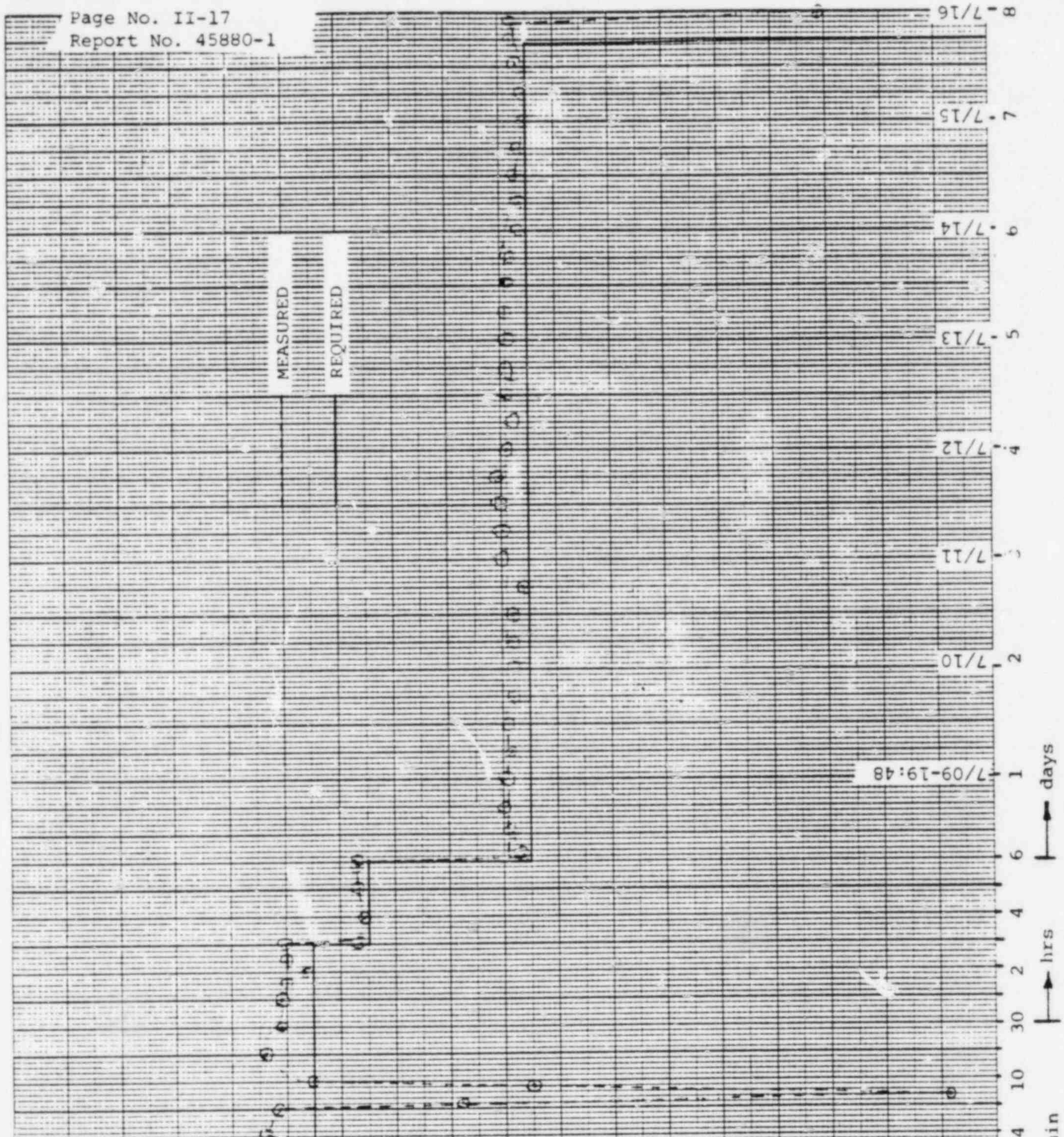


FIGURE II-4. ACCIDENT TEST CHAMBER TEMPERATURE vs TIME

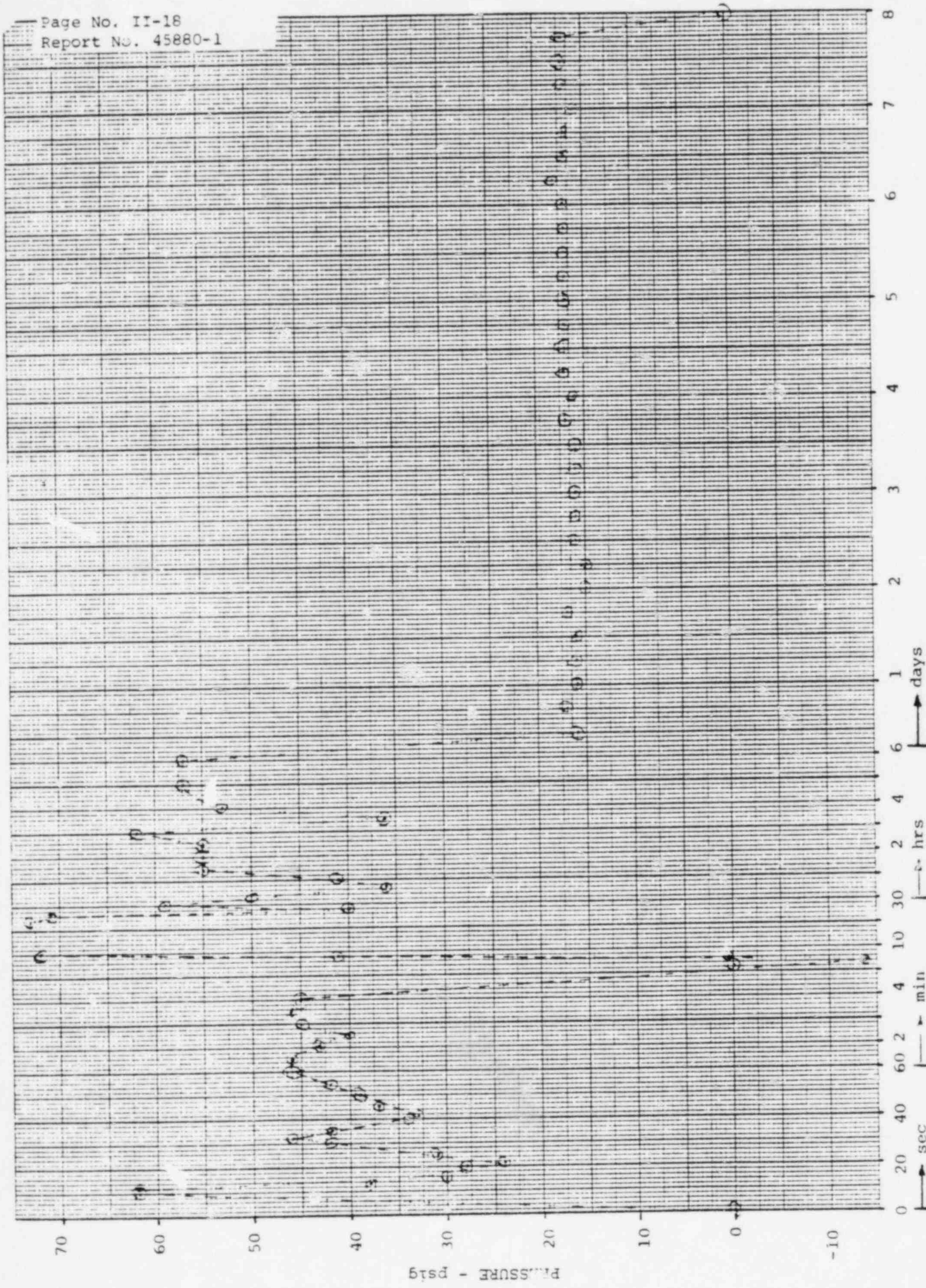


FIGURE II-5. ACCIDENT TEST PRESSURE vs TIME

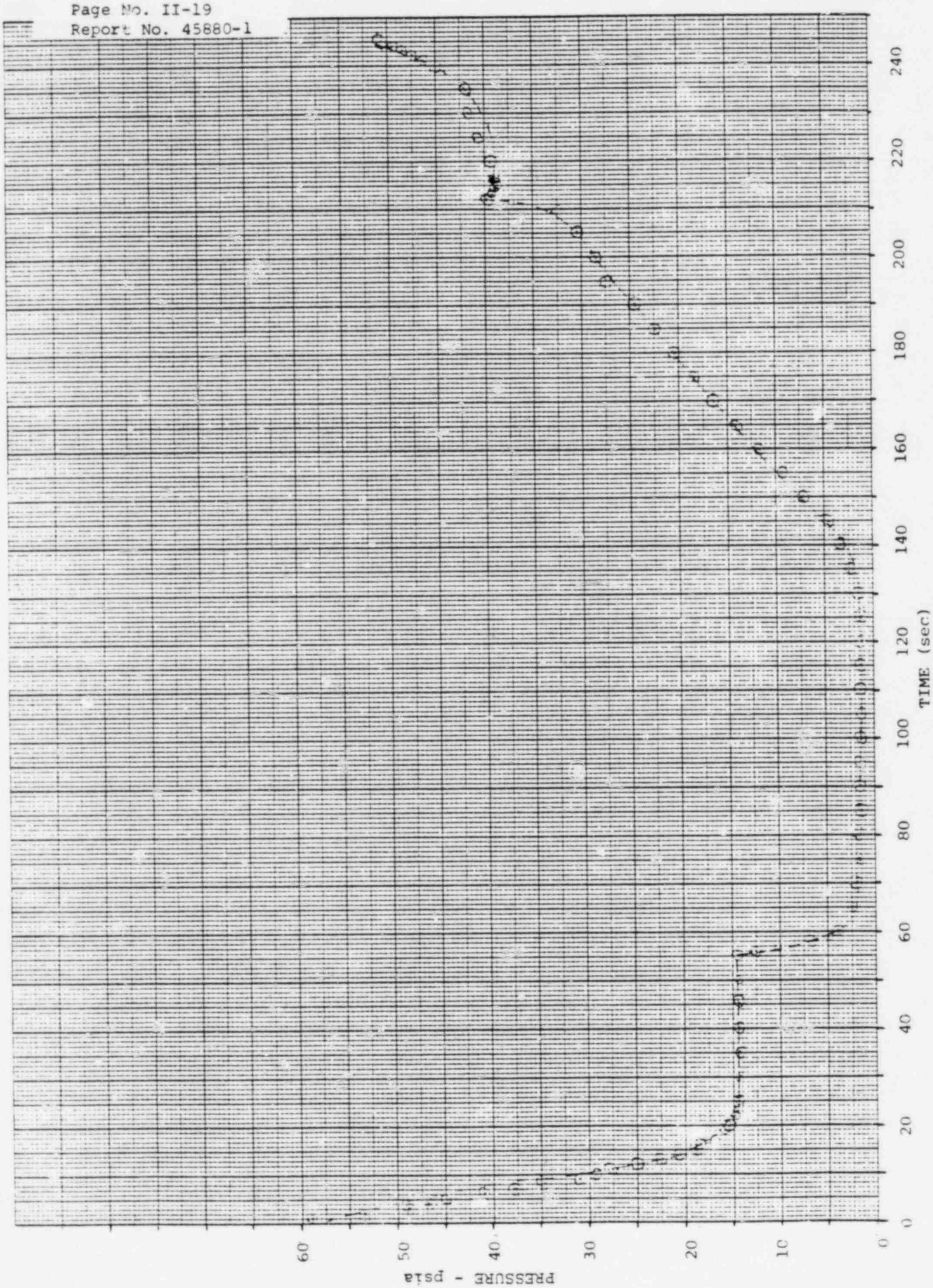


FIGURE II-6. NEGATIVE PRESSURE TRANSIENT vs TIME

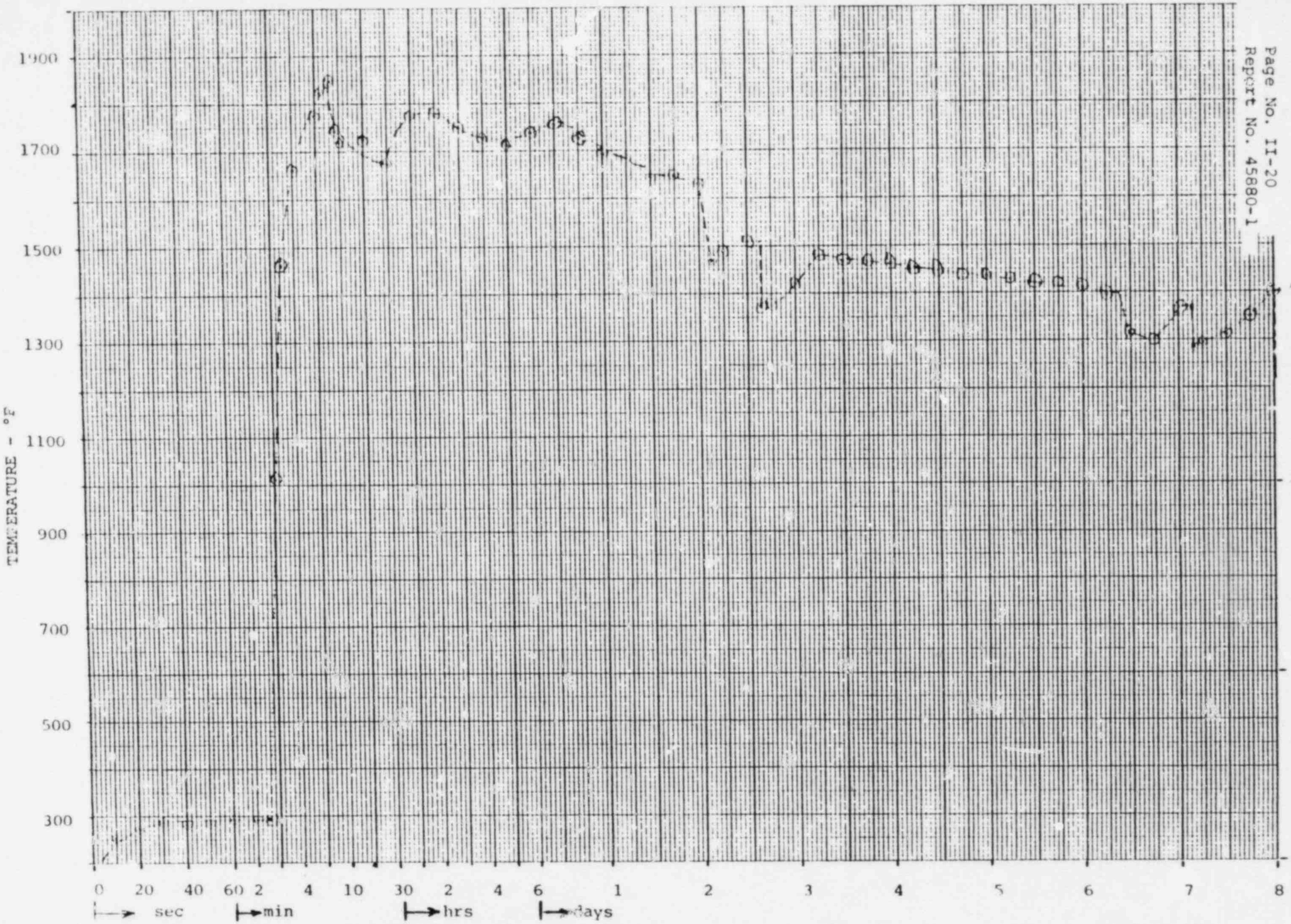


FIGURE II-7. HYDROGEN IGNITOR GLOW PLUG TEMPERATURE vs TIME

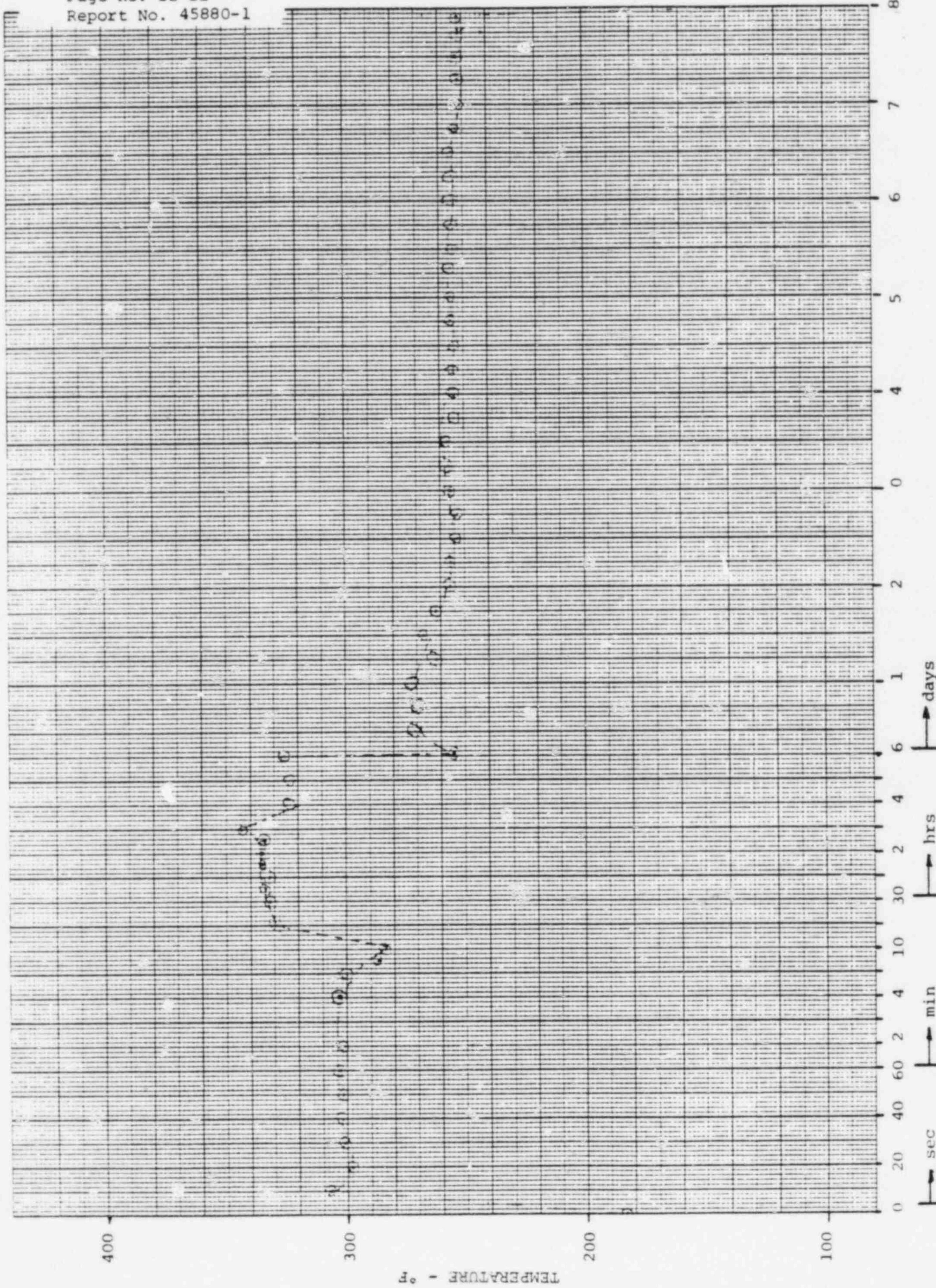
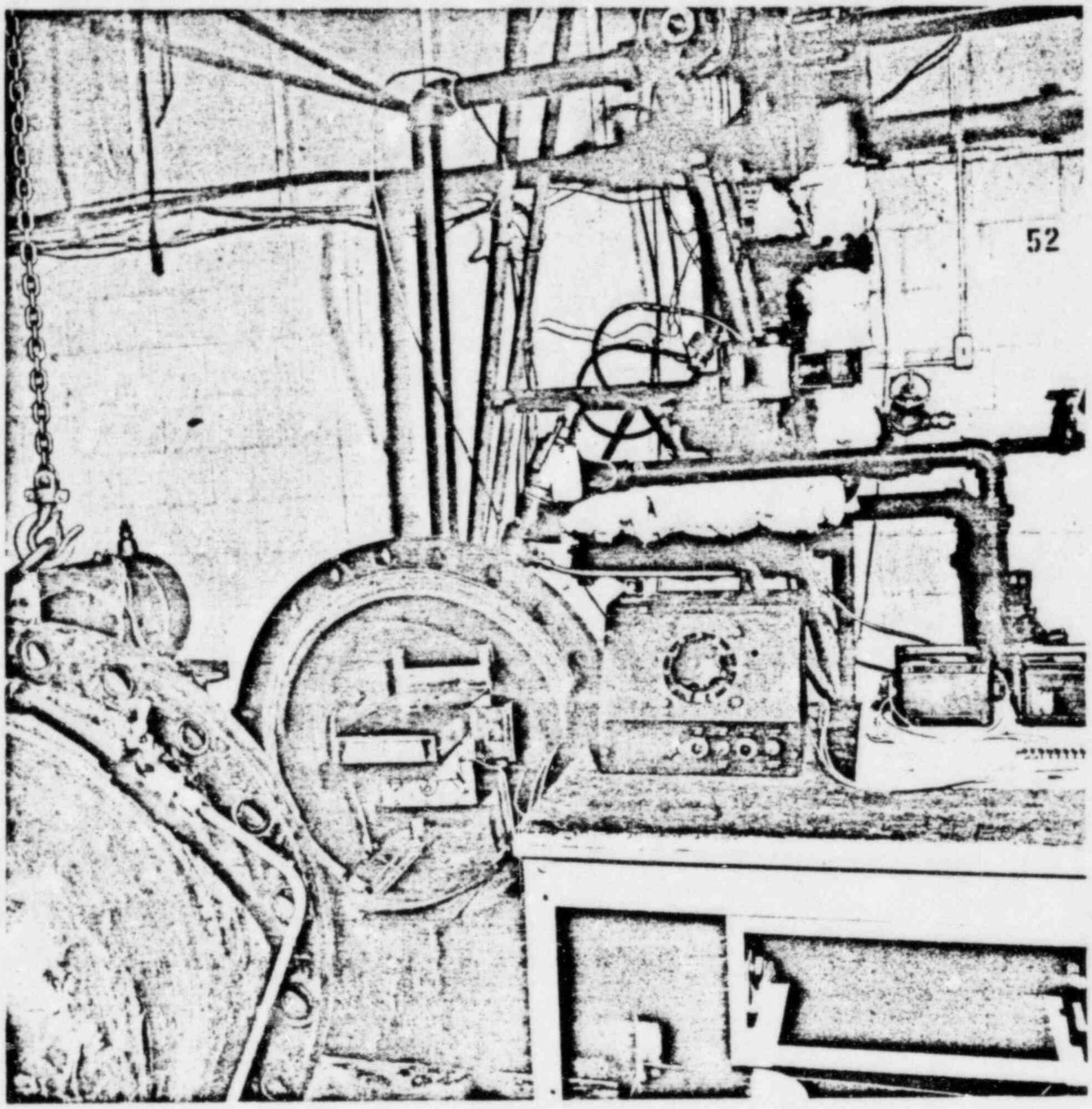


FIGURE II-8. ACCIDENT TEST BODY CASE TEMPERATURE

THIS PAGE INTENTIONALLY LEFT BLANK.

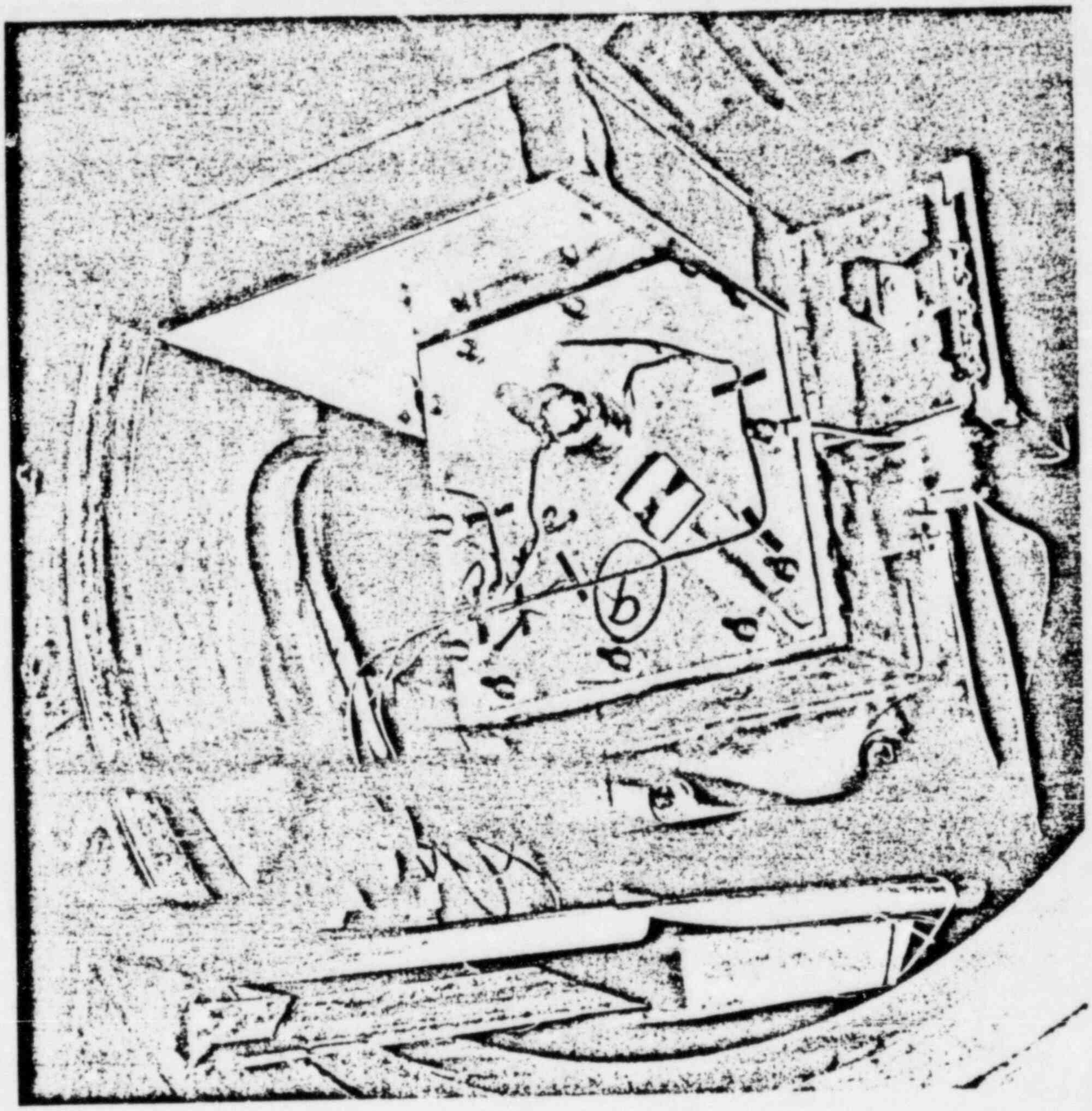
APPENDIX III

PHOTOGRAPHS



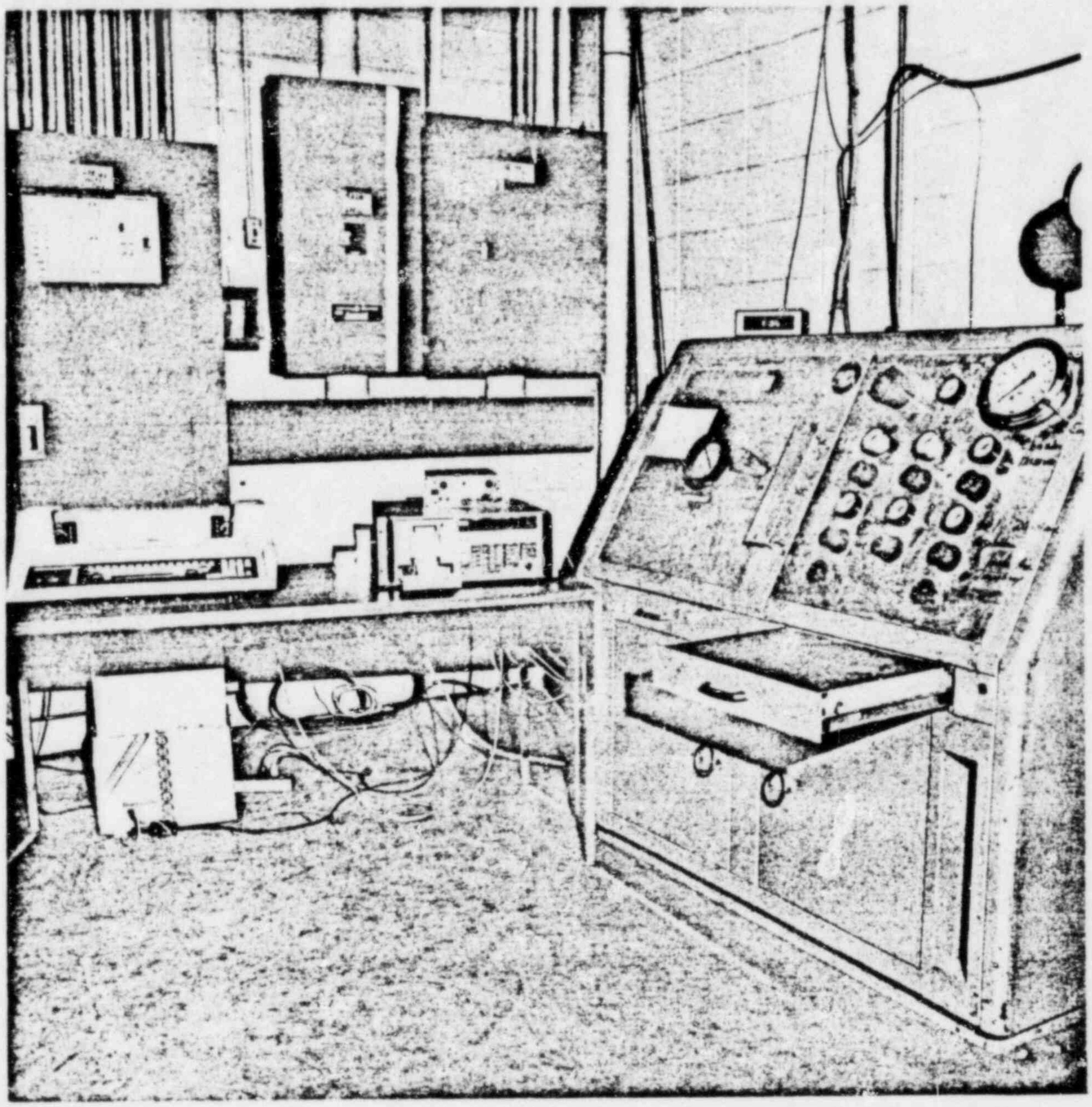
PHOTOGRAPH II-1

VIEW OF TEST SETUP WITH SPECIMEN IN CHAMBER



PHOTOGRAPH II-2

VIEW OF SPECIMEN SHOWING THERMOCOUPLES



PHOTOGRAPH II-3

VIEW CONTROL CONSOLE SHOWING DATALOGGER AND PRINTER

APPENDIX IV

DATA SHEETS

DATA SHEET

Customer Corporate Consulting
Specimen Hydrogen Ignitor Assy
Part No. N/A
Spec. CCL TP 1609-5 Rev 1
Para. 5.2.3.1
S/N 1609-001-000-002
GSI N/A

Amb. Temp. 188°F
Photo N/A
Test Med. Superheat Steam
Specimen Temp. Ambient

WYLE LABORATORIES
Job No. 45880
Report No. 45880-01
Start Date 7/8/82

Test Title LOCA - 330°F

DATE	TIME	POWER SOURCE	VOLTAGE	CURRENT	PLUG TEMP
7-8-82	1622	single Phase, 60Hz.	120VAC	0.94 Amps	1828 °F
7-8-82	~~1649~~ JRP 1653	Single Phase, 60Hz	120VAC	JRP 0.94 Amps	1677.1°F
7-8-82	17~~50~~17 JRP	Single Phase, 60Hz	120VAC	0.94 Amps	1766.9°F
7-8-82	1720	Single Phase, 60 Hz.	108VAC	0.84 Amps.	1600.8 °F
7-8-82	1724	Single Phase, 60Hz.	132VAC	1.08 Amps.	1905.9 °F
7-8-82	1726	Single Phase, 60Hz	120 VAC	0.94 Amps.	1791.5 °F
	~~0700 pm~~				
Notes.	At 1622	hours, the specimen was stabilized at			188°F.
	At 1653	thru 1726, the specimen was stabilized at 330°F.			

Specimen Failed —
Specimen Passed —
NOA Written N/A

Tested By James R. Perkins Date: 7-8-82
Witness Doug Greenwood Date: 7-8-82
Sheet No. 1 of 1
Approved D R Coleman

WH-614A

DATA SHEET

Customer Corporate Consulting
Specimen Hydrogen Ignitor Assy
Part No. N/A
Spec. CCL TP 1609-5 Rev 1
Para. 5.2.3.2.
S/N 1609-001-000-002
GSI N/A

Amb. Temp. 259.2°F
Photo N/A
Test Med. Saturated Steam
Specimen Temp. 270.6°F

WYLE LABORATORIES
Job No. 45880
Report No. 45880-01
Start Date 7/8/82

Test Title LOCA - Daily Monitoring

DATE	TIME	POWER SOURCE	VOLTAGE	CURRENT	PLUG TEMP
7-9-82	07:40	Single Phase, 60 Hz.	120VAC	0.94 Amps.	1739.2°F
7-9-82	14:34	" "	120VAC	0.94 Amps.	1701.4°F
7-10-82	0700	" "	120VAC	0.94 Amps	1629.1°F
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Amps	[illegible]
7-12-82	0720	" "	120VAC	0.95 Amps	1466.9°F
7-12-82	1508	" "	120VAC	0.95 Amps	1469.9°F
7-13-82	0741	" "	120VAC	0.96 Amps	1437.8°F
7-13-82	1510	" "	120VAC	0.96 Amps	1447.9°F
7-14-82	0806	" "	120VAC	0.96 Amps.	1412.5°F
7-15-82	0857	" "	120VAC	0.96 Amps	1325.7°F
7-15-82	0940	" "	120VAC	0.96 Amps	1312.4°F
7-16-82	1237	" "	120VAC	0.96 Amps.	1345.3

Specimen Failed —
Specimen Passed —
NOA Written NOA No. 1

Tested By James K [illegible] Date: 7-16-82
Witness N/A Date:
Sheet No. 1 of 1
Approved [illegible]

WH-614A

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX V

INSTRUMENTATION EQUIPMENT SHEETS

INSTRUMENTATION EQUIPMENT SHEET

Date 7·8·82 Job No. 45880 Test Area LOCA

Technician S. Tothecow Customer CCL Type Test LOCA

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	Data Logger	Fluke	2240	N/A	0343	Multi	Mfg.	5·5·82	11·5·82
2	High Speed Printer	Texas Inst	820	N/A	32756	Multi	PM	1·25·82	7·25·82
3	Power Supply	Elec. Meas.	TR212A	N/A	80247	0-100vdc	±0.1%R	7·2·82	1·2·83
4	Pressure Transducer	Statham	PA418-1003	N/A	94902	0-100psia	See Cert	4·23·82	10·23·82
5	Multimeter	Data Precision	935	N/A	92706	Multi	Mfg.	5·11·82	5·11·83

WYLE 307

Instrument Test Engineer [signature]

WYLE 307

Checked & Received By [signature] Johnson

WH-1029

INSTRUMENTATION EQUIPMENT SHEET

Page 1 of 1

Date 7-6-82. Job No. 45880 Test Area LOCA

Technician Perdue Customer CCL Type Test LOCA

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	Watt meter	Weston	432	18833	80136	0-800 Watts	±.5%	7-2-82	10-2-82
2	A.C. Ampmeter	Weston	433	131333	3361	0-2 Amps.	±.75%	7-2-82	10-2-82
3	A.C. Voltmeter	Weston	433	146032	81390	0-150VAC	±.2%	6-29-82	9-29-82

WYLE 307

Instrument Test Engineer K Burkhart WYLE 307 Checked & Received By G.A. Carlson

WH-1029

INSTRUMENTATION EQUIPMENT SHEET

Page 1 of 1

Date 7-8-82 Job No. 45880- Test Area LOCA

Technician J. LAXSON Customer CCL Type Test LOCA

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	CONTROLER	Honeywell	N/A	81446	81446	-125 +325	± 2%	4-26-82	7-26-82
2	Redundant	THERMOTRON	N/A	3556	3556	-125 +375	± 2%	6-3-82	12-3-82
3	PRESS Gage	USG	N/A	100049	100049	0-+100	± 1%	6-23-82	9-23-82

WYLE 310

WYLE 310

Instrument Test Engineer B. Gossett

Checked & Received By DR Calvin

WH-1029

Pressure Transducer Calibration

Transducer Description PRESSURE PSIA
MFG. STATHAM. Model PA 418-1003 Wyle NO. W91902
S/N 1906. Range 0-100 PSIA. Temp. 71 °F.
Date 4.23.82. Cal by QL QC.
MFG Specs.. Lin. .25% Hysteresis ±.3%
Calibration Interval 180 Days.

Reference STD. D.W. TESTER
MFG AMETEX. Model T.Q. 150
Range 1.5 KPSI S/N 7890. WN. 96345
Cal Date 9.18.80 TO 9.18.82 W72865.
Meas. Unc. of STD.
MANOMETER 30 EB25 W10962 W# 81032
Cal Date 3.22.82 TO 9.22.82

	Indication of STD PSI	PSIA	Pressure PSID High	Low	Pressure Transducer VDC UP/mV	Down/	Best Straight Line End Point Calc.	Shunt
0	0				-.241	VDC		
0	±14.5				.506	.501		
1	10				1.005	1.004		
2	20				1.519	1.519		
3	30				2.023	2.020		
4	40				2.528	2.525		
5	50				3.018	3.015		
6	60				3.516	3.514		
7	70				4.008	4.006		
8	80				4.502	4.500		
9	90				5.010	5.007		
10	100				5.504	5.504		

Excitation Voltage ** 28VDC ±10 VDC
E Input + Pin A - Pin D
E Output + Pin B - Pin C
Res. Input Res. Out
Shunt Cal Pins E & F
Psia Cal 20% .771 VDC 40% N/A
Psi Cal 20% 1.584 VDC 40% N/A
Zero Unbalance .241
F/S Output 4.998 VDC
Non-Linearity % fs .25
Hysteresis % fs .3
Signal mv/psi
Psia Zero -.241 VDC
Psia Amb .506 VDC
Avg. Test Specs.

Remarks:
System Calibration prior to test required.

Standard used Traceable to NBS
Lab report NO

Amb Cond.
Press AMBIENT
Temp 71 °F.

Test Instrument/Readout
HP 3465 A DVM + .03% VDC W# 281
Cal Date 3.22.82 TO 9.22.82

GPM .1-1.5

SPECIFIC GRAVITY 1.0

DATE 9 / 8 / 82

THE W. A. KATES CO.

DEERFIELD, ILLINOIS, U.S.A.

TYPE MFA 1-3 RATED FLOW .1-1.5 GPM

S.O. 81-1463 SERIAL NO. 29322

PURCHASER WYLE LABORATORIES

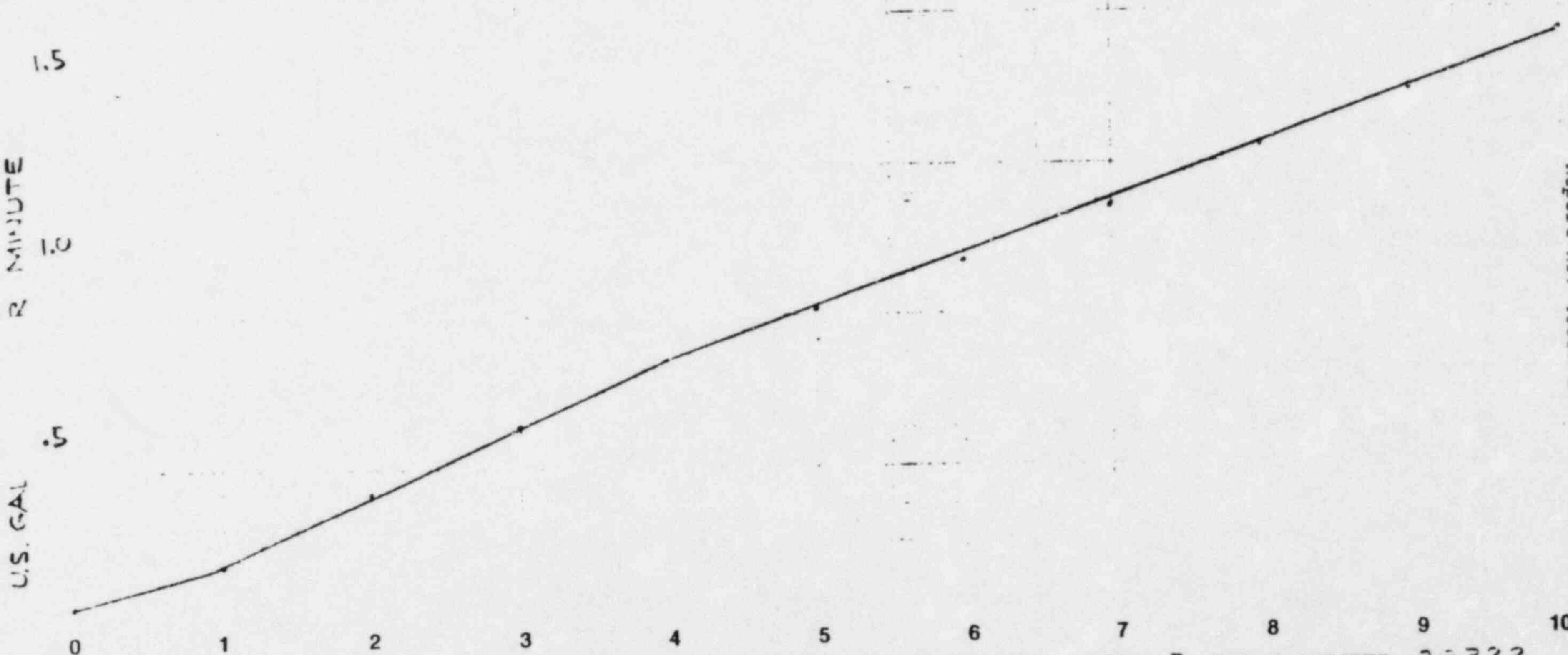
P.O. 4-7939 ITEM 1

TAG OR MARKING

DATE 9/6/82 TESTED WS APP'VD. WJ

CHART # 433

Page No. II-36
Report No. 45880-1



RCENT OF ORIFICE OPENING

SHOP ORDER NO. 8 - 1463 MODEL MFA 1-3 SERIAL NUMBER 29322

SECTION III

POST-ACCIDENT FUNCTIONAL

1.0 REQUIREMENTS

1.1 The Ignitor Assembly shall be subjected to a post-accident functional test.

1.2 After completion of the accident test, the test chamber shall be opened and a functional test performed. The functional test shall consist of measuring the glow plug temperature with an electrical potential of 120 VAC, 108 VAC and 132 VAC. During the above tests, the voltage, current, case temperature and glow plug temperature shall be recorded.

1.3 Acceptance Criteria

a) The glow plug temperature shall be a minimum of 1500°F at 108 VAC.

b) The glow plug temperature shall be a minimum of 1700°F at 120 VAC and 132 VAC.

1.4 The Ignitor Assembly shall then be removed from the test chamber and visually inspected. The results shall be recorded.

2.0 PROCEDURES

2.1 Following the LOCA test and after allowing sufficient time for the chamber to cool down, the test chamber was opened.

2.2 The procedure of Section I was repeated. That is the glow plug temperature was measured at voltages of 108, 120 and 132 VDC.

3.0 RESULTS

3.1 The test specimen showed no evidence of damage due to the LOCA other than some mild discoloration on the surface of the assembly box.

3.2 The results of the post-LOCA functional test were presented in the Data Sheet of Appendix I of this section.

3.3 Appendix II presents the Instrumentation Equipment Sheets.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX I

DATA SHEET

DATA SHEET

Customer Corporate Consulting

Specimen Hydrogen Ignitor Assy.

Part No. N/A

Spec. CCL TP 1609-5 Rev. 1

Para. 5.2.3.7

S/N 1609-001-000-002

GSI N/A

Amb. Temp. 80°F

Photo No

Test Med. Air

Specimen Temp. Ambient

WYLE LABORATORIES

Job No. 45880

Report No. 45880-01

Start Date 7-19-82

Test Title Post LOCA - Functional

Power Source	Voltage	Current	Plug Temp.
60 Hz 1 Phase	108VAC	0.86 Amps.	1549°F
" "	100VAC	0.96 Amps.	1725°F
" "	132VAC	1.10 Amps.	1857°F

Specimen Failed —

Specimen Passed Passed

NOA Written N/A

Tested By [signature] Date: 7-19-82

Witness N/A Date: —

Sheet No. 1 of 1

Approved [signature]

WH-614A

APPENDIX II

INSTRUMENTATION EQUIPMENT SHEETS

INSTRUMENTATION EQUIPMENT SHEET

Date 7-19-82 Job No. 45880 Test Area LOCA

Technician Perdue Customer CCL Type Test Post LOCA - Functional

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	Wattmeter	Weston	432	18833	80136	0-400Watts	±.5%	7-2-82	10-2-82
2	Ampmeter	Weston	433	131333	3361	0-2 Amps.	±.75%	7-2-82	10-2-82
3	Voltmeter	Weston	433	146032	81390	0-150VAC	±.2%	6-29-82	9-29-82
WYLE 307									

WYLE 307

Instrument Test Engineer K Burkhart Checked & Received By D K Calvin

WH-1029

INSTRUMENTATION EQUIPMENT SHEET

Page 1 of 1

Date 7·8·82 Job No. 45880 Test Area LOCA

Technician S. Totherow Customer CCL Type Test LOCA

No.	Instrument	Manufacturer	Model No.	Serial No.	Wyle or Gov't No.	Range	Accuracy	Calibration On	Calibration Due
1	Data Logger	Fluke	2240	N/A	0343	Multi	Mfg.	5·5·82	11·5·82
2	High Speed Printer	Texas Inst	820	N/A	32756	Multi	PM	1·25·82	7·25·82
3	Power Supply	Elec. Meas.	TR212A	N/A	80247	0-100vdc	±0.1%R	7·2·82	1·2·83
4	Pressure Transducer	Statham	PA418-1003	N/A	94902	0-100psia	See Cert	4·23·82	10·23·82
5	Multimeter	Data Precision	935	N/A	92706	Multi	Mfg	5·11·82	5·11·83

WYLE 307

Instrument Test Engineer [signature] WYLE 307 Checked & Received By [signature]

WH-1029

SECTION IV

CCL PROCEDURE 1609-5, REVISION 1

Cort te Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 33096 • Raleigh N.C. 27622 • 919-782-3441

45880

TEST PROCEDURE

PROCEDURE No. 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 1
PREPARED BY [signature] DATE 6/
APPROVED BY [signature] DATE 6/9
APPROVED BY ______ DATE ______
QA REVIEW BY [signature] DATE 6/9

CONTROLLED DOCUMENT
Copy 7 of 3

ACCIDENT TEST (LOCA & HELB)

5.0 The equirements and procedures for accident testing of the Hydrogen Ign or Assembly are presented in the following paragraphs.

5.1 Test nd Requirements

5.1.1 The Hydrogen Ignitor Assembly shall be subjected to a postulatec Design Basis Accident (LOCA & HELB) to determine if the test sample will perform its safety-related function during the environmental conditions specified below.

5.1.2 The accident conditions (temperature, pressure, time profile a spray rate) shall be in accordance with Figure 1609-5-1 of this procedure. The test medium for the containment spray shall be demineralized water. The spray rate shall be 1GPM/ft^2 of test sample surface area.

5.1.3 The Hydrogen Ignitor Assembly shall be energized with 120/1/60 VAC throughout the accident test. The glow plug temperature shall be a minimum of 1700°F. The Ignitor Assembly shall also tested at 108 VAC and 132 VAC and the glow plug temperature sha be a minimum of 1500°F and 1700°F, respectively, at 108 VAC anc 132 VAC.

5.1.4 The following test parameters shall be recordec during the accident test.

Corpor Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

a. Test chamber pressure, temperature and time profile
b. Chamber spray rate (demineralized water)
c. Input power and current to test sample
d. Glow plug assembly temperature
e. Test sample case temperature

5.1.5 The Ignitor Assembly shall be subjected to a negative pressure transient during the accident test.

5.1.6 The Ignitor Assembly shall be subjected to a Post-Accident Functional Test.

5.2 <u>Test Procedure</u>

5.2.1 <u>Test Setup</u>

5.2.1.1 The Hydrogen Ignitor Assembly shall be installed in the test chamber as shown in Figure 1609-5-2. The ignitor assembly shall be connected to a regulated power source. A thermocouple shall be attached to the ignitor glow plug to measure the glow plug temperature. One additional thermocouple shall be attached to the Ignitor Assembly Case to monitor the case temperature. The thermocouple(s) used to monitor and control the test chamber temperature shall be located within six inches of the test sample.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh, N.C. 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No. 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 3
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

5.2.1.2 A steam spraying/water system shall be set up inside the chamber for use during the portion of the test requiring saturated conditions.

5.2.1.3 A second chamber shall be setup in order to provide a negative pressure transient within the LOCA chamber.

5.2.1.4 After completion of the test setup and prior to the start of the accident test, the test sample shall be energized with a 120/1/60-VAC power source. The glow plug temperature shall be a minimum of 1700°F. Record the glow plug temperature, voltage and current. De-energize the electrical power to the Ignitor Assembly.

5.2.2 <u>Instrumentation and Recording Equipment</u>

5.2.2.1 The following test parameters shall be recorded on a Fluke Model 2240 Datalogger:

a. Test chamber temperature
b. Test chamber pressure
c. Glow plug temperature
d. Ignitor Assembly case temperature
e. Time

Co ate Consulting & Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No	1609-5, Rev. 1
ISSUE DATE	6/8/82
PAGE	4
PREPARED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE
QA REVIEW BY	DATE

5.2.2.2 The following test parameters shall be manually monitored as required:

a. Input voltage
b. Input current

5.2.2.3 The parameters listed in Paragraph 5.2.2.1 above sha be recorded at the time intervals listed below.

a. The test data shall be continuously recorde during the initial temperature transient from 185°F to 330°F.
b. Test data shall be recorded at 5-minute intervals at the temperature of 330°F.
c. Test data shall be recorded at 15-minute intervals for the remaining portion of the test profile.

5.2.3 LOCA and HELB Test

5.2.3.1 The test chamber temperature shall be increased to a stabilized at 185°F. The test medium shall be saturated steam. The Ignitor Assembly shall then be energized with a 12 -VAC, single-phase, 60-Hertz po source. Allow the glow plug temperature to stabili and record its temperature. Also, record case temperature, input voltage, and current. De-energi the electrical power to the Ignitor Assembly.

Cor, .ate Consulting & Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No	1609-5, Rev. 1
ISSUE DATE	6/8/82
PAGE	5
PREPARED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE
QA REVIEW BY	DATE

5.2.3.2 The Ignitor Assembly shall then be subjected to the temperature, pressure, time profile shown in Figure 1609-5-1 of this procedure. The test media shall be superheated and/or saturated steam. The following t parameters shall be recorded at the intervals specif in Paragraph 5.2.2 above:

a. chamber pressure
b. chamber temperature
c. glow plug temperature
d. case temperature
e. input voltage
f. input current.

5.2.3.3 After the chamber and test sample temperatures have stabilized at 185°F, superheated and saturated stea shall be injected into the test chamber to increase chamber temperature to 330°F. The time required to increase the temperature from 185°F to 330°F shall : 10 seconds. The chamber pressure shall be a minimu

Corr ite Consulting & Development Company, Ltd.
Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919 782 1441

PROCEDURE No. 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 6
PREPARED BY ________ DATE ______
APPROVED BY ________ DATE ______
APPROVED BY ________ DATE ______
QA REVIEW BY ________ DATE ______

TEST PROCEDURE

30 psig and shall not exceed 70 psig. After the temperature and pressure conditions have been obtained, the demineralized water spray shall be initiated. The spray rate shall be 1GPM/ft^2 of the test sample surface area. The Ignitor Assembly shall be energized with a 120-VAC potential. The glow plug assembly temperature shall be measured and recorded. This test shall be repeated at 108 VAC and 132 VAC. The glow plug temperature shall be 1700°F minimum at 120 VAC and 132 VAC and 1500°F minimum at 108 VAC. After these operational tests are completed, the Ignitor Assembly shall be energized with a 120-VAC potential. This voltage shall remain applied for the remainder of the 7.7-day test. The 330°F and 30 to 70 psig condition specified above shall be maintained for a three-hour time period. A chamber pressure of 70 psig shall be maintained for 10 minutes during this time period to simulate a hydrogen ignition.

5.2.3.4 After three hours at 330°F, the chamber temperature shall be decreased to 310°F. The chamber pressure shall be a minimum of 30 psig and shall not exceed 60 psig. These conditions shall be maintained for three hours.

5.2.3.5 At To + 350 seconds, the Ignitor Assembly shall be subjected to a negative pressure transient as shown in

Co ate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

Figure 1609-5-3. The Transient shall be accomplish by the use of a second chamber (Chamber No.2) of a suitable size in which a suitable vacuum has been established. Through the use of a control valve between Chamber No. 2 and the LOCA chamber, the pressure in the LOCA chamber shall be reduced as sh in Figure 1609-5-3 to a pressure of -14.0 psig ±10% The rate of depressurization and pressurization sh not exceed the maximum values shown in Figure 1609- Note that during the negative pressure transient th demineralized water spray and steam inlet valves sh be closed.

5.2.3.6 After completion of the three hours at 310°F, the chamber temperature shall be reduced to 250°F. Th chamber pressure shall be 15 psig. These conditio shall be maintained for 7 days and 11 hours. Duri this time period a steam spray/water system shall operation to insure saturated conditions inside th [illegible]er.

5.2.3.[illegible] [illegible] completion of the Accident Test, the test ch shall be opened and a Functional Test performed. Functional Test shall consist of measuring the gl plug temperature with an electrical potential of 120/1/60, 108/1/60 and 132/1/60 applied. During

Co.. ;ate Consulting & Development Company, Ltd.

Koger Executive Center
P O Box 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 8
PREPARED BY DATE
APPROVED BY DATE
APPROVED BY DATE
QA REVIEW BY DATE

of the above tests the voltage, current, case temperature, and glow plug temperature shall be recorded. The glow plug temperature shall be a min of 1700°F at 120 VAC and 132 VAC and 1500°F at 108 The Ignitor Assembly shall then be removed from tes chamber and visually inspected. Any deleterious ef noted shall be recorded.

Corp e Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919 782 3441

TEST PROCEDURE

PROCEDURE No 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 9
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

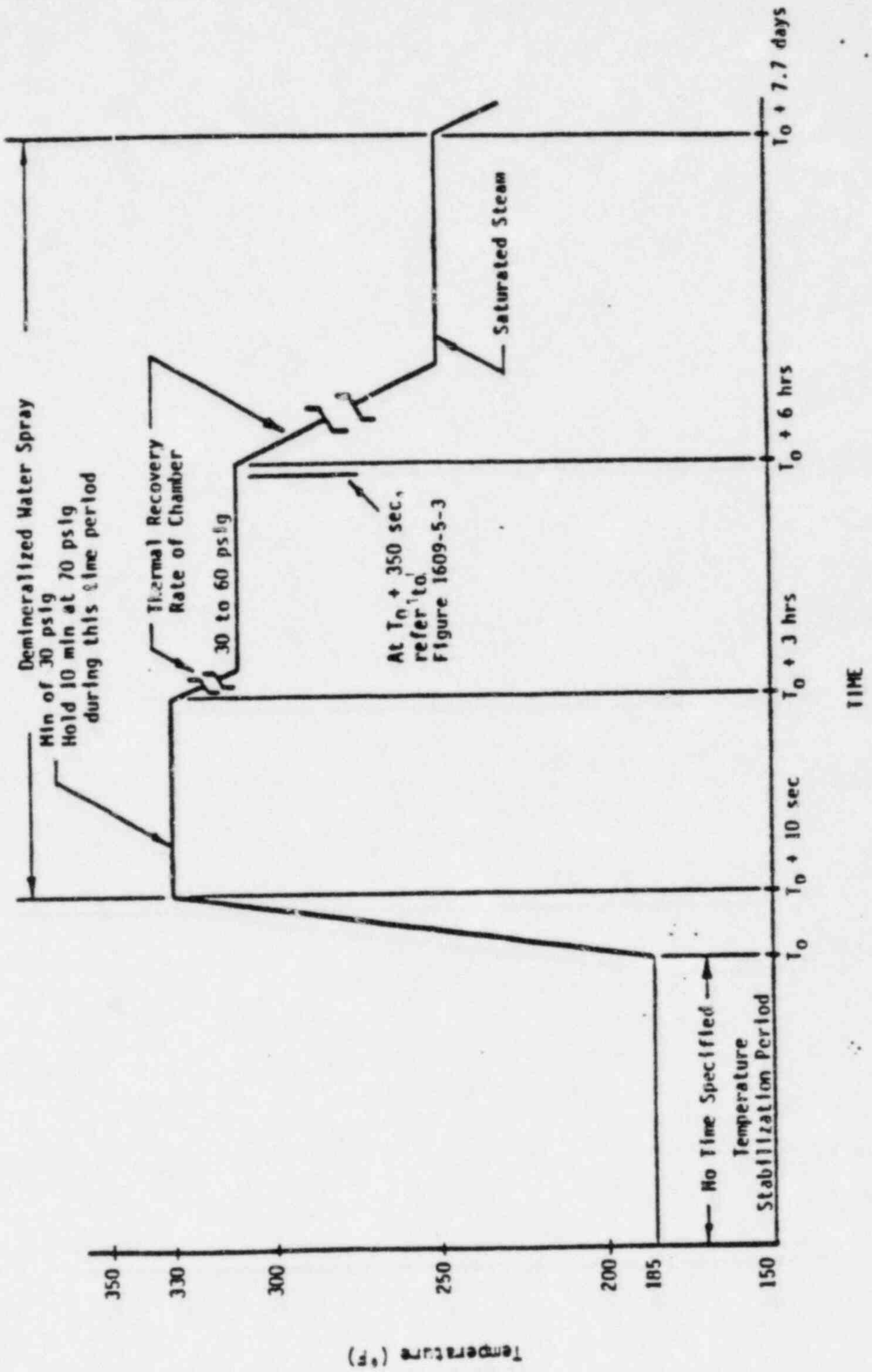


Figure 1609-5.1 Accident Test Profile (LOCA and HELB)

ECL Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
PO Box 30096 • Raleigh, NC 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No	1609-5, Rev. 1
ISSUE DATE	6/8/82
PAGE	10 OF 11
PREPARED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE
QA REVIEW BY	DATE

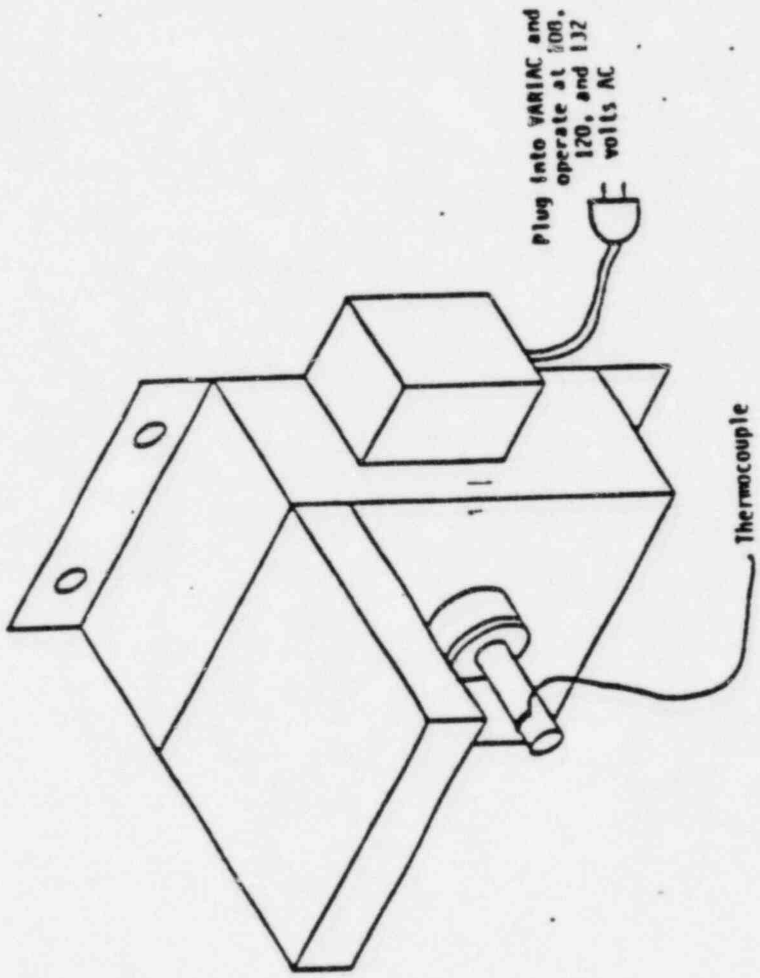


Figure 1609-5-2 Installation of Hydrogen Ignitor Assembly in Test Chamber

Test Procedure 1609-5

Corpora. Consulting & Development Company, Ltd.

Koger Executive Center
P.O. Box 30096 • Raleigh N.C. 27622 • 919 782 3441

TEST PROCEDURE

PROCEDURE NO 1609-5, Rev. 1
ISSUE DATE 6/8/82 PAGE 11 OF
PREPARED BY DATE
APPROVED BY DATE
APPROVED BY DATE
QA REVIEW BY DATE

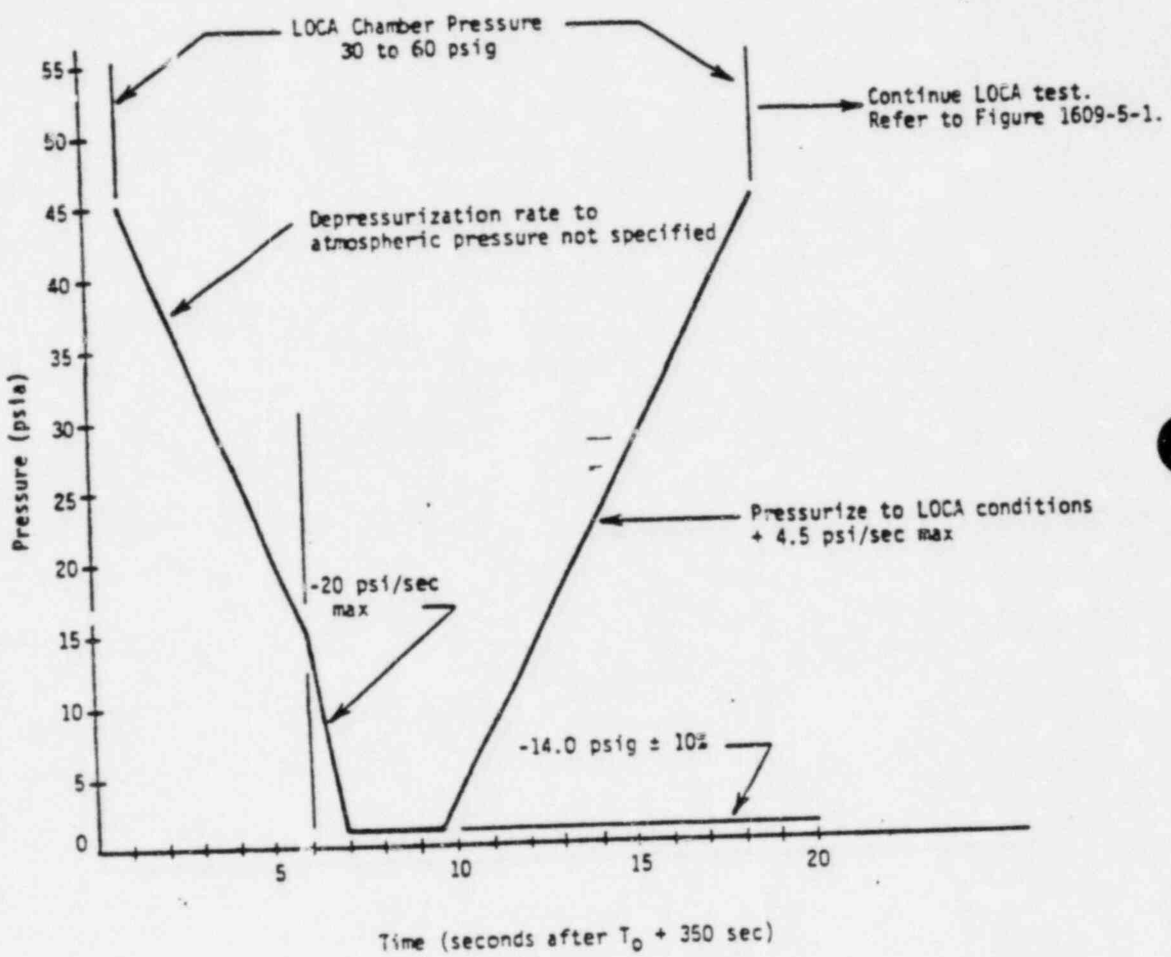


Figure 1609-5-3 Negative Pressure Transient
Test Procedure 1609-5

APPENDIX J - HYDROGEN BURN TEST PROCEDURE AND RESULTS

CCL PROCEDURE
1609-5, Rev. 1

PRE-LOCA BASELINE FUNCTIONAL

ACCIDENT (LOCA) TEST

POST-LOCA
FUNCTIONAL

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P.O. Box 10096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

HYDROGEN BURN TEST

6.0 The requirements and procedures for the Hydrogen Burn Test of the Hydrogen Ignitor Assembly are described in the following paragraphs.

Test Requirements

6.1.1 The Hydrogen Ignitor Assembly shall be capable of igniting a combustible concentration of hydrogen and air. The Ignitor Assembly shall ignite mixtures of 4 to 12 percent hydrogen by volume. R1

6.1.2 The Ignitor Assembly shall remain operational after being subjected to multi-ignition of the combustible concentration of hydrogen and air mixtures. R1

6.1.3 The Ignitor Assembly shall be tested at the specified extremes of the power supply voltage to demonstrate it will ignite the combustible concentration of hydrogen and air. The test voltage shall be 120/1/60 VAC, 108/1/60 VAC, 132/1/60 VAC. R1

6.1.4 The Ignitor Assembly shall be subjected to a minimum of 100 ignitions of the hydrogen and air mixture specified below. R1

6.1.5 A spare test sample will be used to calibrate the test system and to verify ignitor assembly operation prior to installing the actual test sample in the system. R1

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
... 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

6.1.6 The data obtained from this test will be used to establish a known operating procedure for each test condition specified below. The intent of this test is to prevent over or under testing on the actual test sample. R1

6.2 Test Procedure

6.2.1 The Hydrogen Ignitor Assembly shall be placed in a test chamber that has a known volume. The Ignitor Assembly shall be instrumented and electrically connected to a power supply as shown in Figure 1 of this procedure. The Hydrogen Ignitor Assembly shall be tested in each of the conditions specified in the table below. R1

Number of Ignitions Required	Input Voltage (VAC)	H_2/Air Mixture (% by Volume)	
			R2
4	120	4 ±5%	
4	108	4 +5%	
4	132	4 ±5%	
4	120	8 ±5%	
4	132	8 ±5%	
4	108	8 ±5%	
4	108	12 ±5%	
4	120	12 ±5%	
4	132	12 ±5%	
*70	120	as required to obtain multiple burns.	R1

*multiple burns shall consist of one ignition followed by another ignition. Flow of H_2/air mixture shall be interrupted between ignitions. R2

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
[illegible] 33096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

6.2.2 The following test parameters shall be measured and recorded during each of the ignition tests specified above: R1

a. input voltage
b. current
c. glow plug assembly temperature
d. test sample case temperature
e. hydrogen/air burn temperature
f. hydrogen/air mixture (percent by volume)
g. chamber pressure R1

The parameters shall be recorded with a computer data acquisition system.

6.3 Test Results R2

The prime test sample was subjected to the Hydrogen Burn Test in accordance with the requirements and procedure specified above. Wyle Test Report 57149, documenting the results of the test, is included in Appendix K to this report.

The test sample complied with the Hydrogen Burn test requirements. The instrumentation and equipment used in the performance of the functional tests, along with their calibration due dates, are shown in the Wyle report in Appendix K.

Paragraph 6.2.1, above, was revised to show that, during the multiple burn portion of the test, the H_2/air mixture was manually interrupted for each ignition.

Corporate Consulting
& Development Company, Ltd.

Koger Executive Center
P O Box 30096 • Raleigh N C 27622 • 919-782-3441

TEST PROCEDURE

PROCEDURE No 1609-6, Rev. 2
ISSUE DATE ______ PAGE 4 OF 4
PREPARED BY ______ DATE ______
APPROVED BY ______ DATE ______
APPROVED BY ______ DATE ______
QA REVIEW BY ______ DATE ______

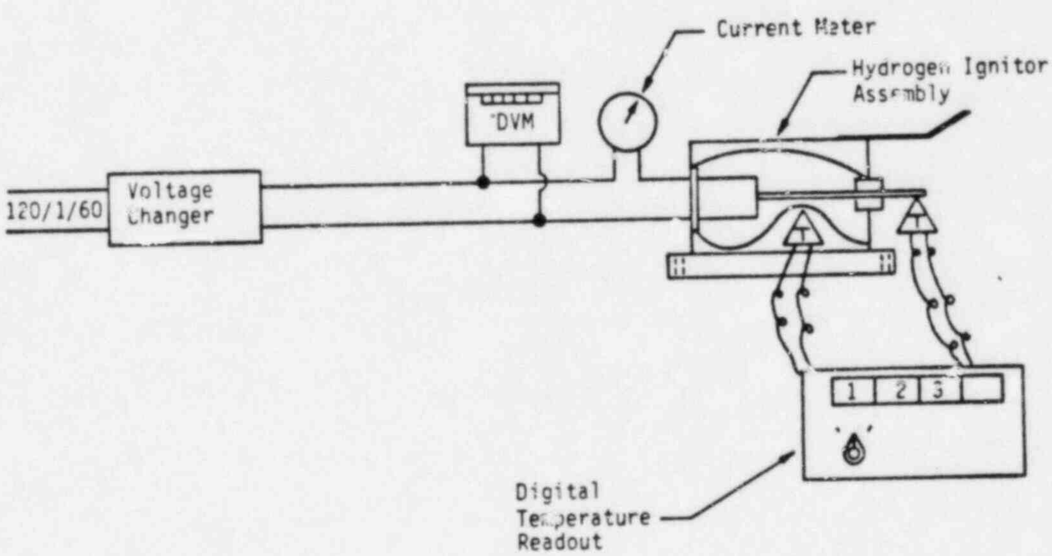


Figure 1609-6-1 Hydrogen Burn Test Setup

Test Procedure 1609-6

APPENDIX K - WYLE HYDROGEN BURN TEST REPORT 57149

TEST REPORT

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS, NORCO FACILITY

REPORT NO. 57149
OUR JOB NO. FS 57149
CONTRACT N/A
YOUR P. O. NO. 1333

Corporate Consultants and Development Co., Ltd.
P. O. Box 30096
Raleigh, North Carolina 27612

233 Pages

DATE 5 October 1982

This is to certify that the enclosed test data sheets contain true and correct data obtained in the performance of the test program as set forth in your purchase order.

Test methods, results, and equipment used are recorded on these data sheets.

Where applicable, instrumentation used in obtaining this data has been calibrated using standards which are traceable to the National Bureau of Standards.

SUMMARY:

One hydrogen ignitor assembly was subjected to a hydrogen burn test in accordance with the Corporate Consulting and Development Company Test Procedure No. 1609-6, Revision 1, dated 6/8/82.

STATE OF CALIFORNIA }
COUNTY OF RIVERSIDE } ss.

Ray C. Myrick, being duly sworn, deposes and says: That the information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

Ray C. Myrick

SUBSCRIBED and sworn to before me this 5th day of October, 19 82

Catherine C Kelty
Notary Public in and for the County of Riverside, State of California

My Commission expires 14 July, 19 83

OFFICIAL SEAL
CATHERINE C KELTY
NOTARY PUBLIC - CALIFORNIA
RIVERSIDE COUNTY
My comm. expires JUL 14, 1983

W-867A

DEPARTMENT FLUID SYSTEMS

DEPT. MGR. R. Stepelevitch
R. Stepelevitch

TEST ENGINEER R. Stepelevitch
R. Stepelevitch

TEST WITNESS

N/A
DCAS-QAR VERIFICATION

QUALITY CONTROL L. Housteau
L. Housteau

TABLE OF CONTENTS

CONTENTS	PAGE NUMBERS

1.0 TEST SETUP AND PROCEDURE

A spare ignitor assembly was used for facility checkout and the establishment of test parameters. Upon satisfactory checkout, the test ignitor assembly was installed in the combustion chamber as shown in the Figure 1 schematic and also the photographs on pages 7 and 8.

The test was performed in accordance with the Corporate Consulting and Development Company, Ltd. procedure and supplemented by the detailed Wyle Laboratories Checklist, Job No. 57149. The required hydrogen/air mixtures were established by flowing a measured amount of hydrogen over a specified time period into an evacuated chamber of known volume.

The following parameters were recorded on a computer:

1. Input voltage
2. Current
3. T1 - Hydrogen/air burn temperature (chamber)
4. T2 - Glow plug assembly temperature
5. T3 - Ignitor assembly case temperature
6. P1 - Combustion chamber pressure

Video tape coverage of the chamber internal ignitions was also provided.

2.0 TEST RESULTS

The parameters listed in Section 1.0 were recorded on a computer and data plots are included in this report. During the course of testing the glow plug assembly thermocouple became heat damaged. A post-test calibration was performed to verify glow plug temperature. There was no visual damage of the ignitor assembly observed. There was no malfunction of the ignitor assembly during the test program.

WYLE LABORATORIES

DATA SHEET

Customer CORPORATE CONSULTANT AND DEVELOPMENT COMP. Job No. FS 57149

Date 8-16-82

Specimen HYDROGEN IGNITER ASSY

RECEIVING INSPECTION

No. of Specimens Received: ONE

Record identification information exactly as it appears on the tag or specimen:

Manufacturer N/A

Part Numbers N/A

How does identification information appear: (name plate, tag, painted, imprinted, etc.)

N/A

Serial Numbers:* N/A

Examination: Visual, for evidence of damage, poor workmanship, or other defects, and completeness of identification.

Inspection Results: There was no visible evidence of damage to the specimens unless noted below.

DIRTY BROWN COLOR SMEARS
STRAIN GAUGE REMAINS
DENTAL CEMENT BLOTCH
IGNITER HAS METALIC WRAP ON END

* If additional space is required for serial numbers, use an additional page, or reference first functional test data sheet (if applicable).

Inspected By R. S. Lemma

Sheet No. of

Approved R. Stypelutch Date: 8-27-82

W-614
Q.C. Form Approval

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

TEST TITLE HYDROGEN BURN TEST

CUSTOMER CCD (CORP. CONSULTANTS & DEV. Job No. 57149 Date 8-25-82

Specimen GH_2 IGNITOR ASSY. Technician R. WASSEM

Part No. N/A Serial No. N/A Engineer R. STEPELEVITCH

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
CARRIER DEMOD	VALIDYNE	CD-19	0-10VDC	7409	SYS. CAL	SYS. CAL	±0.1%FS.
PRESS. TRANSDUCER	VALIDYNE	DP-15	0 to 10 PSIG	7485	8-25-82 SYS RW	9-25-82	±0.1%FS
PRESS. GAUGE	HEISE	12"	0 to 30 PSIG	9706	8-[illegible]-82	2-20-83	±0.1%F.S.
VOLTAGE STAND.	ANALOGIC	AN3100	0± to 10VDC	7977	3-25-82	9-26-82	±0.0005%
DVM	FLUKE	8600A	RW 99±0 to 200VDC AC	7986	3-17-82	3-20-83	±0.2% VAC ±0.02% VDC
DVM	FLUKE	8600A	±0 to 200VDC VAC	8688	5-18-82	5-22-83	±0.2% VAC ±0.02% VDC
AMP	VALIDYNE	BA172	0 to 10V	E824-5-A	SYS. CAL	SYS. CAL	N/A
AMP	VALIDYNE	BA172	0 to 10V	4958-5-B	SYS. CAL	SYS. CAL	N/A
FLOW METER	PORTER INSTR. Co.	B-157-2	269 to 8010 SCCM CH_2	7604	10-28-81	10-28-82	±2%FS.
CURRENT TRANSFORMER	F.W.BELL Co	5031-M	0-35 AMPS.	45625	SYS. CAL	SYS. CAL	N/A
PRESS. GAUGE	DURAGAUGE	6"	0 to 15 PSIG	7707	6-24-82	11-21-82	±0.5%FS.
STOP WATCH	MICRONTA	2A1	0 to 9HR. 59MIN 59.9SEC	9123	2-23-82	8-29-82	±0.1SEC
COMPUTER	VARIAN	V77600	N/A	8951	SYS. CAL	SYS. CAL	N/A

QA Form Approval [illegible]
W614D-82

Where applicable, the listed test equipment has been calibrated using standards which are traceable to the National Bureau of Standards. Certificates and reports of all calibrations are retained in the Wyle Laboratories QA files and are available for inspection upon request.

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

DATA SHEET

TEST TITLE HYDROGEN BURN

CUSTOMER CORPORATE CONSULTANTS & DEV. CO. Job No. FS 57149

Specimen HYDROGEN IGNITOR ASSEMBLY Date Started 8/27/82

Part No N/A Serial No. N/A Date Comp. 8/30/82

Spec. 1609-6 REV 1 Par. 6.0 Photo YES Amb. Temp. 72 ± 18°F

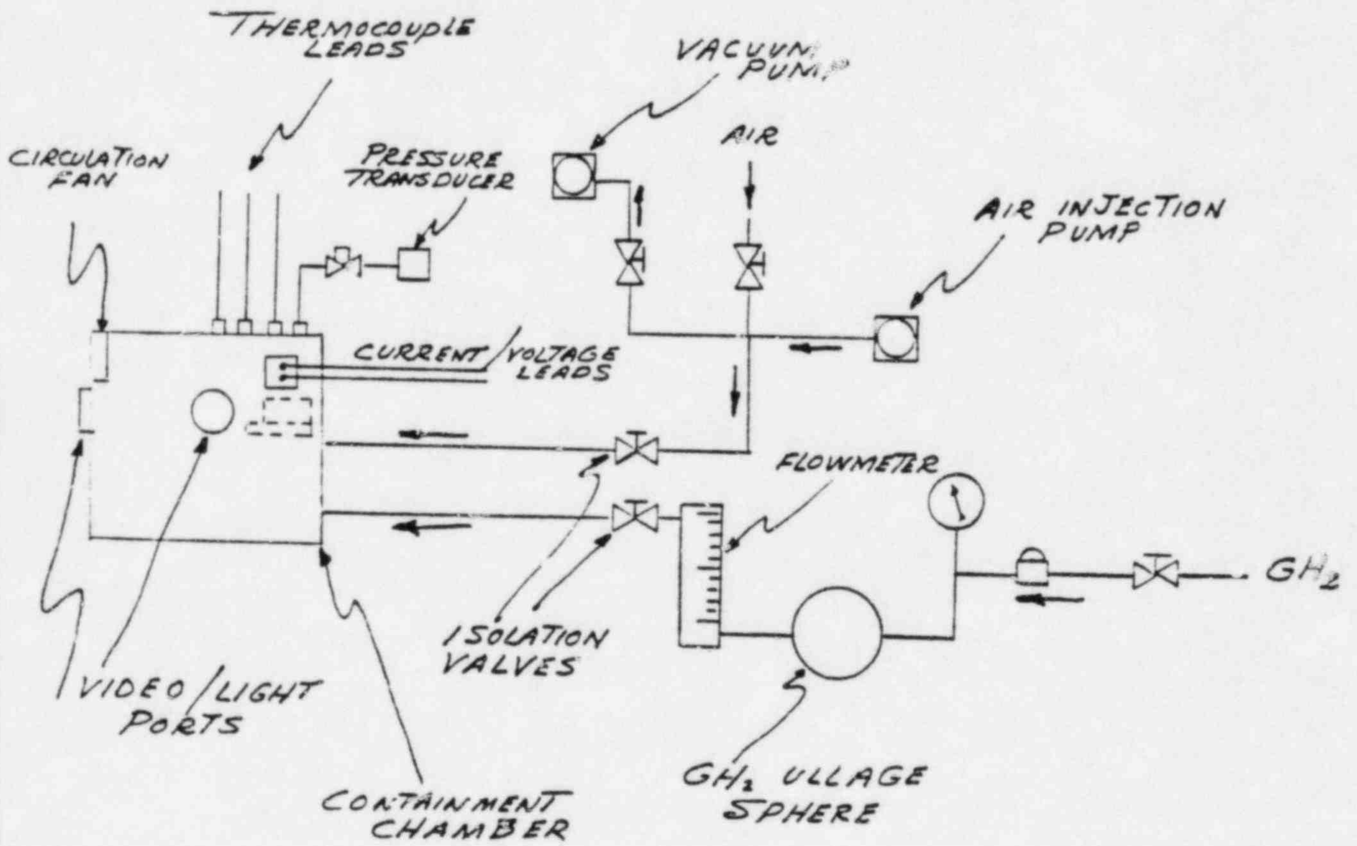
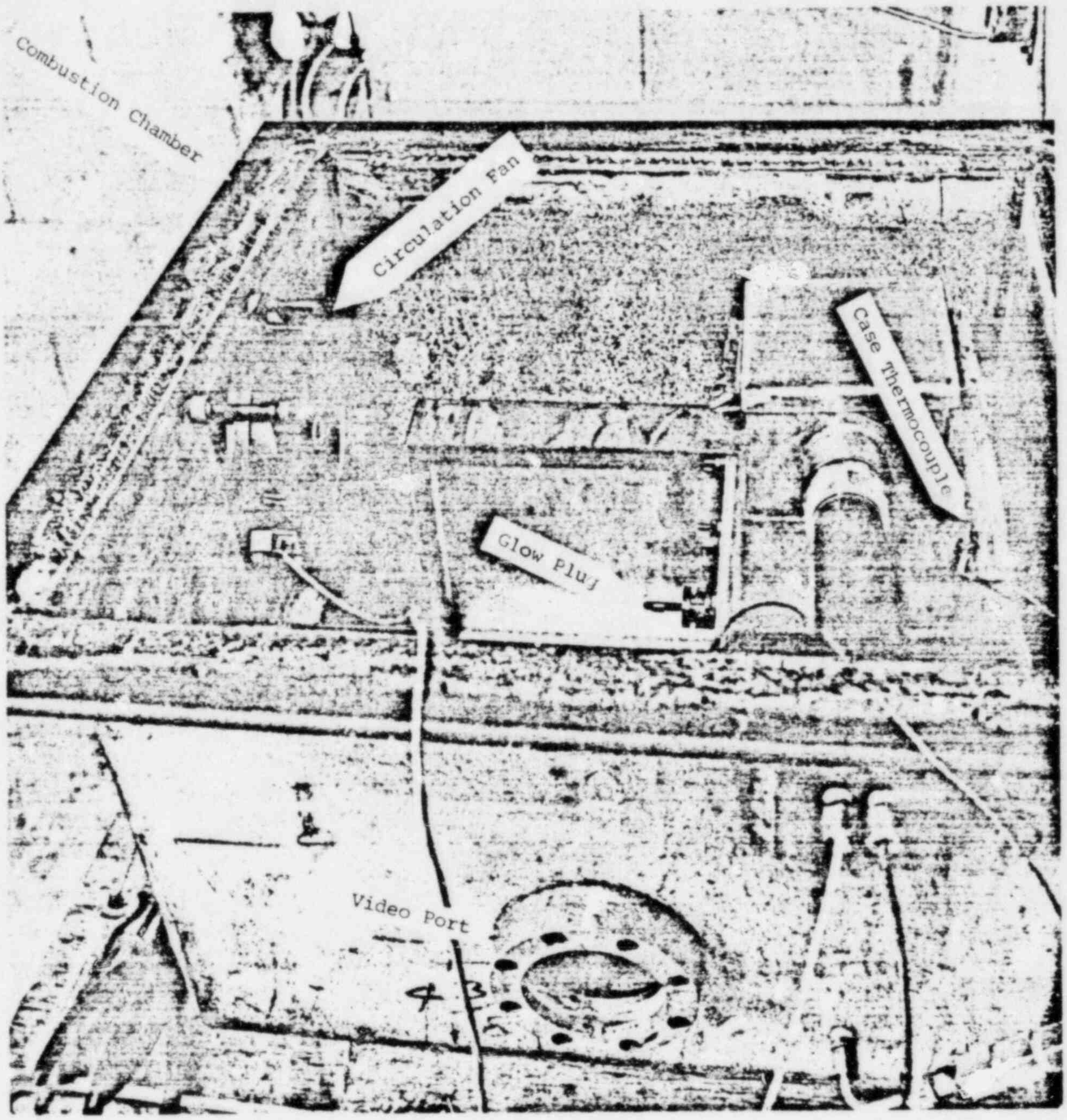


FIGURE 1

Tested by [signature]

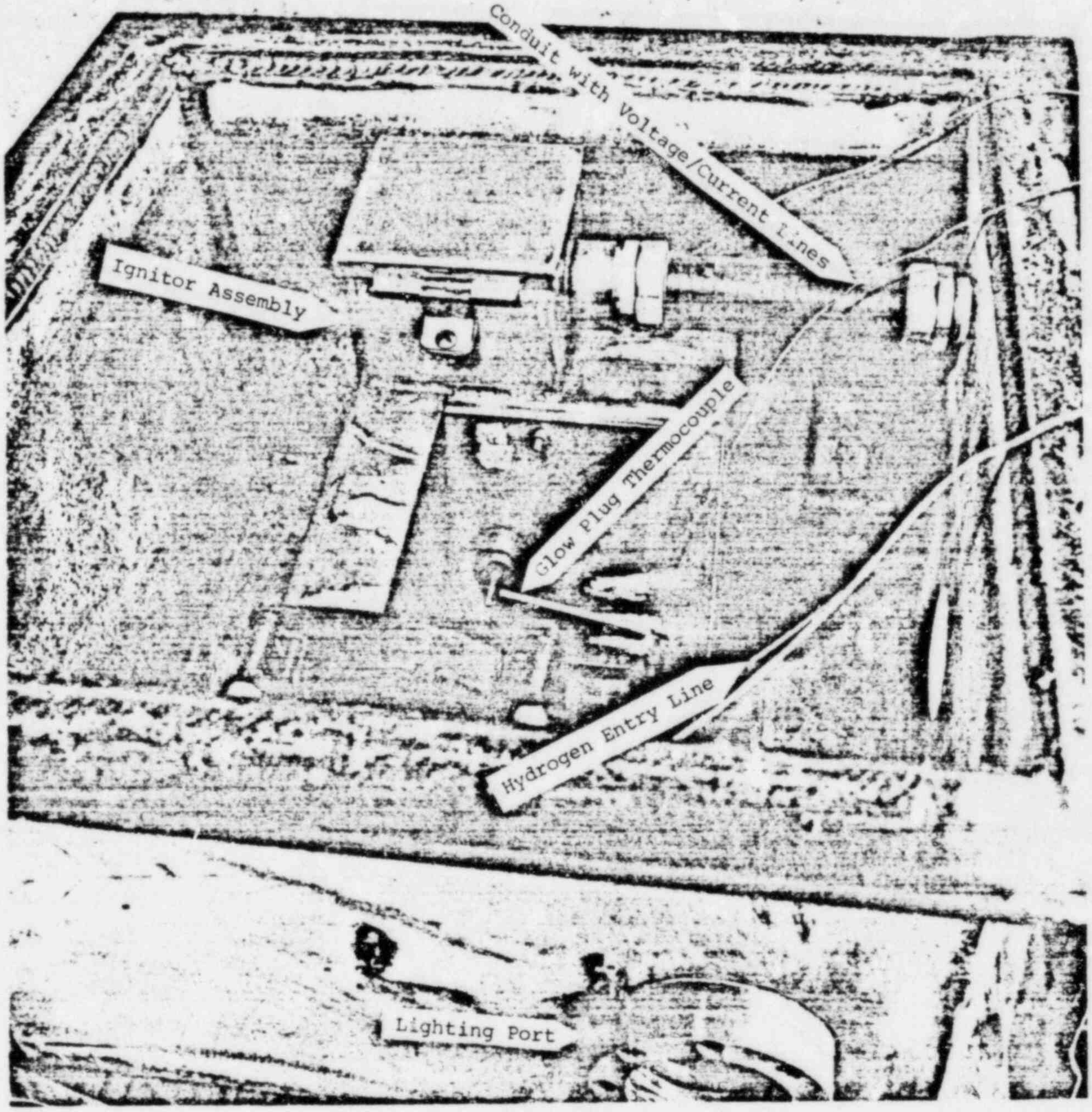
Engineer R. Stepelenitch

W614A-82 QA Form Approval LH



PHOTOGRAPH 1

INTERNAL VIEW OF CHAMBER



PHOTOGRAPH 2
INTERNAL VIEW OF CHAMBER

TEST CHECKLIST JOB NO. 57149

1. Verify area clear.
2. Verify calibration/zero checks on instrumentation completed.
3. Close X-ducer solenoid valve.
4. Adjust variac to obtain required ignition voltage.
5. Evacuate chamber (30 sec min.)
6. Open test chamber "Atmo" valve and allow air to enter.
7. Open X-ducer solenoid valve and activate circulation fan.
8. Computer ready.
9. Flow GH_2 into chamber for required mixture:

Voltage	Mixture	Req'd Flowmeter RDG.	Ignition Cycle No.	CHK OFF
120	4%	6.45	1	
120	4%	6.45	2	
120	4%	6.45	3	
120	4%	6.45	4	
108	4%	6.45	5	
108	4%	6.45	6	
108	4%	6.45	7	
108	4%	6.45	8	
132	4%	6.45	9	
132	4%	6.45	10	
132	4%	6.45	11	
132	4%	6.45	12	
120	8%	9.6	13	
120	8%	9.6	14	
120	8%	9.6	15	
120	8%	9.6	16	
132	8%	9.6	17	
132	8%	9.6	18	
132	8%	9.6	19	
132	8%	9.6	20	
108	8%	9.6	21	
108	8%	9.6	22	
108	8%	9.6	23	
108	8%	9.6	24	

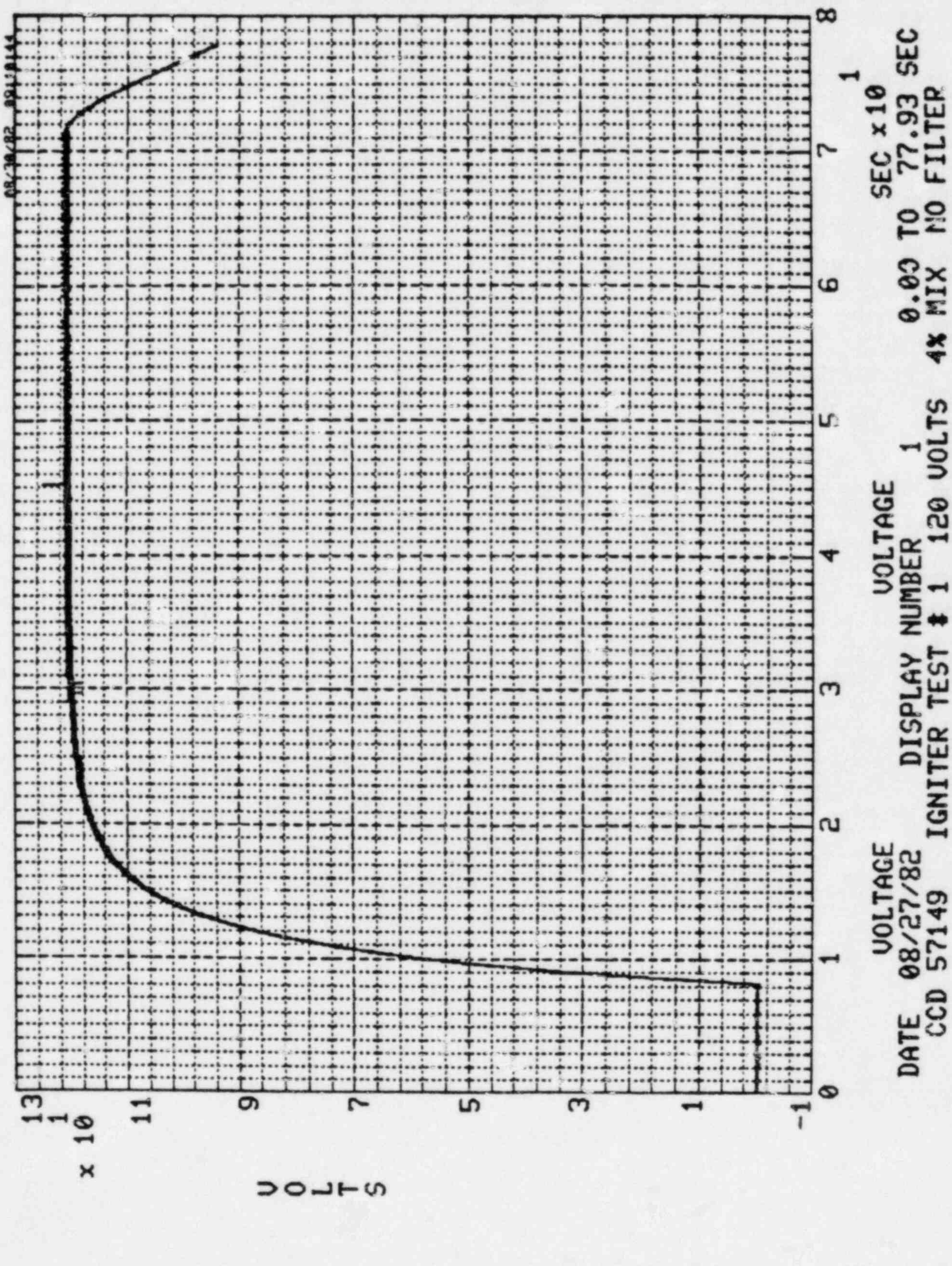
Voltage	Mixture	Req'd Flowmeter RDG.	Ignition Cycle No.	CHK OFF
108	12%	12.65	25	
108	12%	12.65	26	
108	12%	12.65	27	
108	12%	12.65	28	
120	12%	12.65	29	
120	12%	12.65	30	
120	12%	12.65	31	
120	12%	12.65	32	
132	12%	12.65	33	
132	12%	12.65	34	
132	12%	12.65	35	
132	12%	12.65	36	

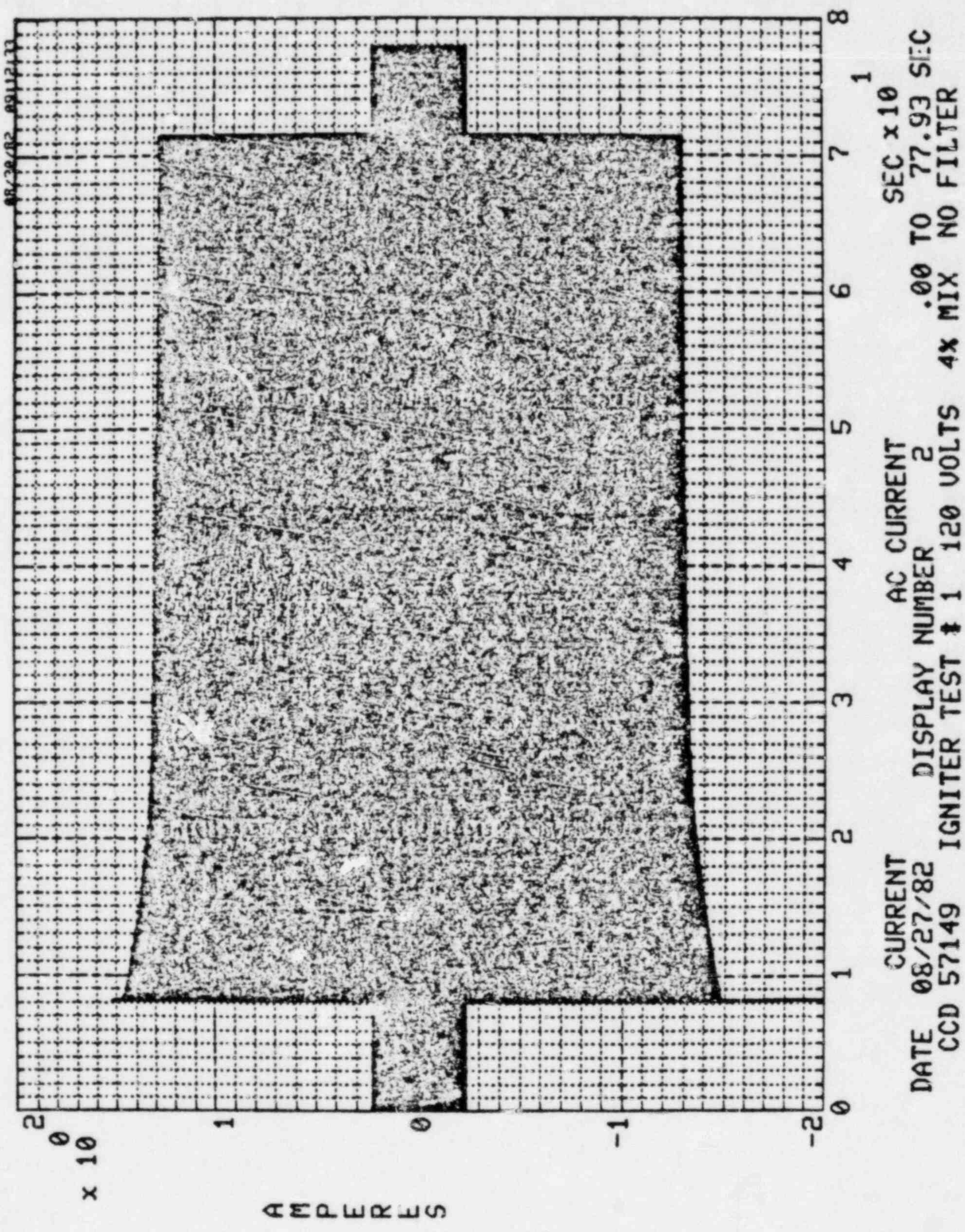
10. Computer on -- verify ready light.
11. Video on.
12. Activate ignition switch (repeat process for all conditions listed, 36 ignitions.)

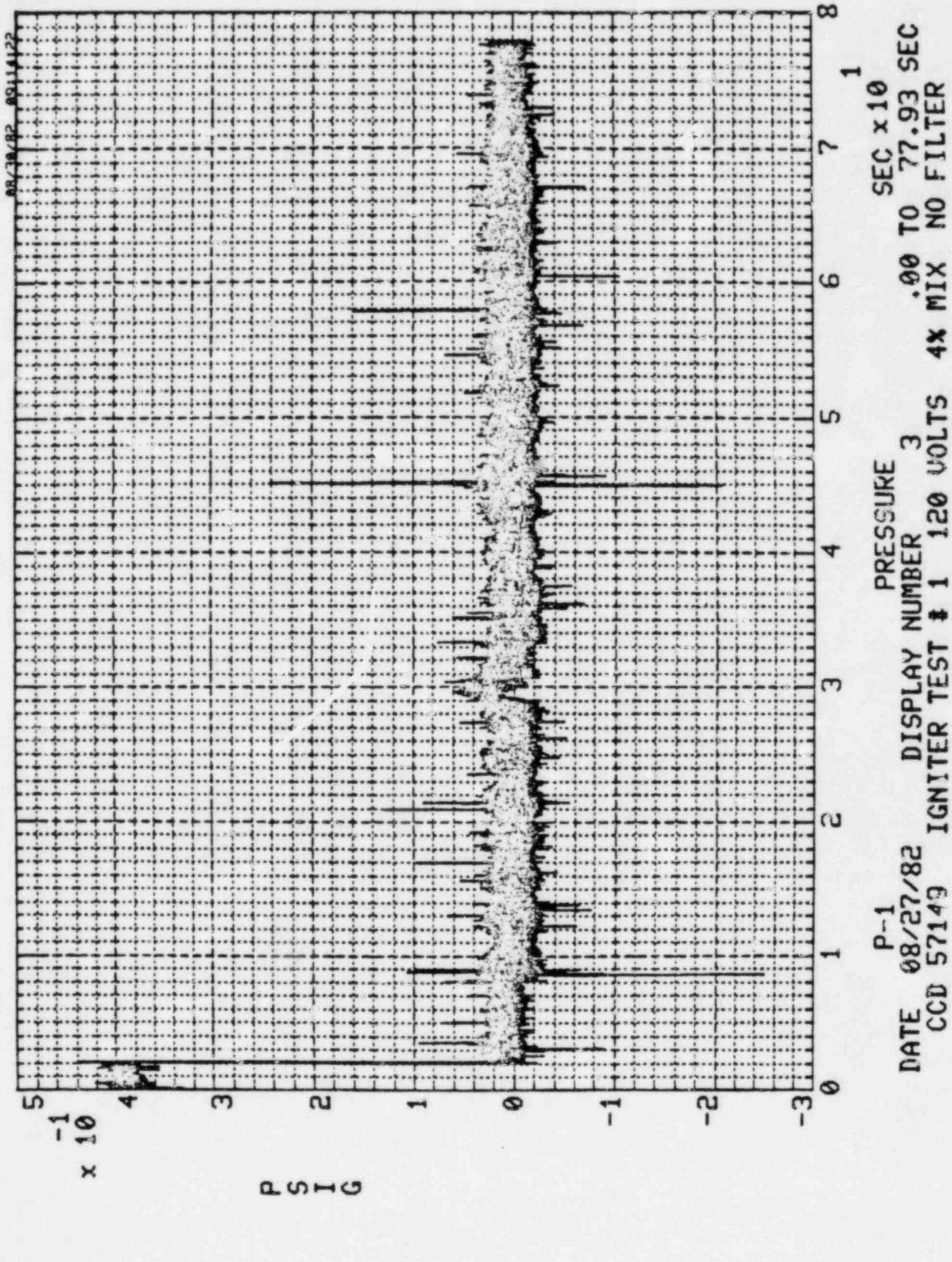
    Multiple ignitions (37 → 100).
13. Evacuate chamber.
14. Adjust variac to *selected voltage.

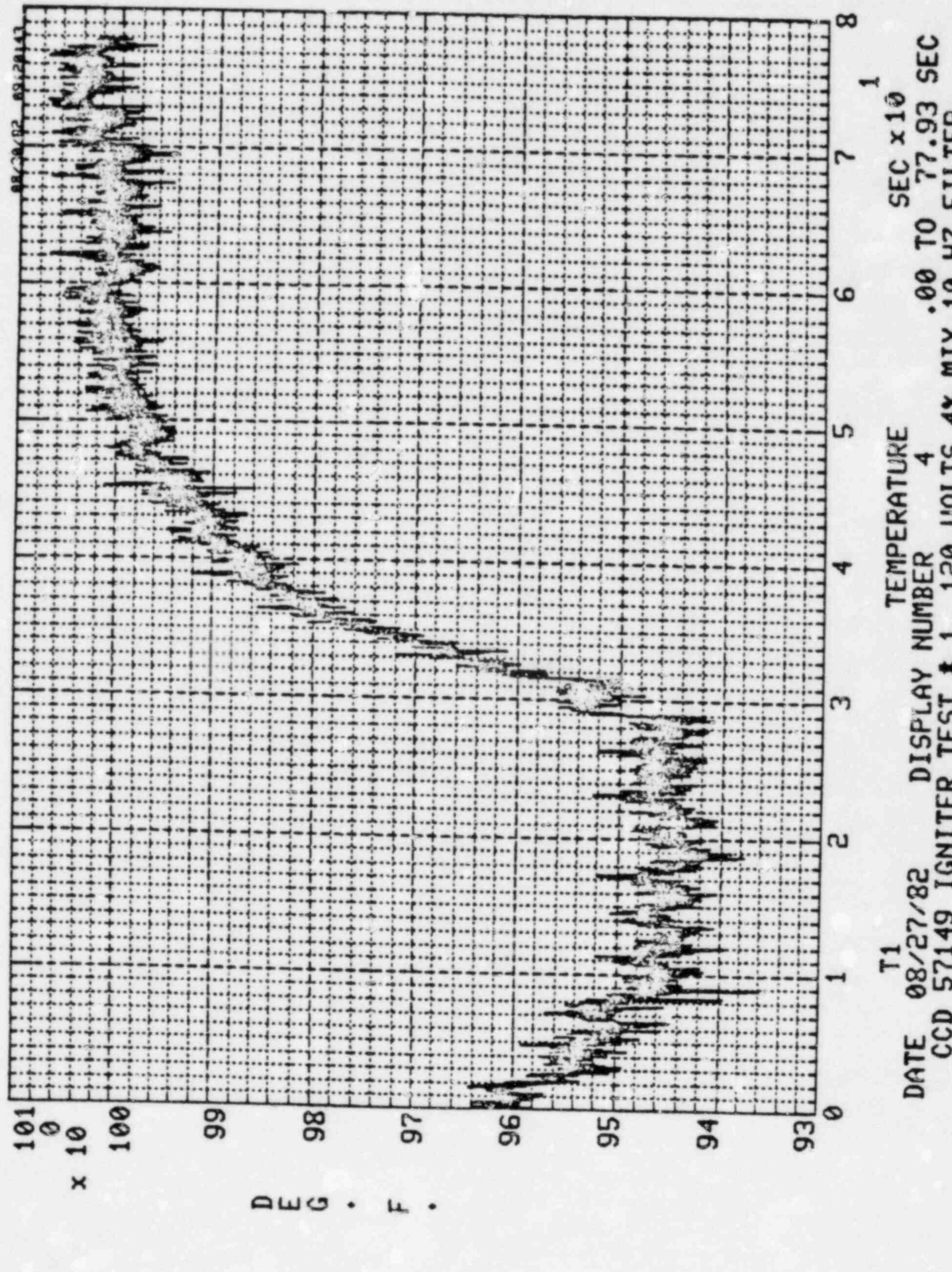
    (*customer)
15. Open chamber "Atmo" valve.
16. Verify X-ducer solenoid valve open and circulation fan operating.
17. Computer on.
18. Video on.
19. Flow GH_2 at 12% mixture flow rate (12.65 div.).
20. Activate ignition switch and allow ignition to occur.
21. Verify ignition has occurred by observing chamber air temp and pressure activity on visicorder. Close GH_2 supply.
22. After ignition has occurred, hold for 30 seconds and open GH_2 valve to flow gas into chamber.
23. Repeat Steps 21 and 22 while recording data on computer and operating video tape.
24. Secure test setup.

R. Stepelevitch 8/25

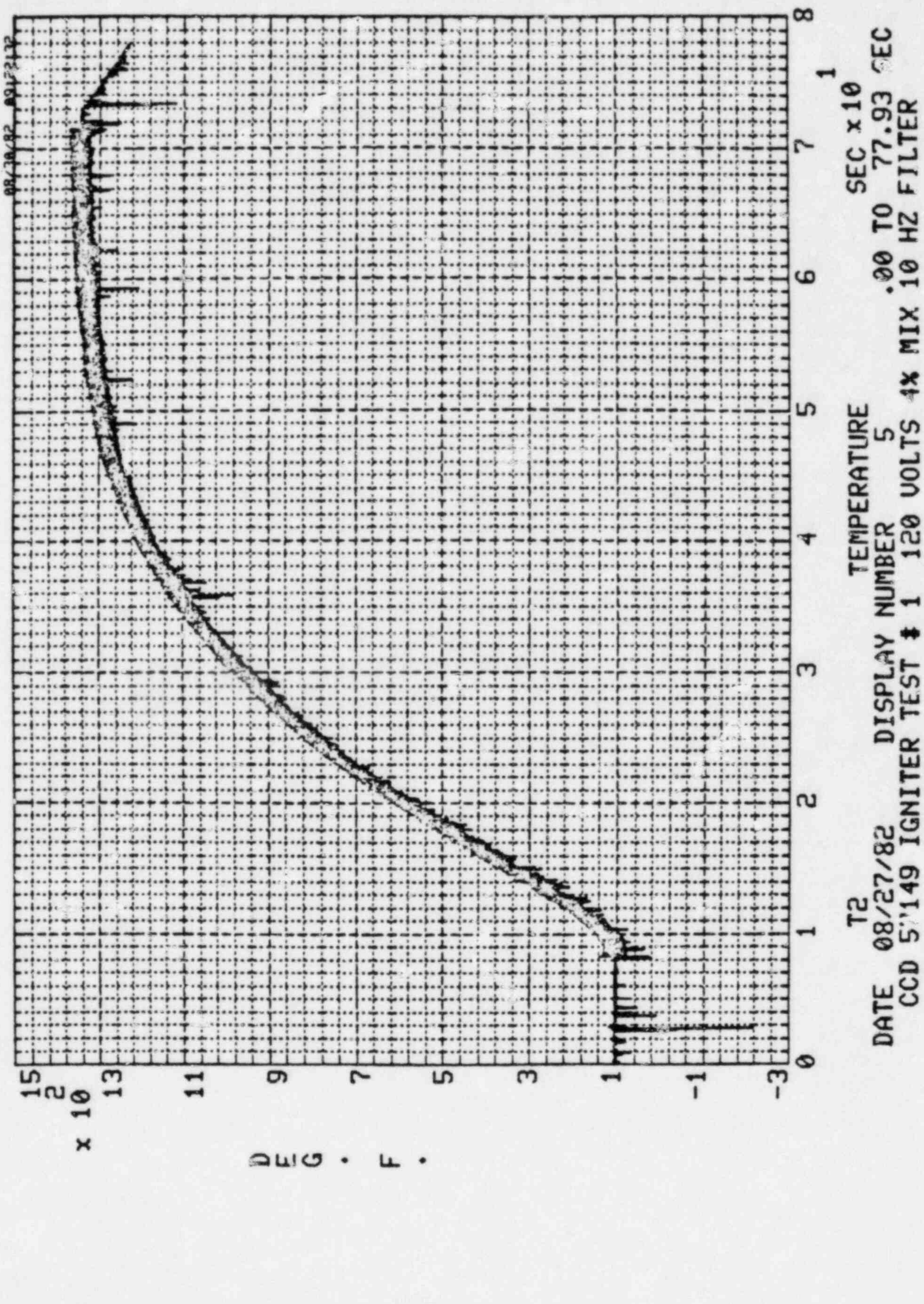

VOLTS
x 10
1
13
11
9
7
5
3
1
-1
0
1
2
3
4
5
6
7
8
SEC x 10
1
VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 1 120 VOLTS
0.03 TO 77.93 SEC
4% MIX NO FILTER

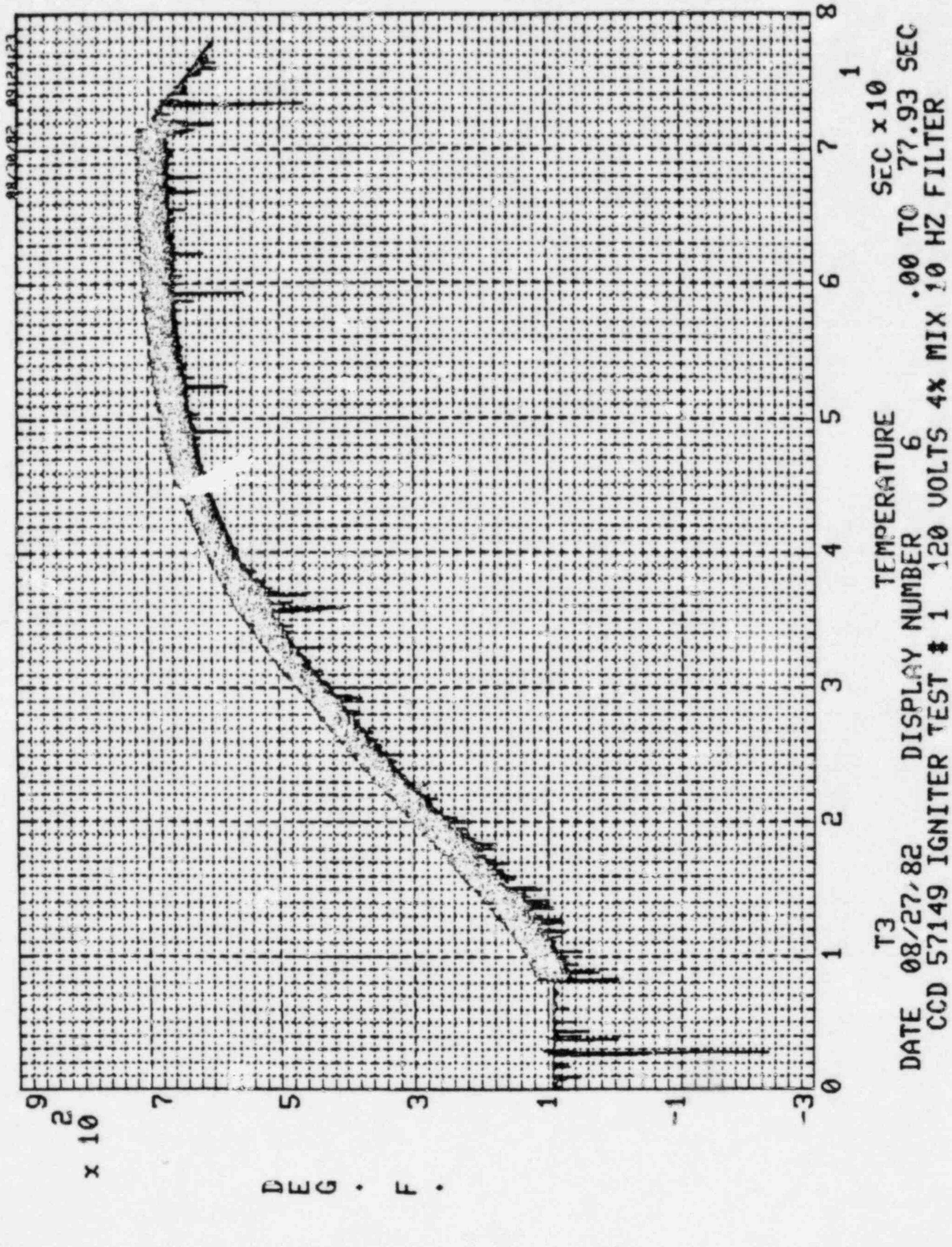

CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 1
120 VOLTS
4X MIX
SEC x10
.00 TO 77.93 SEC
NO FILTER
AMPERES
x 10
0 1 2 3 4 5 6 7 8
2 1 0 -1 -2

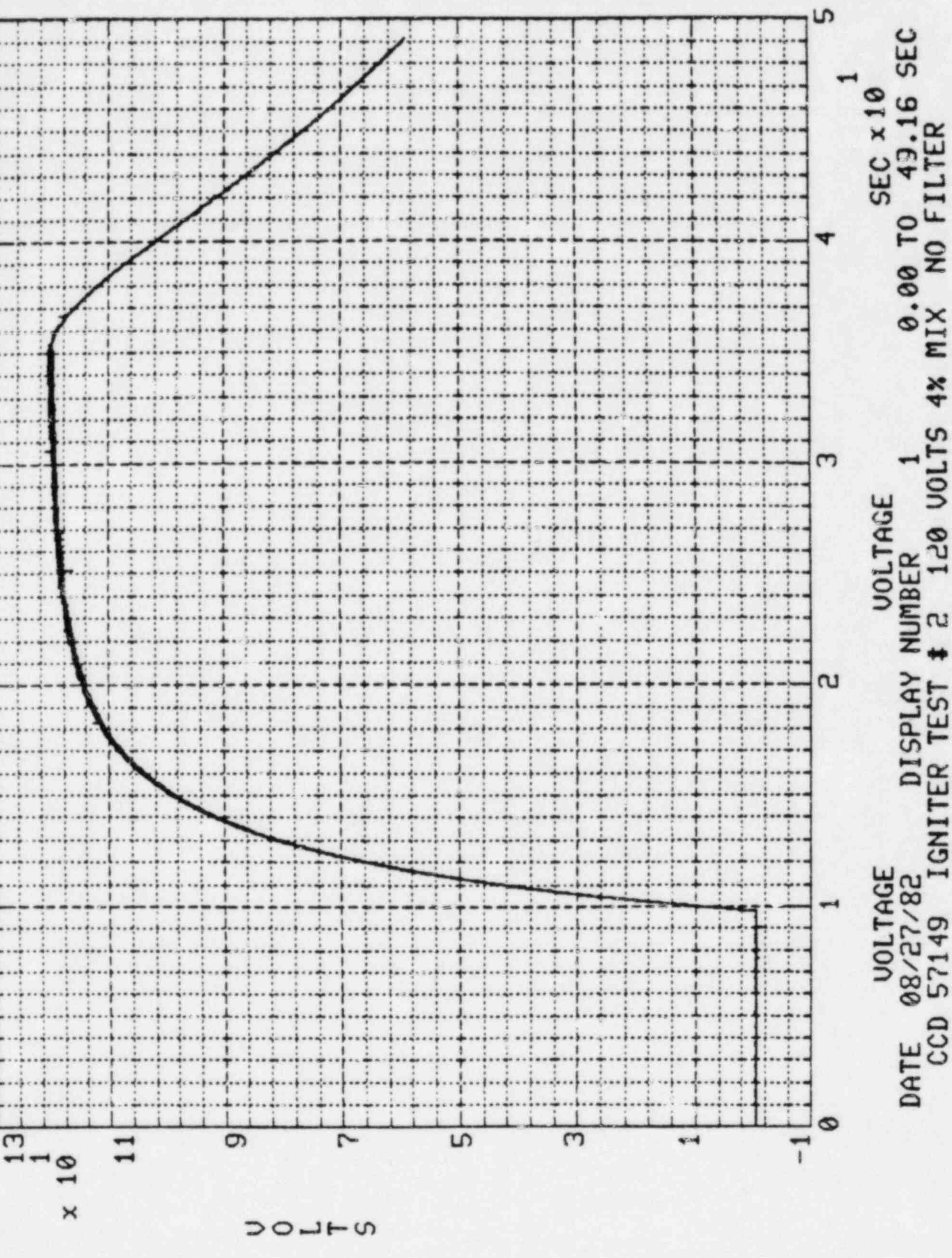

08/30/82 09114122
P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 1 120 VOLTS 4X MIX NO FILTER
.00 TO 77.93 SEC
SEC x10 1
x 10 -1
PSIG
5
4
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6
7
8



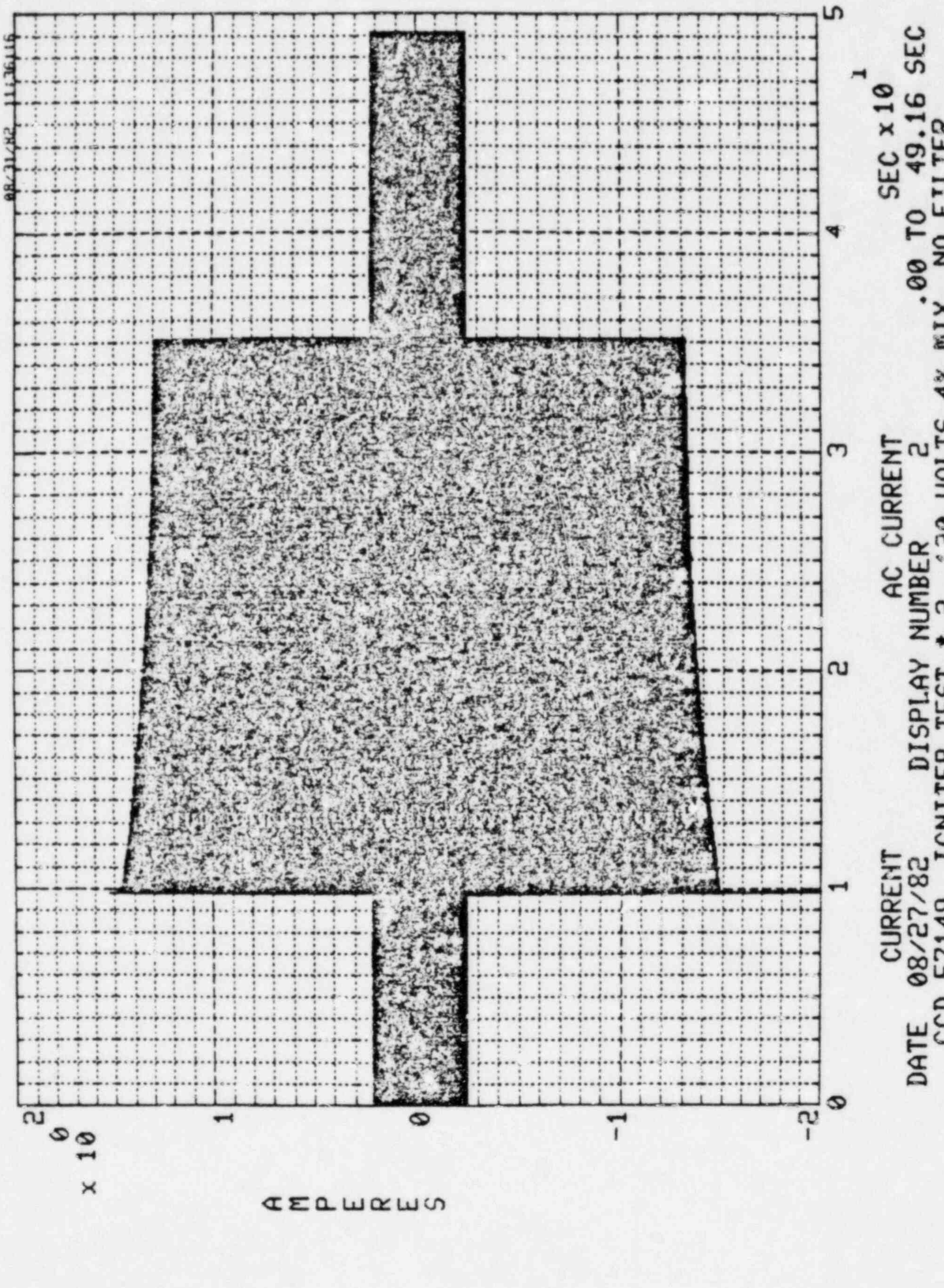
101
x 10^0
100
99
98
97
96
95
94
93
DEG. F.
0
1
2
3
4
5
6
7
8
SEC x10^1
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
.00 TO 77.93 SEC
CCD 57149 IGNITER TEST # 1 120 VOLTS 4% MIX 10 HZ FILTER

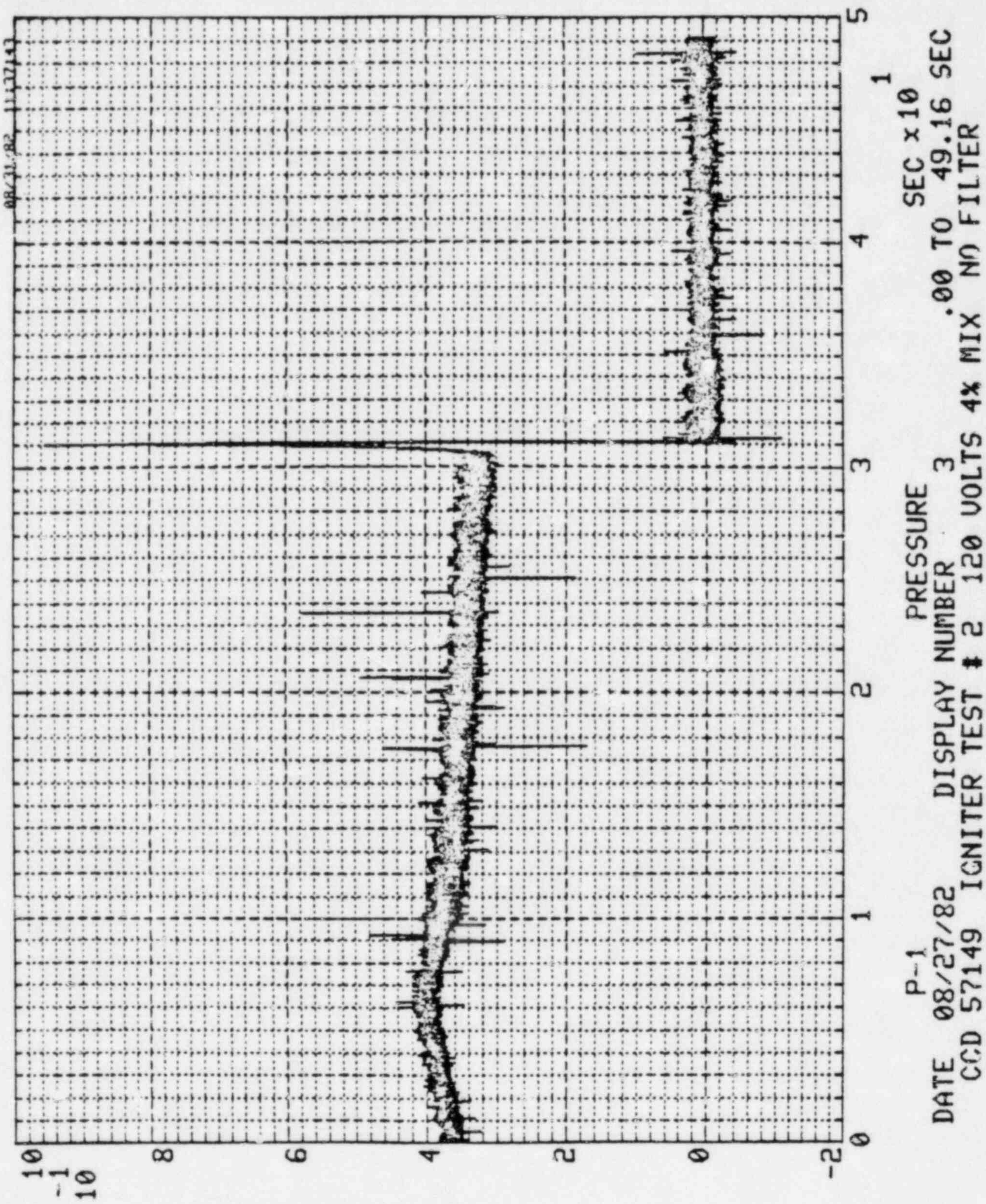

08/30/82 09:32:32
15
13
11
9
7
5
3
1
-1
-3
x 10^2
DEG. F.
0
1
2
3
4
5
6
7
8
SEC x 10^1
T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
.00 TO 77.93 SEC
CCD 57149 IGNITER TEST # 1 120 VOLTS 4% MIX 10 HZ FILTER

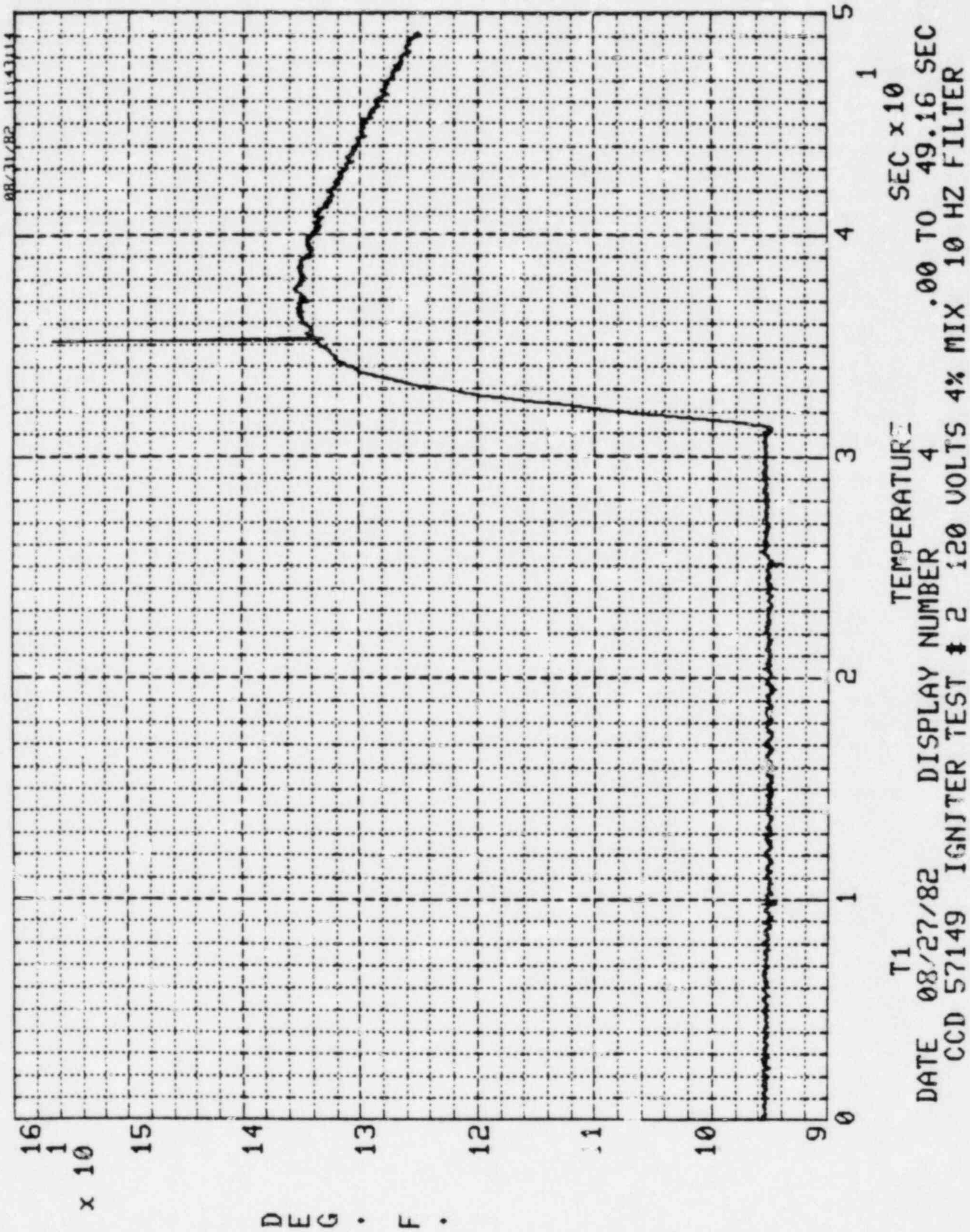

T3
TEMPERATURE
DATE 08/27/82
DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 1 120 VOLTS 4% MIX 10 HZ FILTER
.00 TO 77.93 SEC
SEC x 10^1
DEG. F.
x 10^2

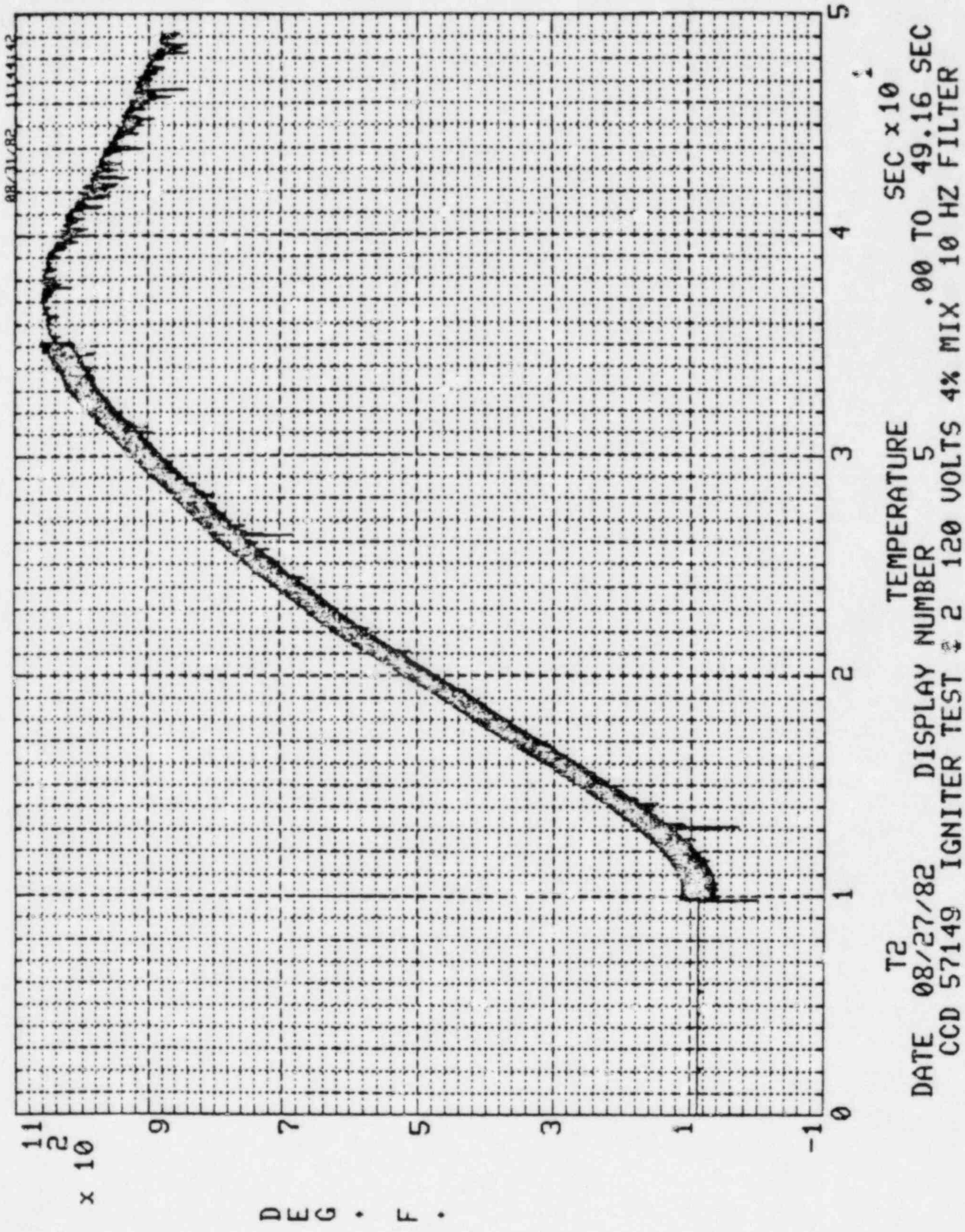


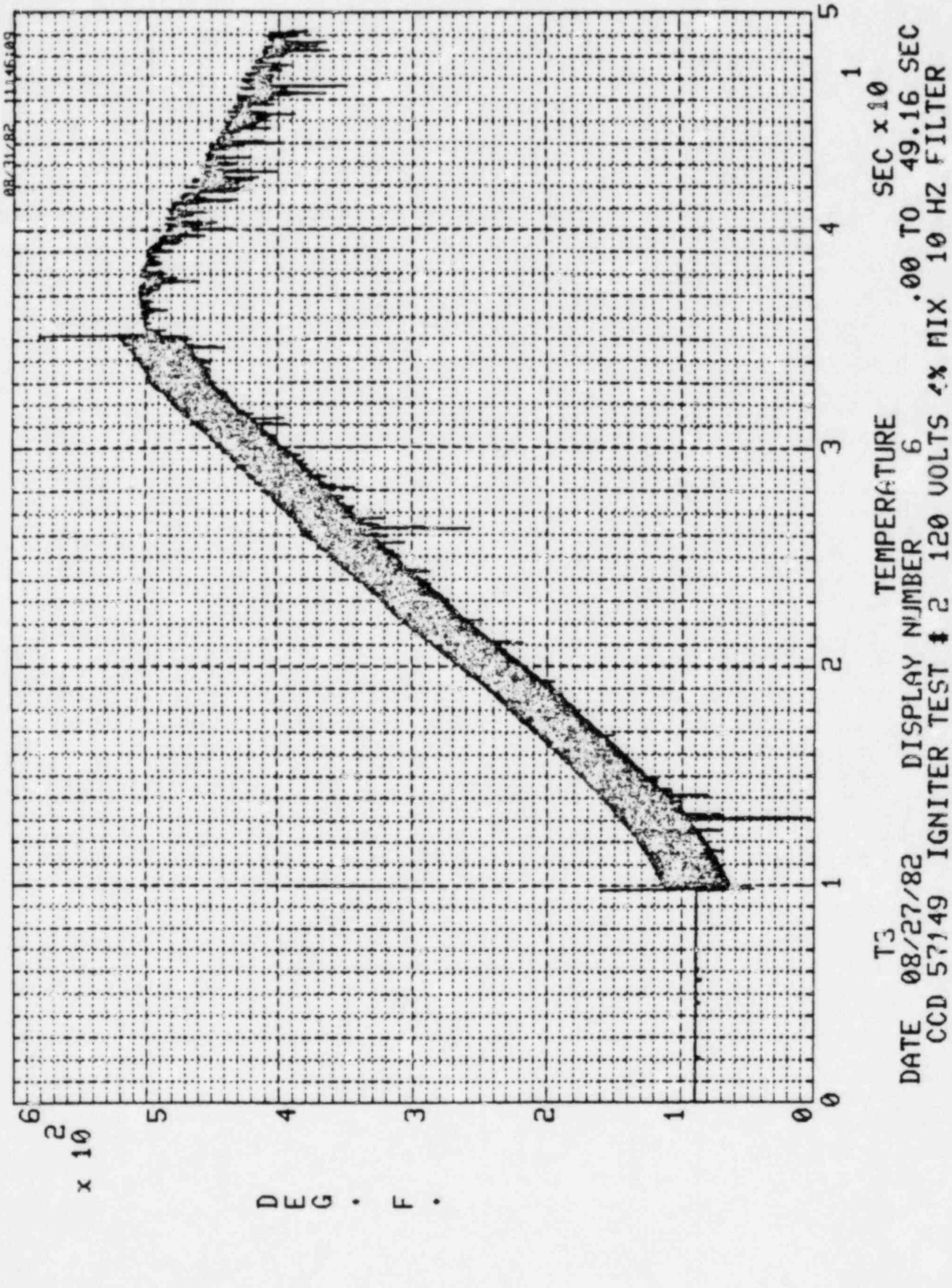
VOLTS
x 10 1
13
11
9
7
5
3
1
-1
0
1
2
3
4
5
SEC x 10 1
VOLTAGE VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 49.16 SEC
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX NO FILTER

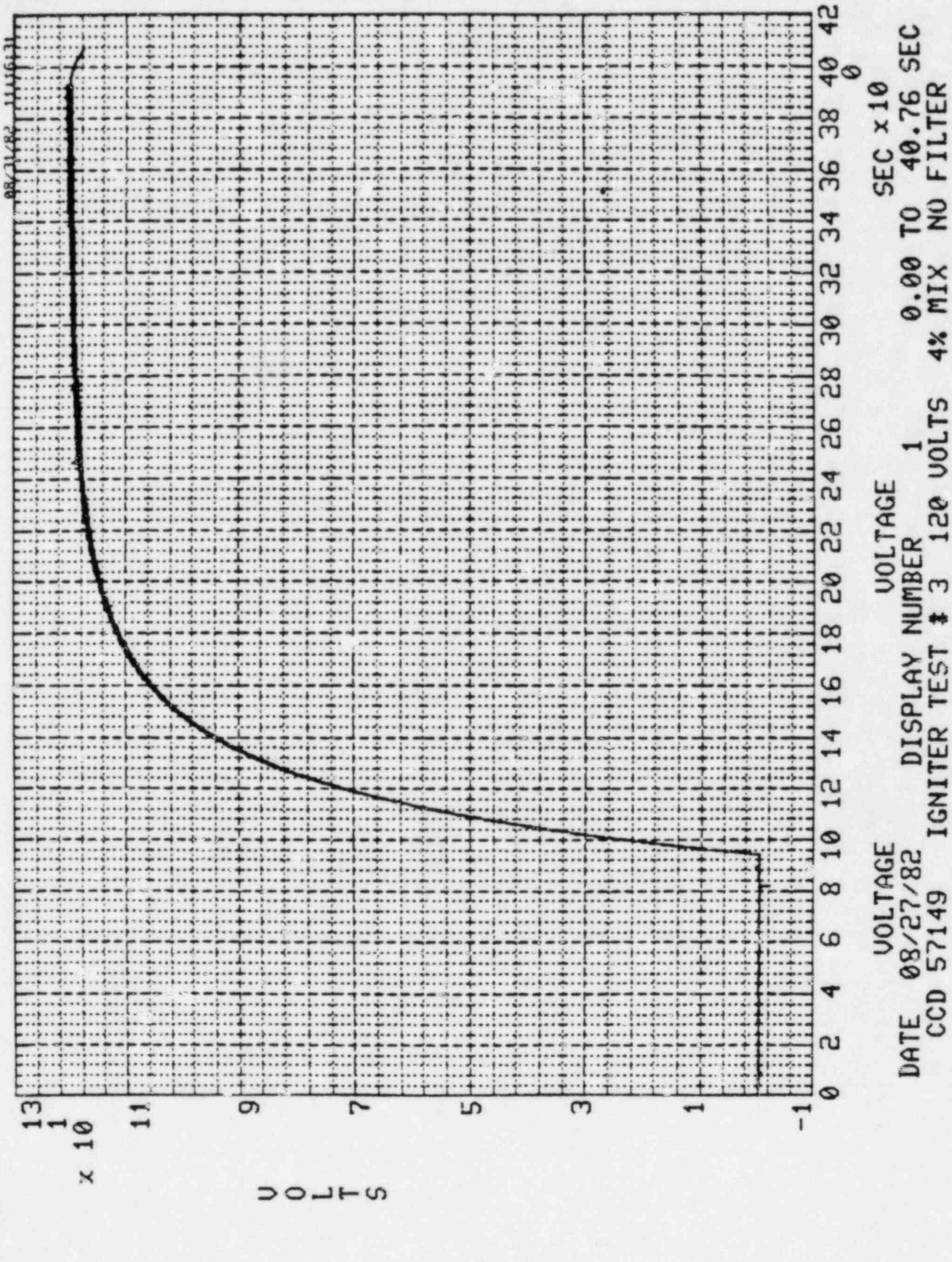

CURRENT AC CURRENT SEC x 10^1
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 49.16 SEC
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX NO FILTER
AMPERES x 10^0
0
1
2
3
4
5
2
1
0
-1
-2

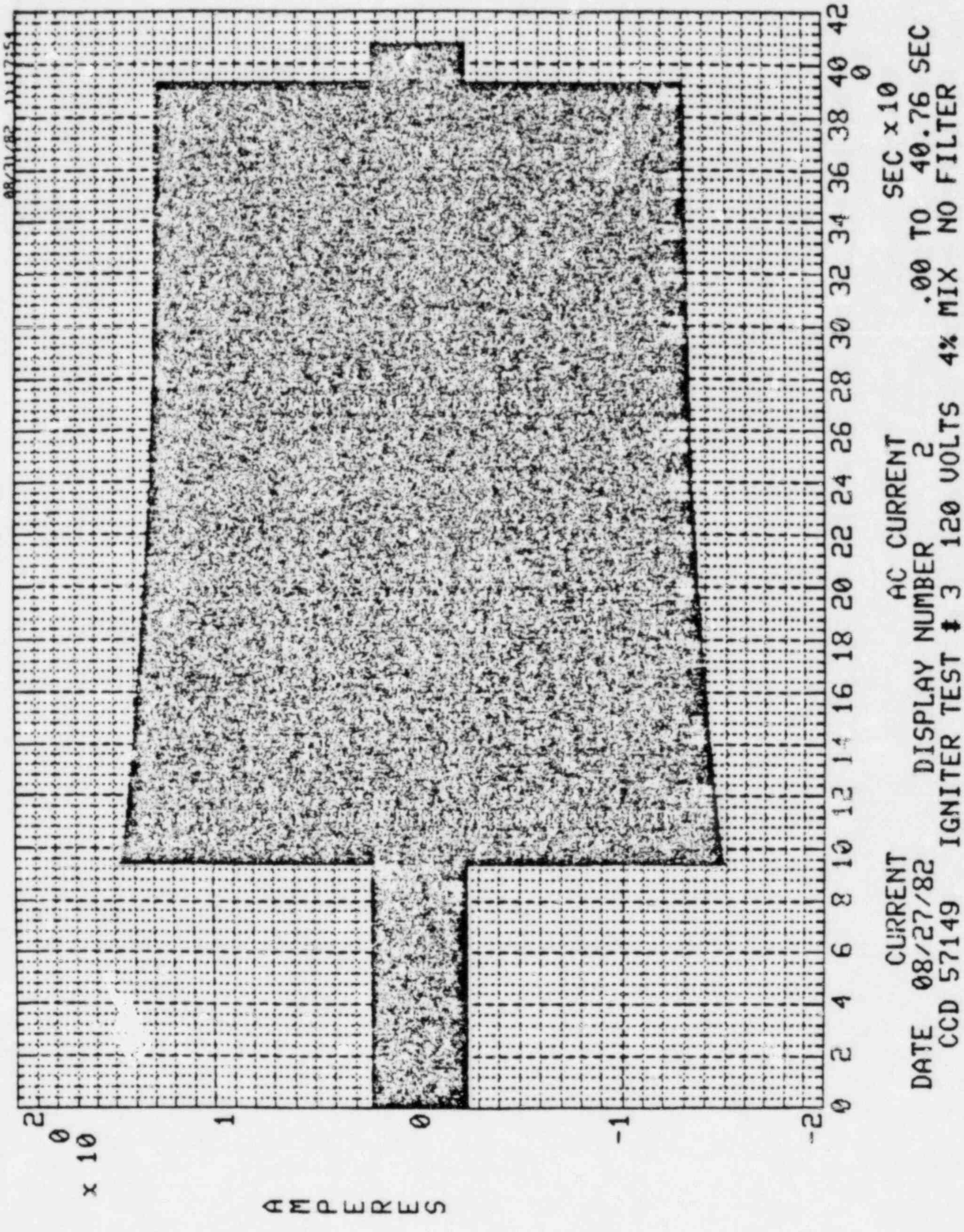

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX .00 TO 49.16 SEC NO FILTER
SEC x10
P S I G
x 10

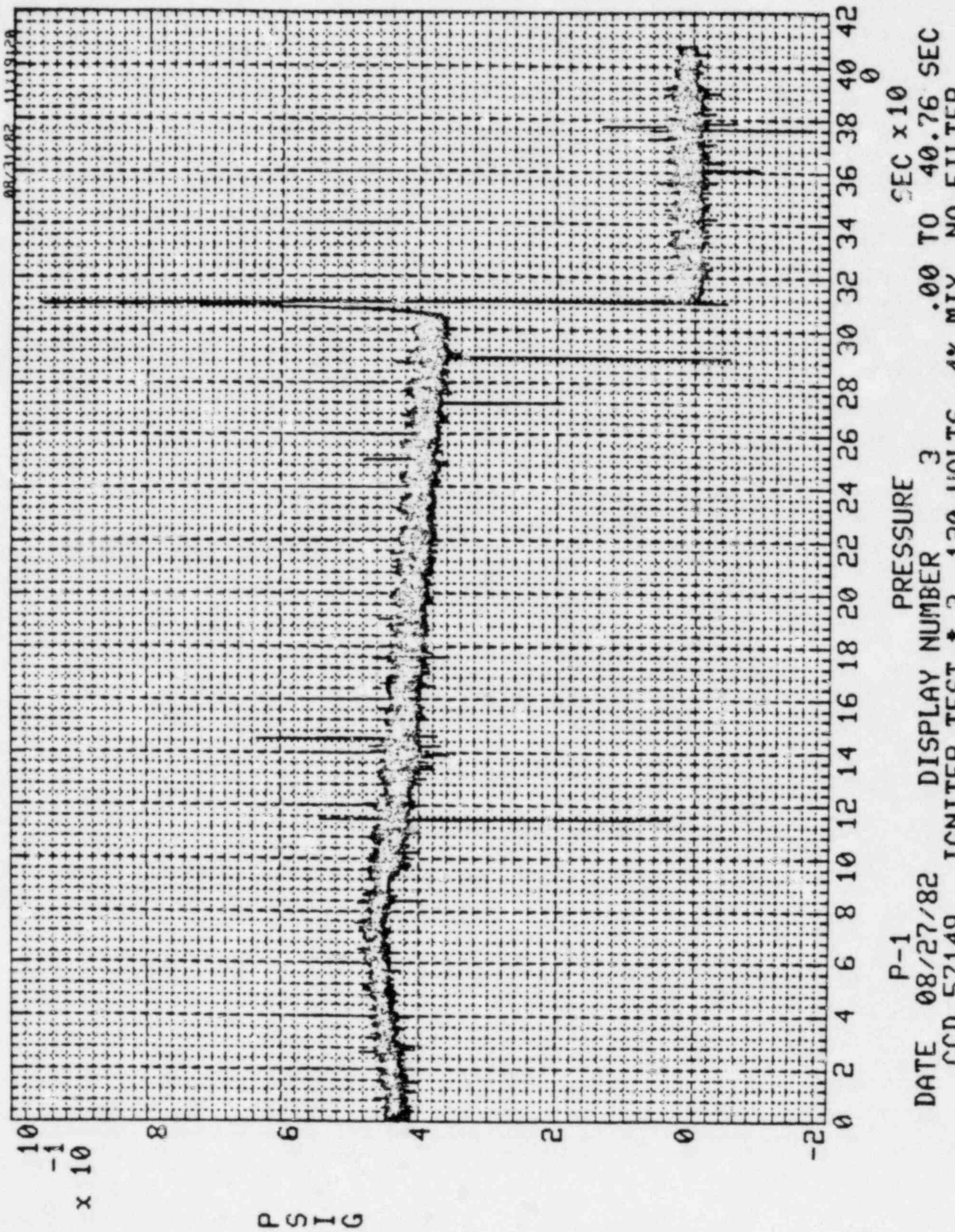

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX .00 TO 49.16 SEC 10 HZ FILTER
SEC x10 1
DEG. F.
x 10 1
0 1 2 3 4 5
9 10 11 12 13 14 15 16

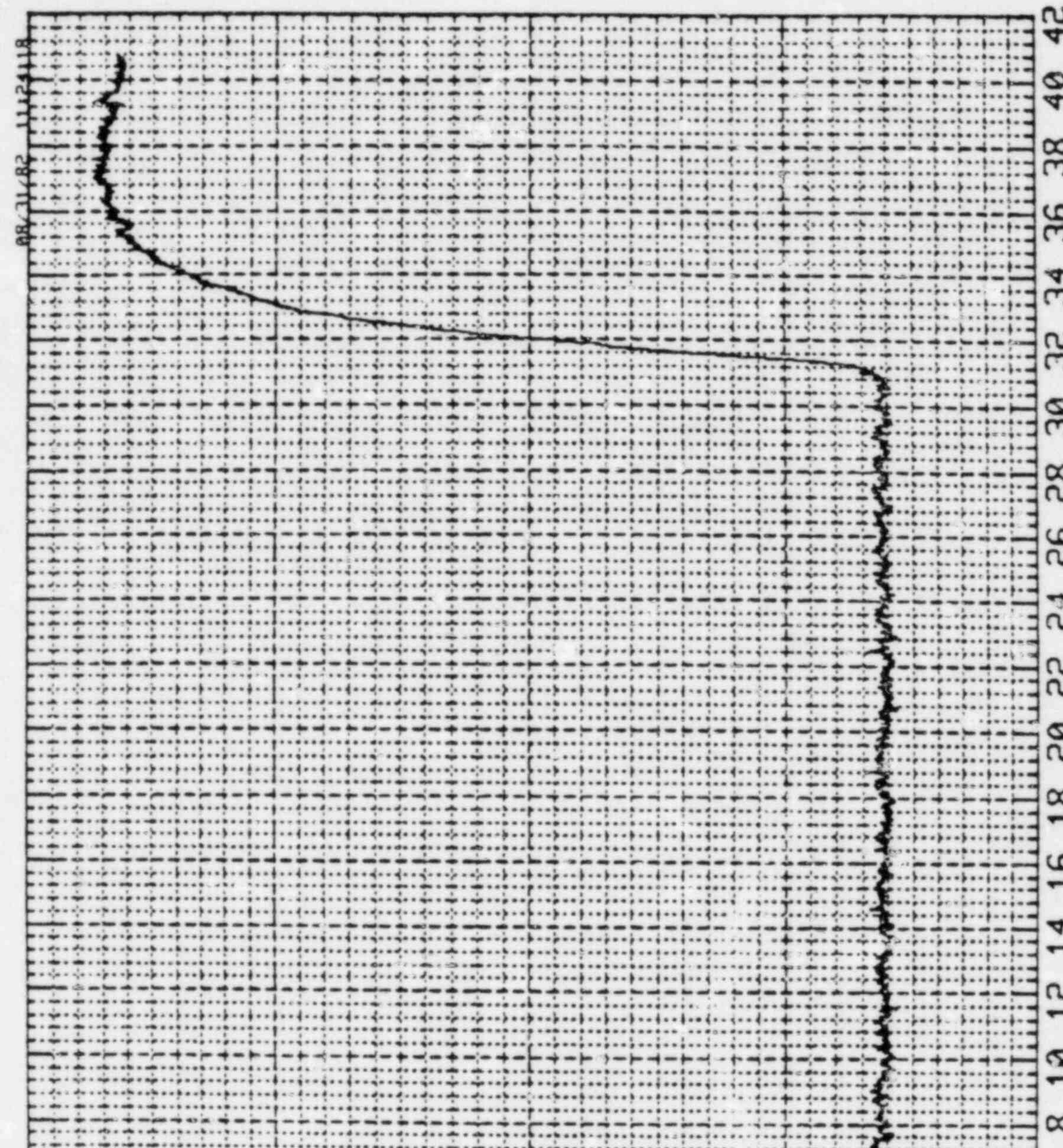

DEG. F. x 10^2
11
9
7
5
3
1
-1
0
1
2
3
4
5
SEC x10^1
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 49.16 SEC
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX 10 HZ FILTER


T3
DATE 08/27/82 DISPLAY NUMBER 6
TEMPERATURE
CCD 57149 IGNITER TEST # 2 120 VOLTS 4% MIX .00 TO 49.16 SEC 10 HZ FILTER
SEC x 10 1
DEG. F.
x 10 2
08/31/82 11:46:09
0
1
2
3
4
5
6


VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 3 120 VOLTS 4% MIX
SEC x10
0.00 TO 40.76 SEC
NO FILTER
VOLTS
x 10
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
-1 1 3 5 7 9 11 13


CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 3 120 VOLTS 4% MIX NO FILTER
SEC x10 0
.00 TO 40.76 SEC
AMPERES
x 10 0
2
1
0
-1
-2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42


P-1
PRESSURE
DATE 08/27/82
DISPLAY NUMBER 3
CCD 57149
IGNITER TEST # 3
120 VOLTS
4% MIX
.00 TO 40.76 SEC
NO FILTER
SEC x10
PSIG
x 10

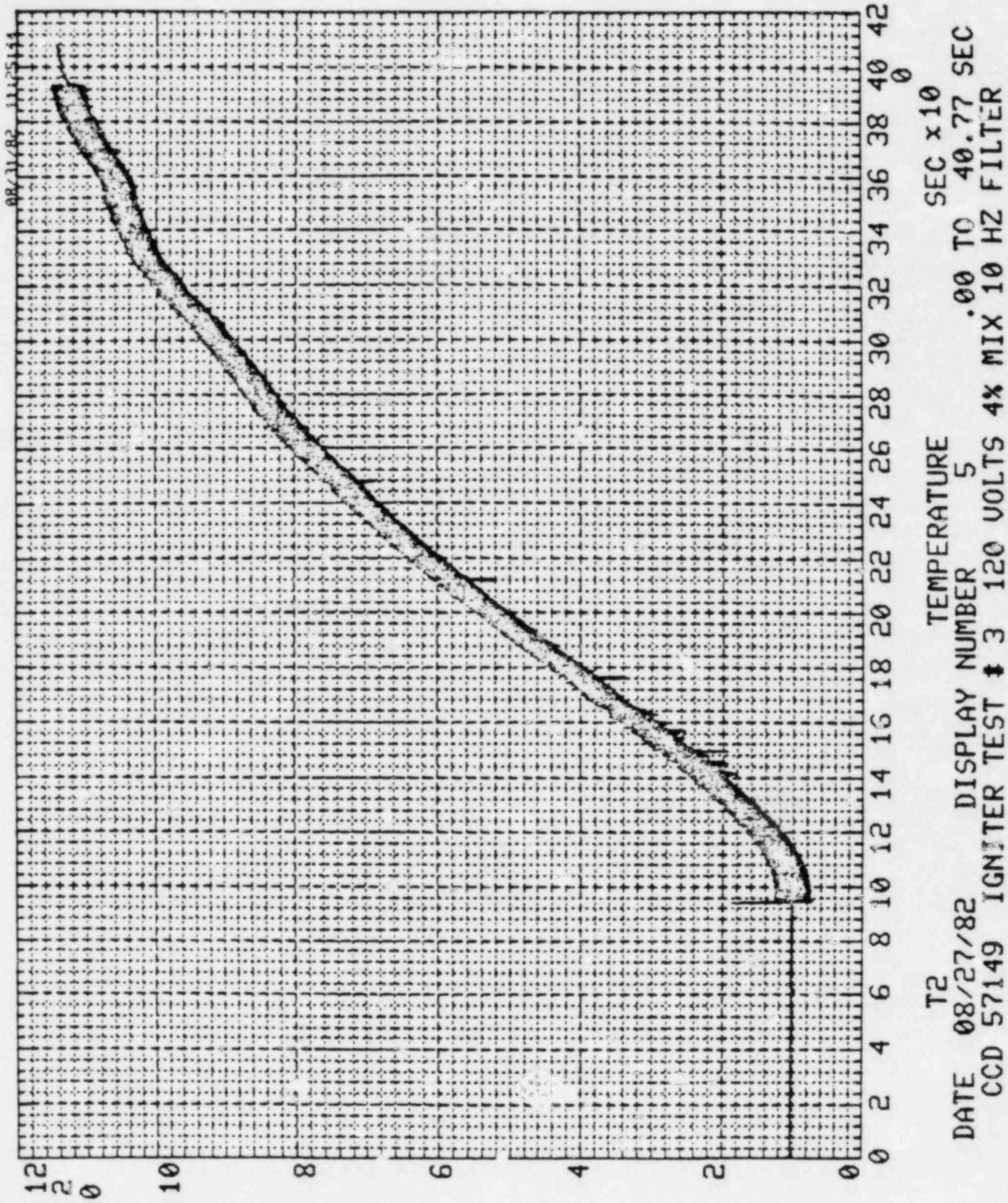


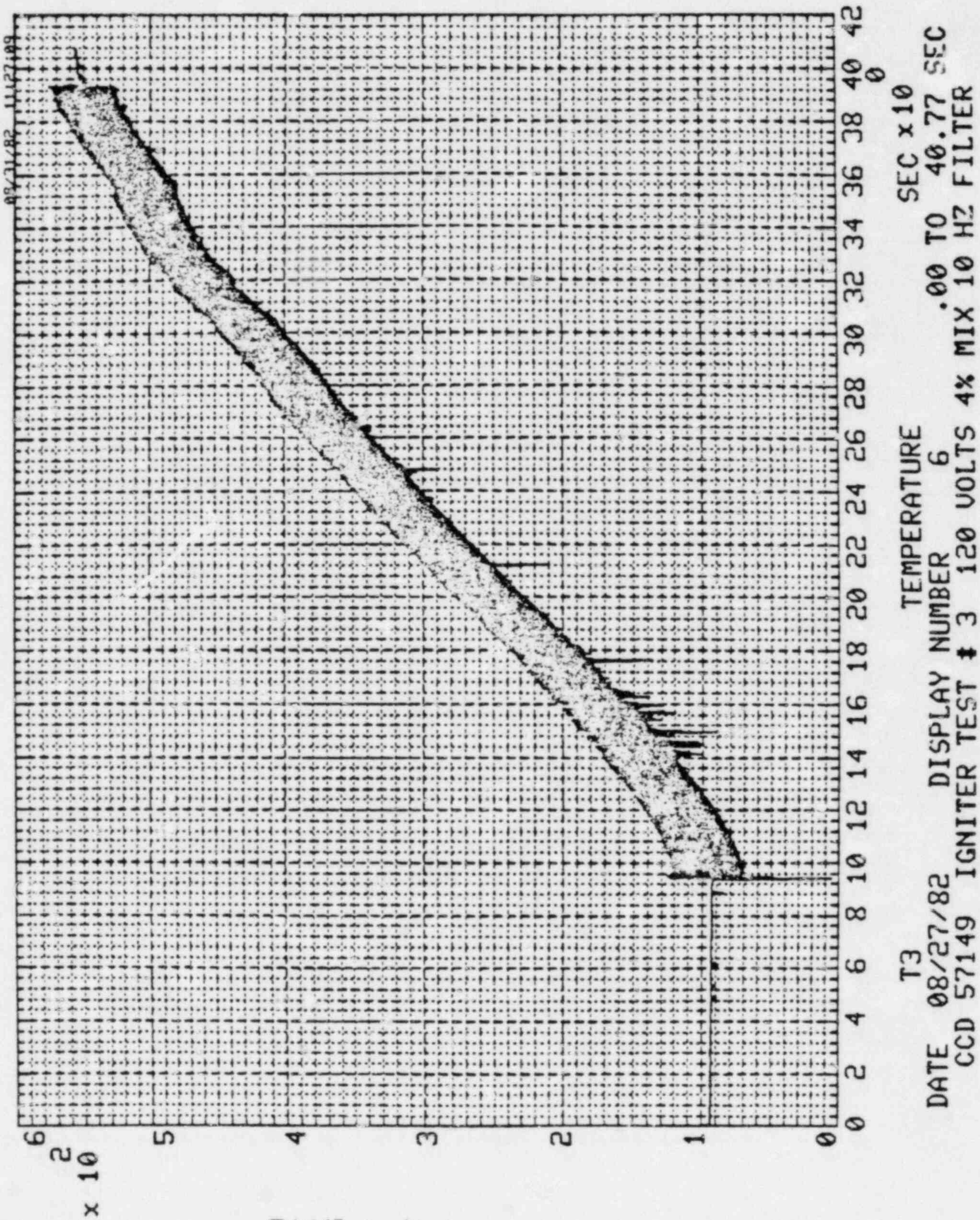
TEMPERATURE

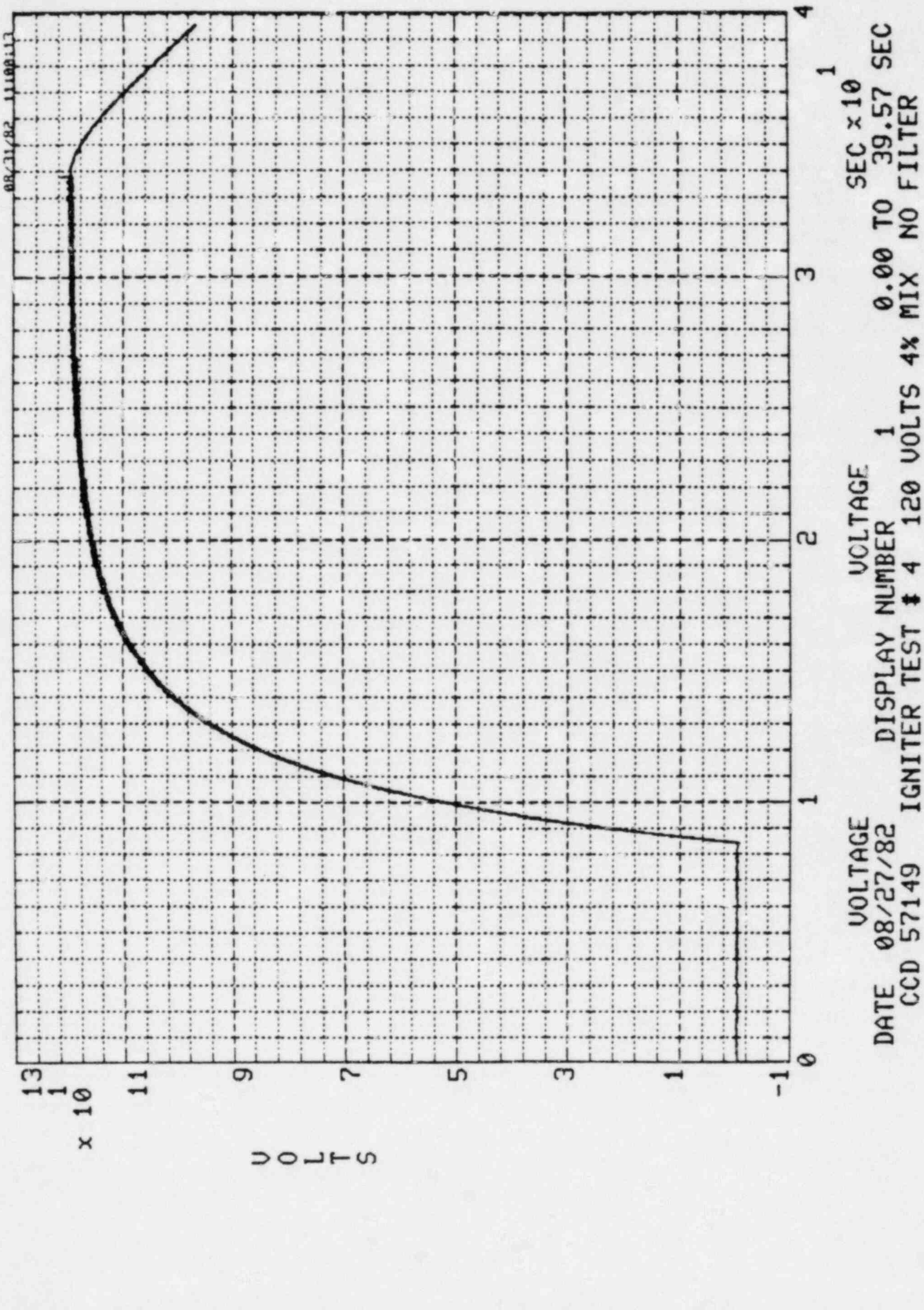
T1

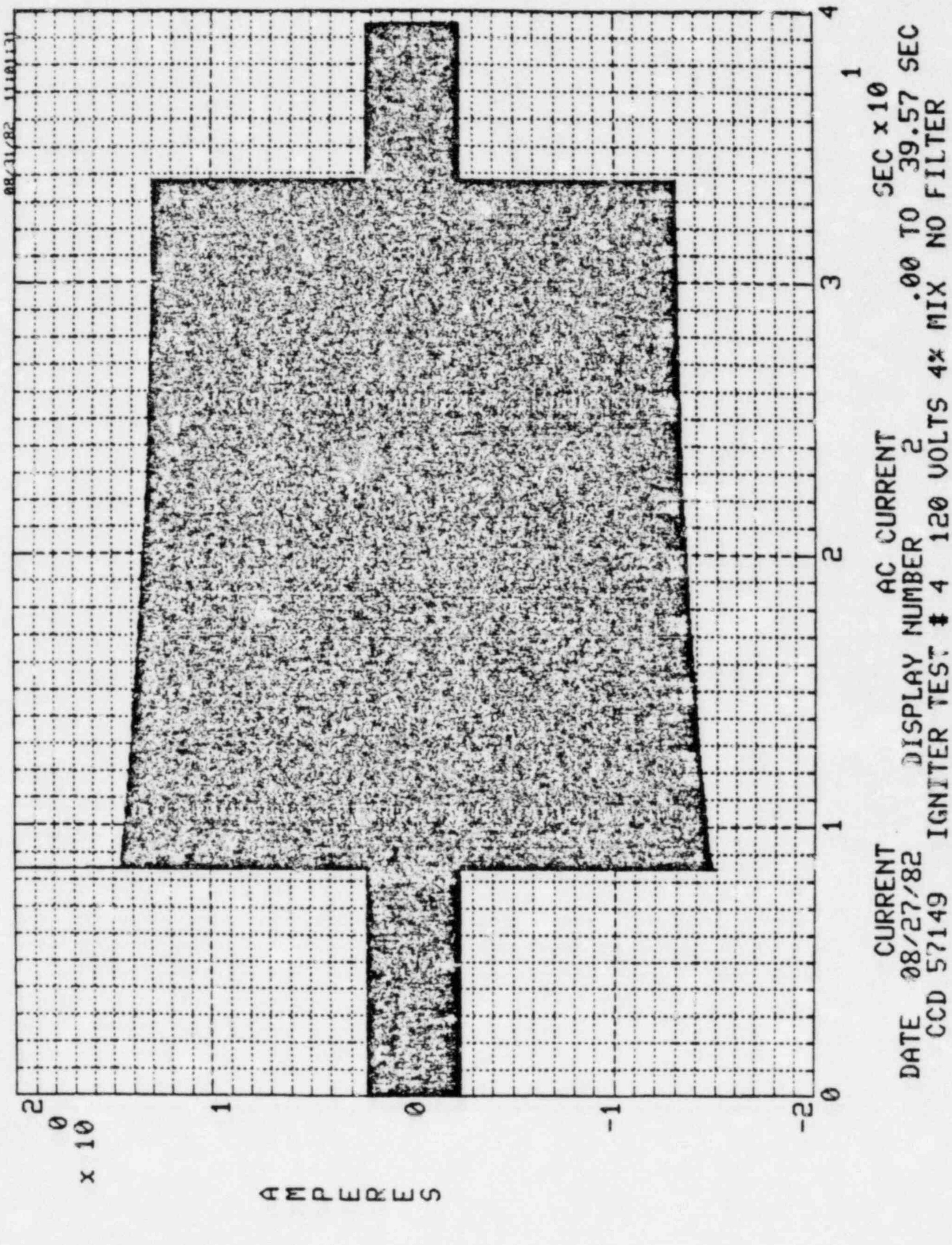
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 40.77 SEC

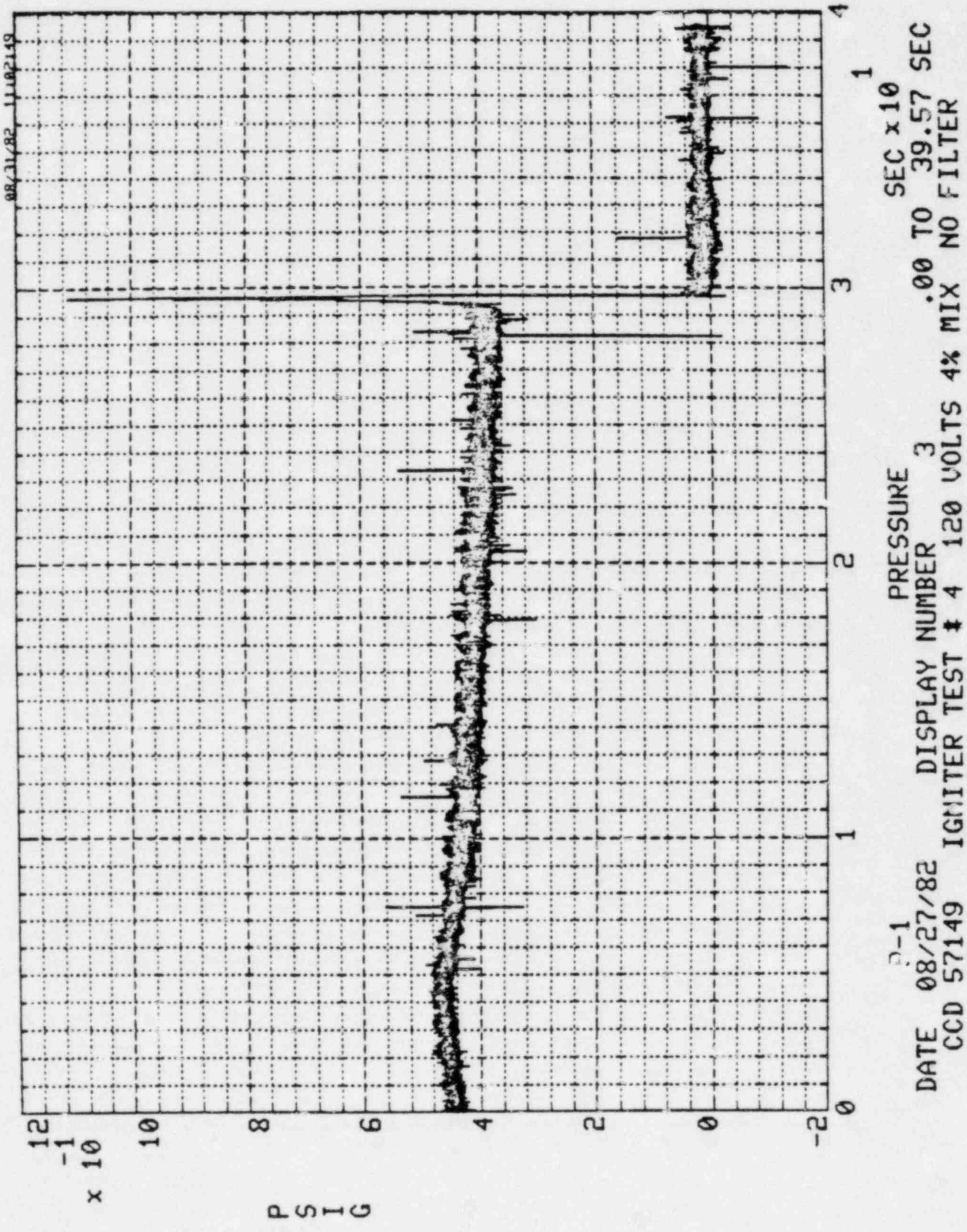
CCD 57149 IGNITER TEST # 3 120 VOLTS 4% MIX 10 HZ FILTER

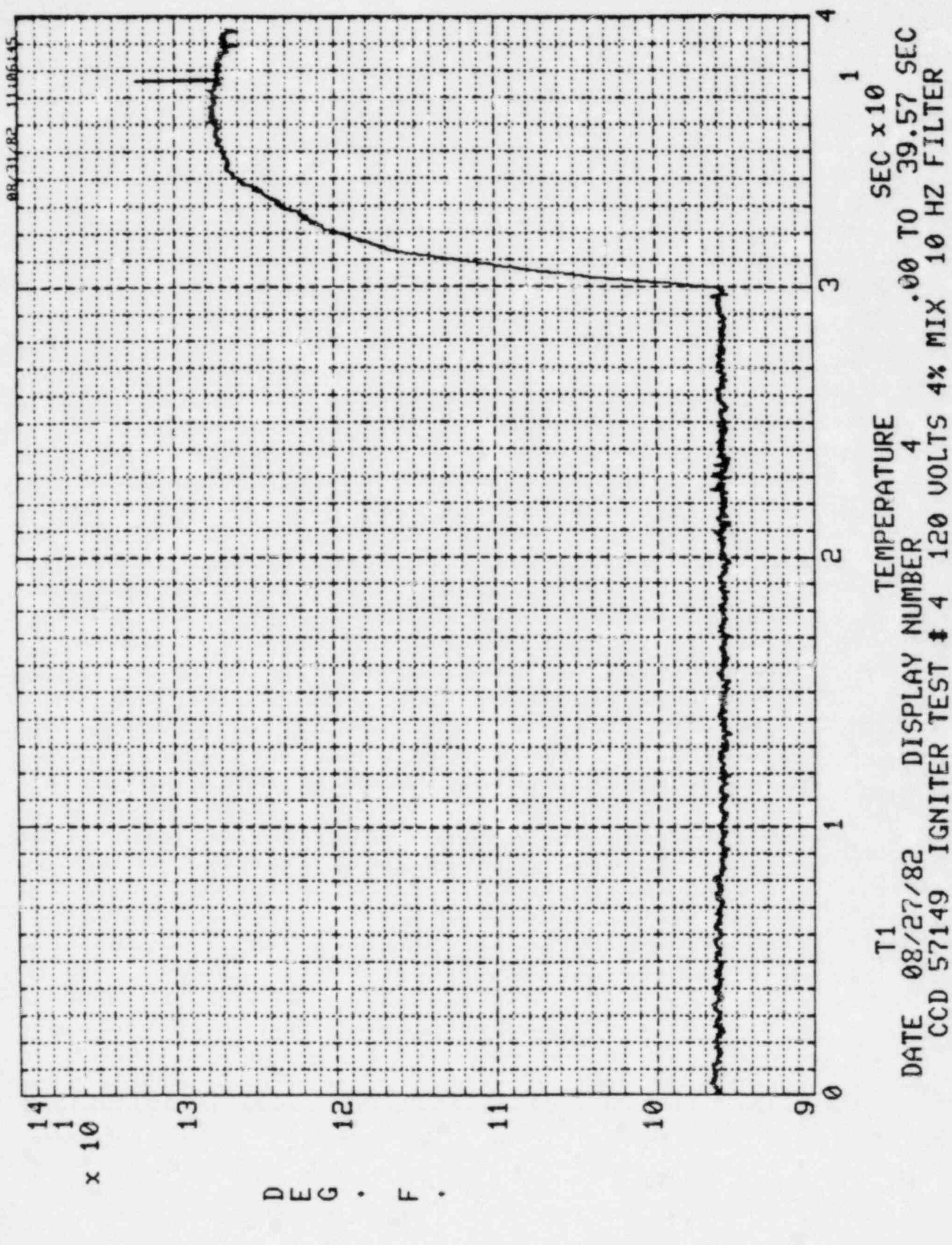

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 3 120 VOLTS 4% MIX 10 HZ FILTER
SEC x10 0
DEG. F.
x 10 2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
0 2 4 6 8 10 12

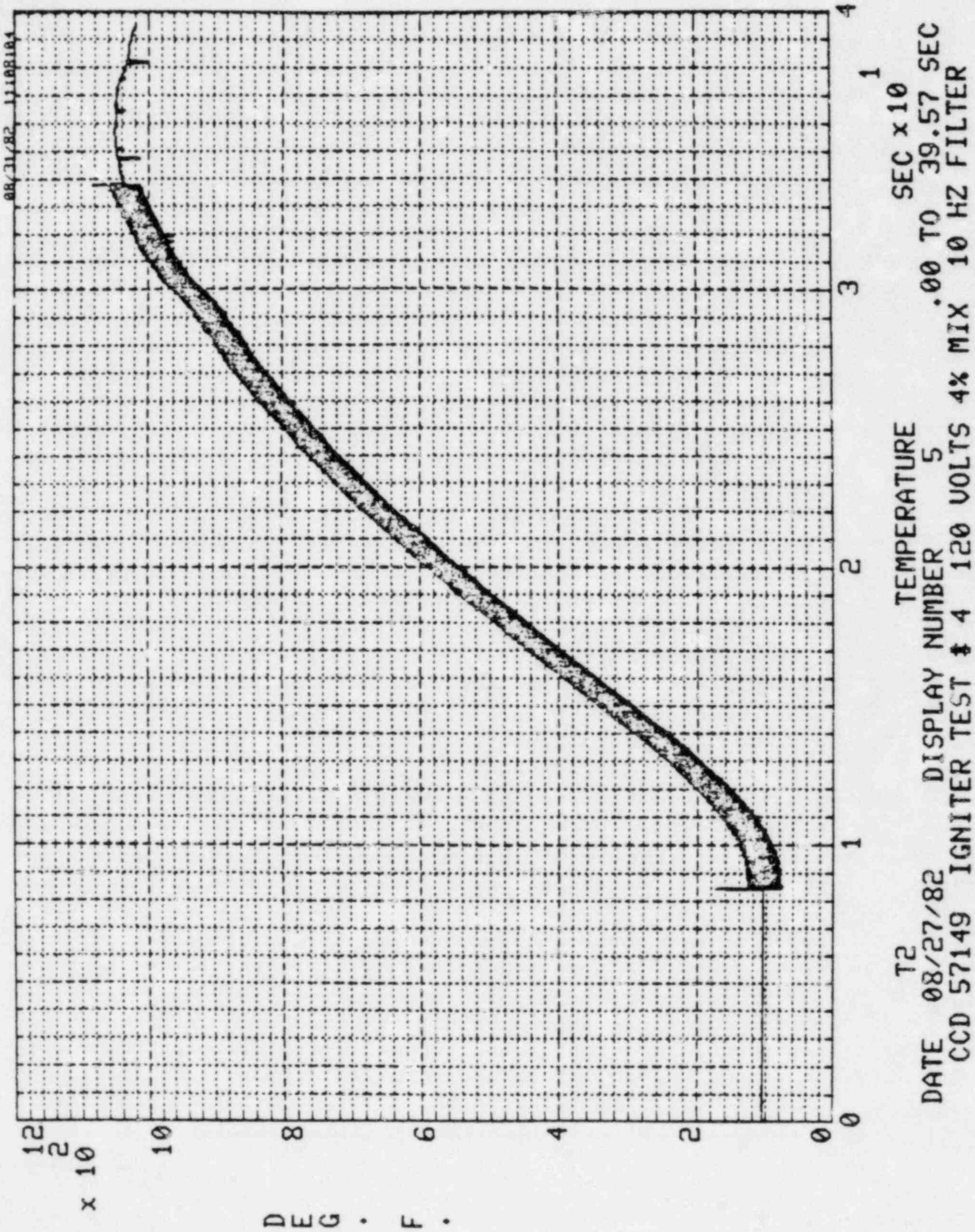

T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 3 120 VOLTS 4% MIX 10 HZ FILTER
SEC x10
0
DEG. F.
x 10
2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
0 1 2 3 4 5 6
08/31/82 11:27:09

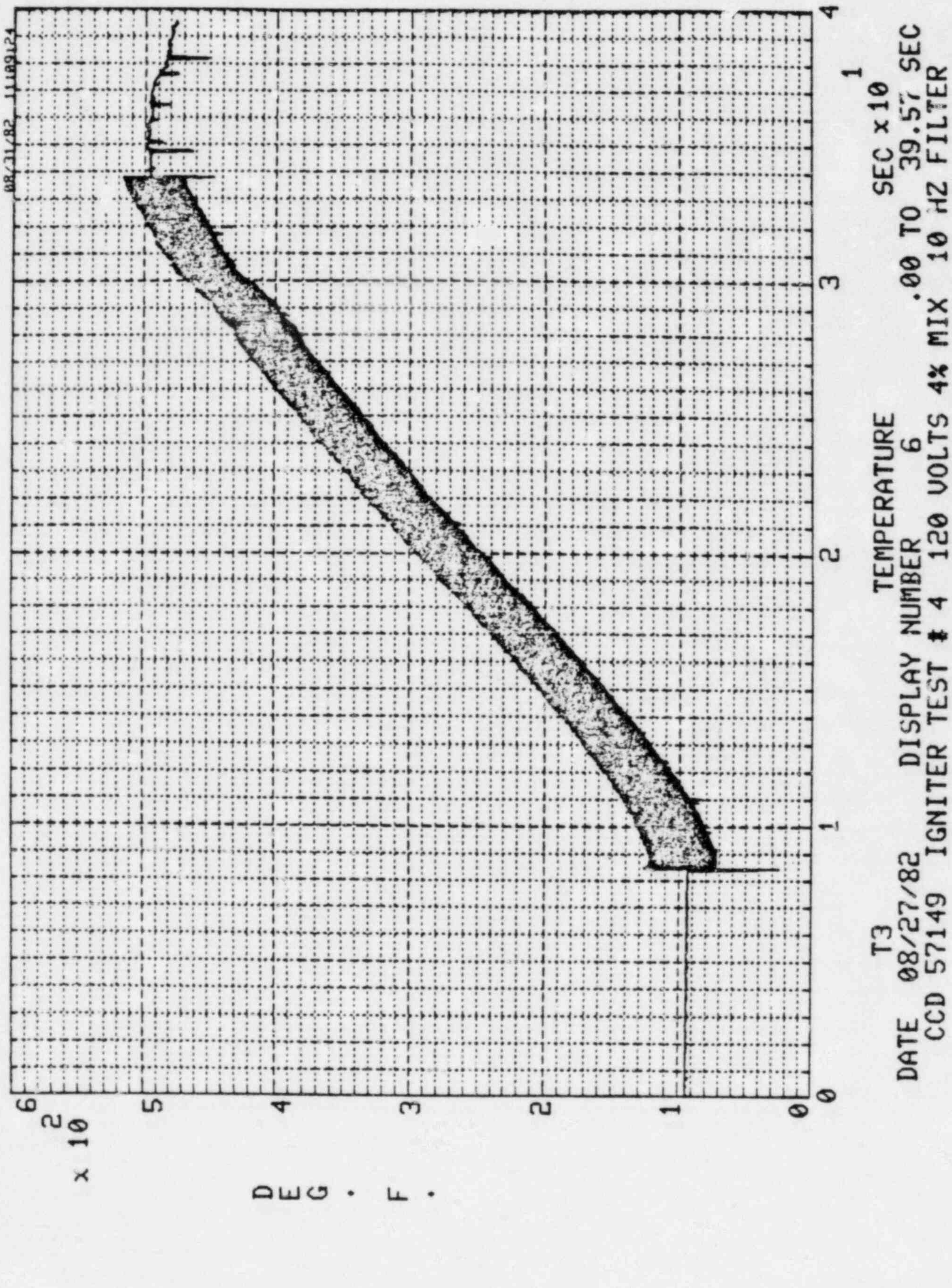

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 4 120 VOLTS 4% MIX
SEC x 10^1
0.00 TO 39.57 SEC
NO FILTER
VOLTS x 10^1
08/31/82 11:08:13

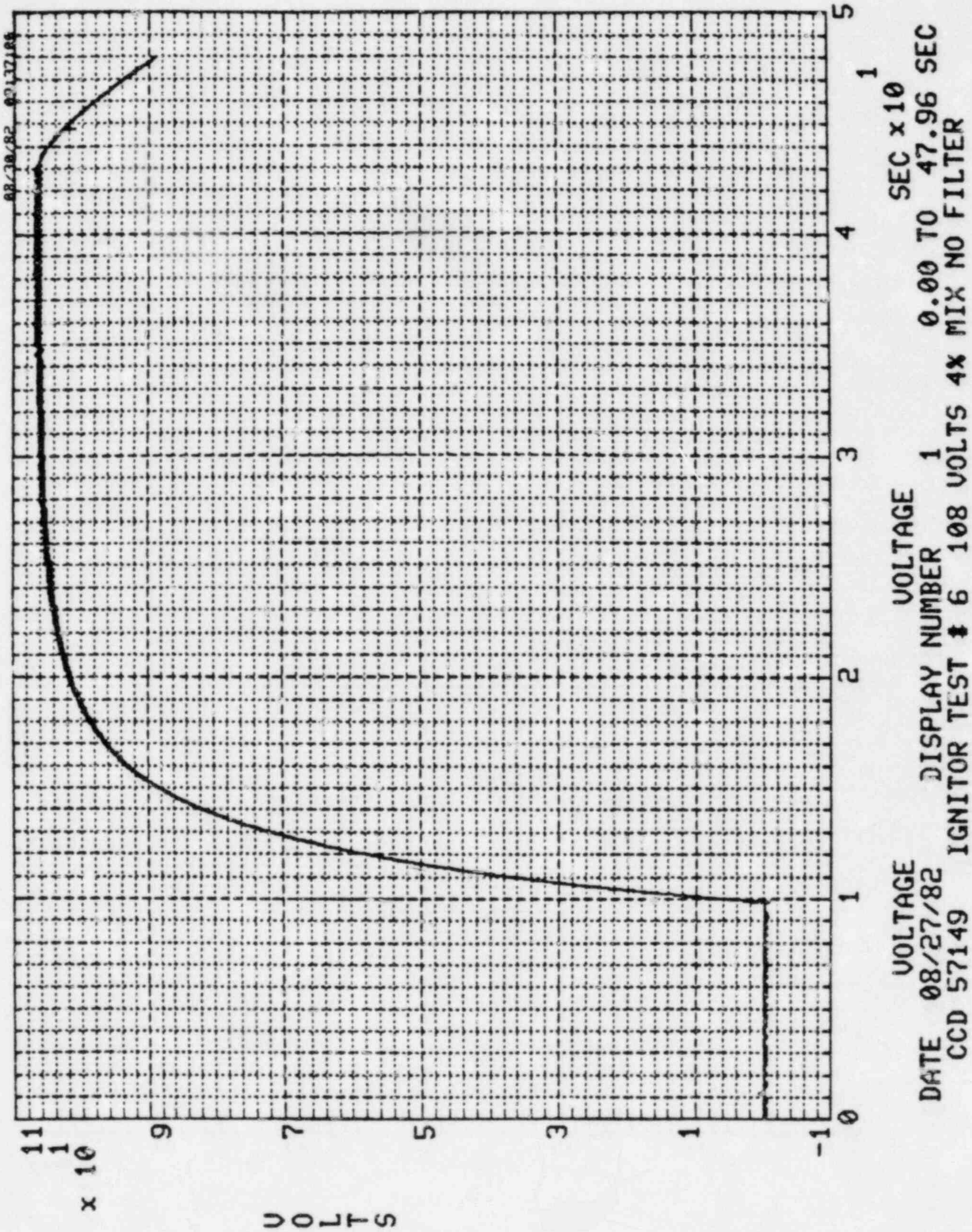

CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 4 120 VOLTS 4% MIX
SEC x10 1
.00 TO 39.57 SEC
NO FILTER
AMPERES
x 10 0
2
1
0
-1
-2
0
1
2
3
4
08/31/82 11:01:31

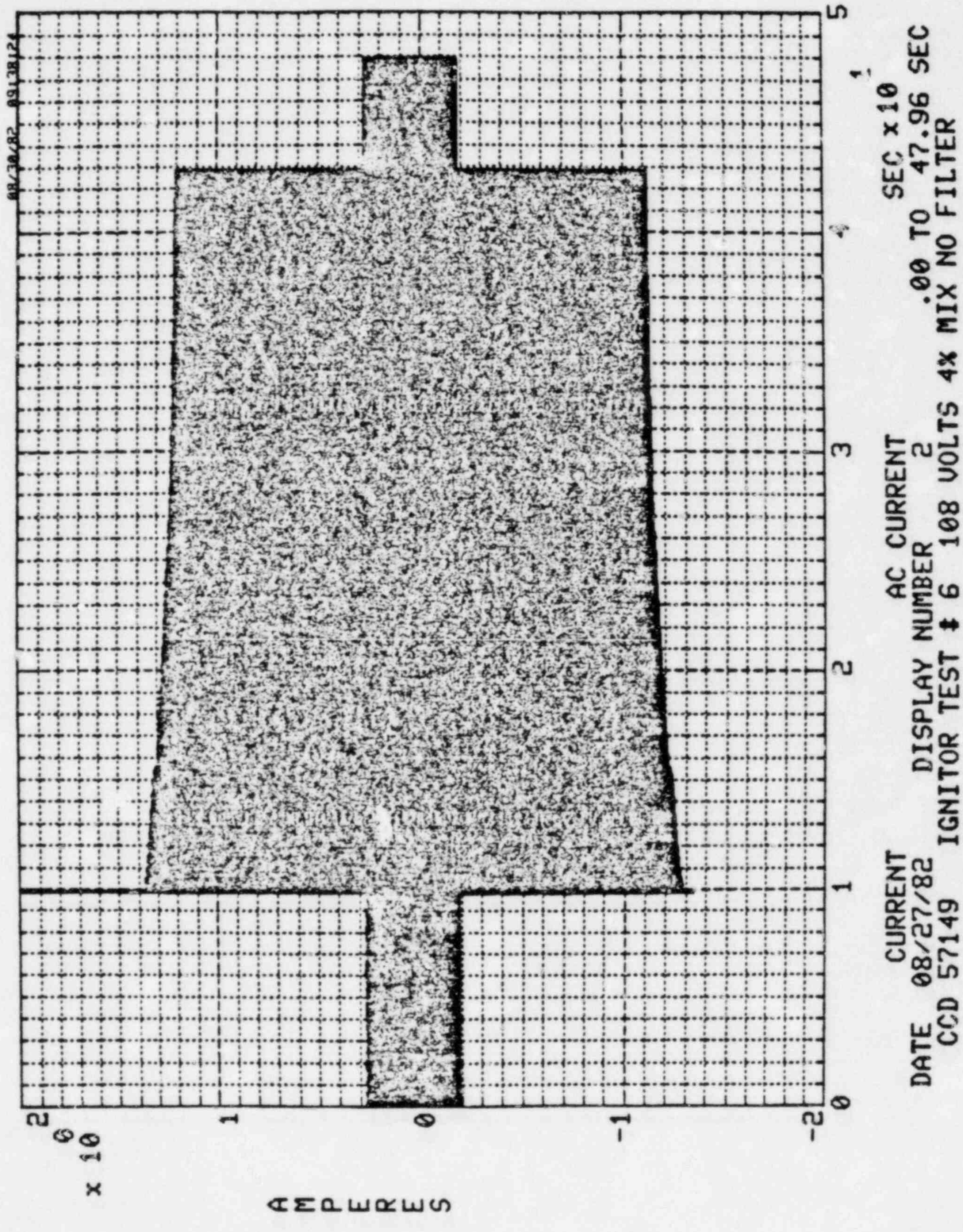

PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 4 120 VOLTS 4% MIX NO FILTER
SEC x 10
PSIG
x 10
-1
12
10
8
6
4
2
0
-2
0
1
2
3
4

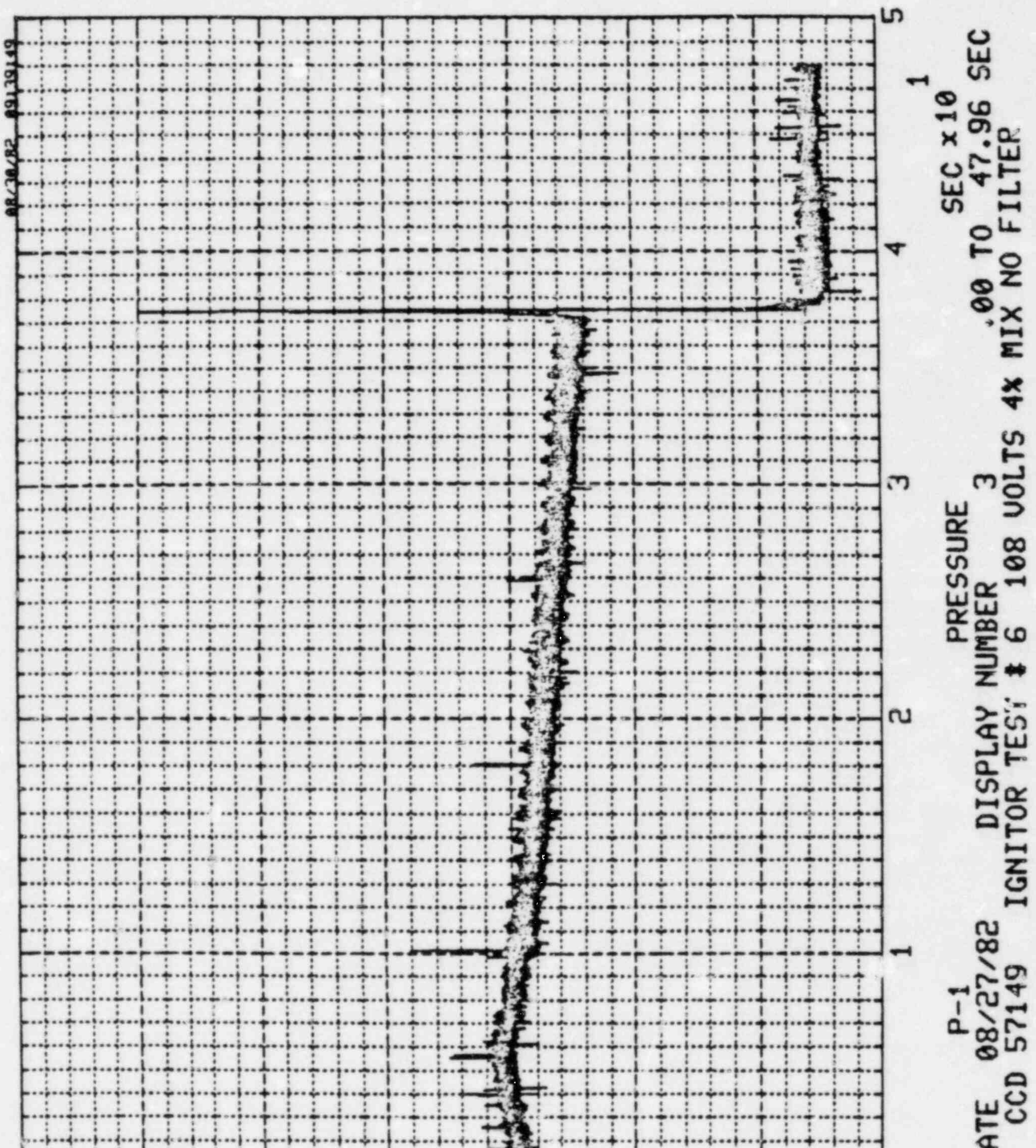

08/31/82 11:06:45
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 4 120 VOLTS 4% MIX .00 TO 39.57 SEC 10 HZ FILTER
SEC x 10^1
0
1
2
3
4
DEG. F. x 10^1
9
10
11
12
13
14

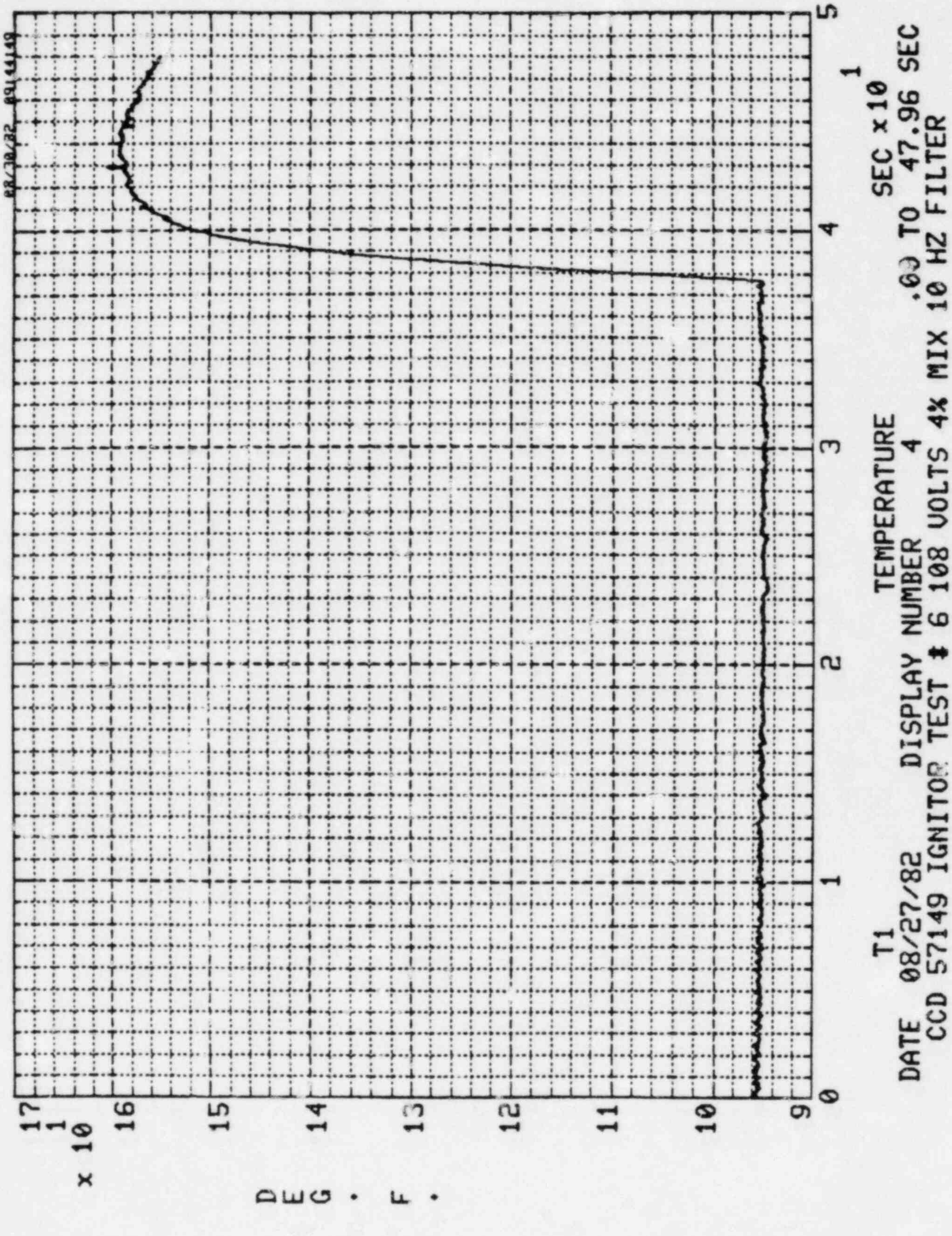

08/31/82 11:08:04
x 10^2
DEG. F.
0 2 4 6 8 10 12
0 1 2 3 4
SEC x 10^1
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 4 120 VOLTS 4% MIX 10 HZ FILTER

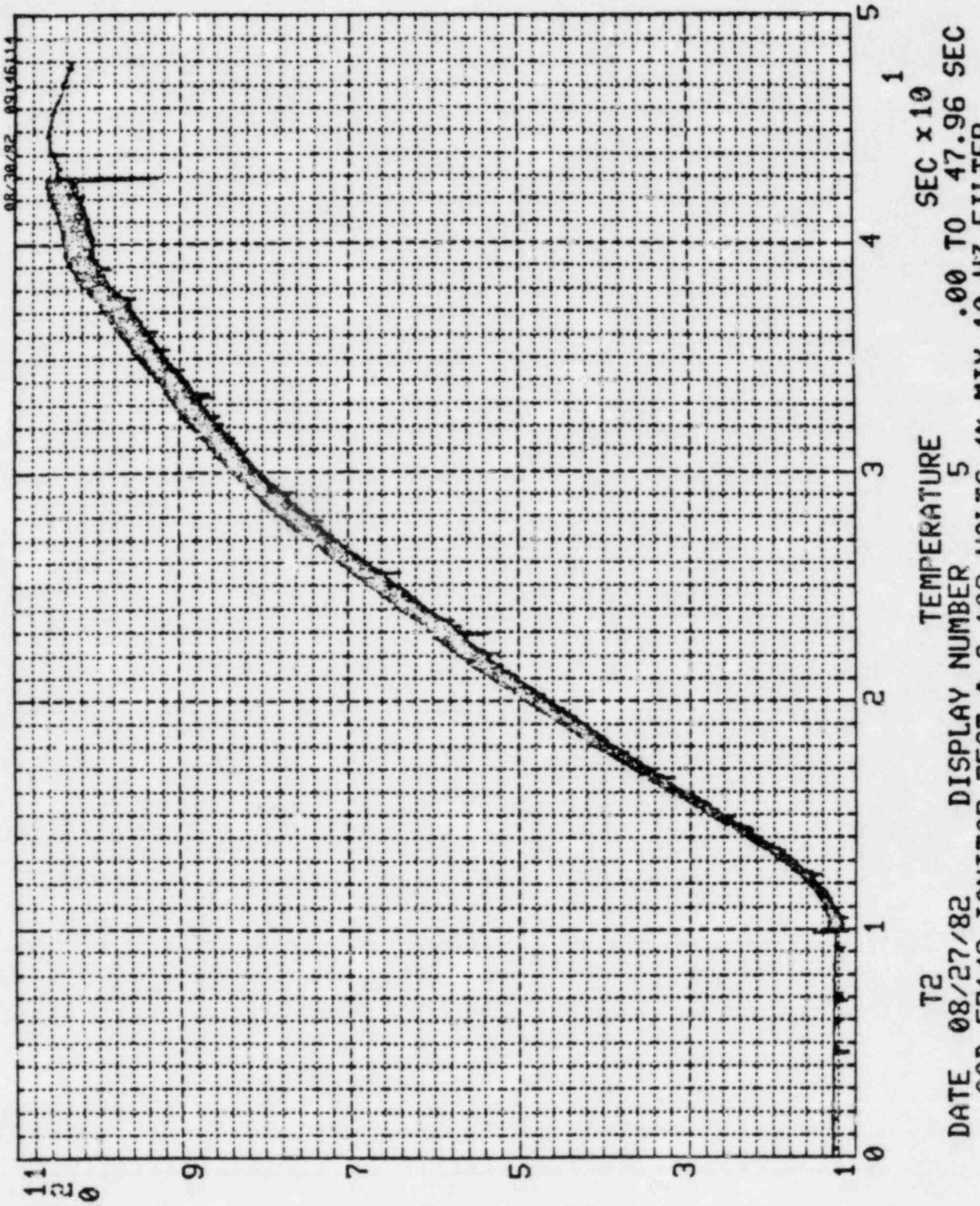

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 4 120 VOLTS 4% MIX .00 TO 39.57 SEC
10 HZ FILTER
SEC x10^1
DEG. F.
x 10^2
0
1
2
3
4
5
6
08/31/82 11:09:24

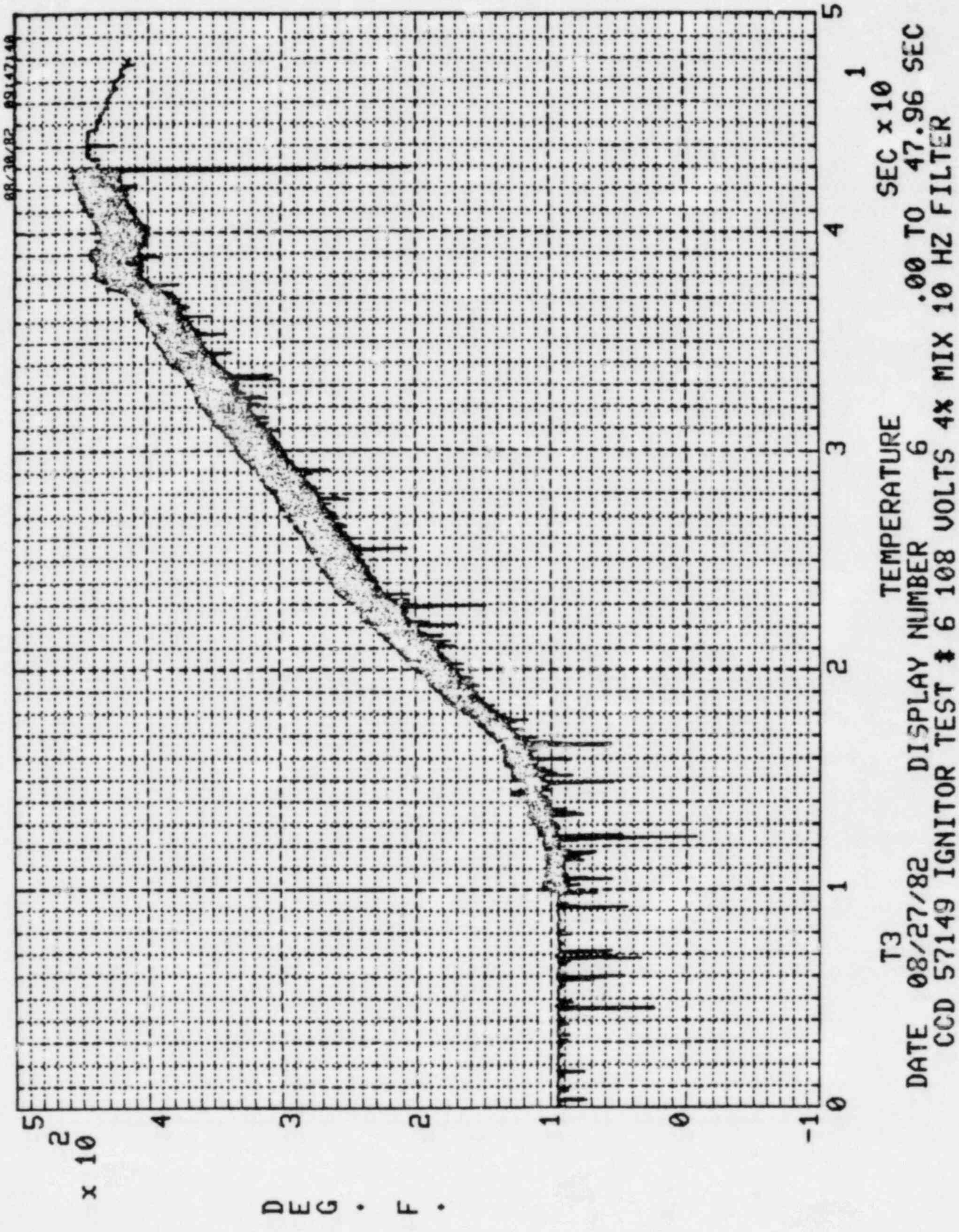

VOLTAGE
VOLTS x 10^1
SEC x 10^1
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 47.96 SEC
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4X MIX NO FILTER
VOLTAGE

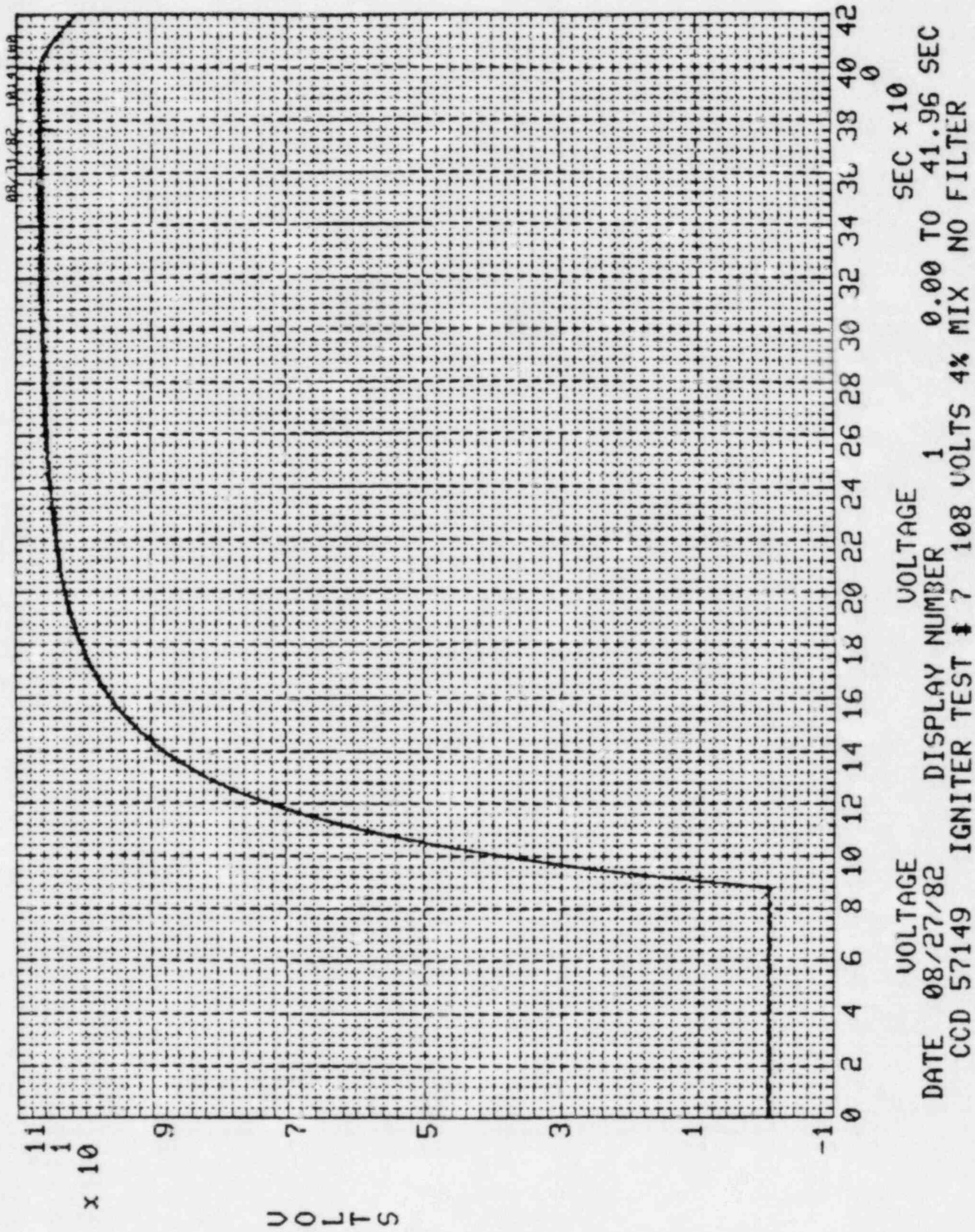

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 47.96 SEC
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4% MIX NO FILTER
SEC x 10 1
AMPERES x 10 0
0
1
2
3
4
5
2
1
0
-1
-2

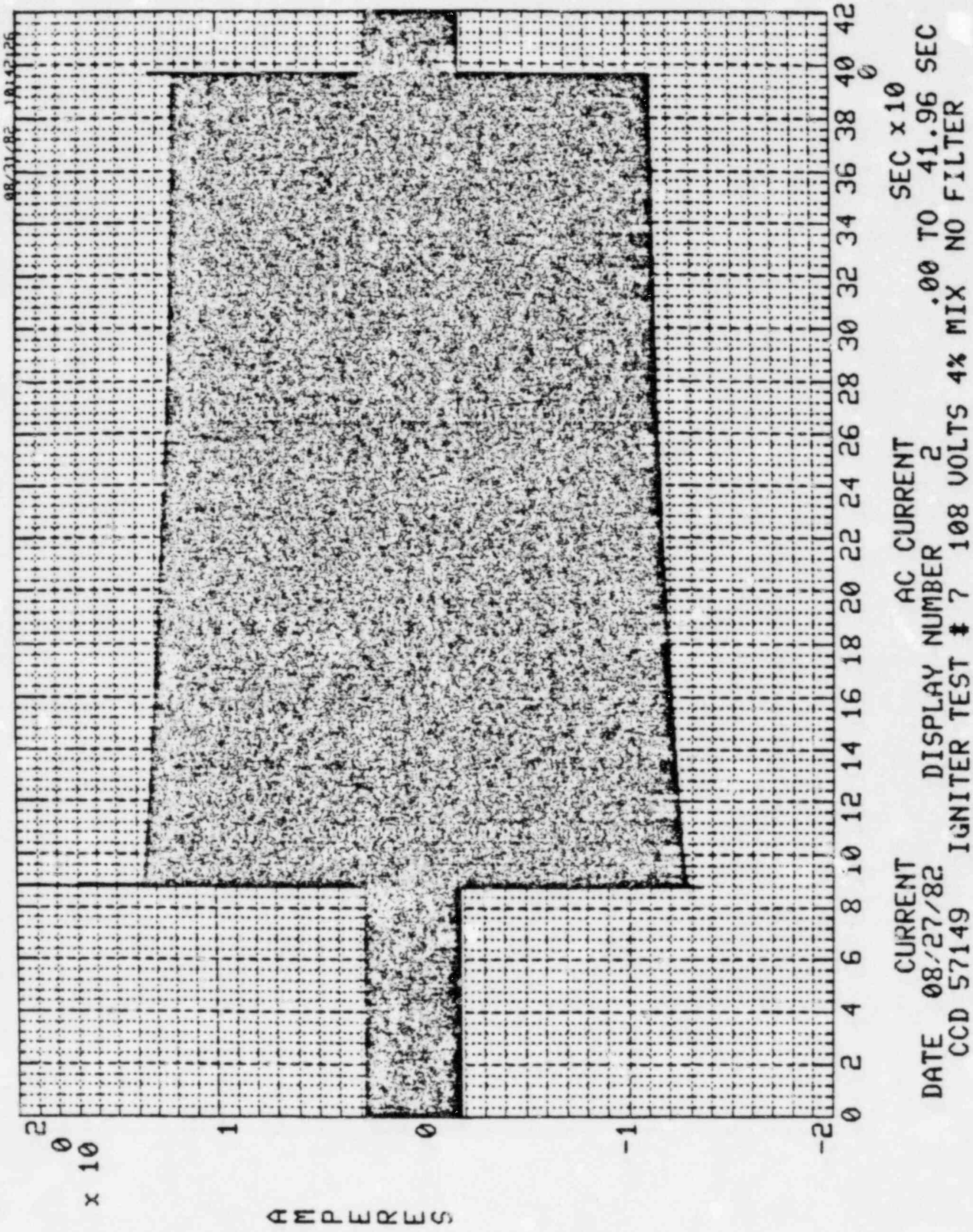

P
S
I
G
x 10
-1
13
11
9
7
5
3
1
-1
0
1
2
3
4
5
SEC x 10
1
PRESSURE
P-1
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 47.96 SEC
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4% MIX NO FILTER

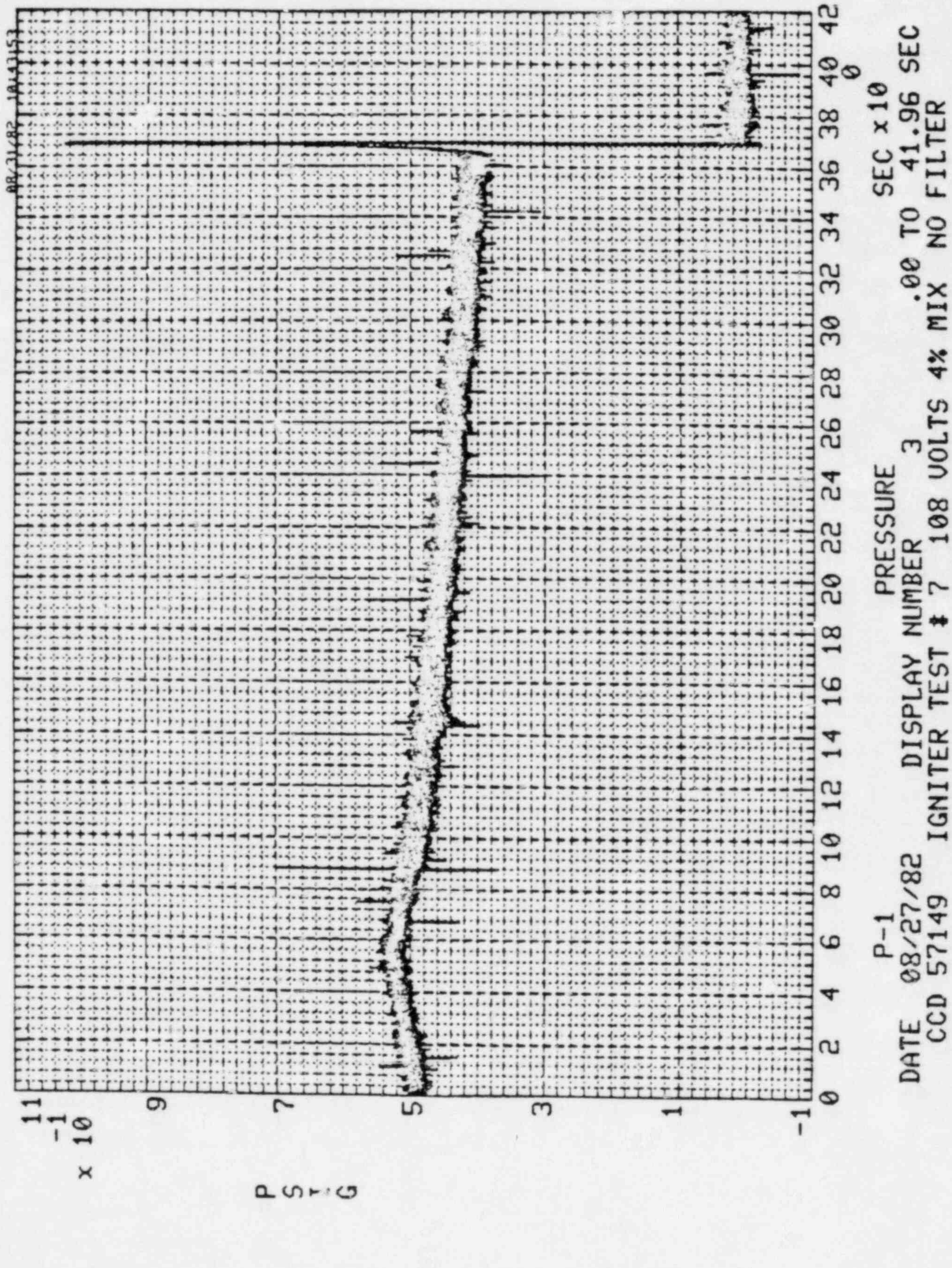

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4% MIX 10 HZ FILTER
.00 TO 47.96 SEC
SEC x10 1
DEG. F. x 10 1
17
16
15
14
13
12
11
10
9
0
1
2
3
4
5

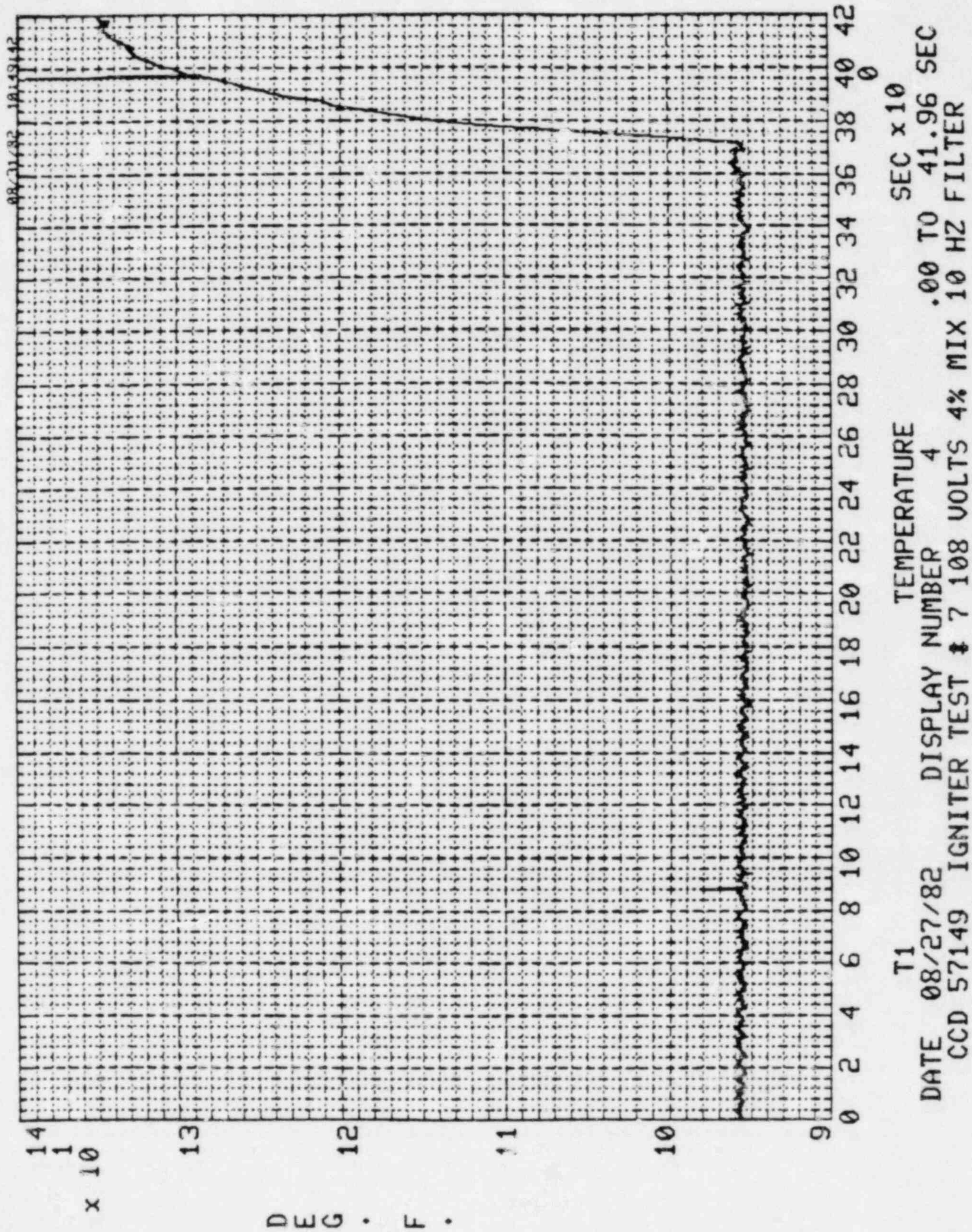

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 47.96 SEC
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4% MIX 10 HZ FILTER
SEC x10
DEG. F. x 10
0 1 2 3 4 5
1 3 5 7 9 11
08/30/82 09:46:14

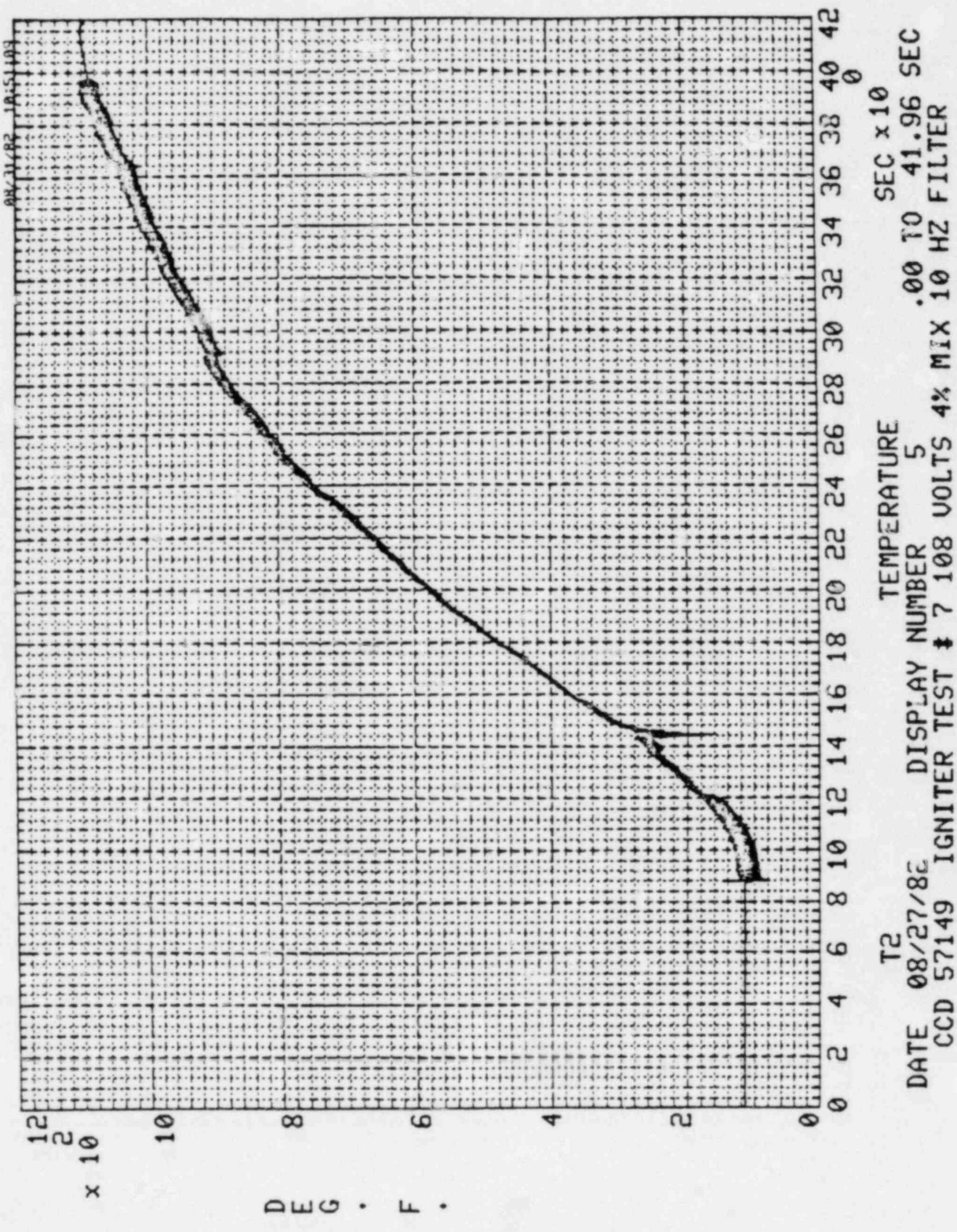

T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 47.96 SEC
CCD 57149 IGNITOR TEST # 6 108 VOLTS 4% MIX 10 HZ FILTER
SEC x 10
1
DEG. F.
x 10
2
0
1
2
3
4
5
-1

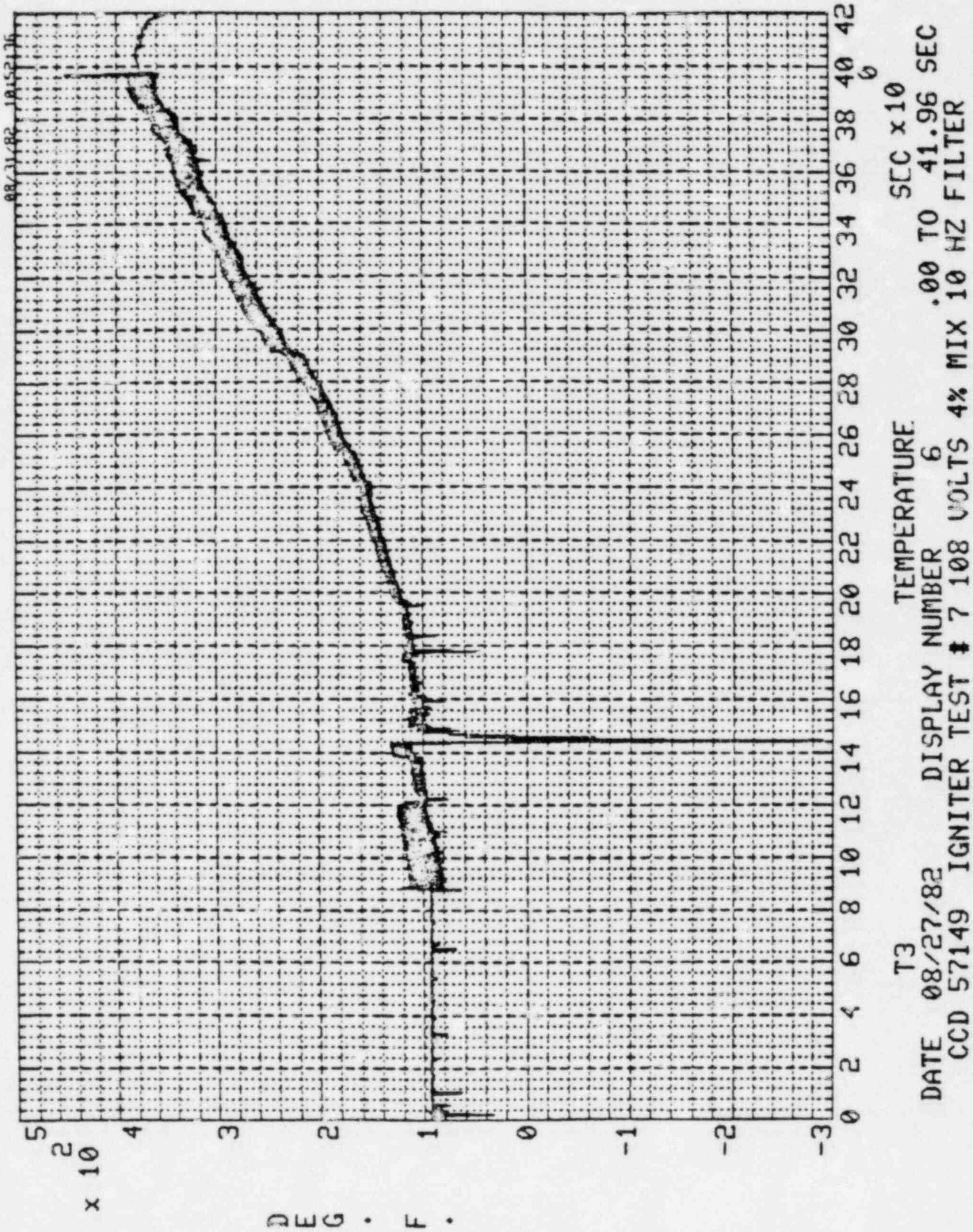

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 7 108 VOLTS 4% MIX
SEC x10
0.00 TO 41.96 SEC
NO FILTER
VOLTS
x 10
11
9
7
5
3
1
-1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42

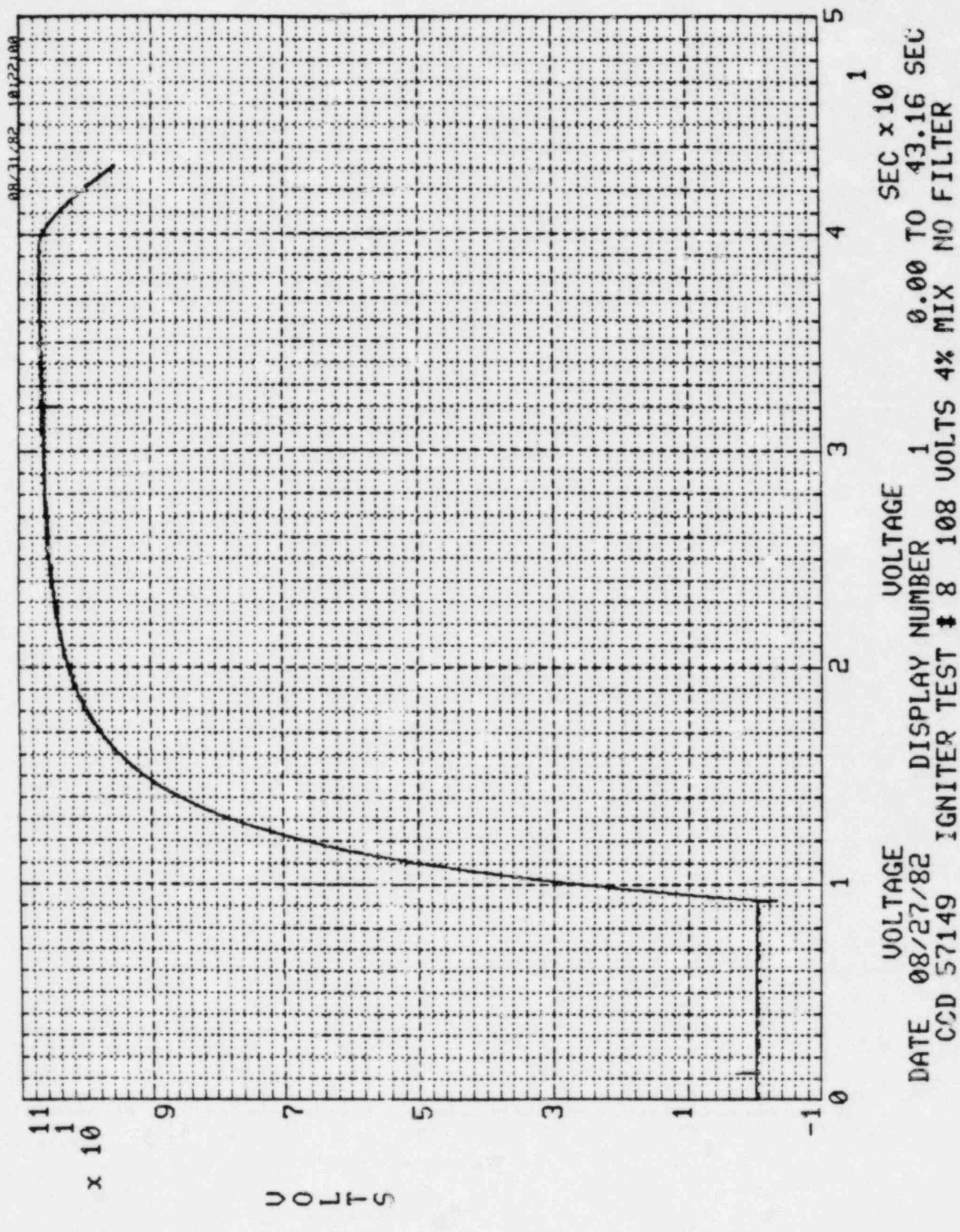

CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 7 108 VOLTS 4% MIX NO FILTER
SEC x10
0
.00 TO 41.96 SEC
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
2 1 0 -1 -2
x 10
0
AMPERES

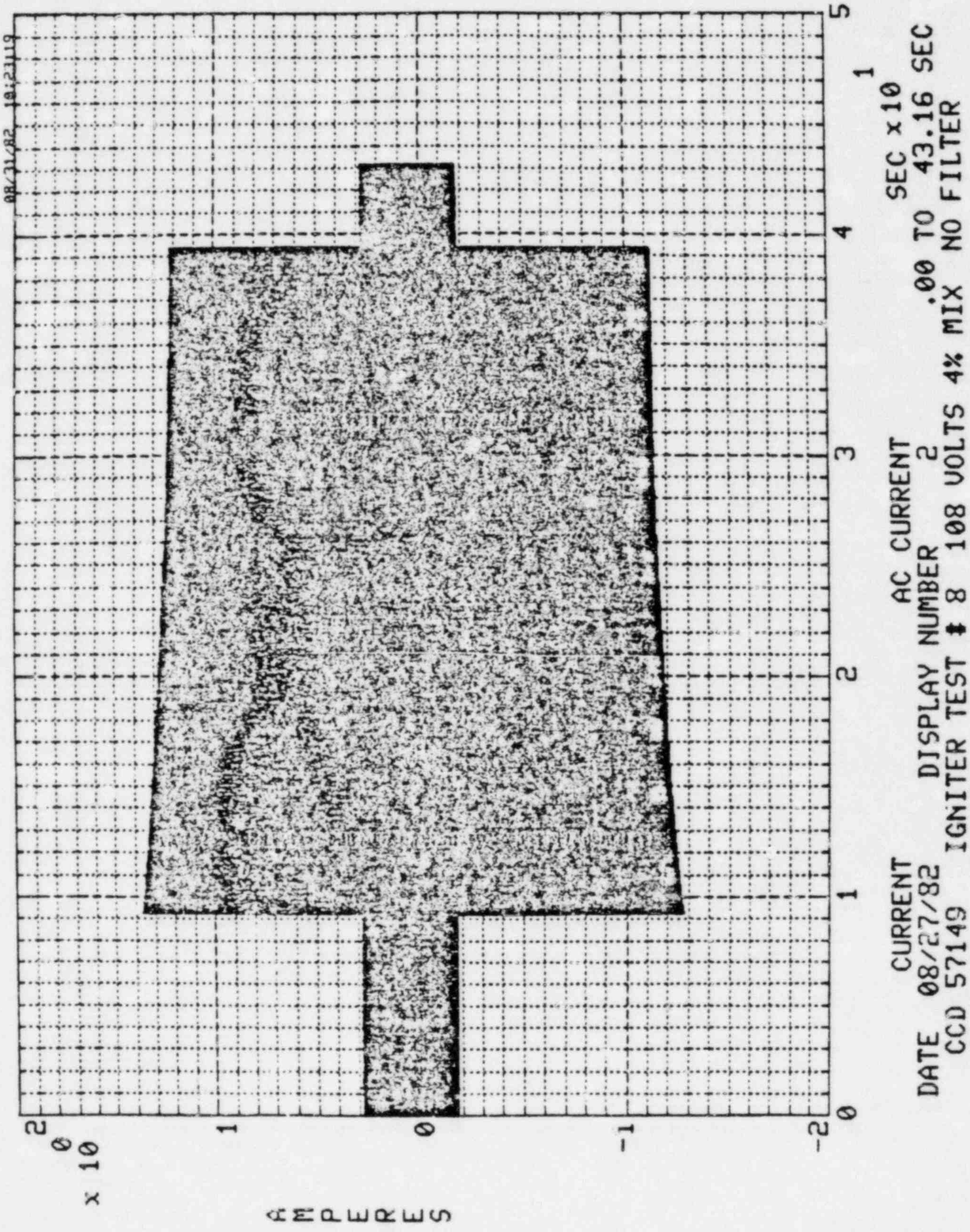

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 7 108 VOLTS 4% MIX NO FILTER
SEC x 10^0
PSIG x 10^-1

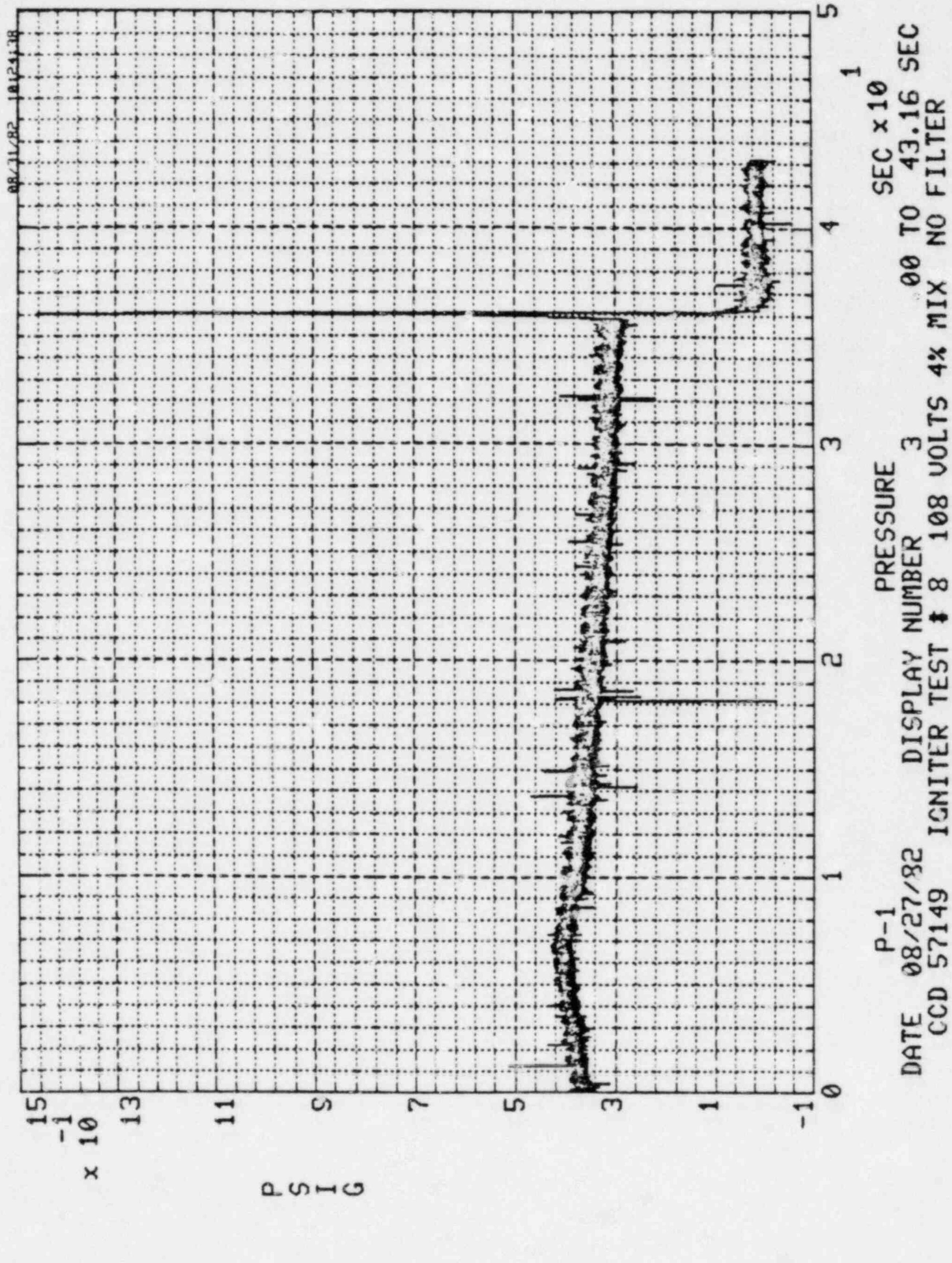

14
13
12
11
10
9
x 10 1
DEG. F.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
SEC x10 0
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 7 108 VOLTS 4% MIX 10 HZ FILTER

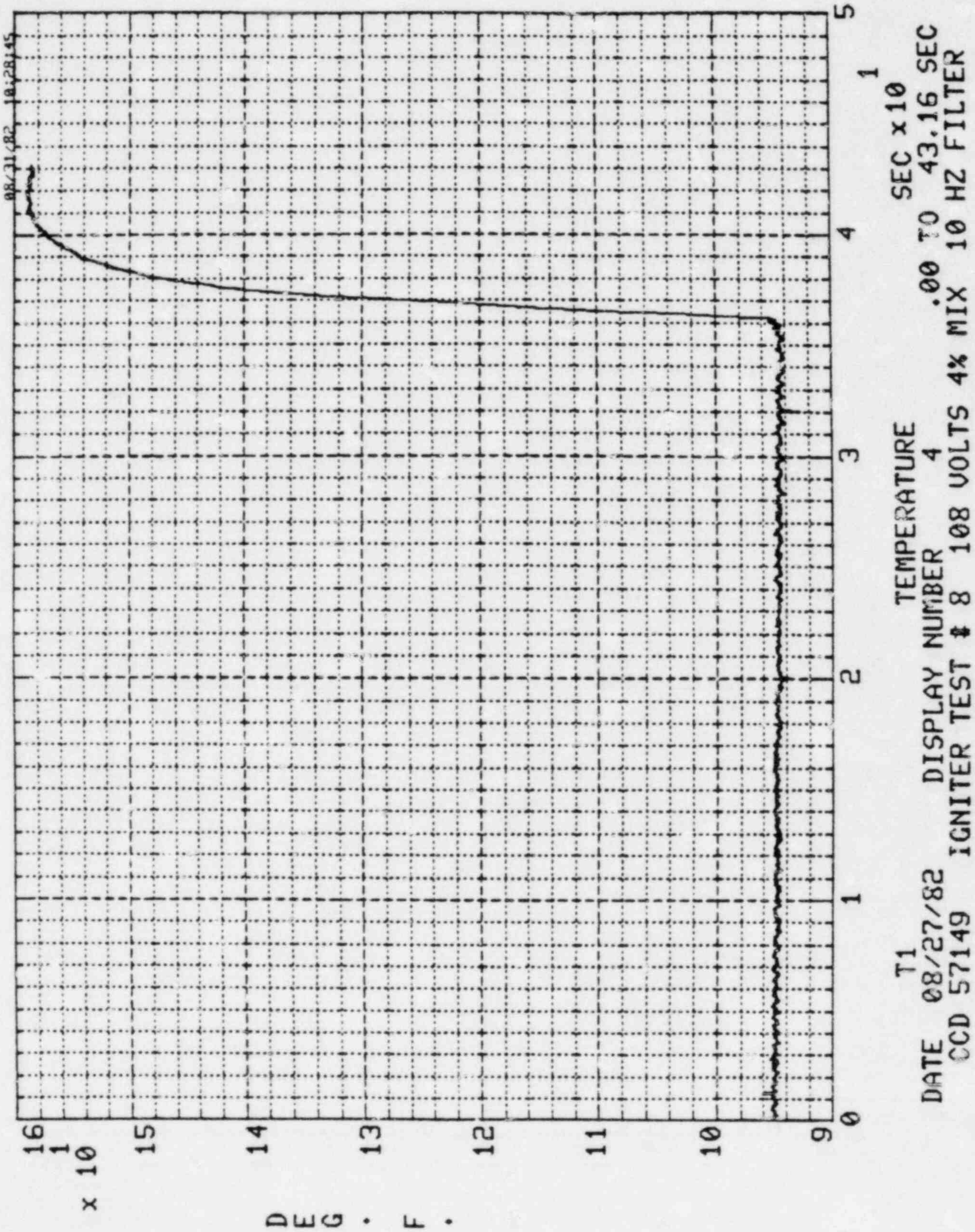

T2 TEMPERATURE SEC x 10
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 7 108 VOLTS 4% MIX 10 HZ FILTER
x 10
2
DEG. F.
0 2 4 6 8 10 12
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42

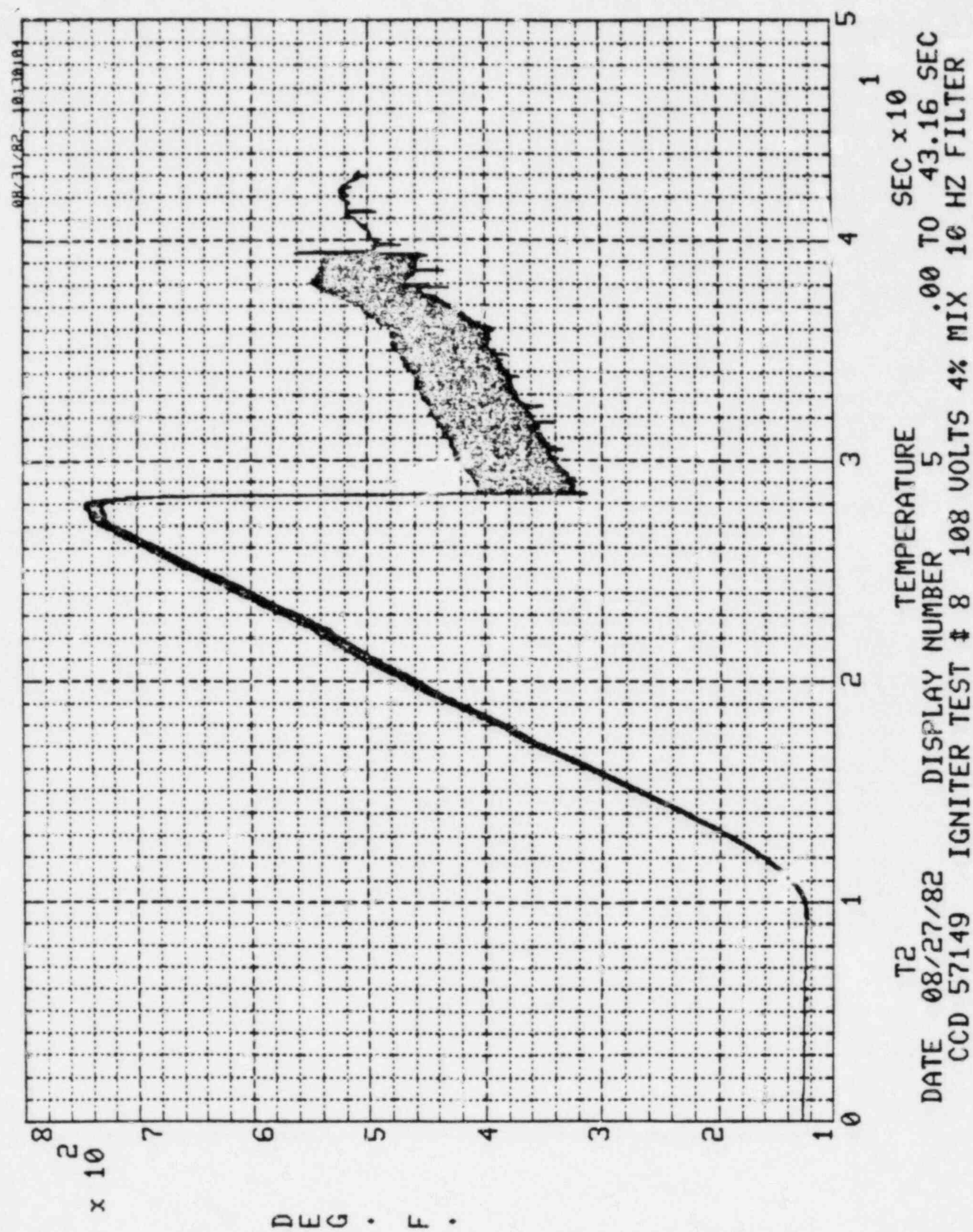

5
4
3
2
1
0
-1
-2
-3
x 10^2
DEG. F.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
SEC x10^0
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 7 108 VOLTS 4% MIX 10 HZ FILTER

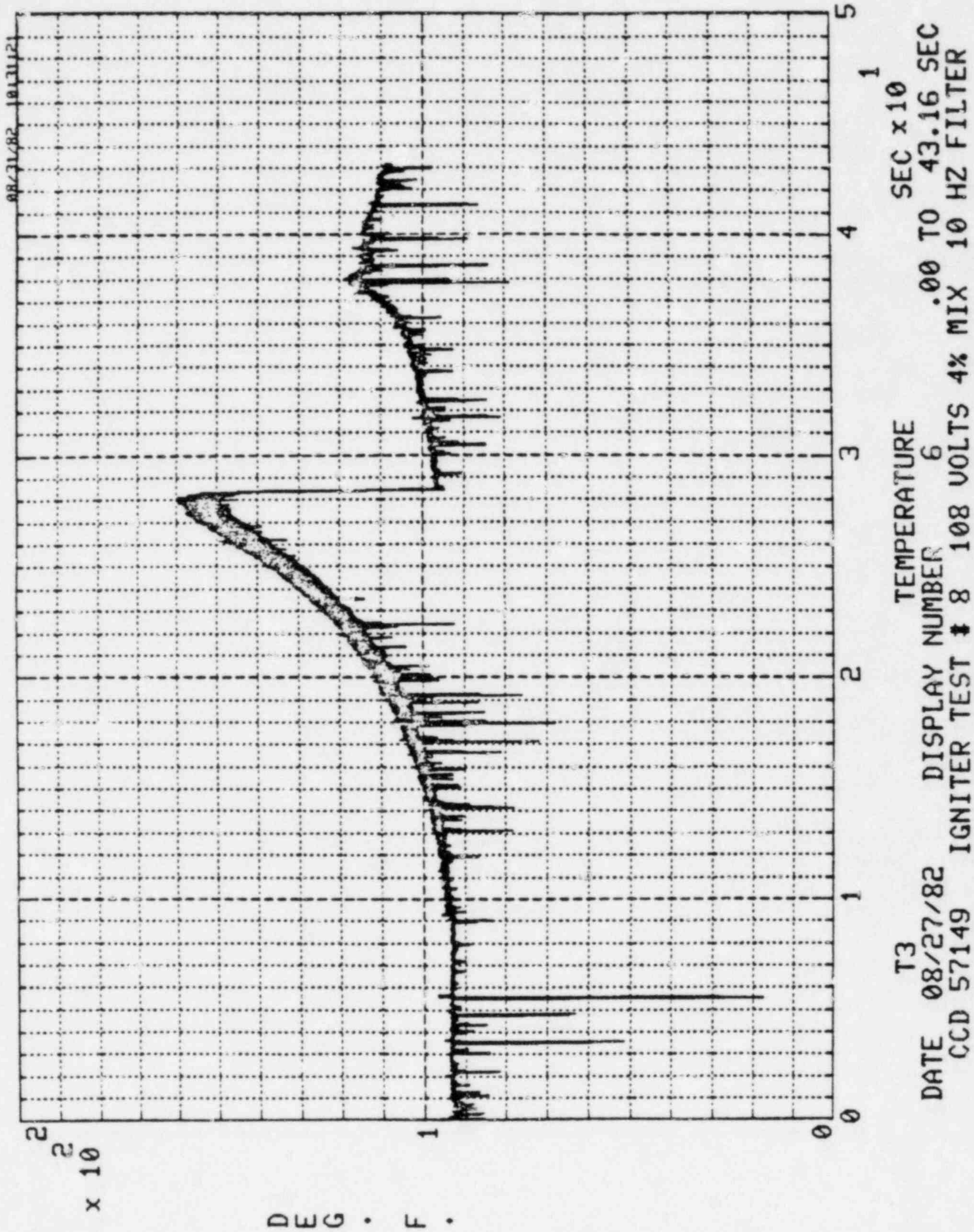

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 8 108 VOLTS 4% MIX NO FILTER
0.00 TO 43.16 SEC
SEC x 10^1
VOLTS x 10^1
-1
1
3
5
7
9
11
0
1
2
3
4
5

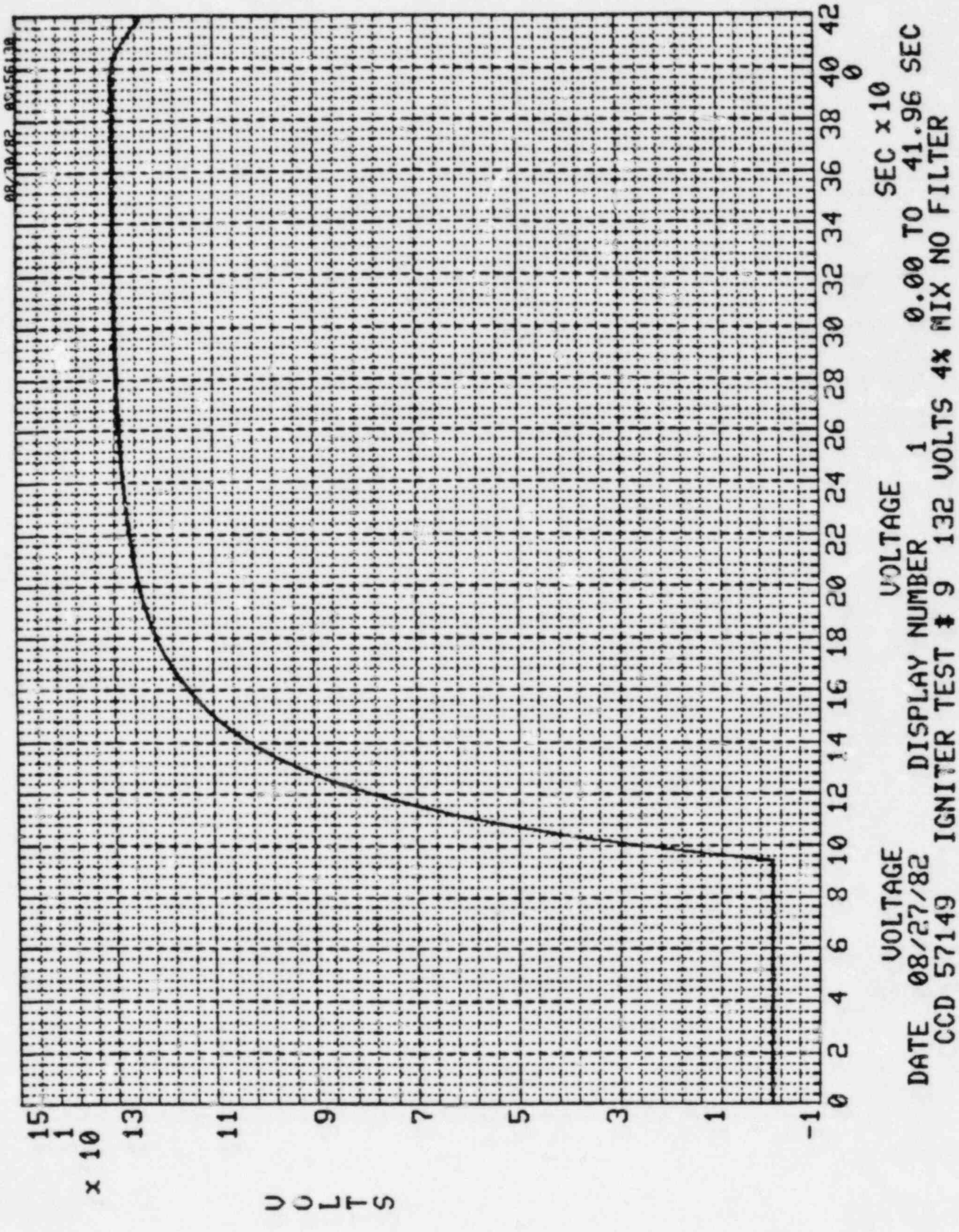

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 8 108 VOLTS 4% MIX NO FILTER
SEC x 10 1
AMPERES
x 10 0
0
1
2
3
4
5
-2
-1
0
1
2

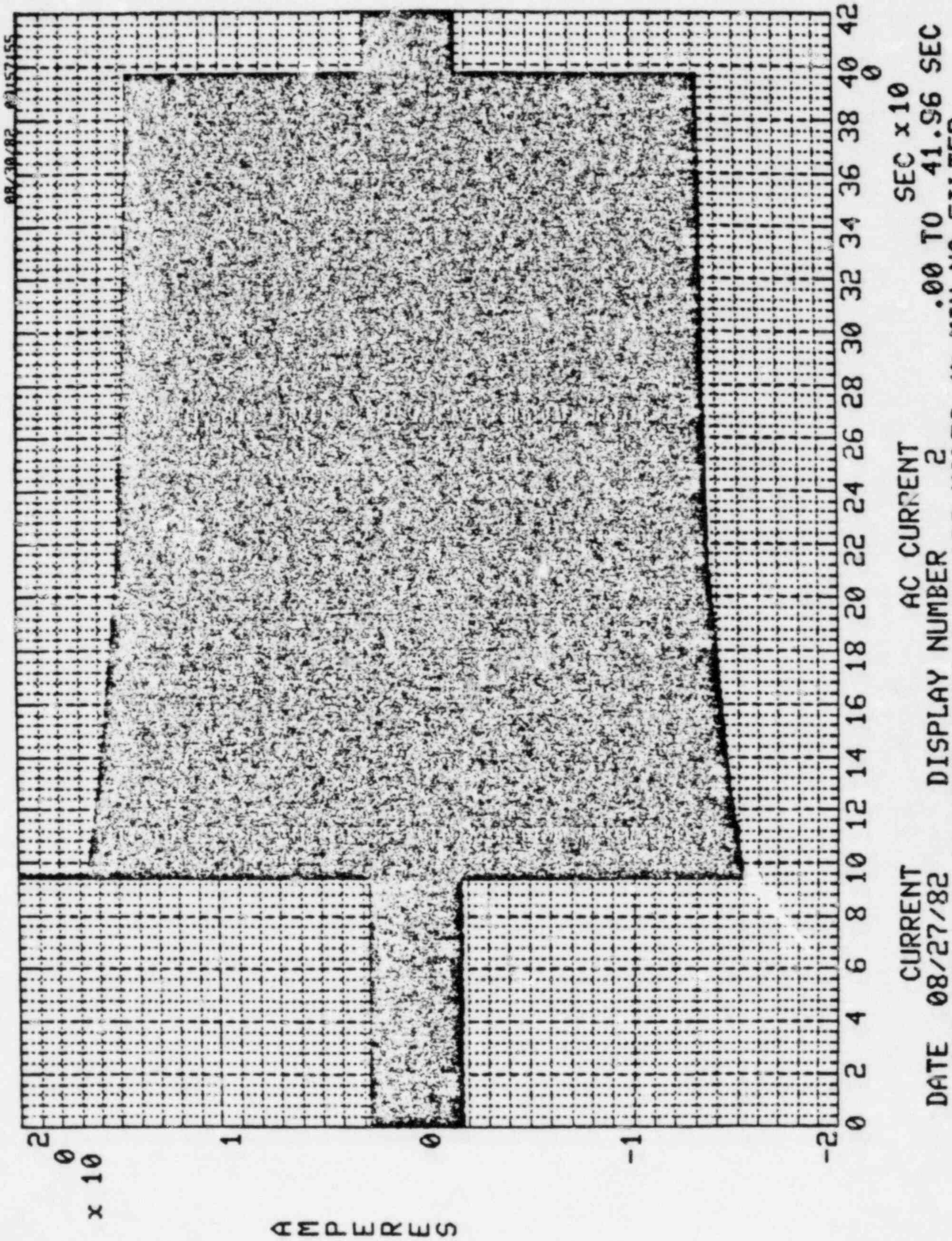

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 8 108 VOLTS 4% MIX NO FILTER
SEC x10 1
PSIG
x 10 -1
15
13
11
9
7
5
3
1
-1
0
1
2
3
4
5

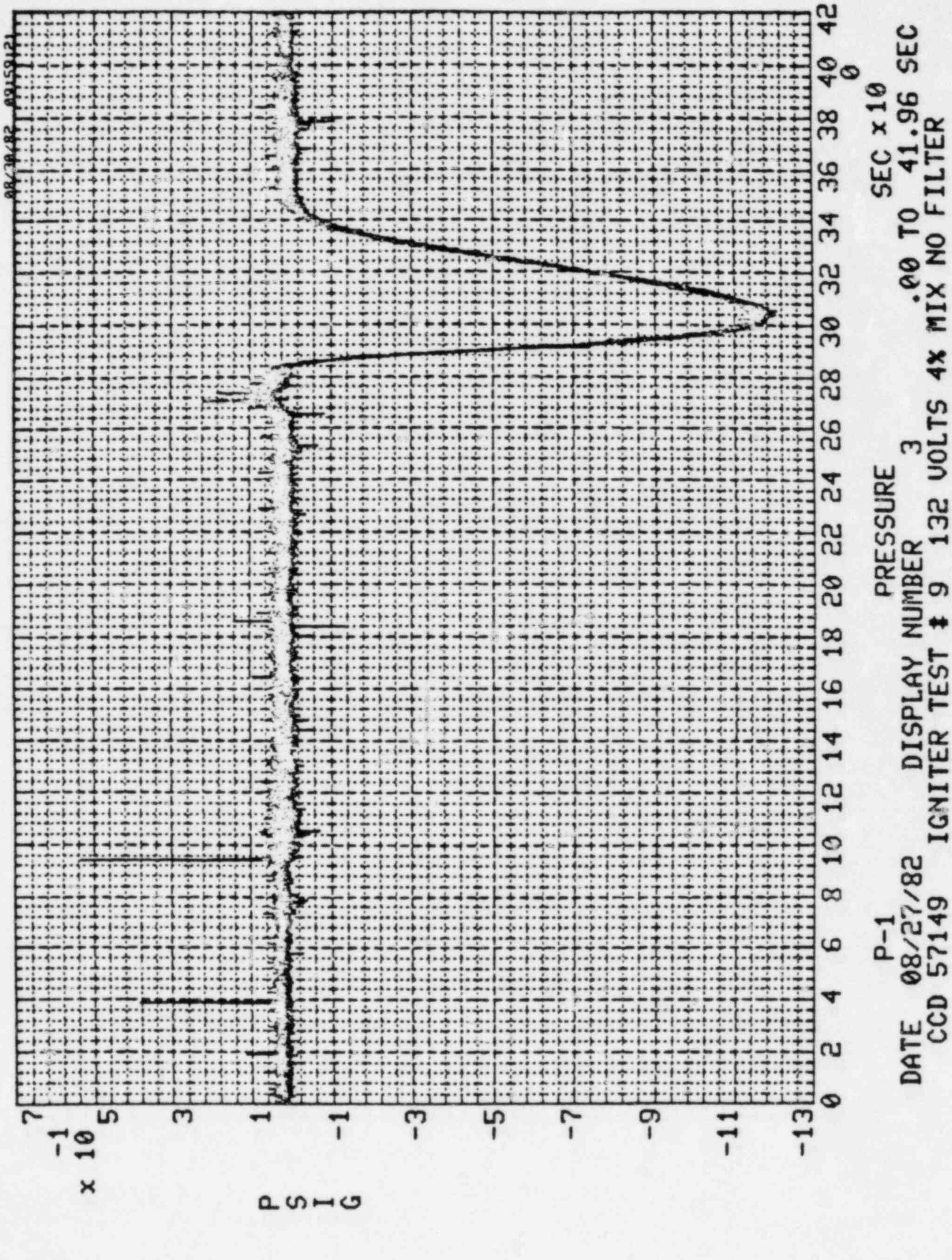

08/31/82 10:28:15
DEG. F x 10 1
SEC x 10 1
TEMPERATURE
T1
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 8 108 VOLTS 4% MIX .00 TO 43.16 SEC 10 HZ FILTER

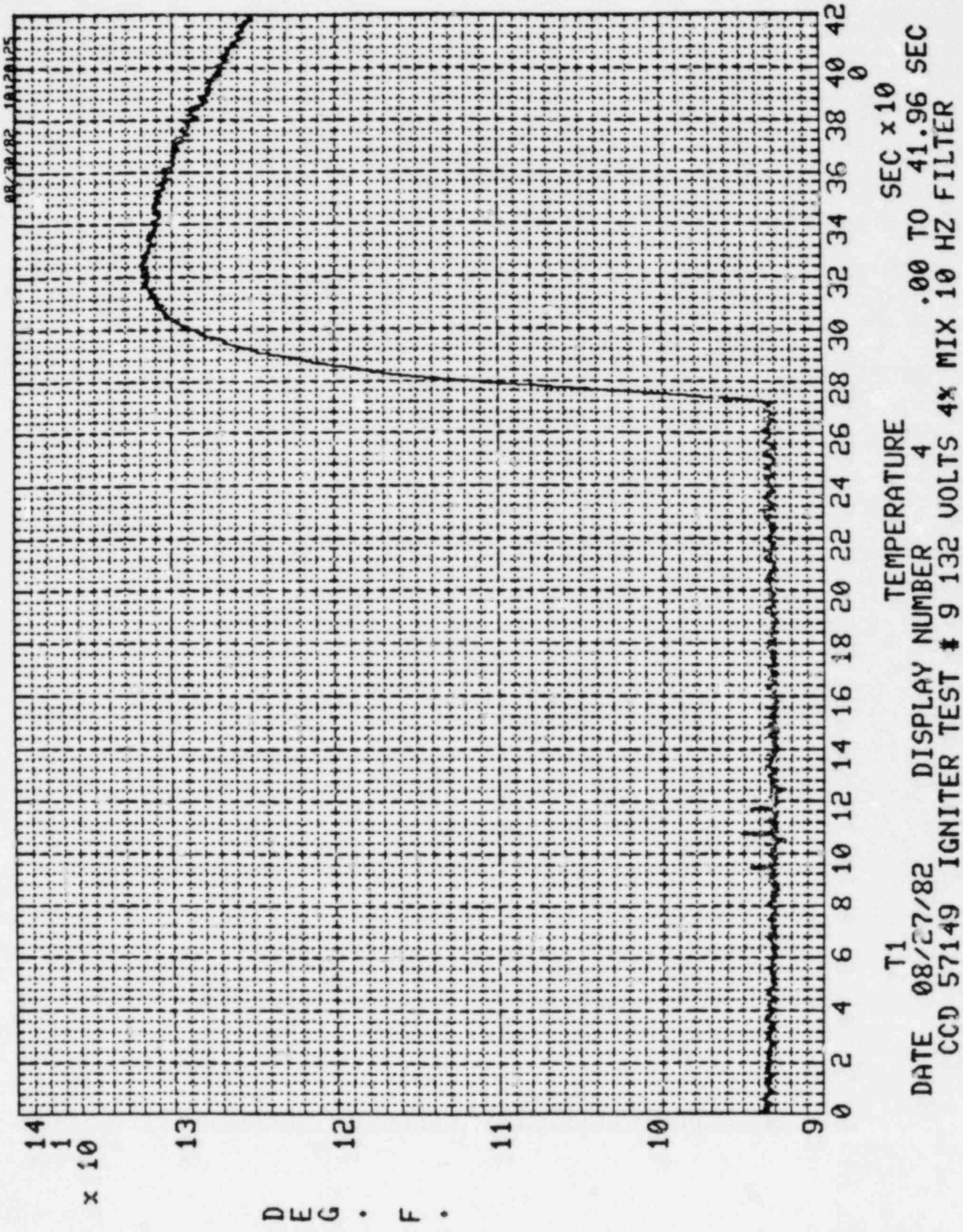

08/31/82 10:30:04
x 10^2
DEG. F.
0
1
2
3
4
5
6
7
8
SEC x10^1
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 8 108 VOLTS 4% MIX 10 HZ FILTER

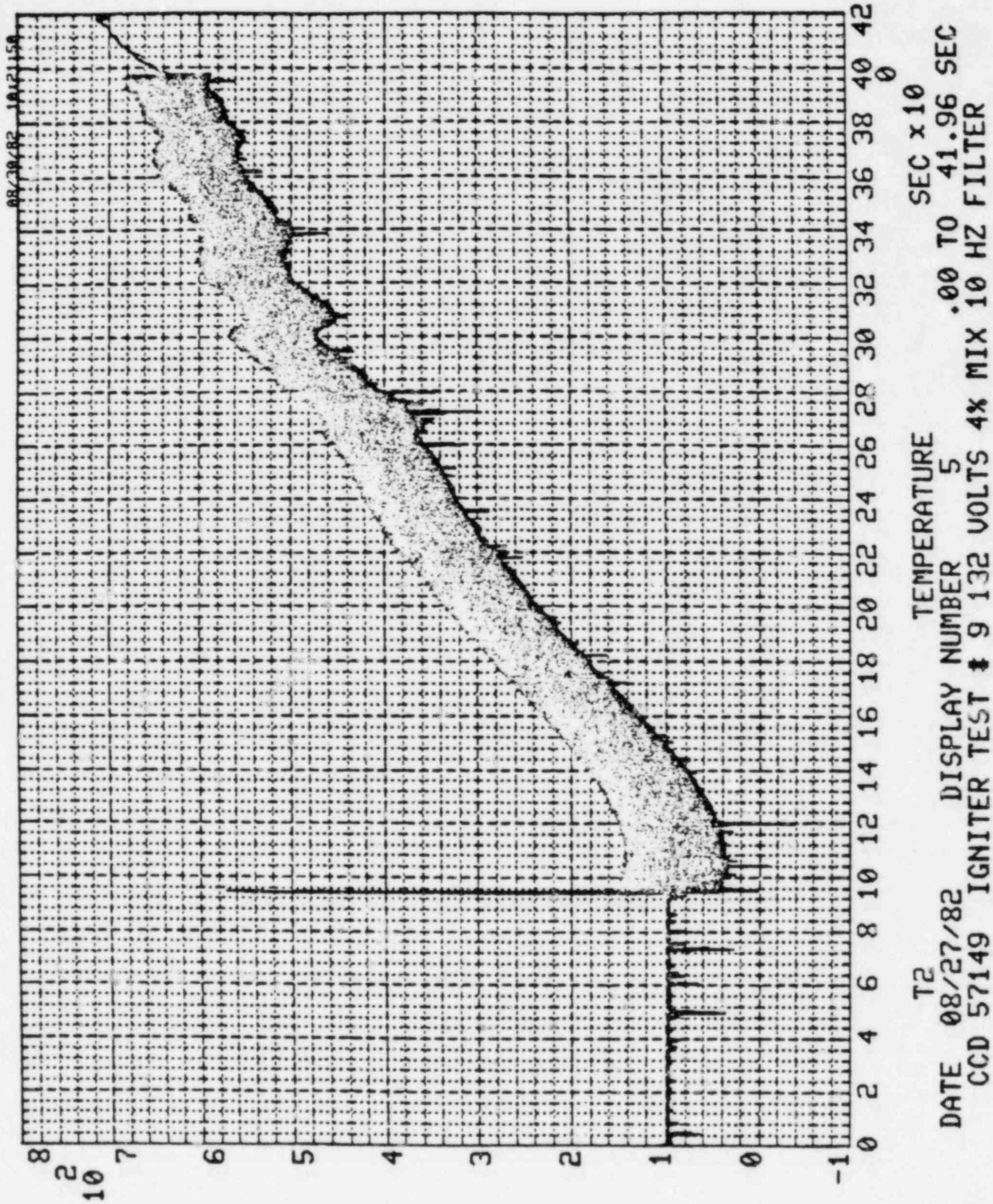

08/31/82 10:31:21
T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 8 108 VOLTS 4% MIX 10 HZ FILTER
SEC x10 1
0
1
2
3
4
5
D E G . F .
x 10 2
0
1
2

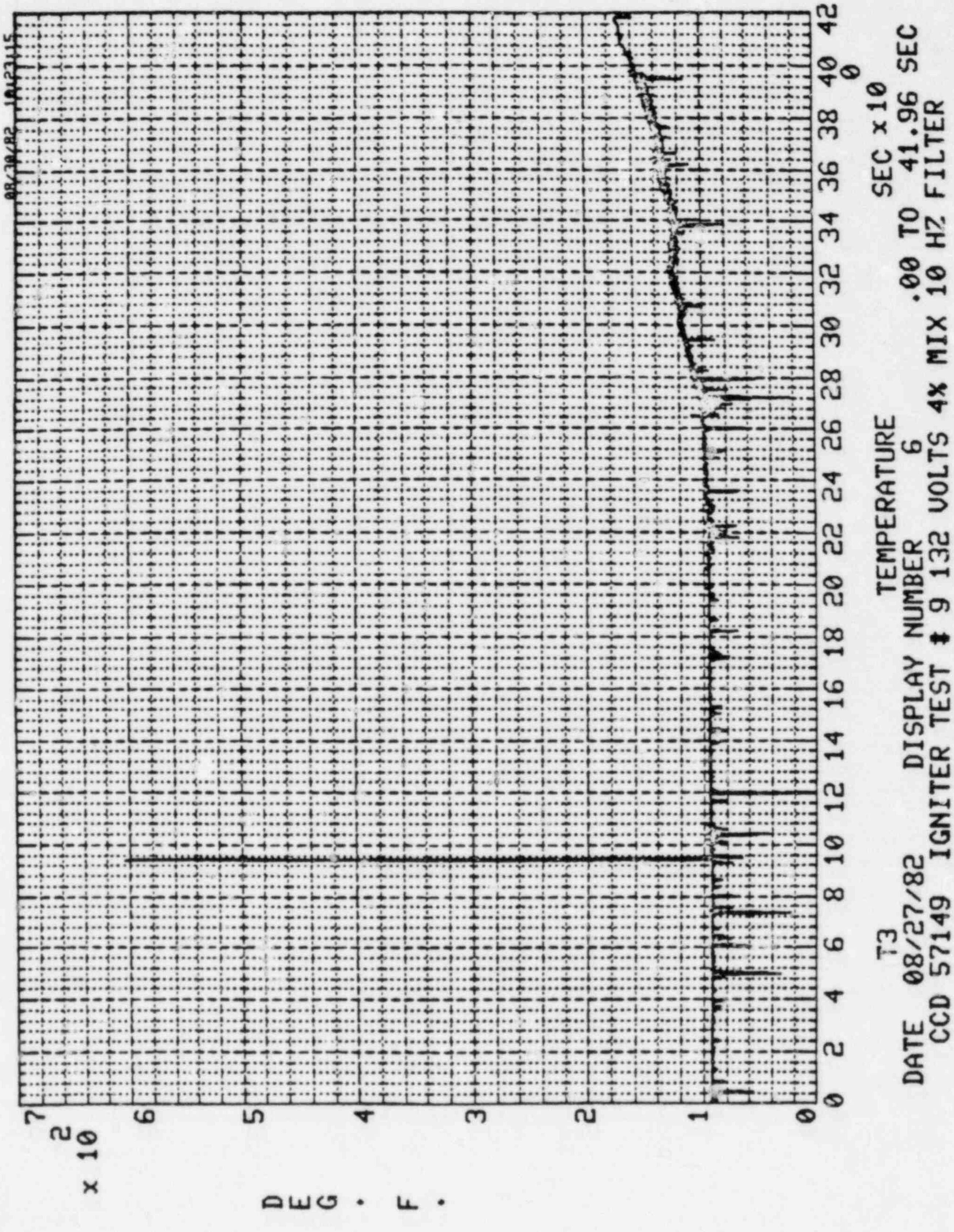

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 9 132 VOLTS 4% MIX NO FILTER
SEC x10
0.00 TO 41.96 SEC
VOLTS
x 10

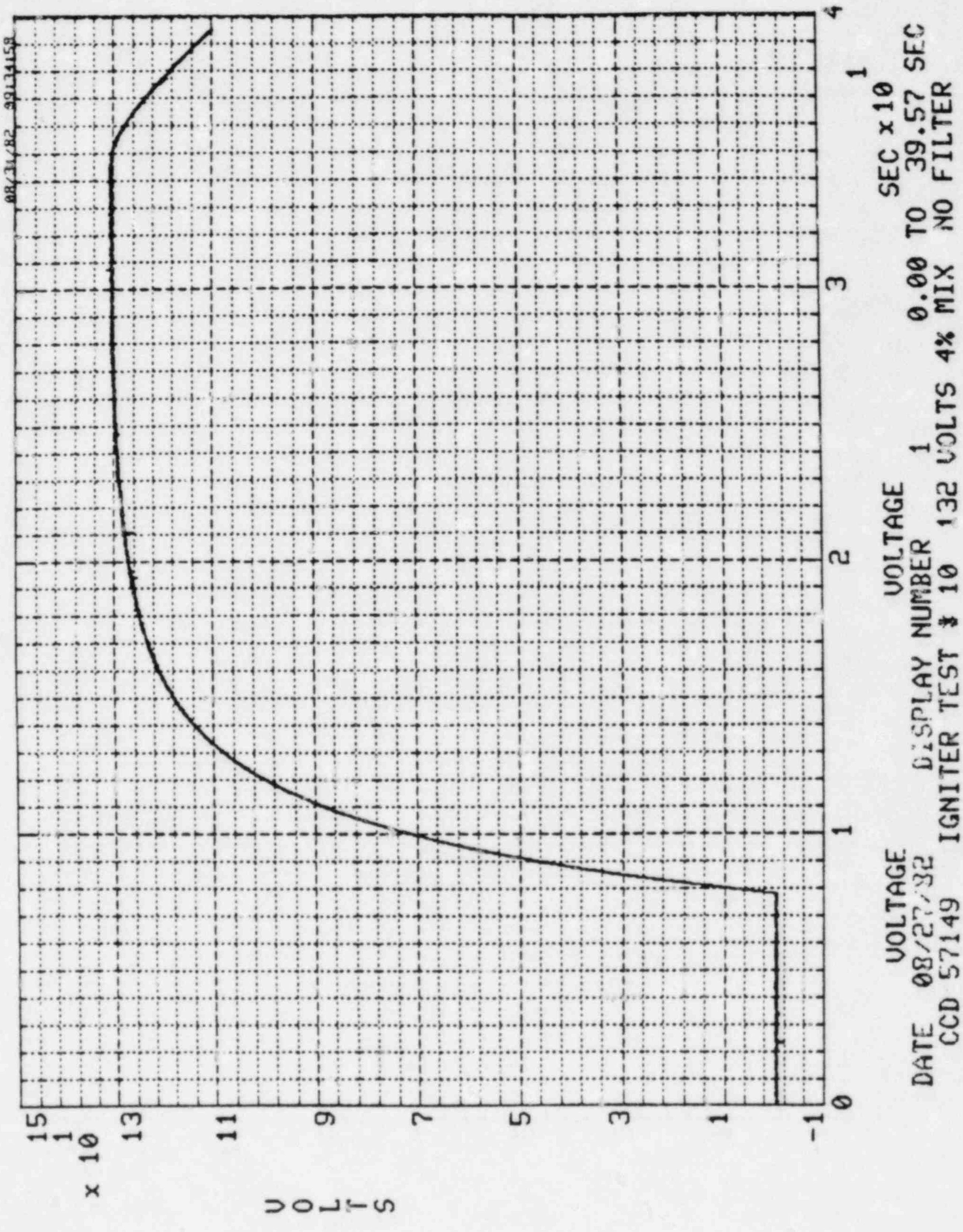

08/30/82
AMPERES
x 10^0
2
1
0
-1
-2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
SEC x10^0
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 9 132 VOLTS 4% MIX NO FILTER

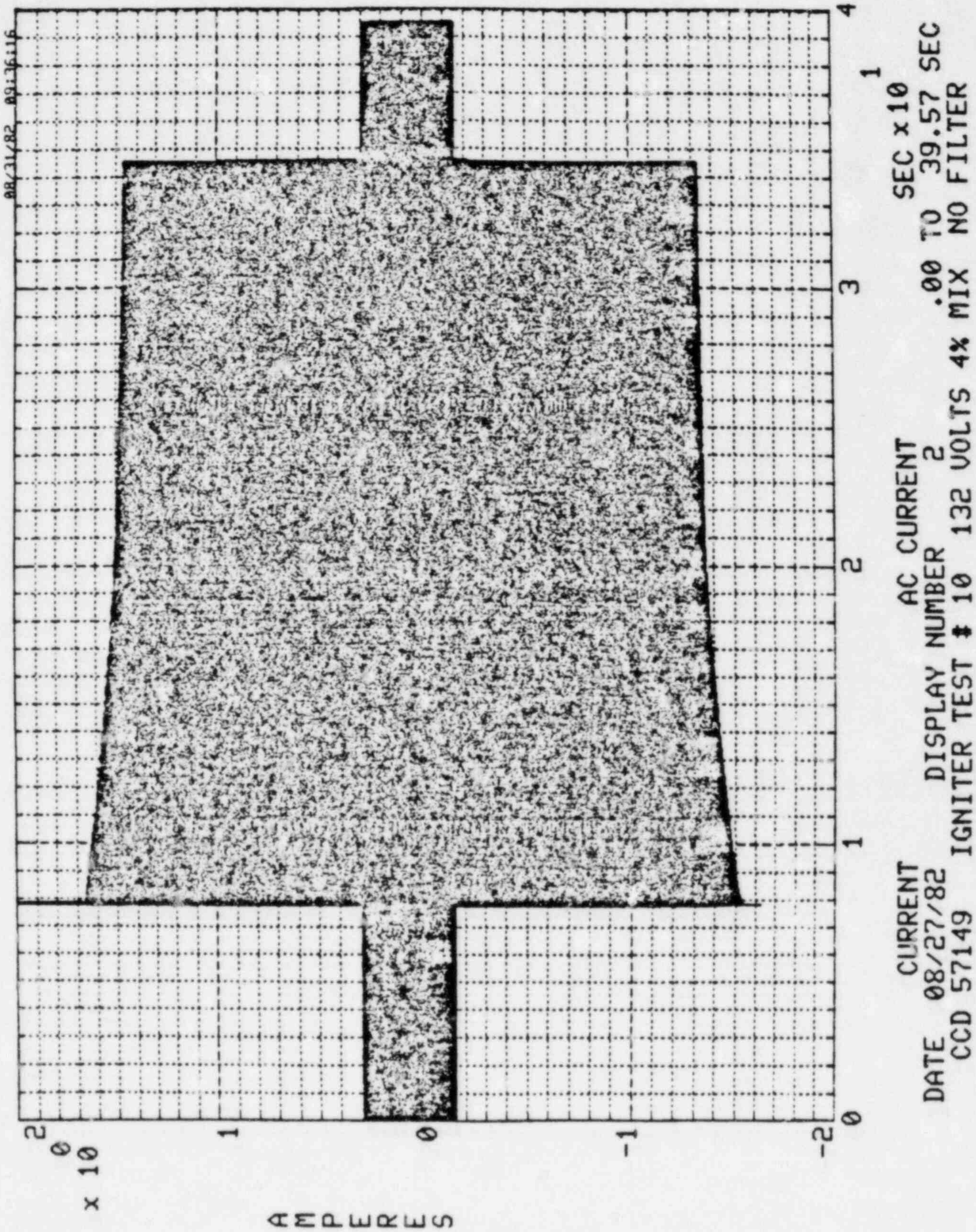

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 9 132 VOLTS 4% MIX NO FILTER
SEC x 10^0
PSIG x 10^-1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
7 5 3 1 -1 -3 -5 -7 -9 -11 -13

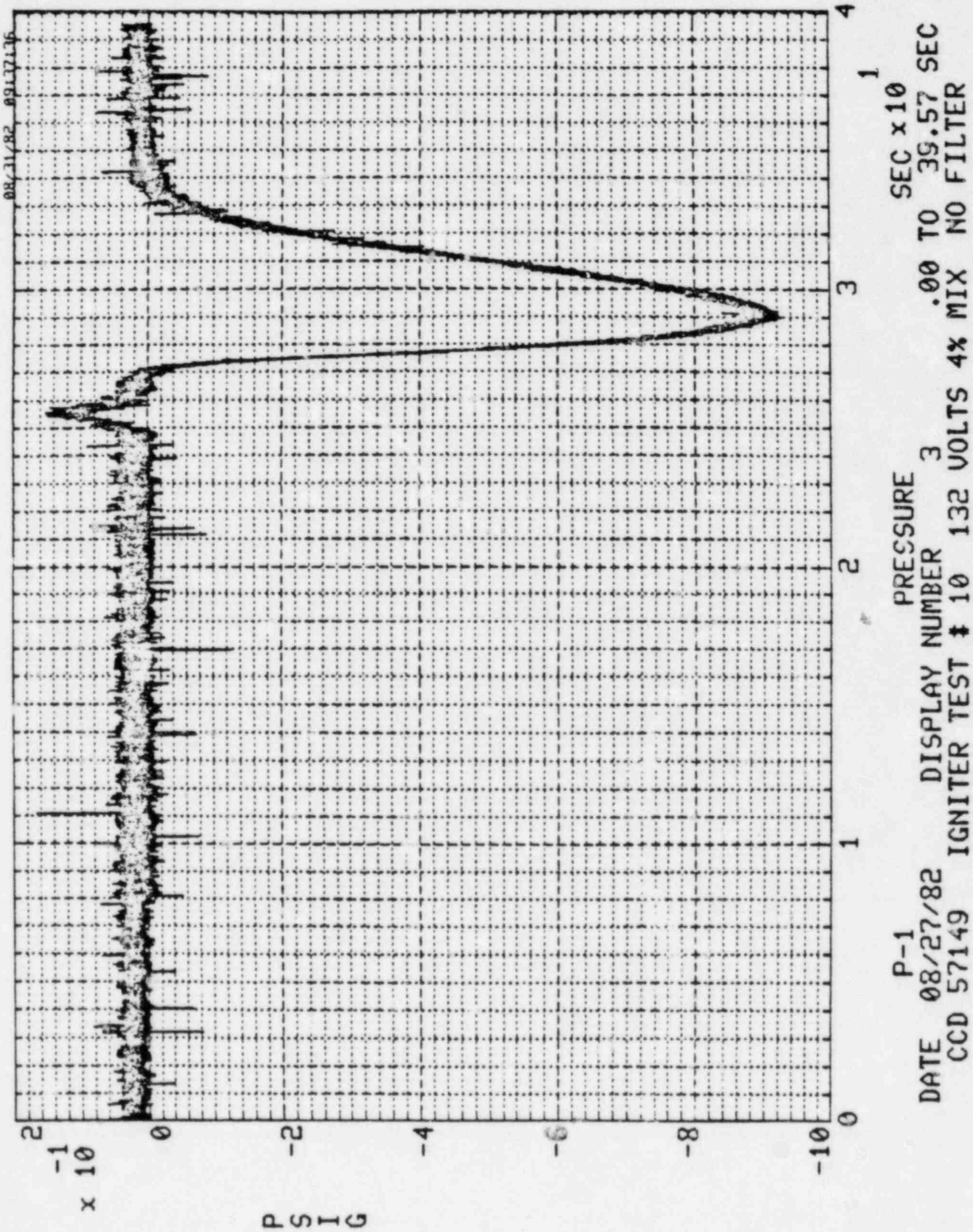

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 9 132 VOLTS 4% MIX 10 HZ FILTER
SEC x10
0
.00 TO 41.96 SEC
DEG. F.
x 10
1
08/30/82 10:28:25

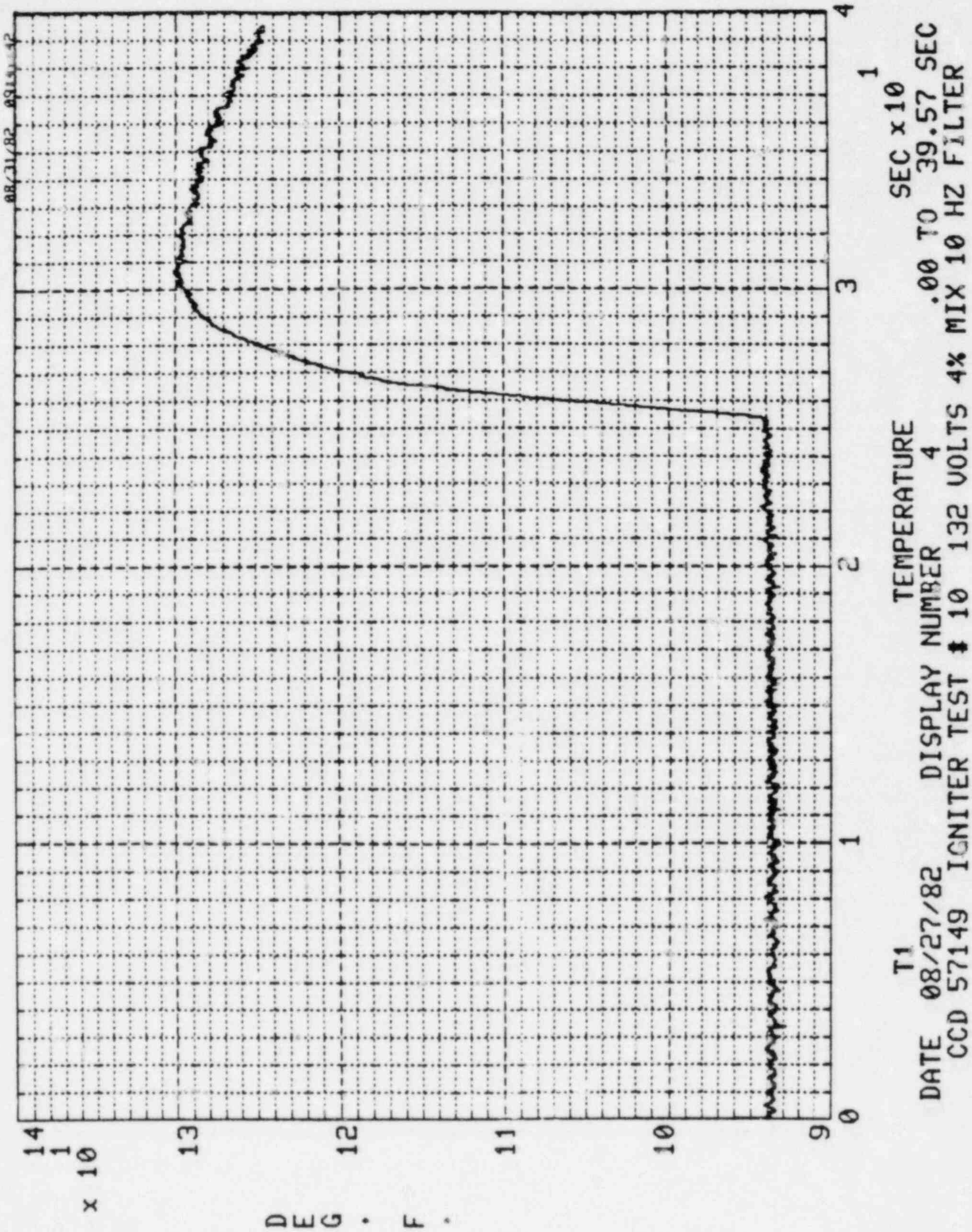

08/30/82 10:21:58
T2 TEMPERATURE
SEC x 10
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 41.96 SEC
CCD 57149 IGNITER TEST # 9 132 VOLTS 4% MIX 10 HZ FILTER
x 10 2
DEG. F.

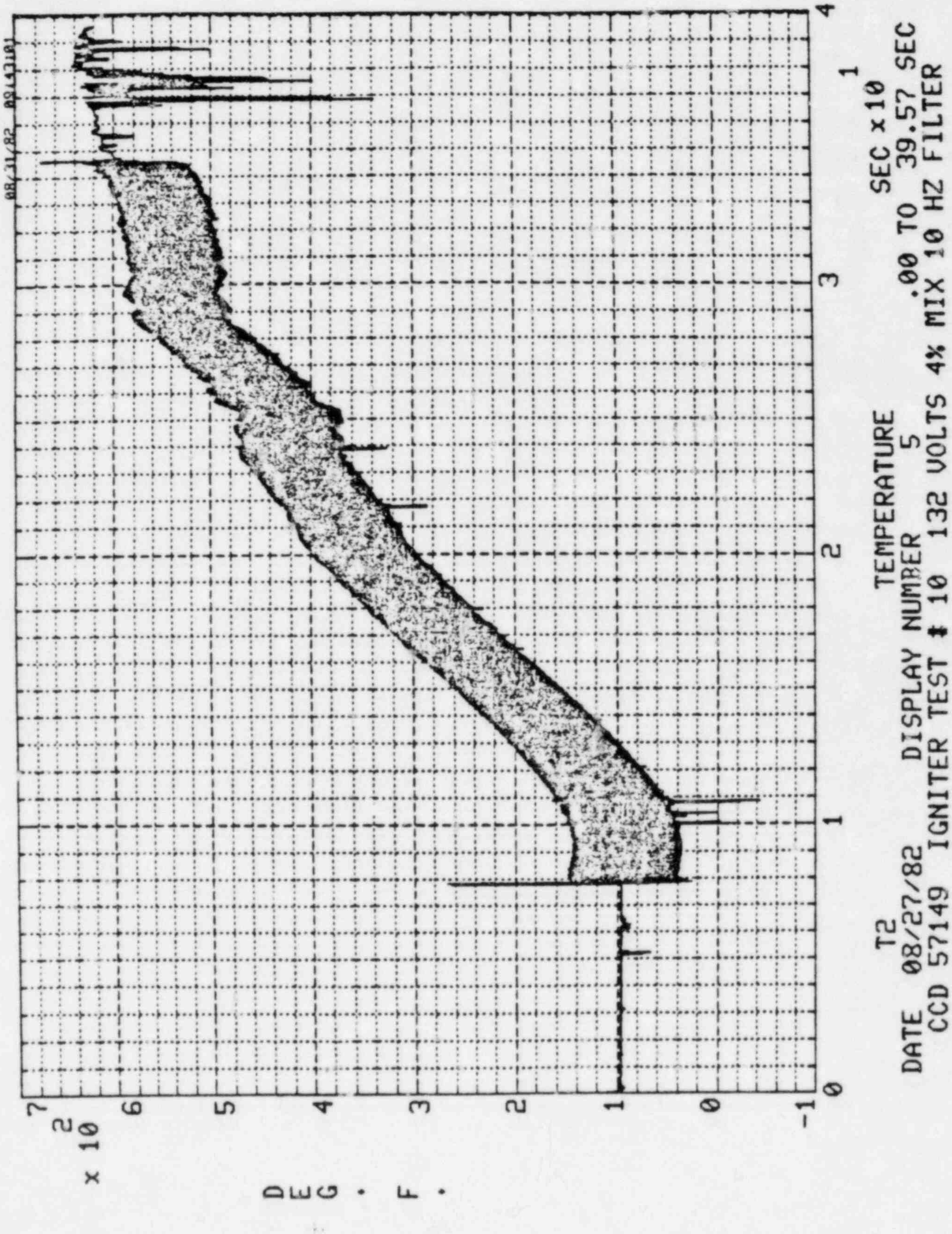

08/30/82 10:23:15
x 10^2
DEG. F.
SEC x10^0
TEMPERATURE
T3
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 9 132 VOLTS 4% MIX 10 HZ FILTER
.00 TO 41.96 SEC

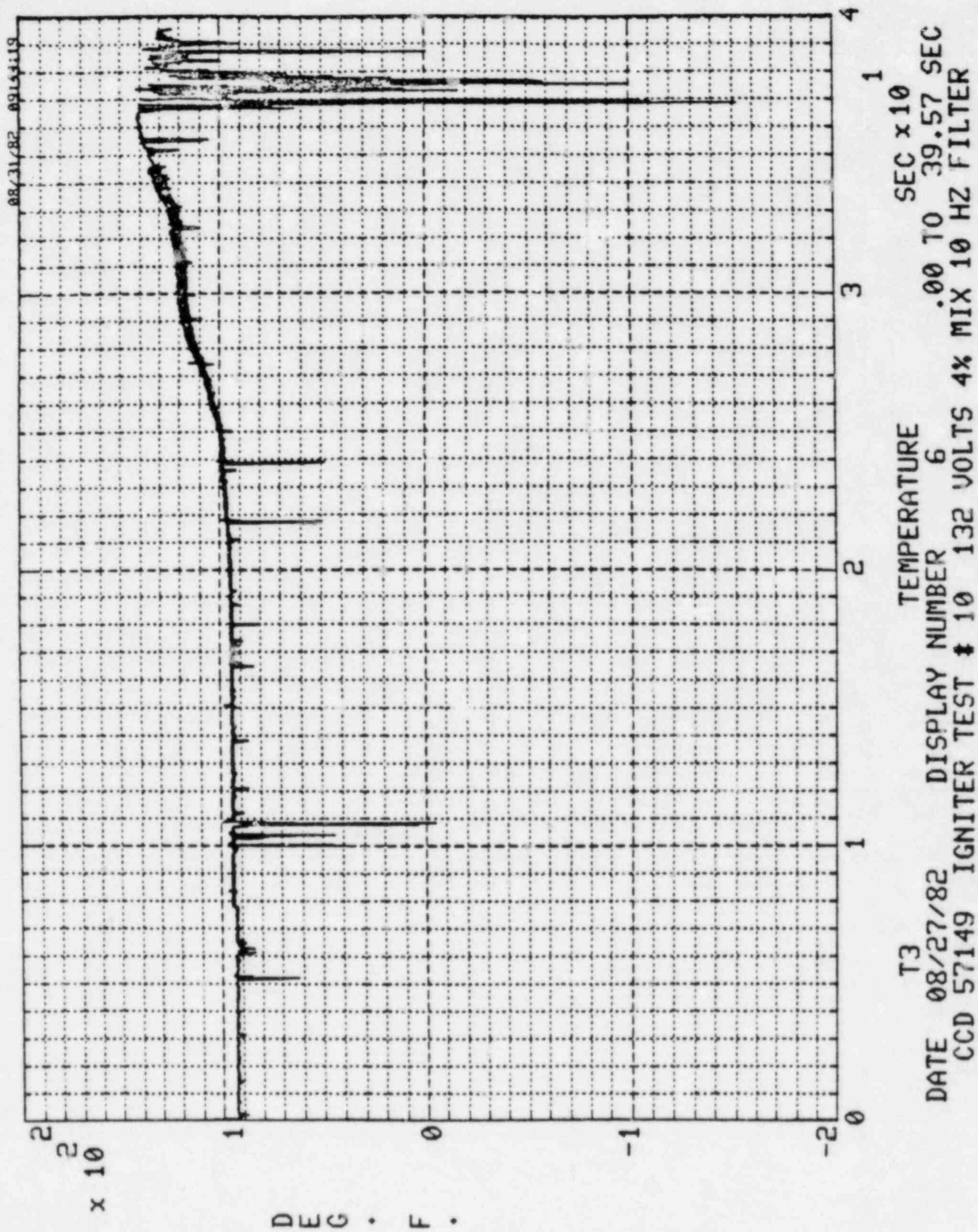

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 10 132 VOLTS 4% MIX
0.00 TO 39.57 SEC
NO FILTER
SEC x10 1
0
1
2
3
4
VOLTS
x 10 1
-1
1
3
5
7
9
11
13
15

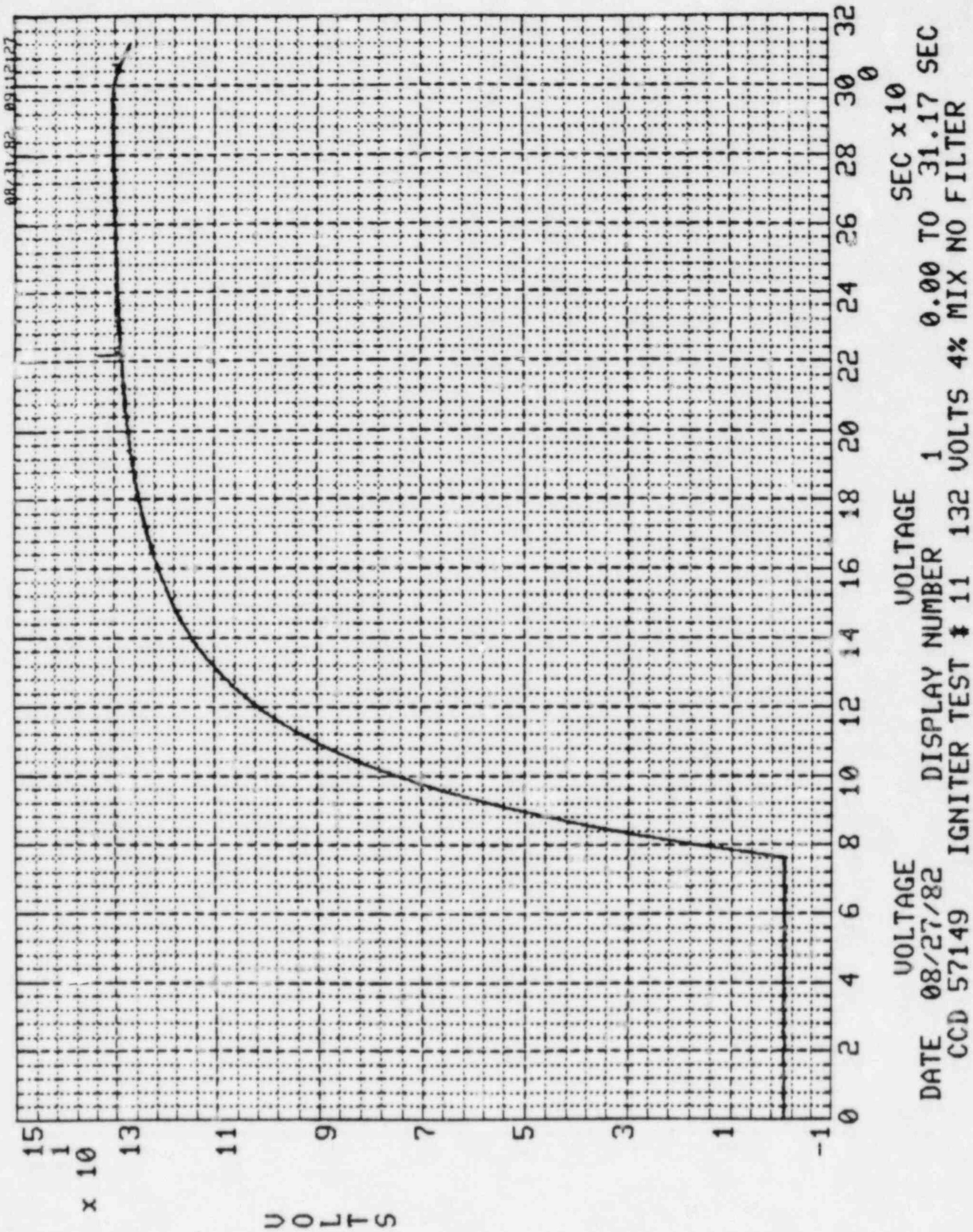

08/31/82 09:36:16
AMPERES
x 10^0
SEC x 10^1
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 10 132 VOLTS 4% MIX NO FILTER

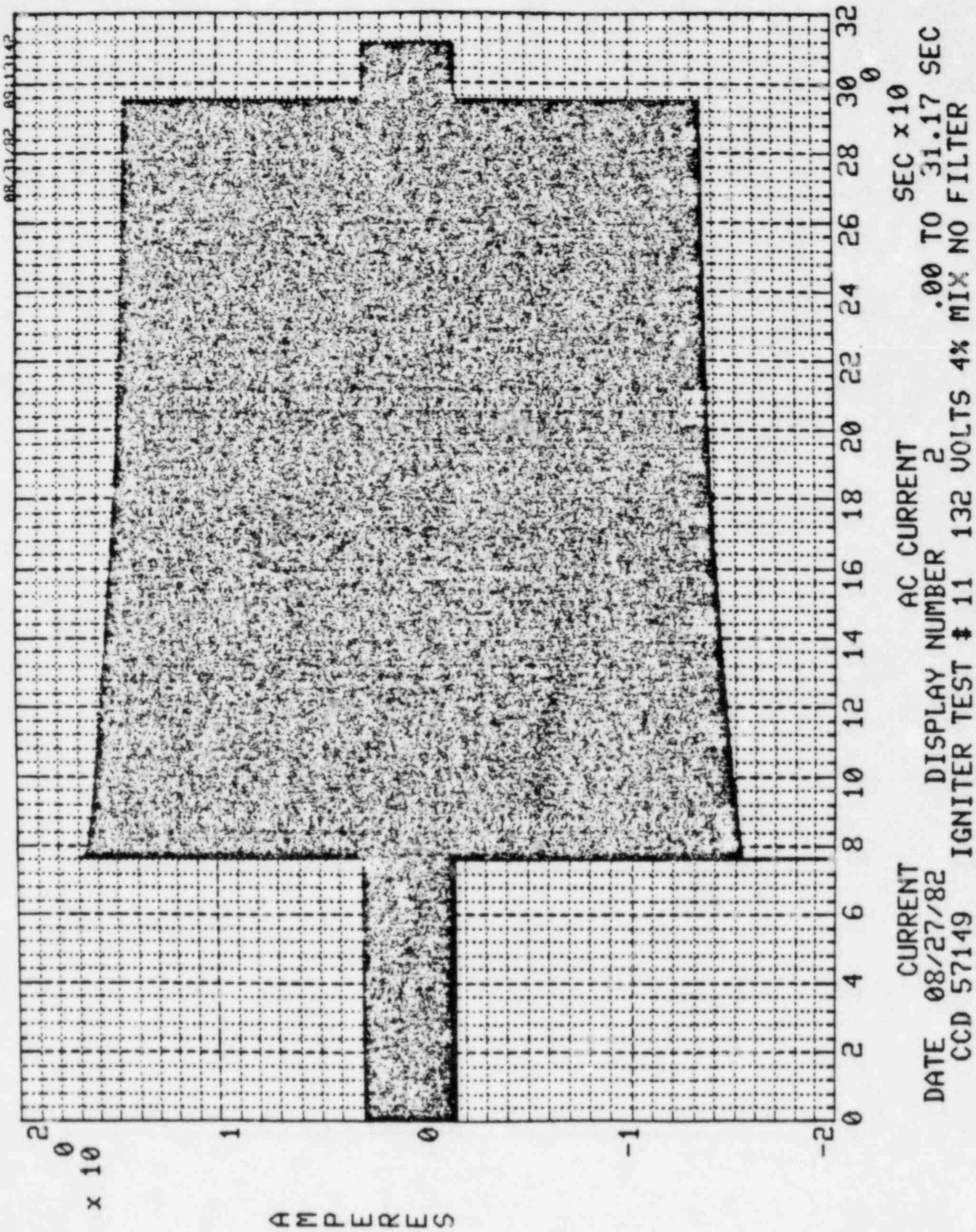

08/31/82 09:37:36
PSIG
x 10^-1
2
0
-2
-4
-6
-8
-10
0
1
2
3
4
SEC x10^1
P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 10 132 VOLTS 4% MIX
.00 TO 39.57 SEC
NO FILTER

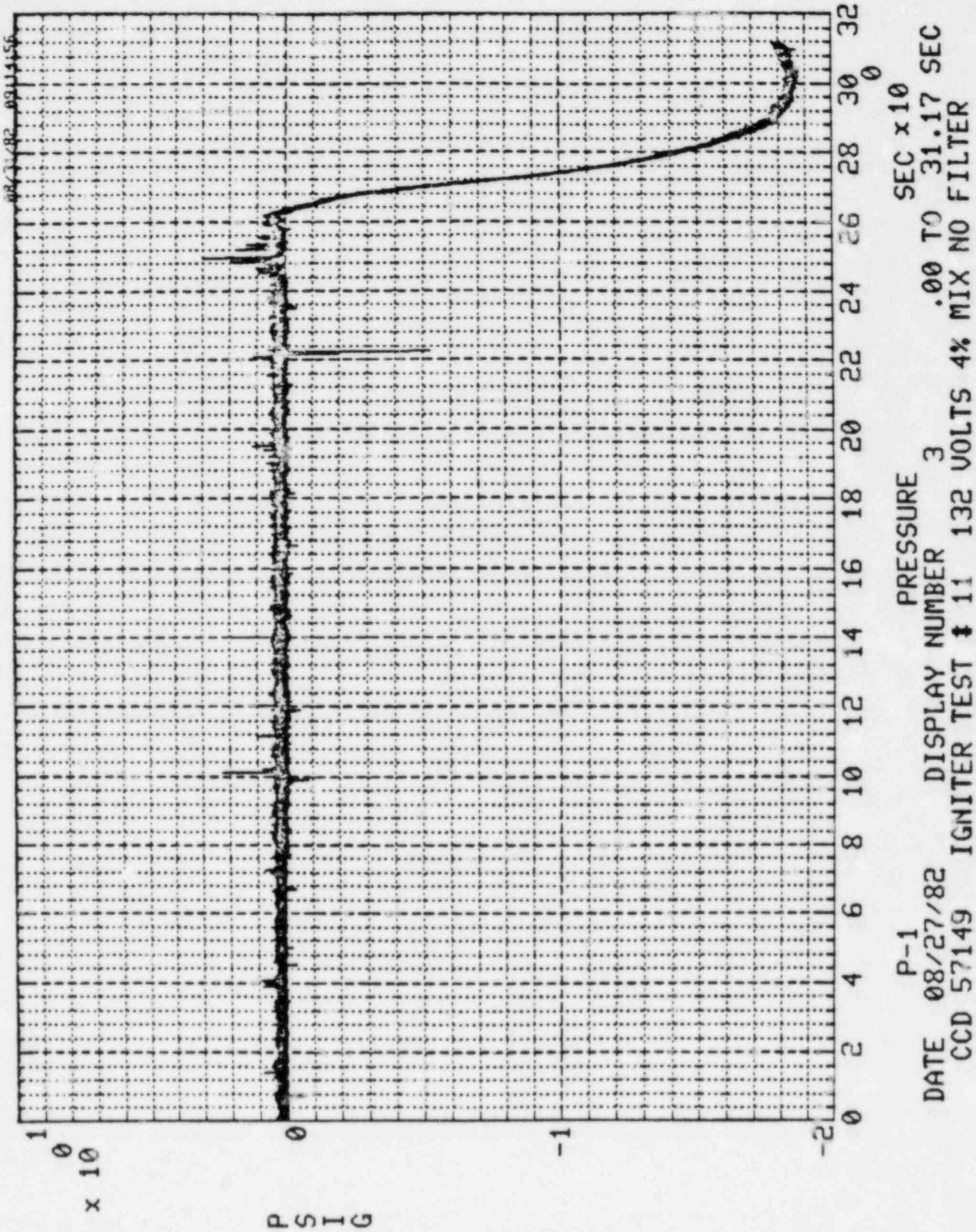

14
x 10^1
13
12
11
10
9
DEG. F.
0
1
2
3
4
SEC x 10^1
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 10 132 VOLTS 4% MIX 10 HZ FILTER

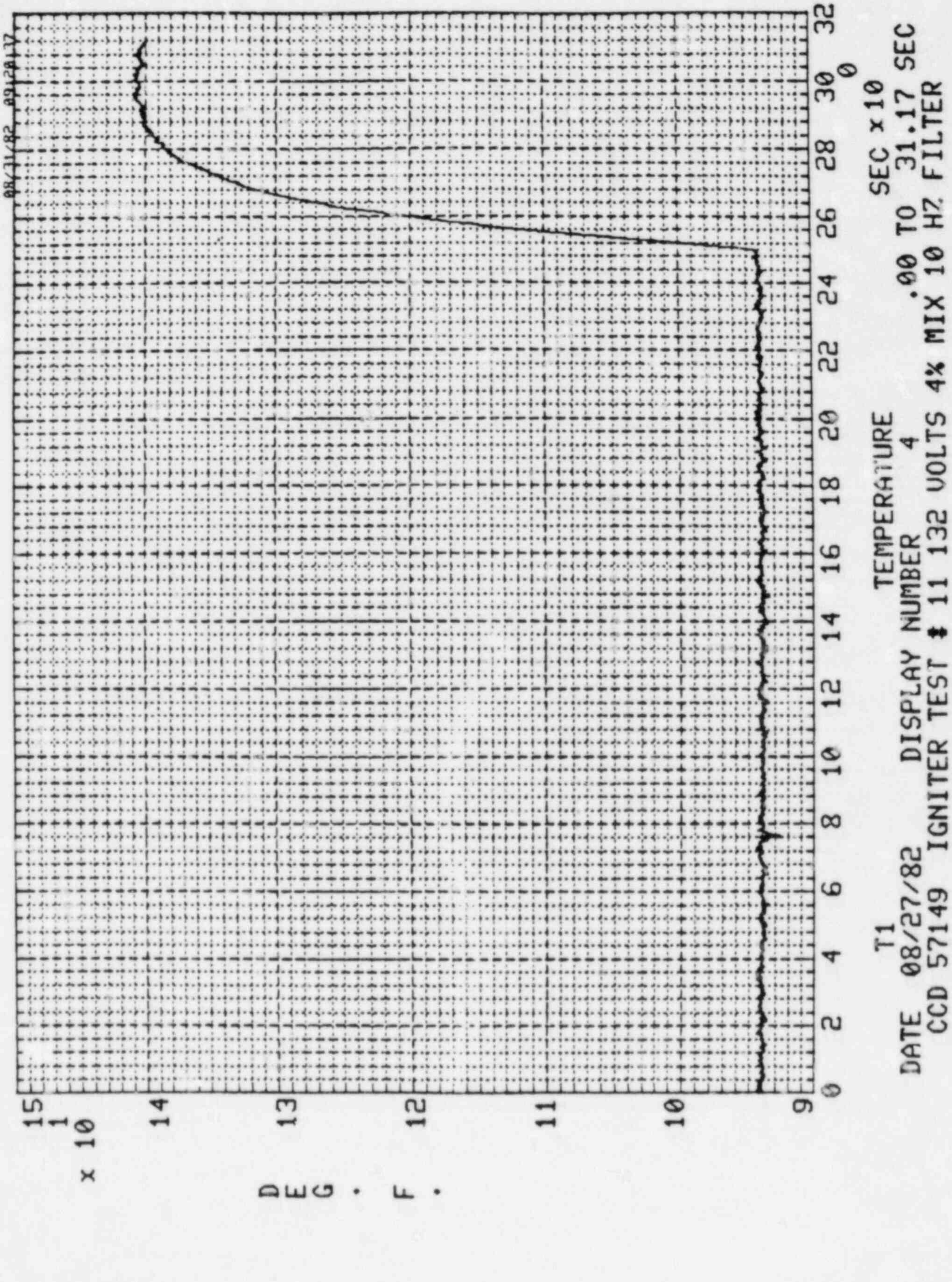

T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
SEC x10
1
.00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 10 132 VOLTS 4% MIX 10 HZ FILTER
DEG. F.
x 10
2
0
1
2
3
4
-1
5
6
7

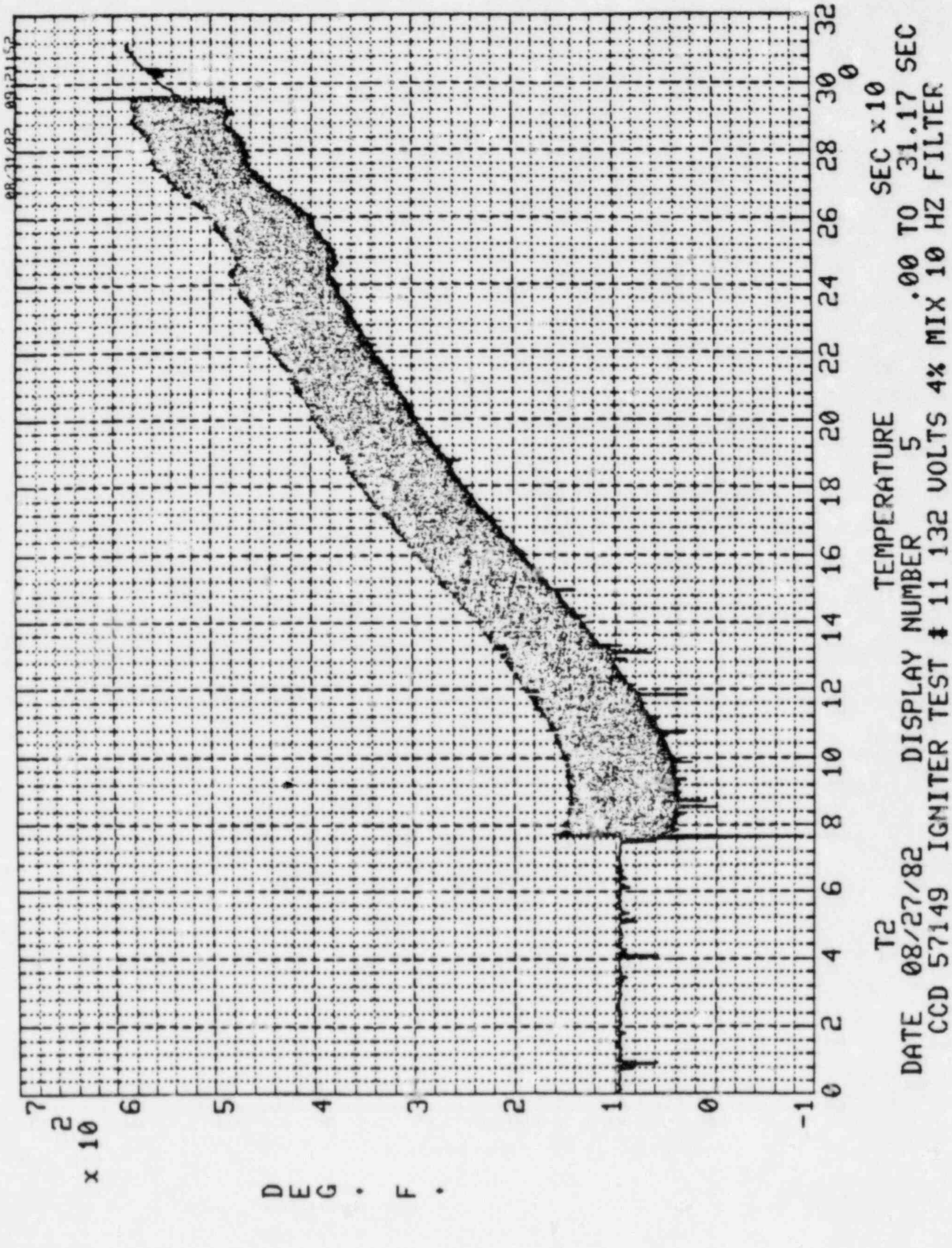

08/31/82 0913:19
2
1
0
-1
-2
x 10^2
DEG. F.
0
1
2
3
4
SEC x 10^1
T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 10 132 VOLTS 4% MIX 10 HZ FILTER

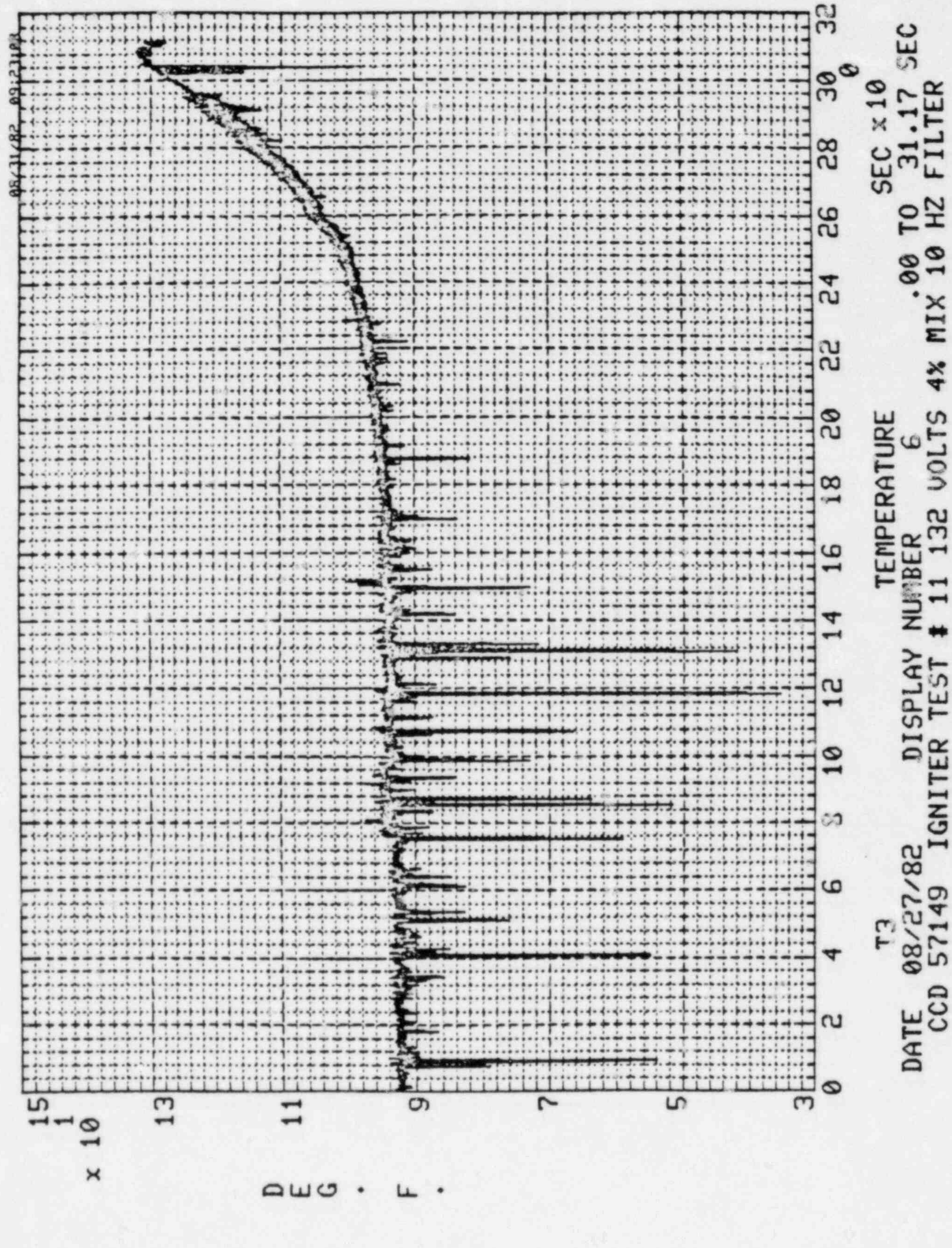

08/31/82 09:12:27
VOLTS x 10^1
SEC x10^0
VOLTAGE VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX NO FILTER

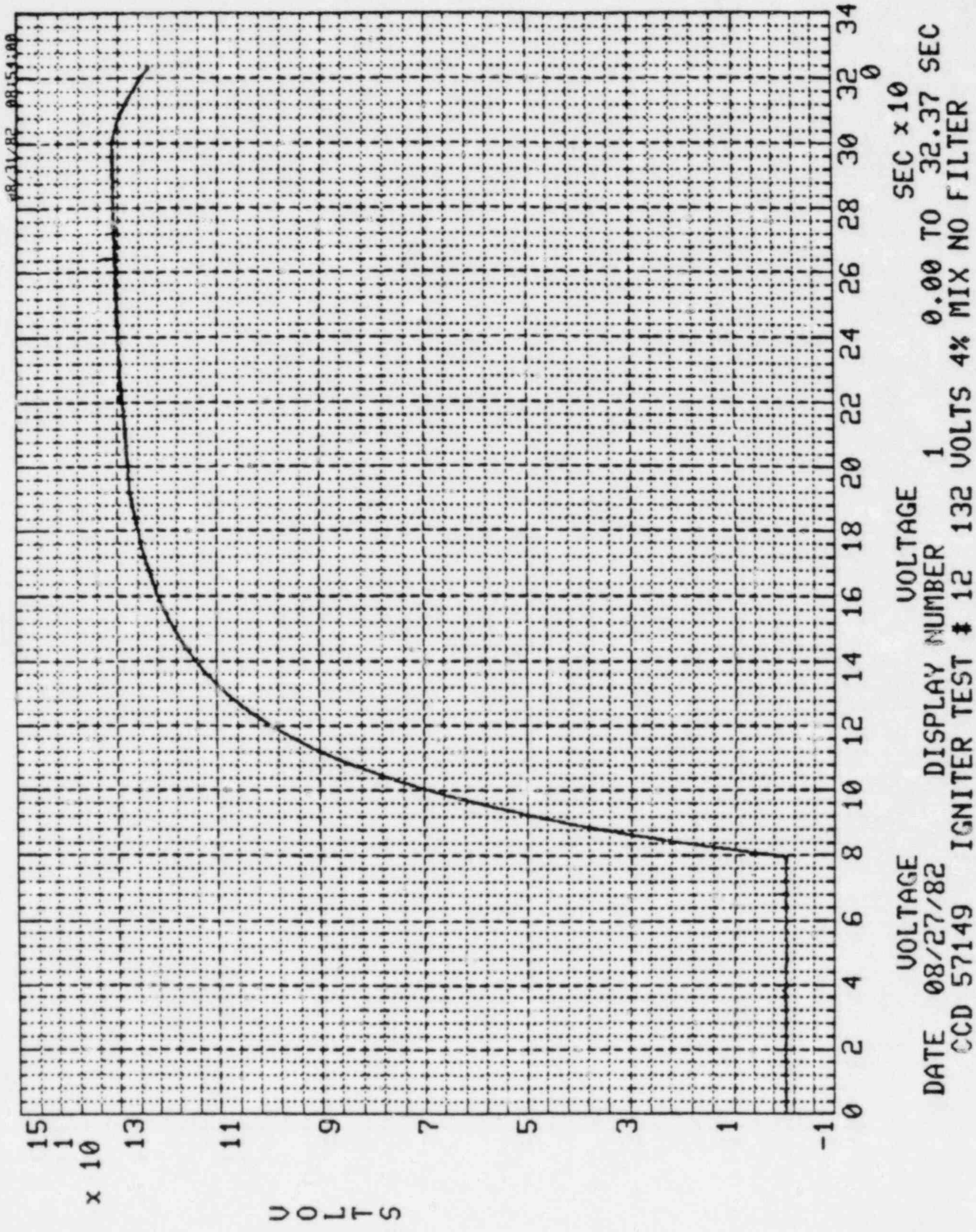

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX NO FILTER
SEC x 10^0 .00 TO 31.17 SEC
AMPERES
x 10^0

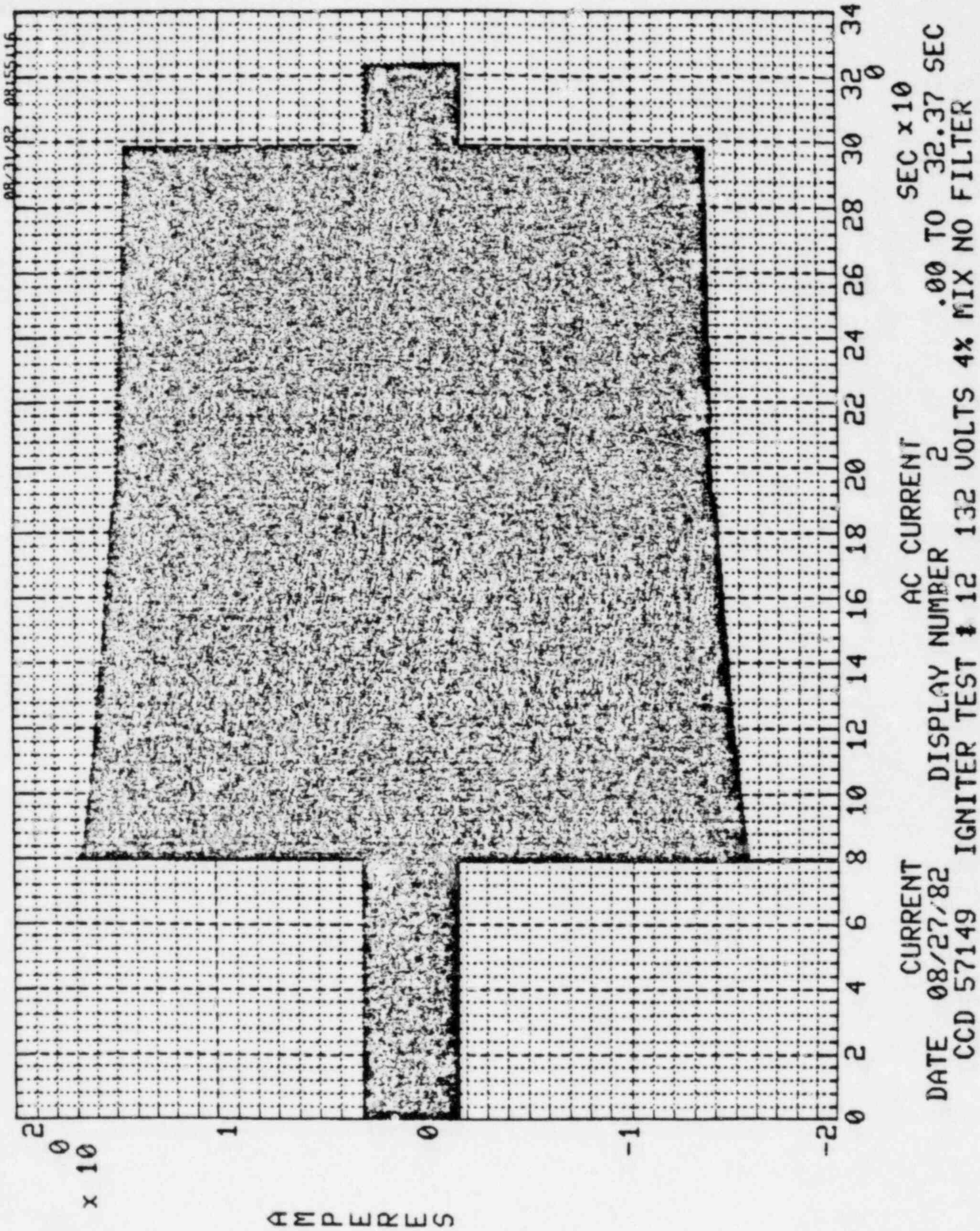

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
SEC x10
0
.00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX NO FILTER
P
S
I
G
x 10
0
1
0
-1
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

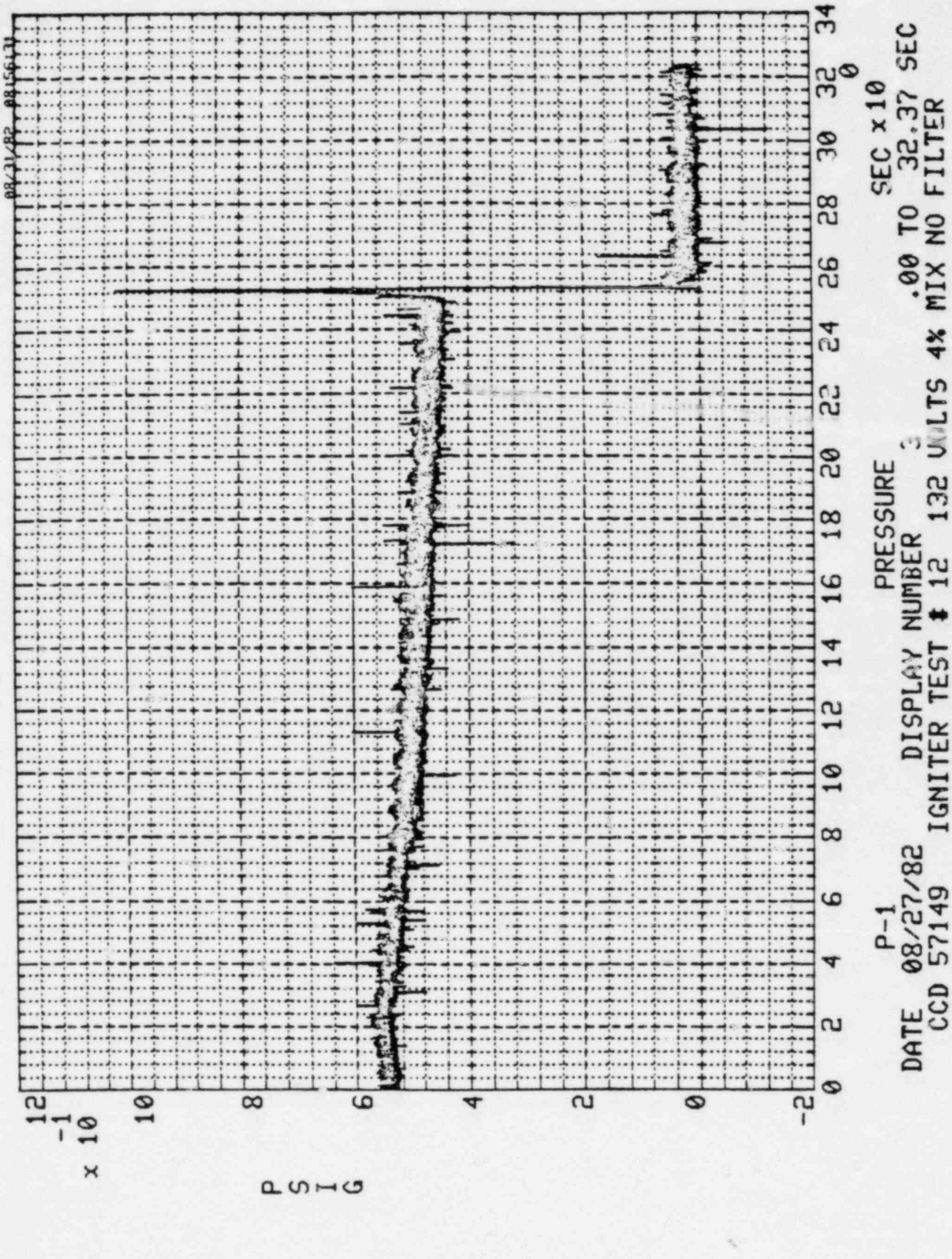

08/31/82 09:28:17
15
14
13
12
11
10
9
x 10 1
DEG. F.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
SEC x 10 0
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX 10 HZ FILTER

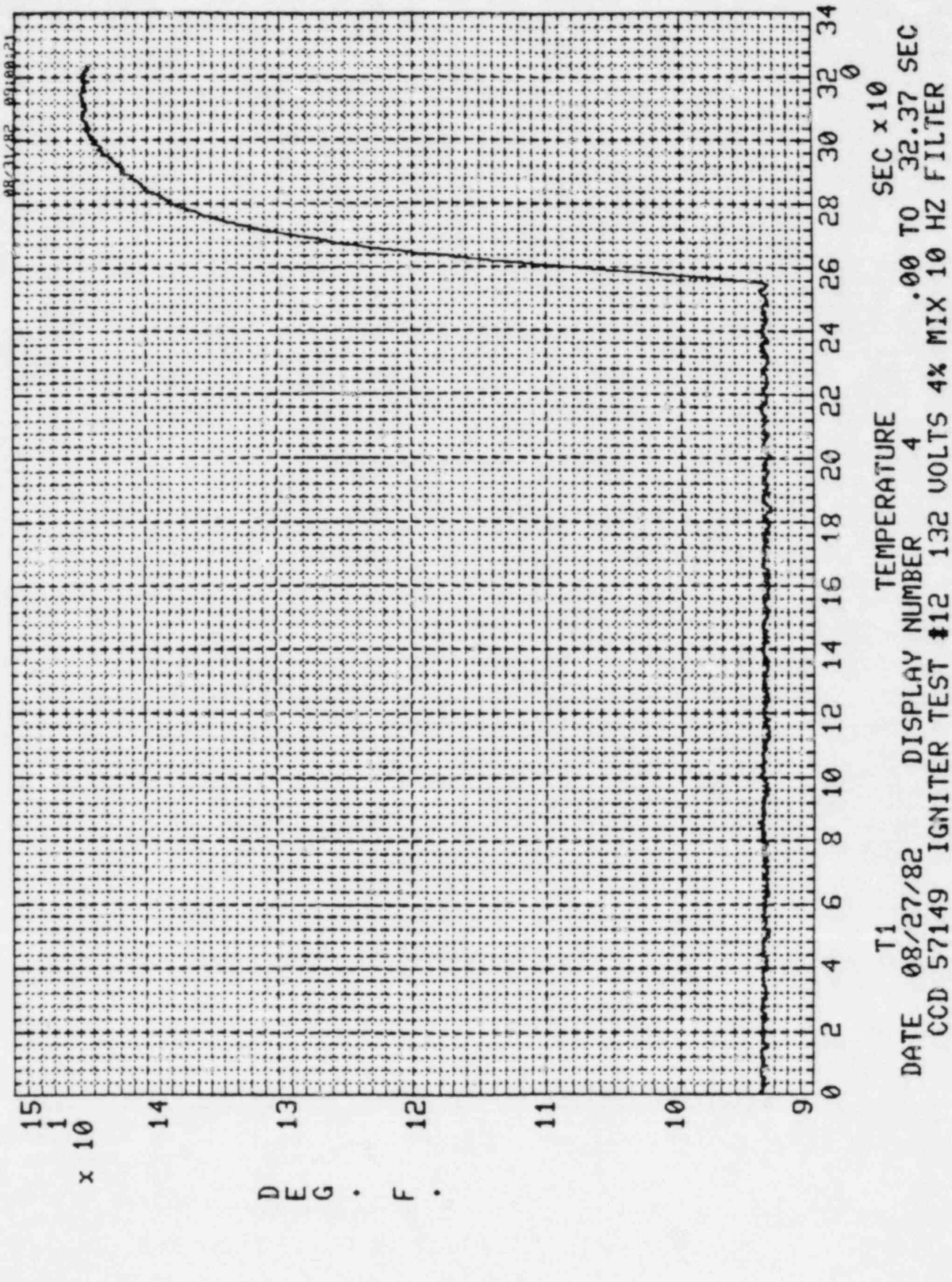

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX 10 HZ FILTER
SEC x 10^0 .00 TO 31.17 SEC
DEG. F. x 10^2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
-1 0 1 2 3 4 5 6 7

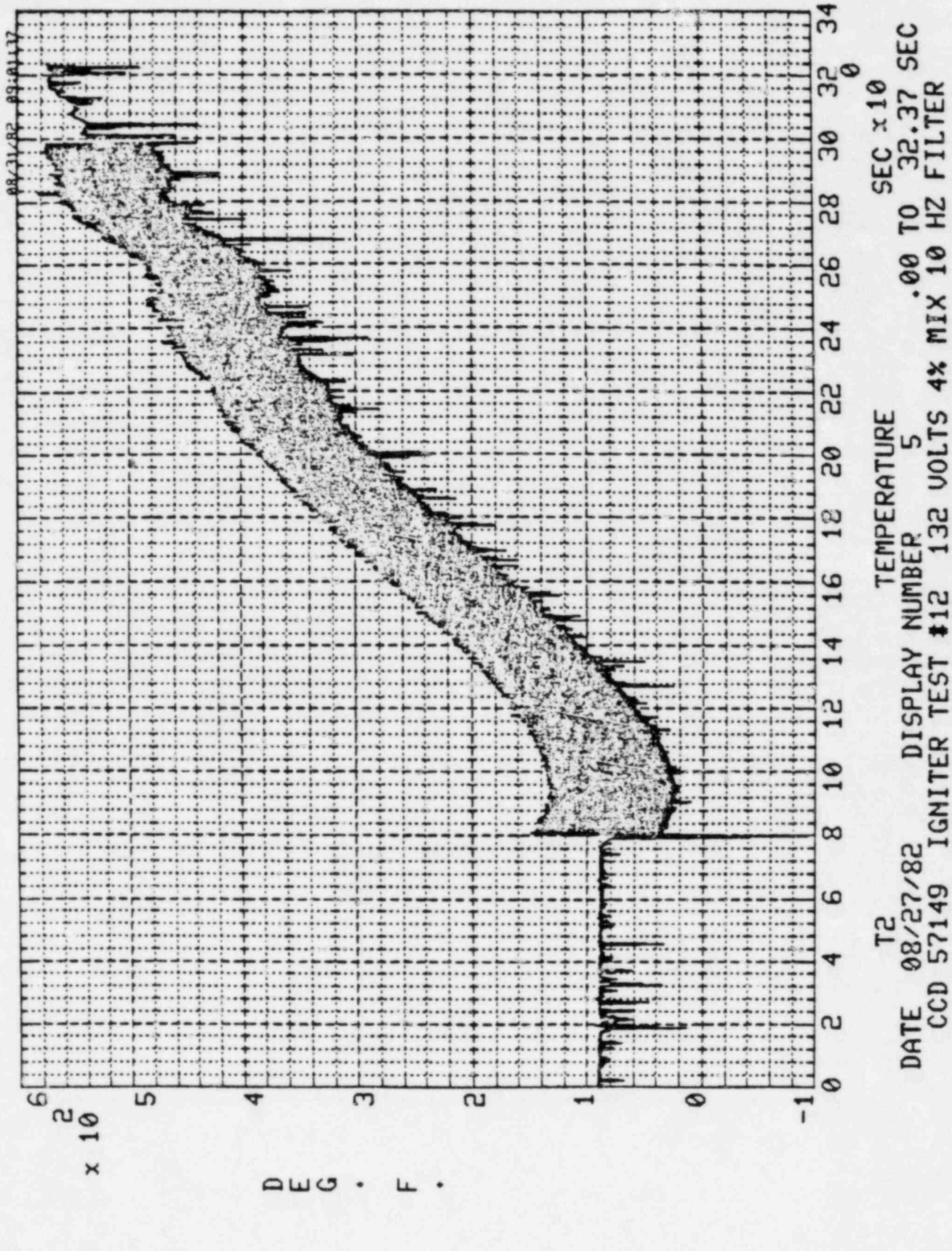

T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 11 132 VOLTS 4% MIX 10 HZ FILTER
SEC x 10^0 .00 TO 31.17 SEC
DEG. F. x 10^1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
3 5 7 9 11 13 15

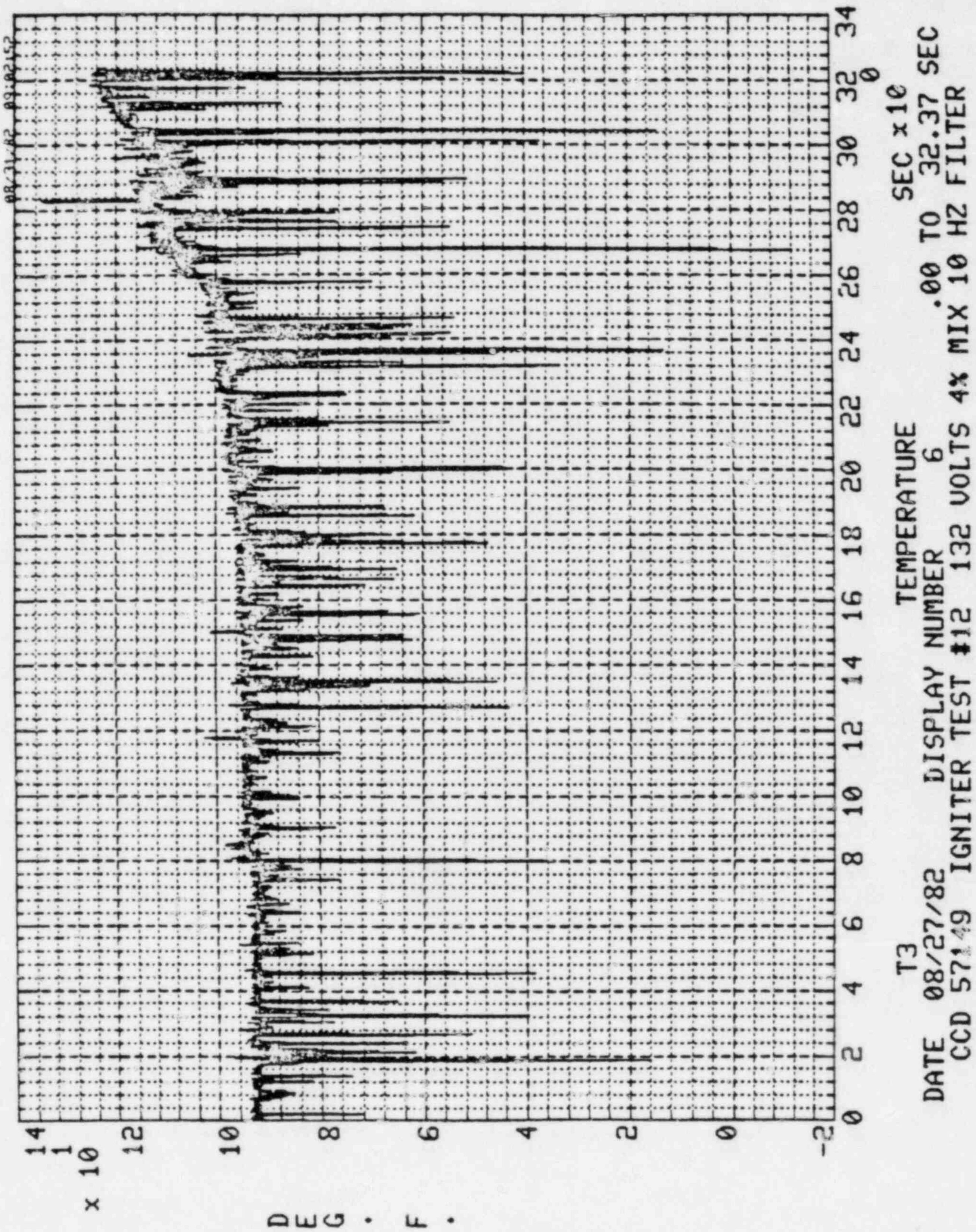

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 12 132 VOLTS 4% MIX NO FILTER
0.00 TO 32.37 SEC
SEC x 10 0
VOLTS x 10 1
08/31/82 08:54:00

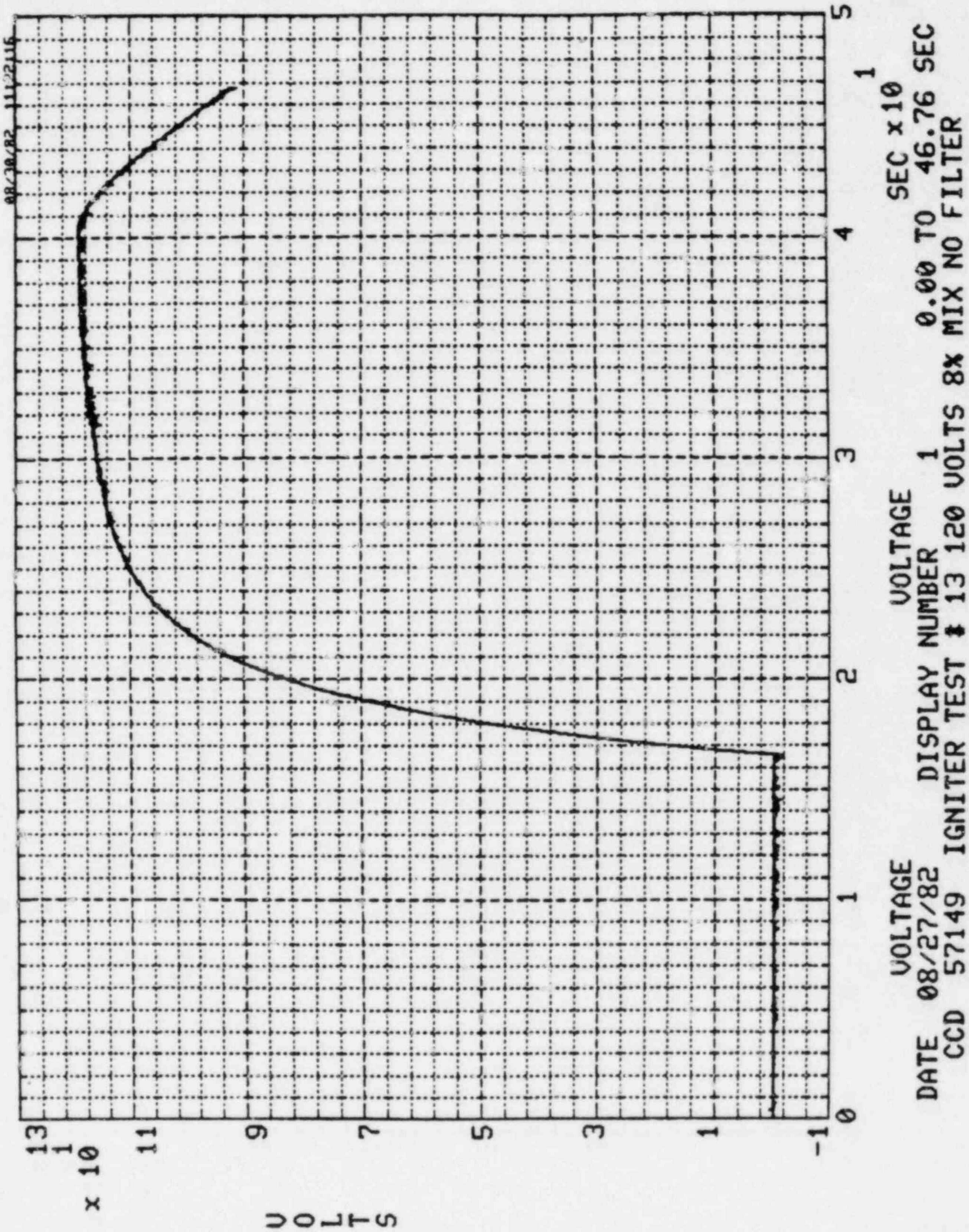

CURRENT
AC CURRENT
DATE 08/27/82
DISPLAY NUMBER 2
.00 TO 32.37 SEC
CCD 57149
IGNITER TEST # 12 132 VOLTS 4% MIX NO FILTER
SEC x10 0
AMPERES x 10 0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
2 1 0 -1 -2

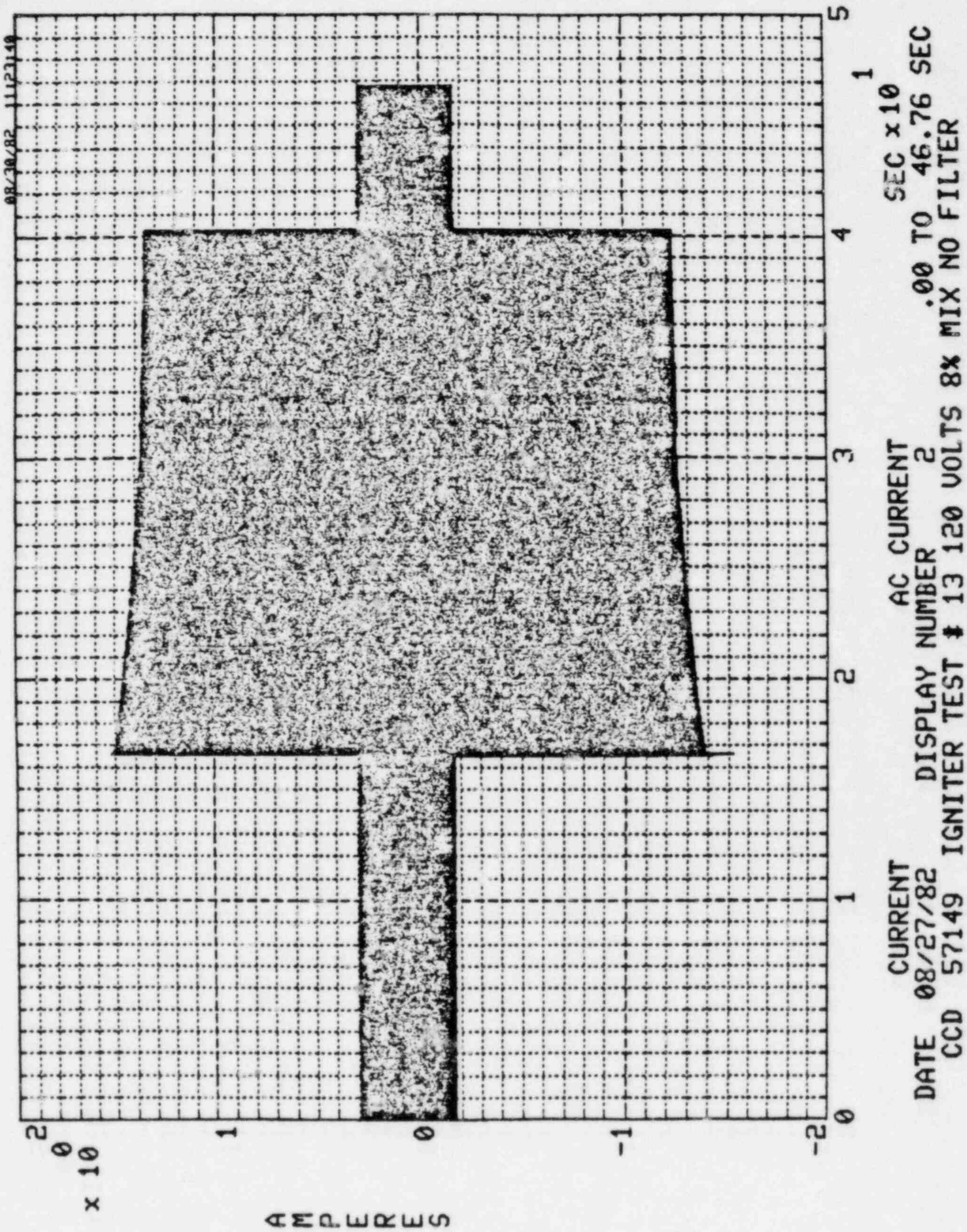

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 12 132 VOLTS 4% MIX NO FILTER
.00 TO 32.37 SEC
SEC x 10^0
PSIG x 10^-1
12
10
8
6
4
2
0
-2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34

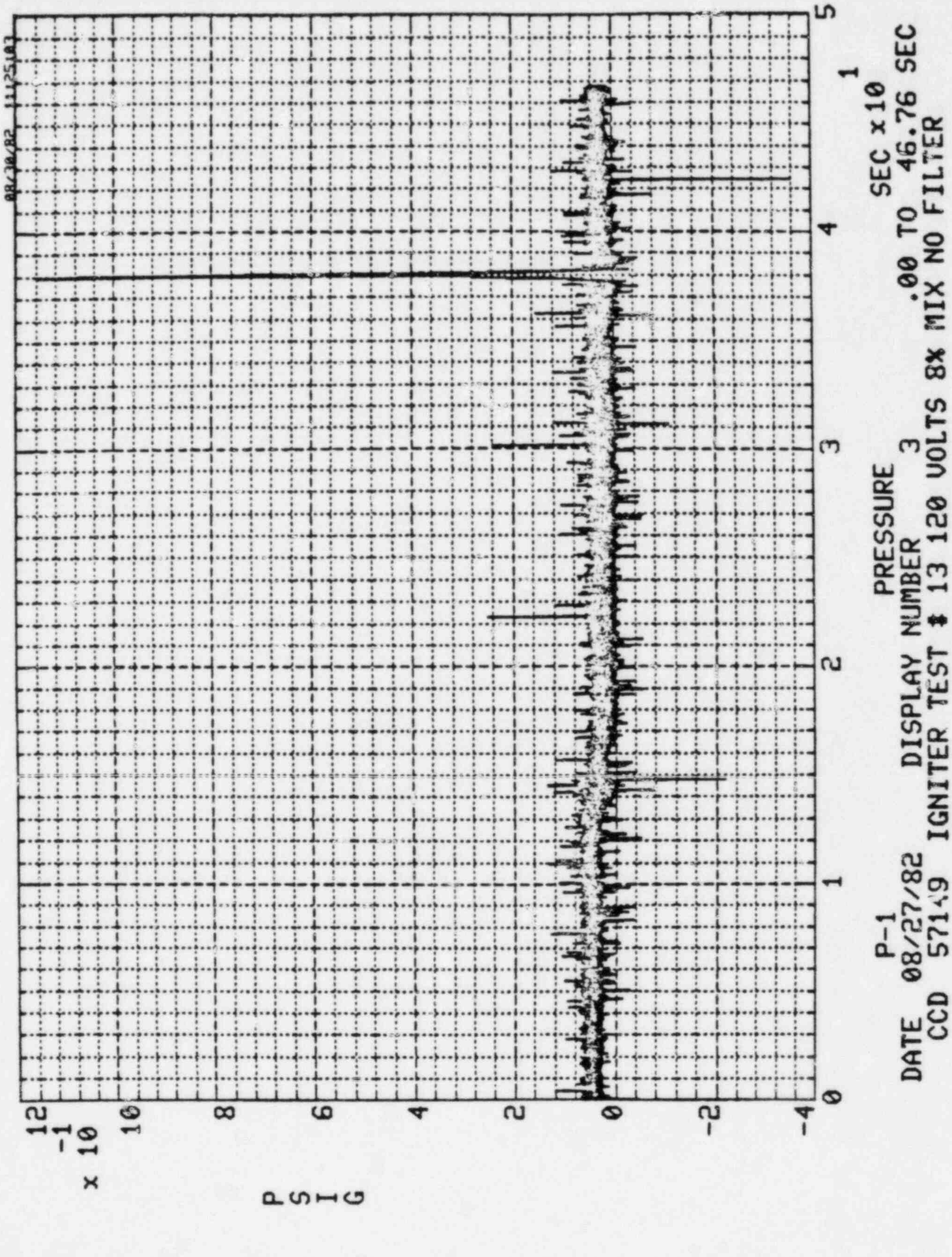

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST #12 132 VOLTS 4% MIX 10 HZ FILTER
.00 TO 32.37 SEC
SEC x10
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
9 10 11 12 13 14 15
x 10
1
DEG. F.

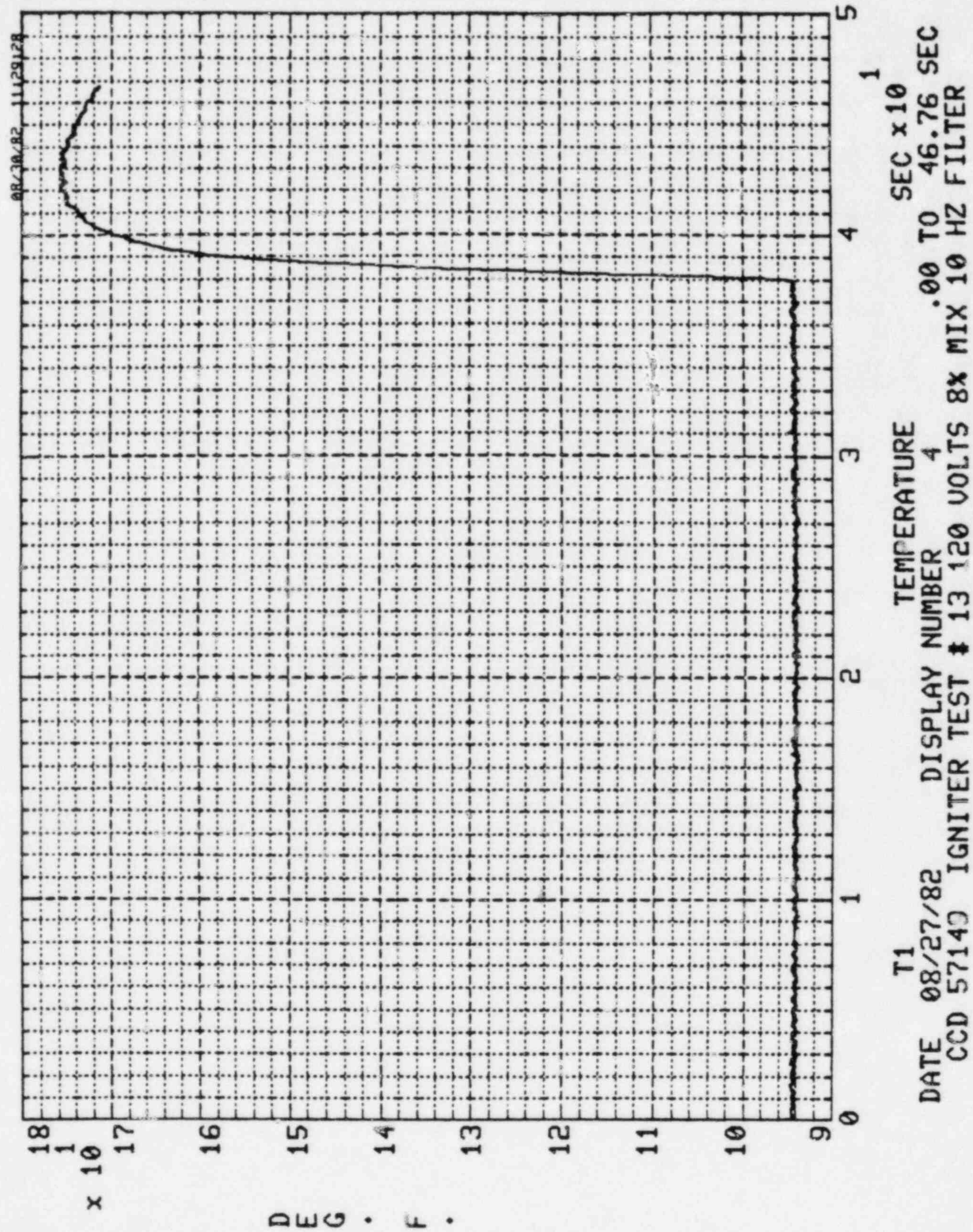

08/31/82 09:01:37
DEG. F.
x 10^2
6
5
4
3
2
1
0
-1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
T2
TEMPERATURE
SEC x10
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST #12 132 VOLTS 4% MIX 10 HZ FILTER
.00 TO 32.37 SEC

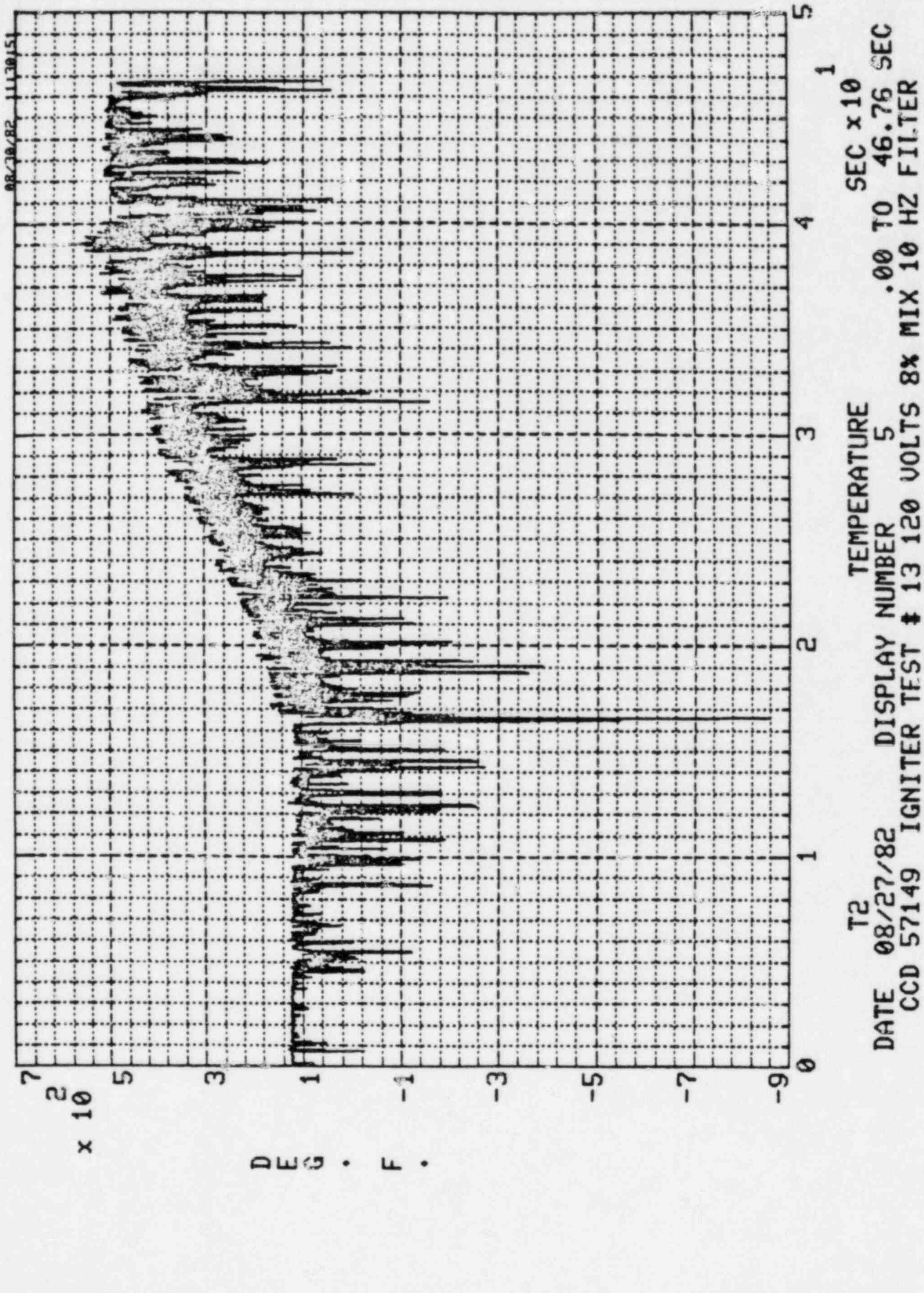

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST #12 132 VOLTS 4% MIX .00 TO 32.37 SEC
10 HZ FILTER
SEC x10 0
DEG. F.
x 10 1
14
12
10
8
6
4
2
0
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34

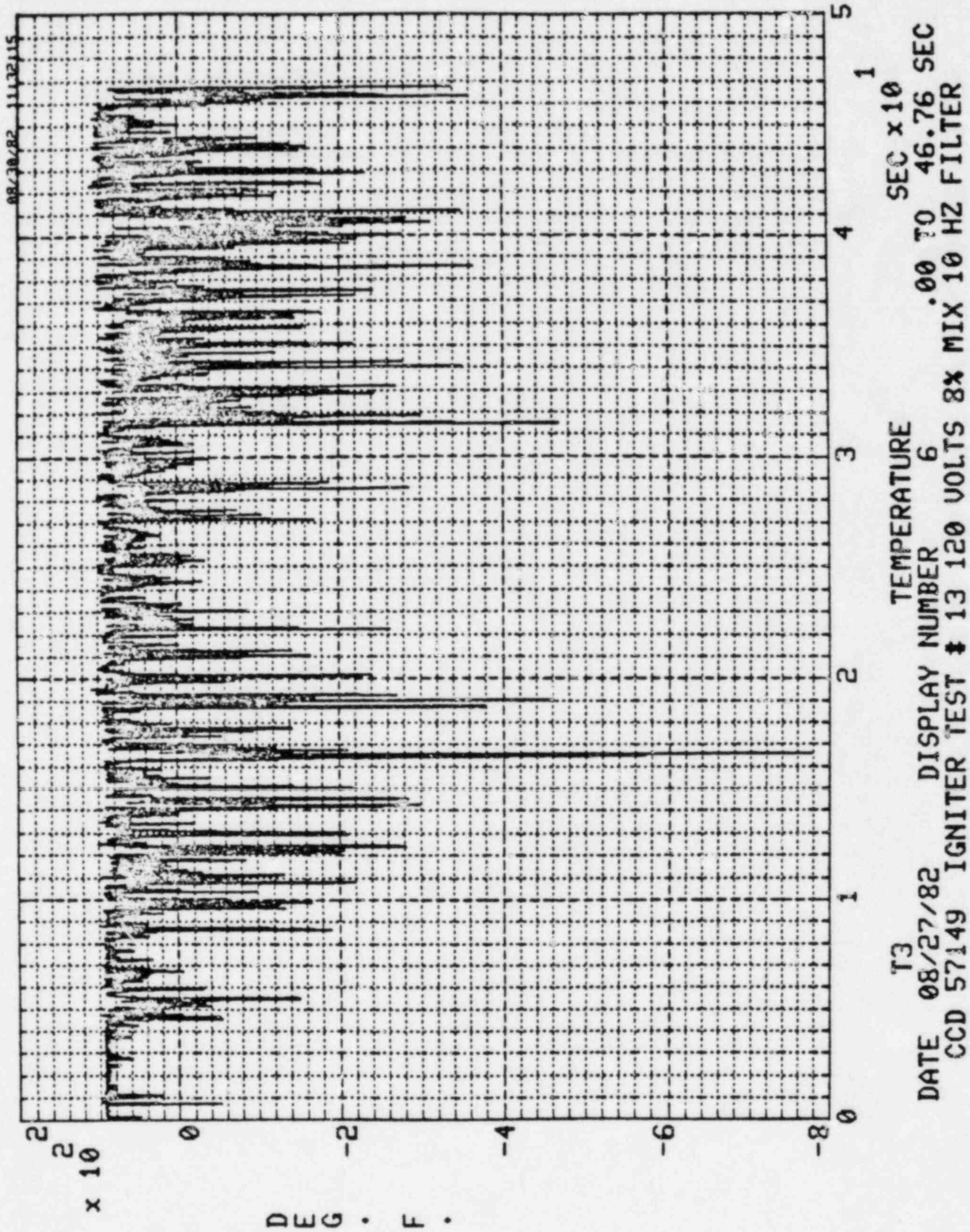

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 13 120 VOLTS 8% MIX NO FILTER
SEC x10 1
0.00 TO 46.76 SEC
VOLTS x 10 1
08/30/82

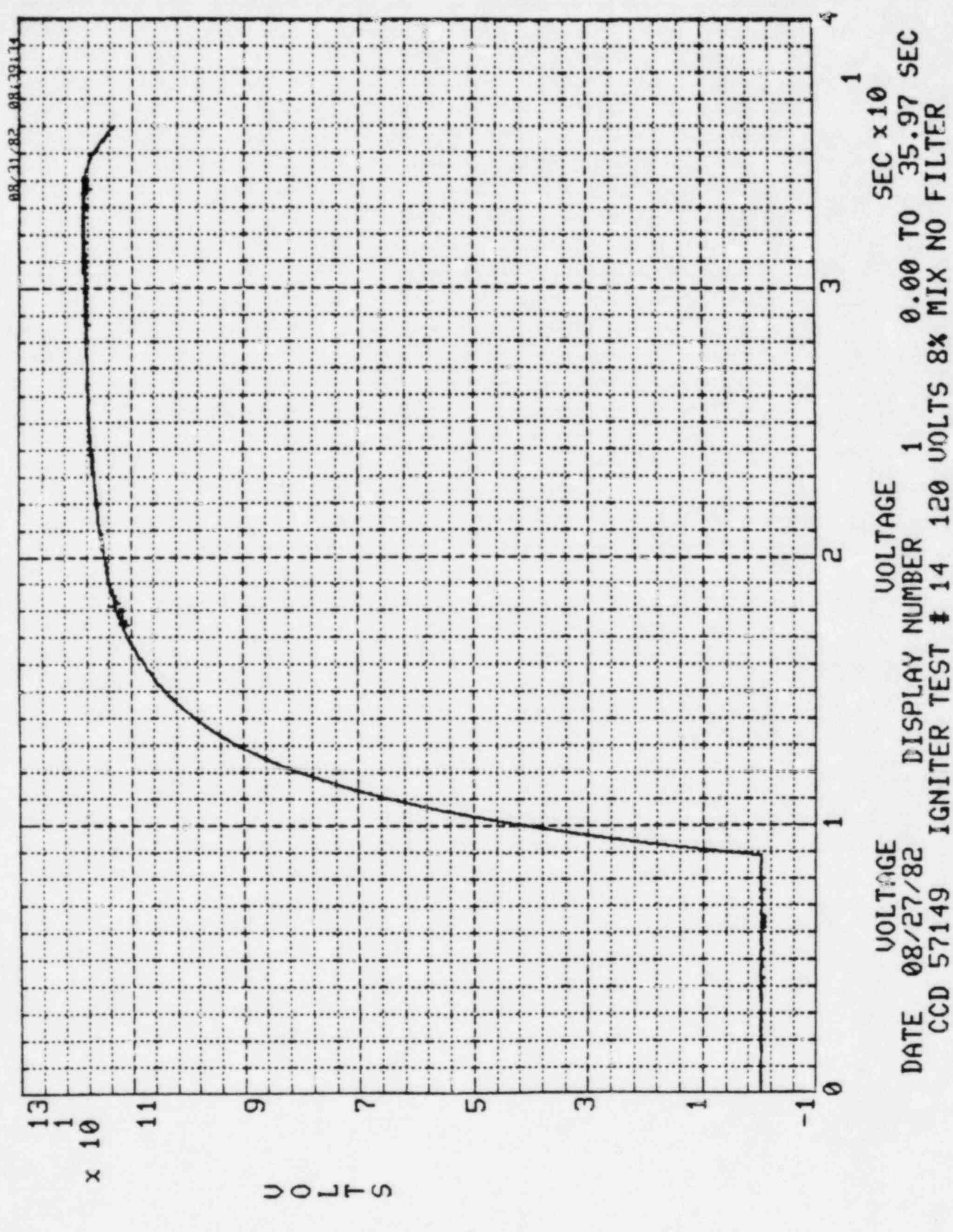

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 46.76 SEC
CCD 57149 IGNITER TEST # 13 120 VOLTS 8% MIX NO FILTER
SEC x10 1
AMPERES
x 10 0
0
1
2
3
4
5
2
1
0
-1
-2
08/30/82

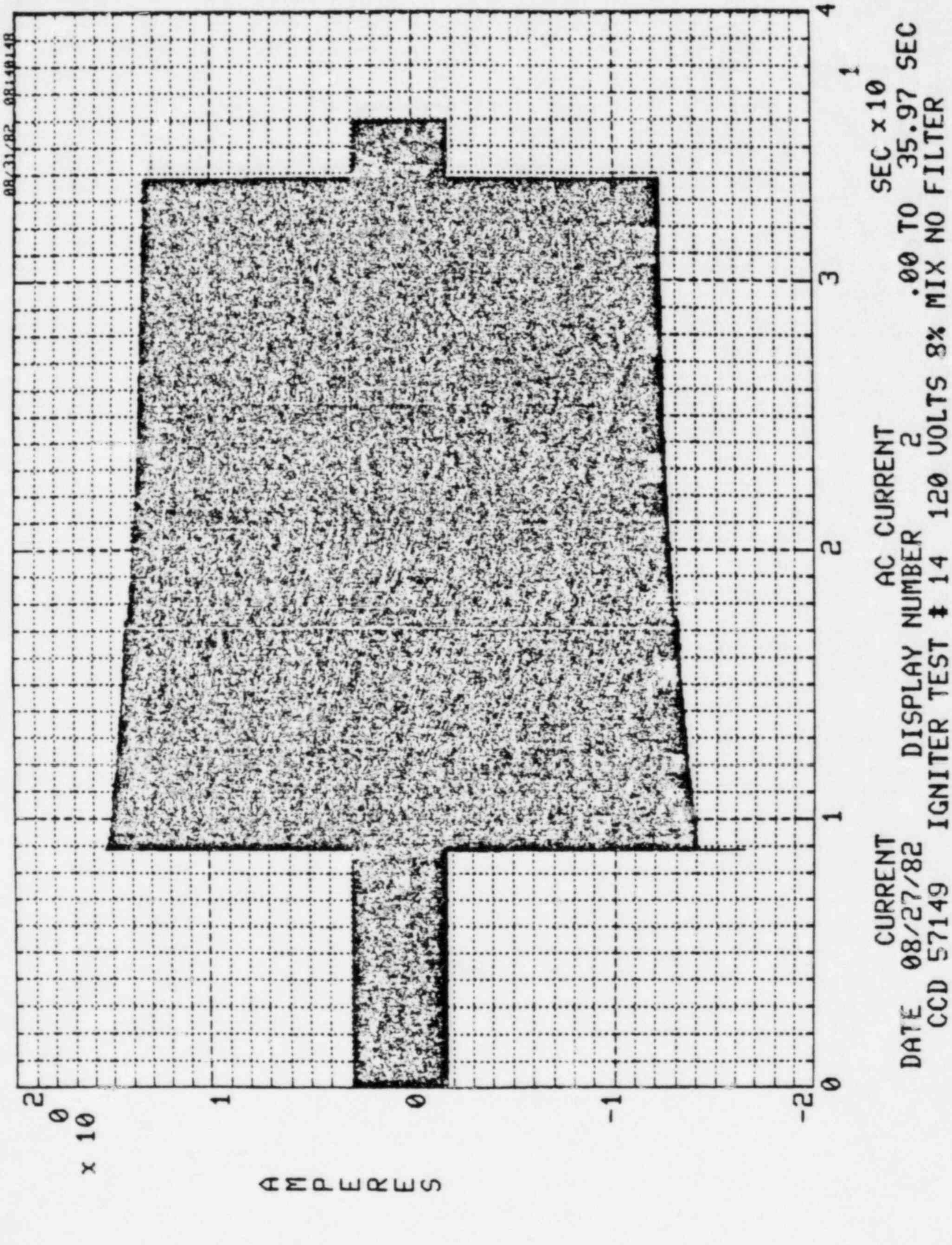

08/30/82 11:25:03
12
10
8
6
4
2
0
-2
-4
x 10 -1
PSIG
0
1
2
3
4
5
SEC x10 1
P-1
DATE 08/27/82
CCD 57149
PRESSURE
DISPLAY NUMBER 3
.00 TO 46.76 SEC
IGNITER TEST # 13 120 VOLTS 8% MIX NO FILTER

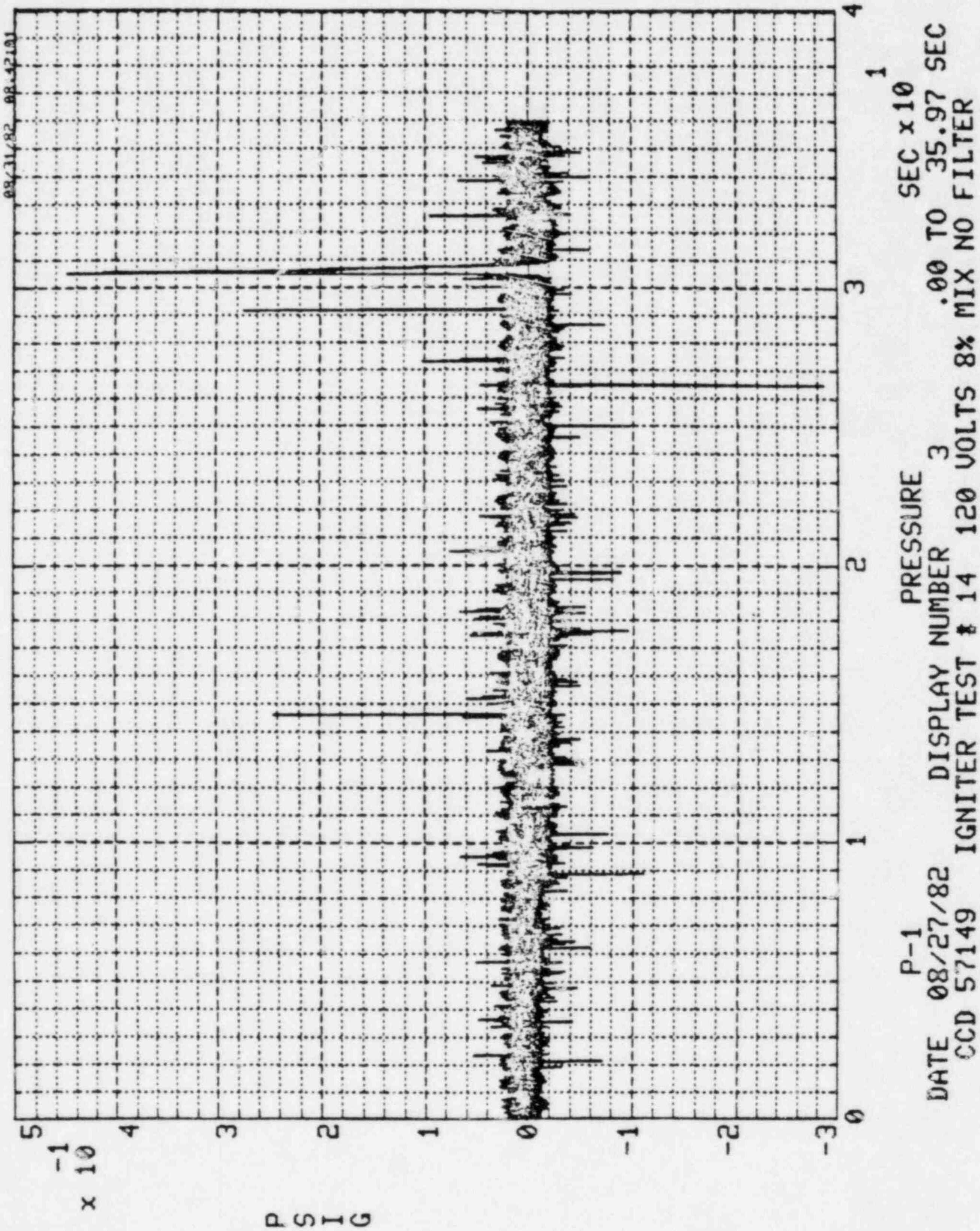

T1
DATE 08/27/82
DISPLAY NUMBER 4
TEMPERATURE
CCD 57149 IGNITER TEST # 13 120 VOLTS 8% MIX 10 HZ FILTER
SEC x 10
.00 TO 46.76 SEC
DEG. F. x 10
08/30/82 11:29:28
0
1
2
3
4
5
9
10
11
12
13
14
15
16
17
18

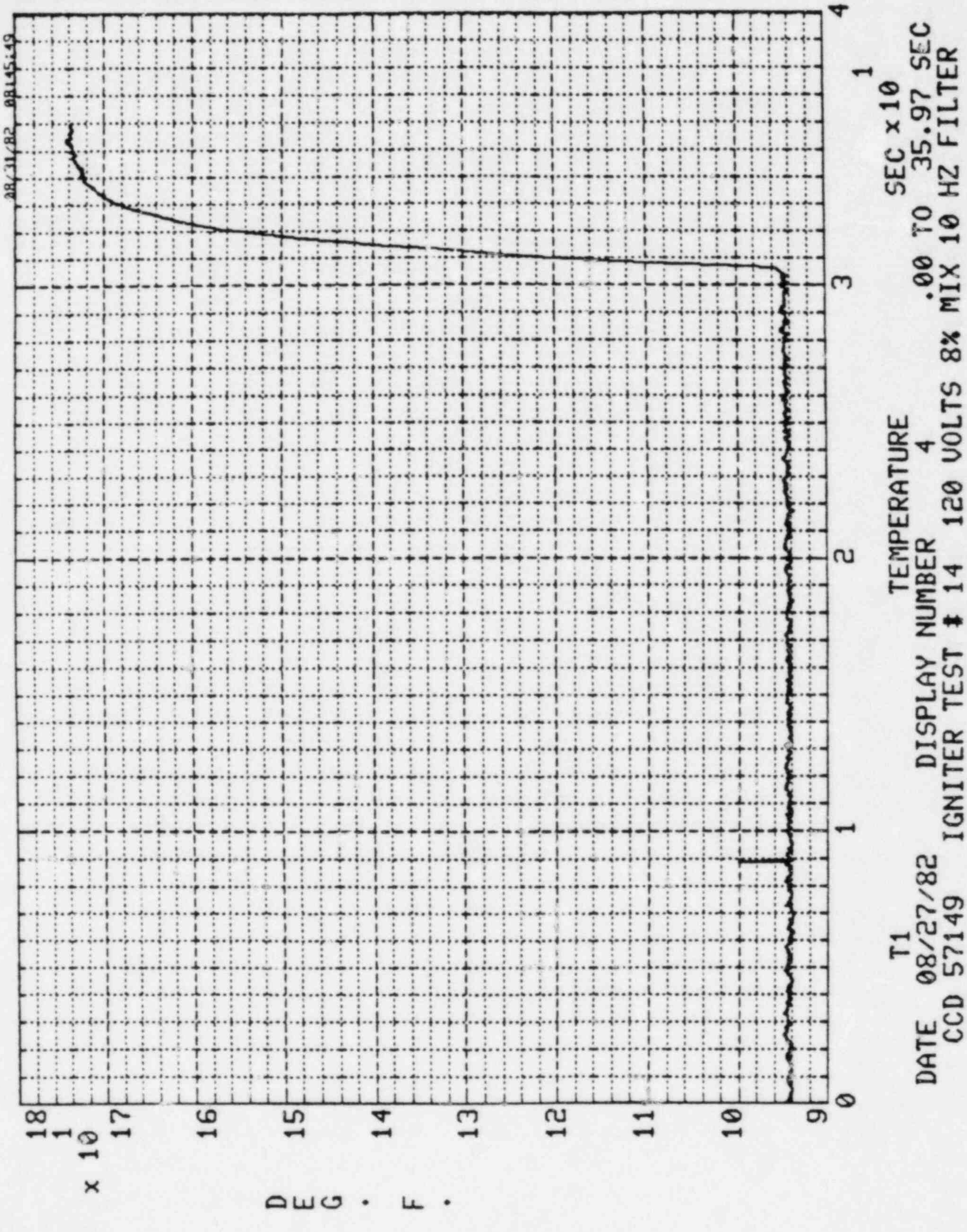

08/30/82 11:30:51
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 46.76 SEC
CCD 57149 IGNITER TEST # 13 120 VOLTS 8% MIX 10 HZ FILTER
SEC x 10 1
DEG. F. x 10 2
7
5
3
1
-1
-3
-5
-7
-9
0
1
2
3
4
5

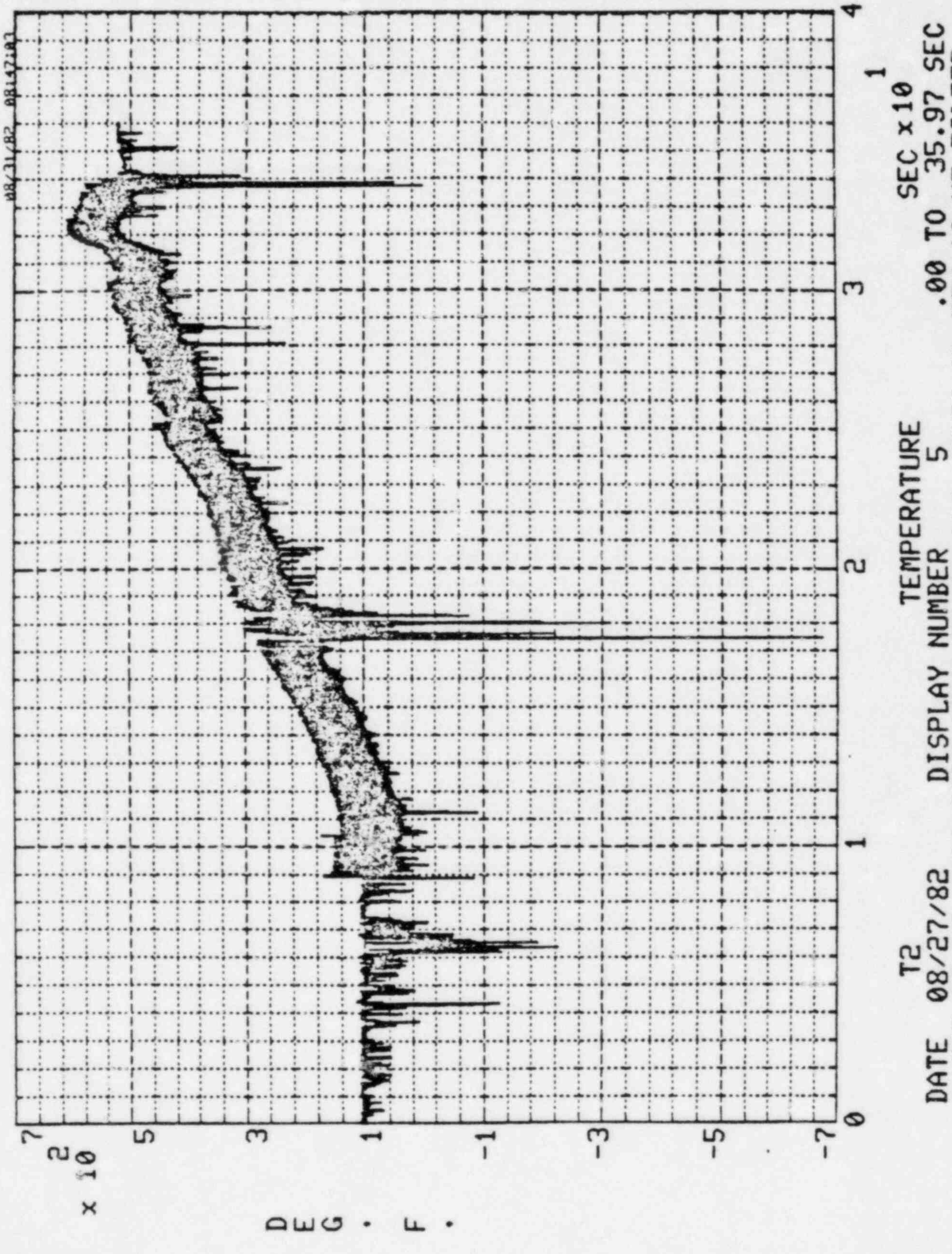

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 46.76 SEC
CCD 57149 IGNITER TEST # 13 120 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
DEG. F.
x 10 2
2
0
-2
-4
-6
-8
0
1
2
3
4
5

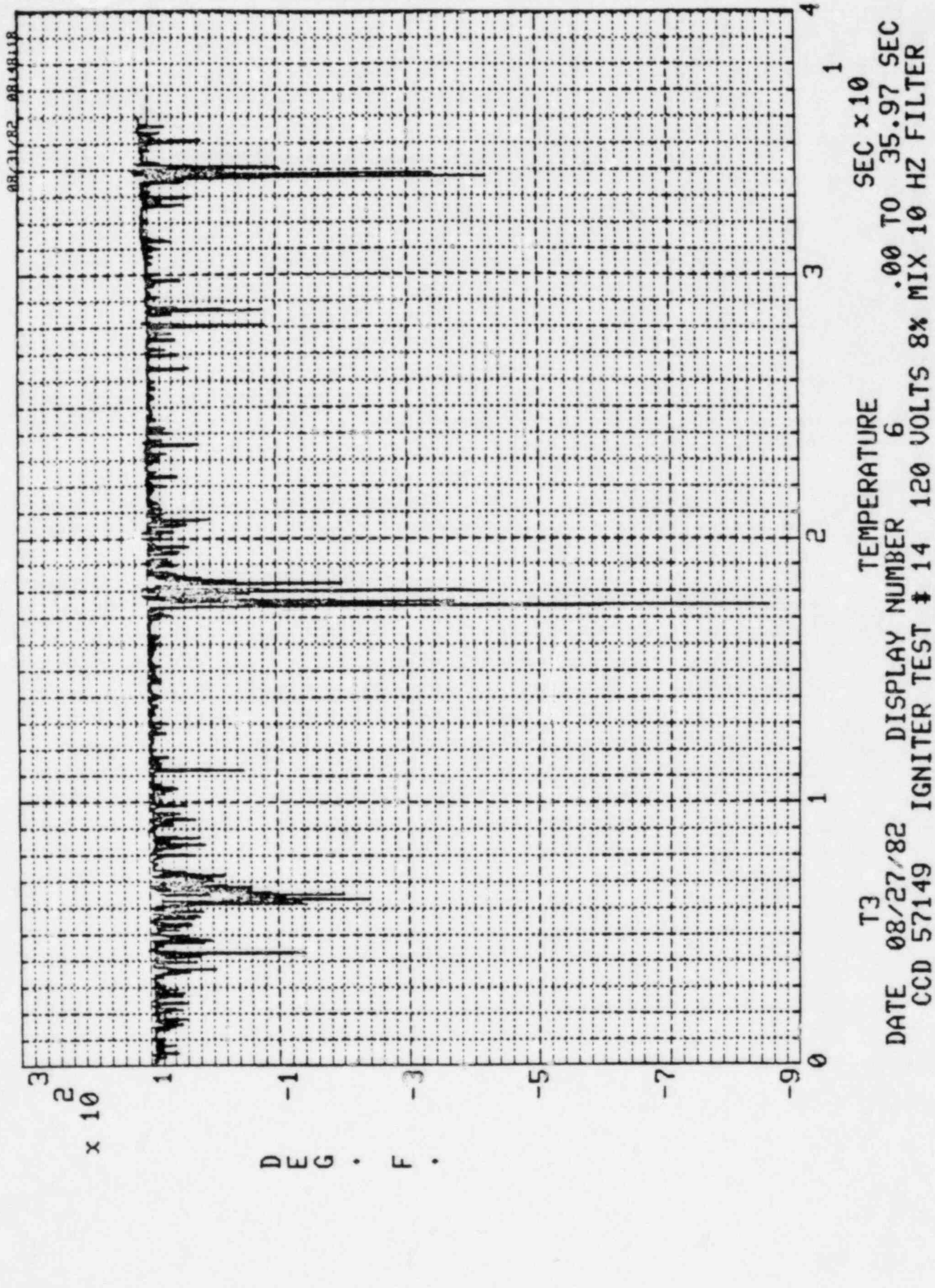

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 14 120 VOLTS 8% MIX NO FILTER
SEC x10^1
0.00 TO 35.97 SEC
VOLTS
x 10^1

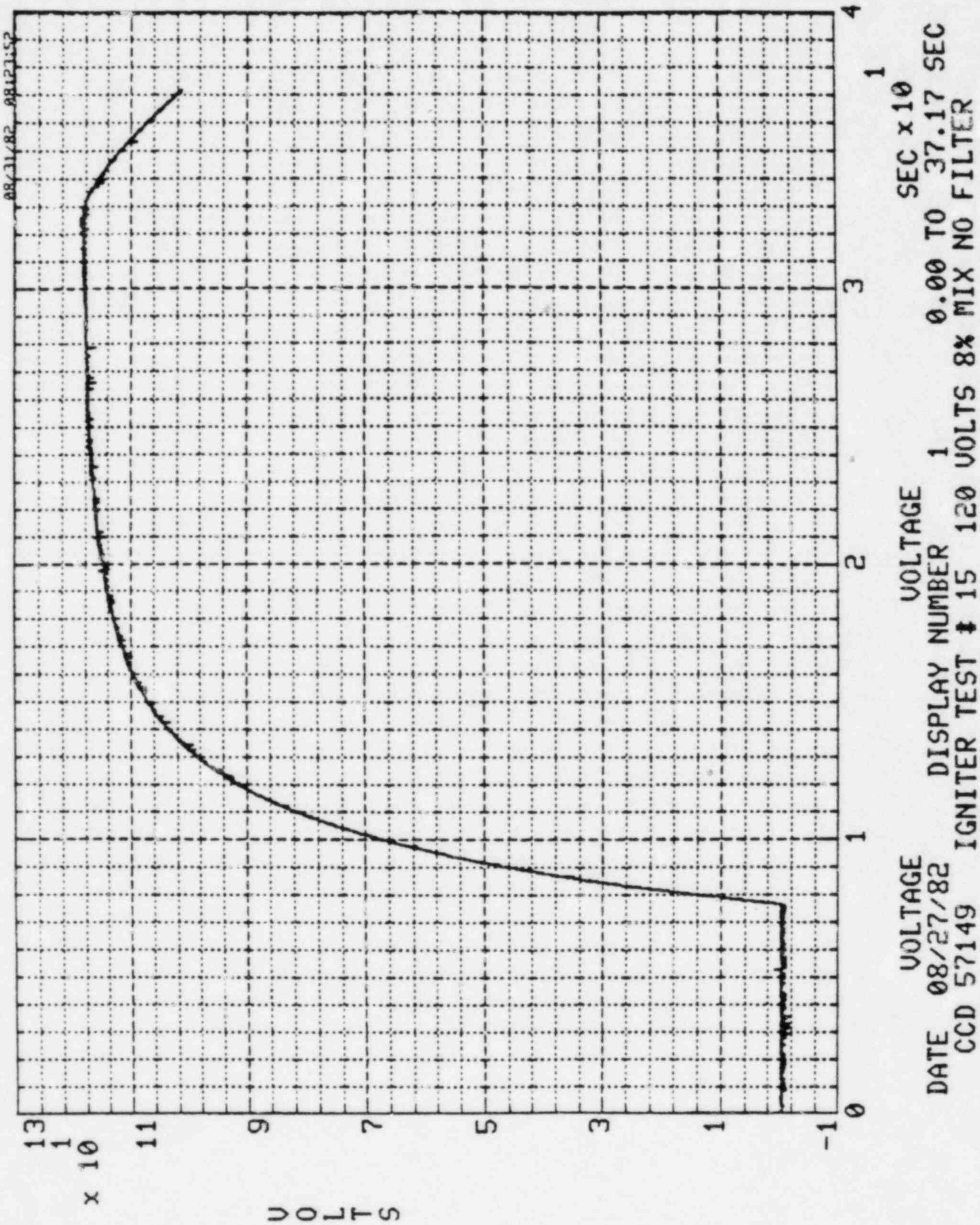

08/31/82
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 14 120 VOLTS 9% MIX NO FILTER
SEC x10 1
AMPERES x 10 0
0
1
2
3
4
-2
-1
0
1
2

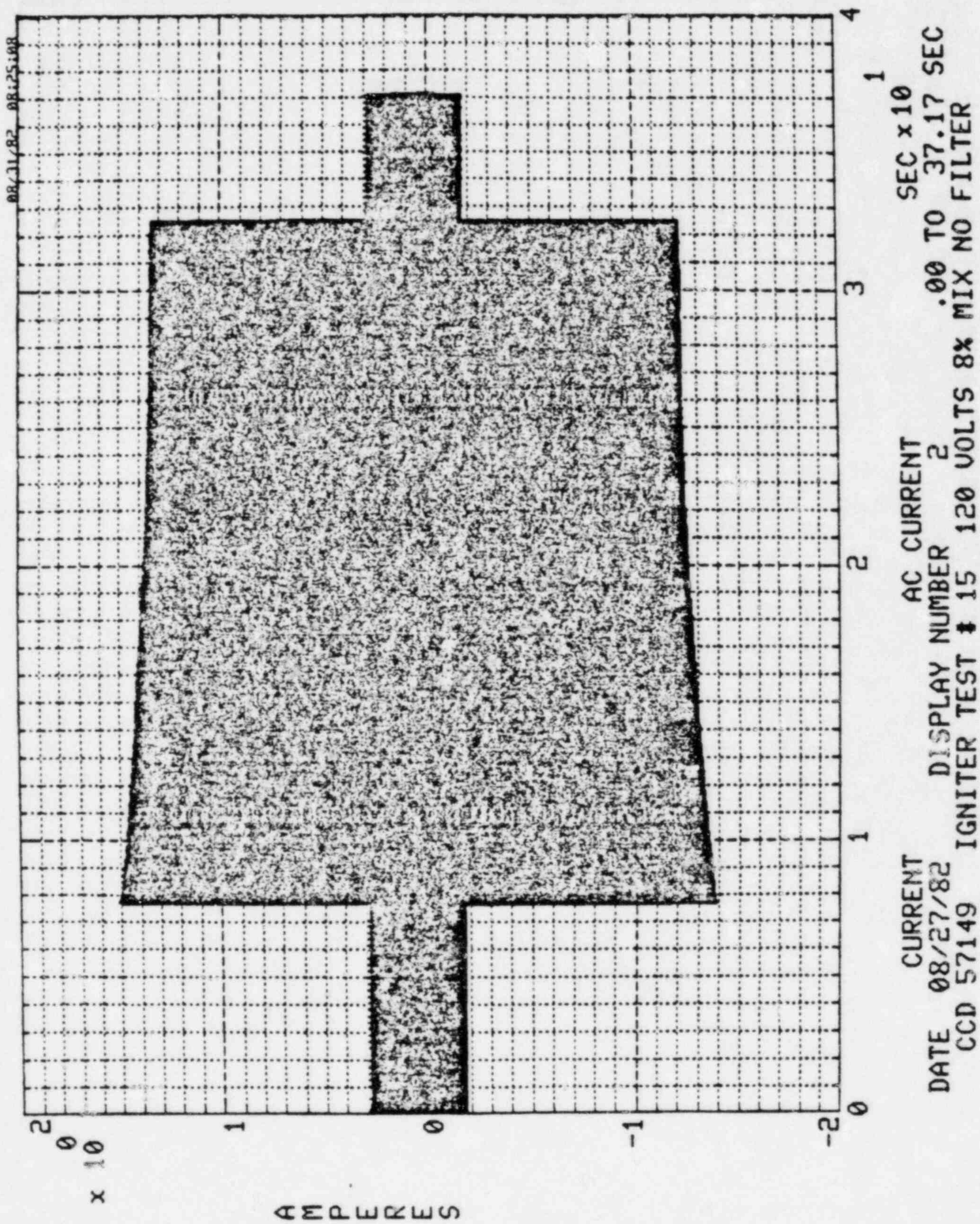

08/31/82 08:42:01
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 14 120 VOLTS 8% MIX NO FILTER
SEC x10^1 .00 TO 35.97 SEC
PSIG x 10^-1
5
4
3
2
1
0
-1
-2
-3
0
1
2
3
4

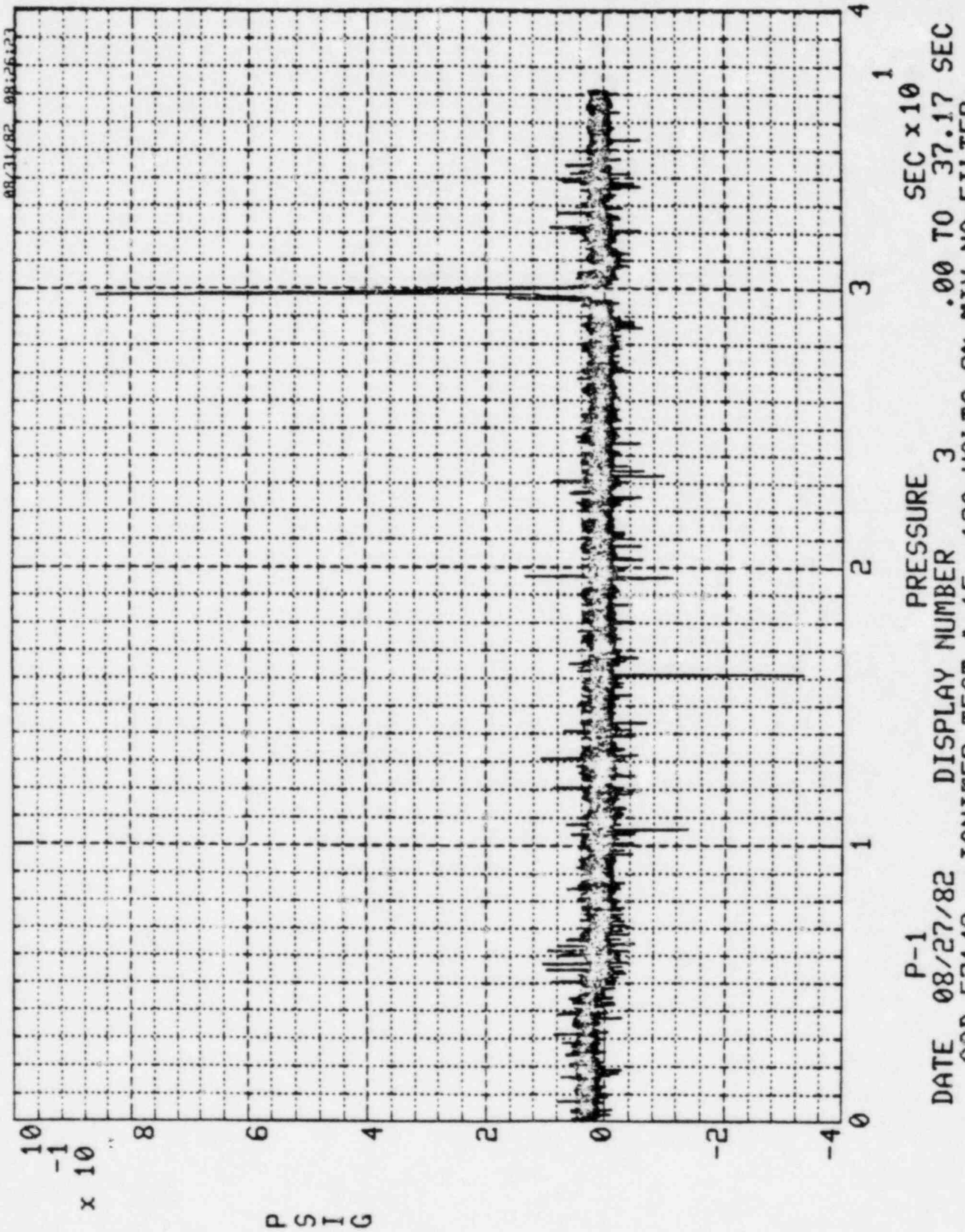

08/31/82 08:45:19
DEG. F.
x 10 1
SEC x 10 1
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 14 120 VOLTS 8% MIX 10 HZ FILTER

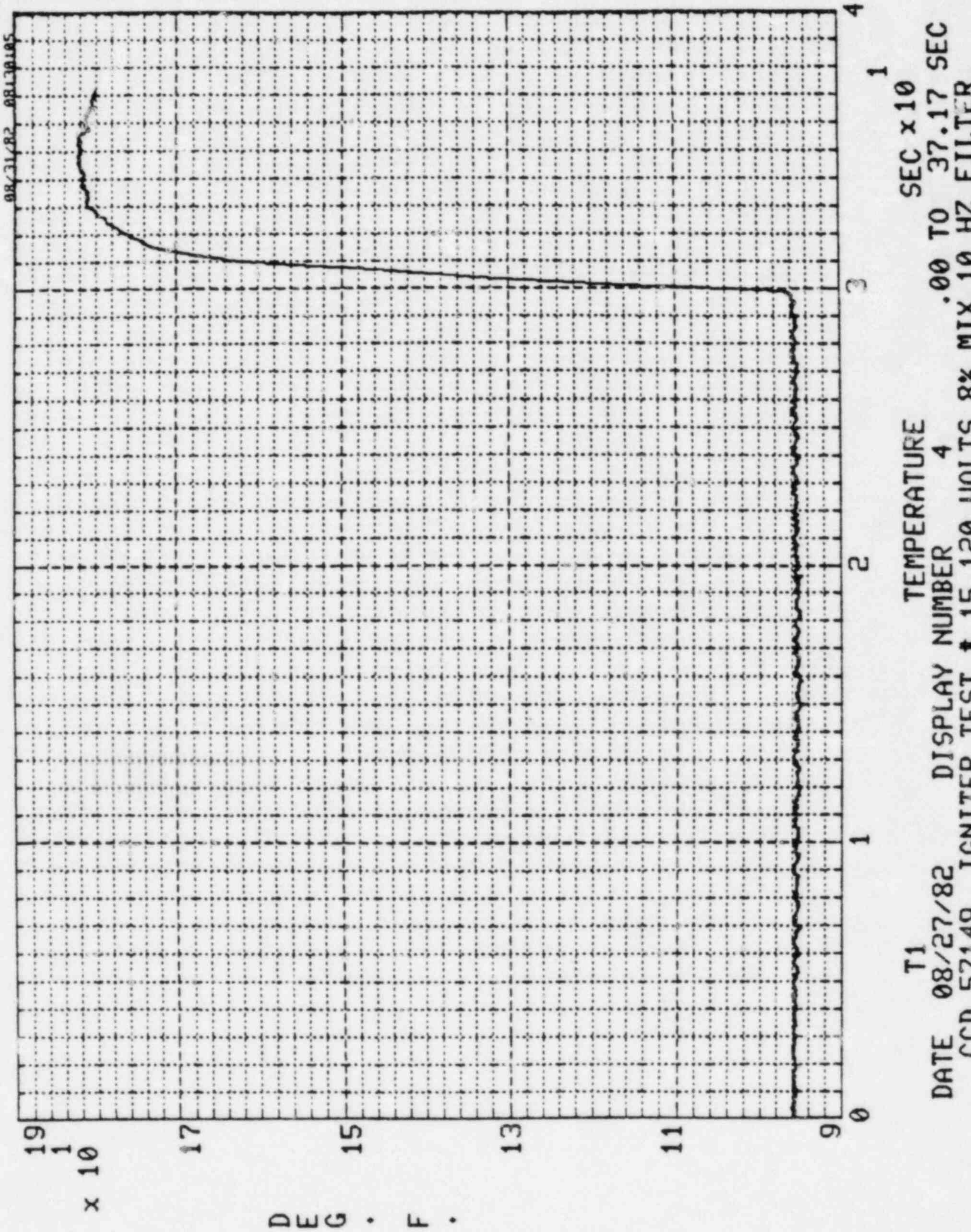

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 14 120 VOLTS 8% MIX 10 HZ FILTER
SEC x10^1
DEG. F. x10^2
7
5
3
1
-1
-3
-5
-7
0
1
2
3
4

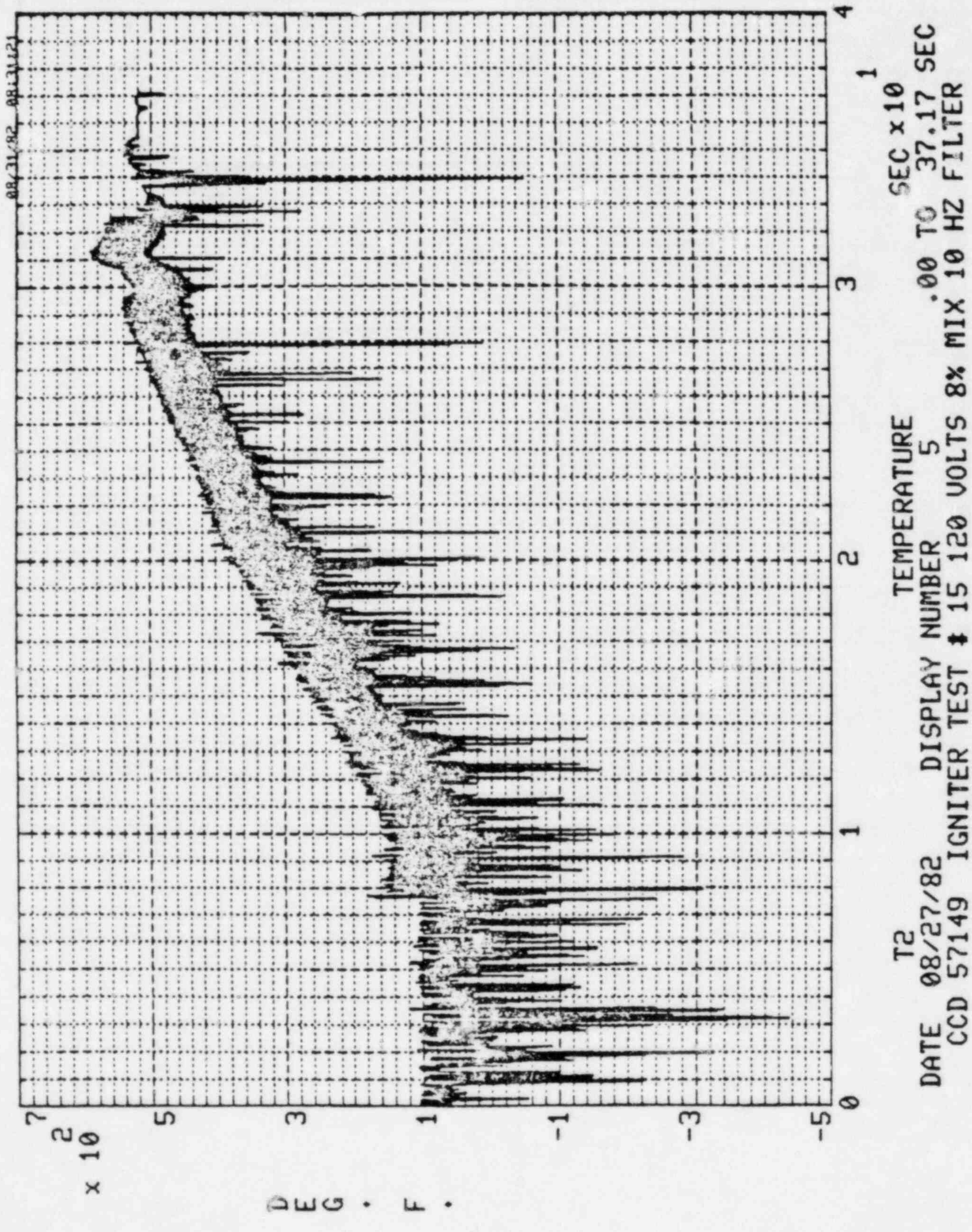

08/31/82 08:48:18
x 10^2
DEG. F.
3
1
-1
-3
-5
-7
-9
0
1
2
3
4
SEC x 10^1
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 14 120 VOLTS 8% MIX 10 HZ FILTER

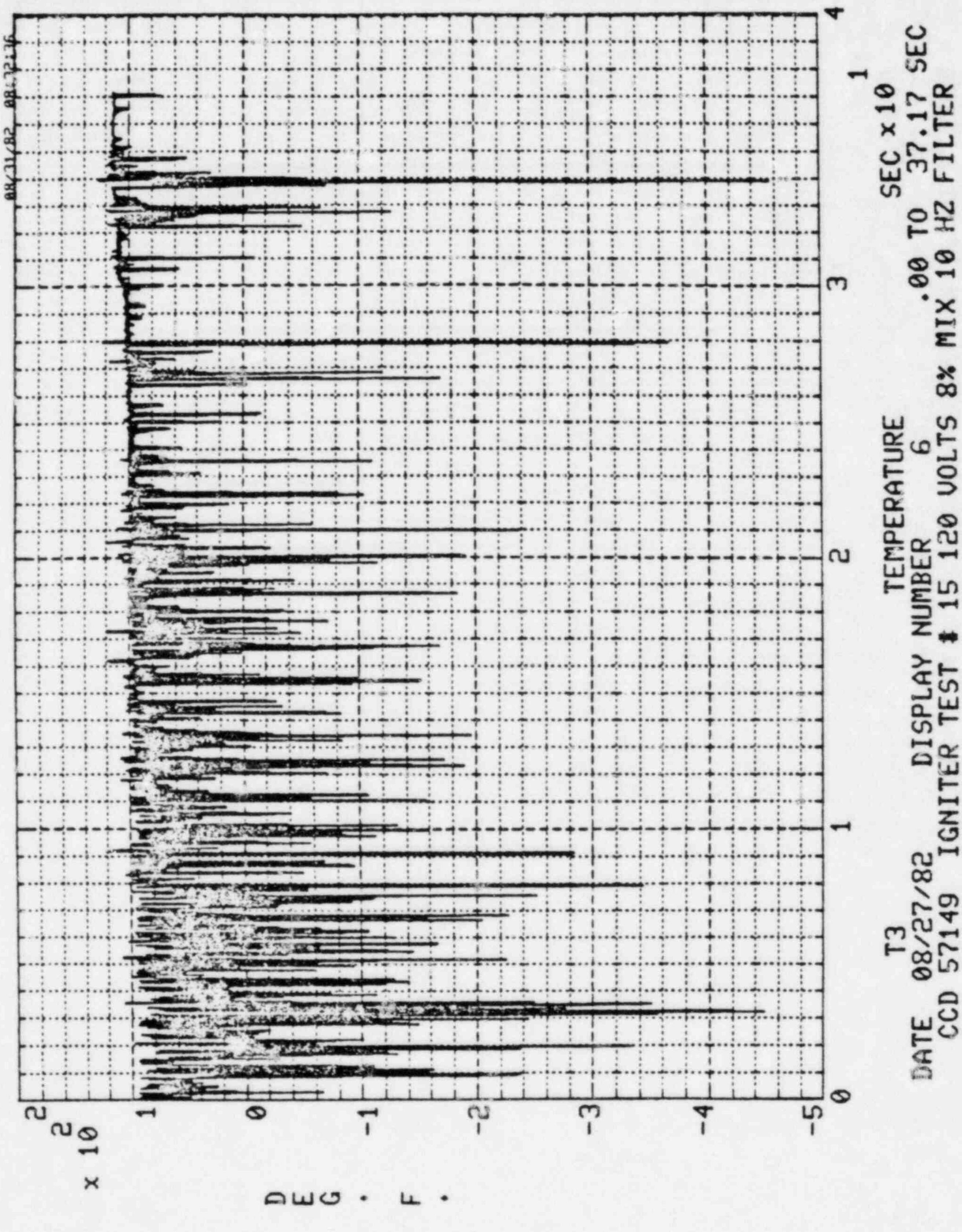

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 15 120 VOLTS 8% MIX NO FILTER
0.00 TO 37.17 SEC
SEC x 10
1
VOLTS
x 10
1
08/31/82 08:23:52

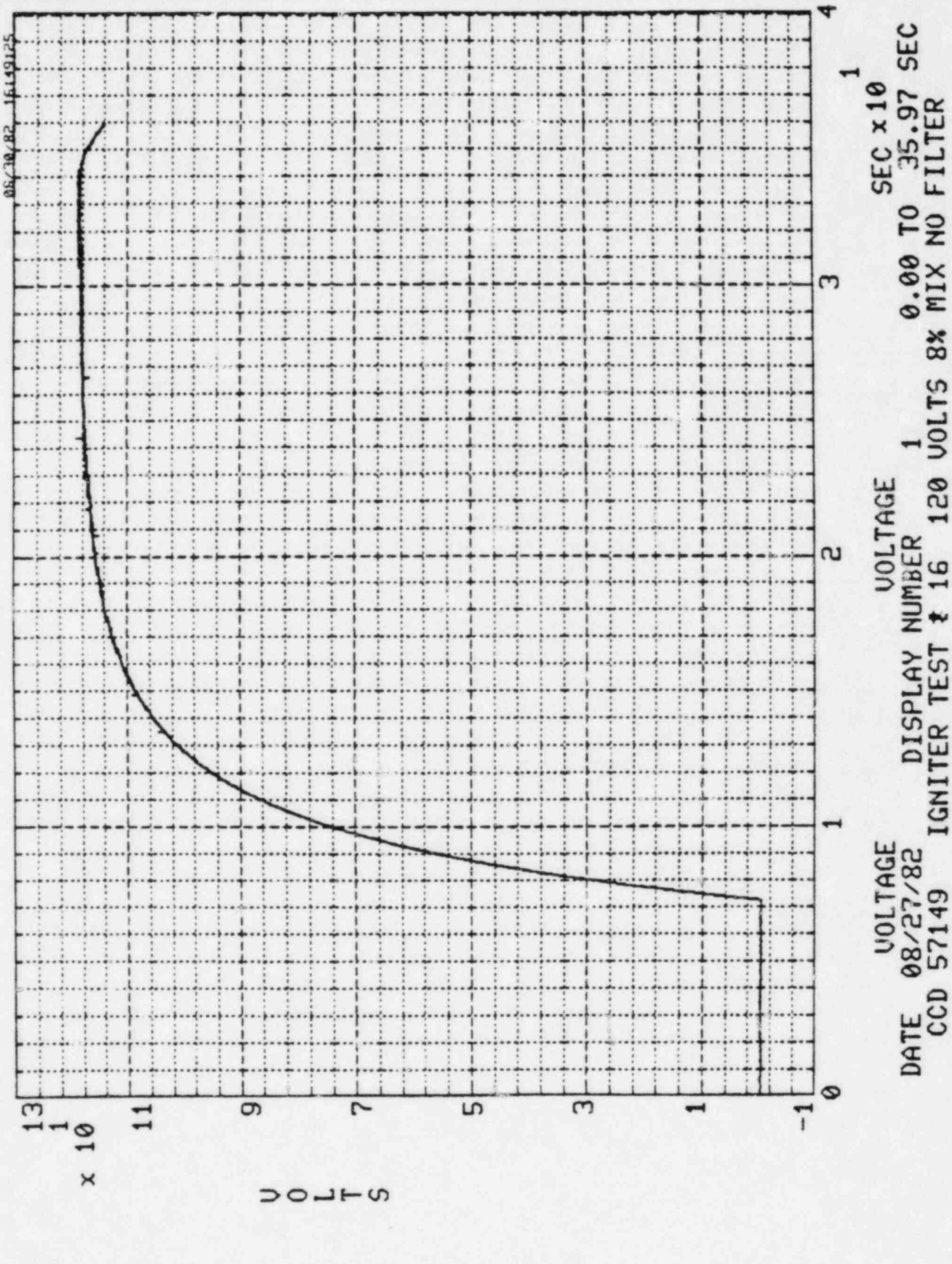

08/31/82 08:25:08
AMPERES x 10 0
2
1
0
-1
-2
0
1
2
3
4
SEC x10 1
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 15 120 VOLTS 8% MIX NO FILTER

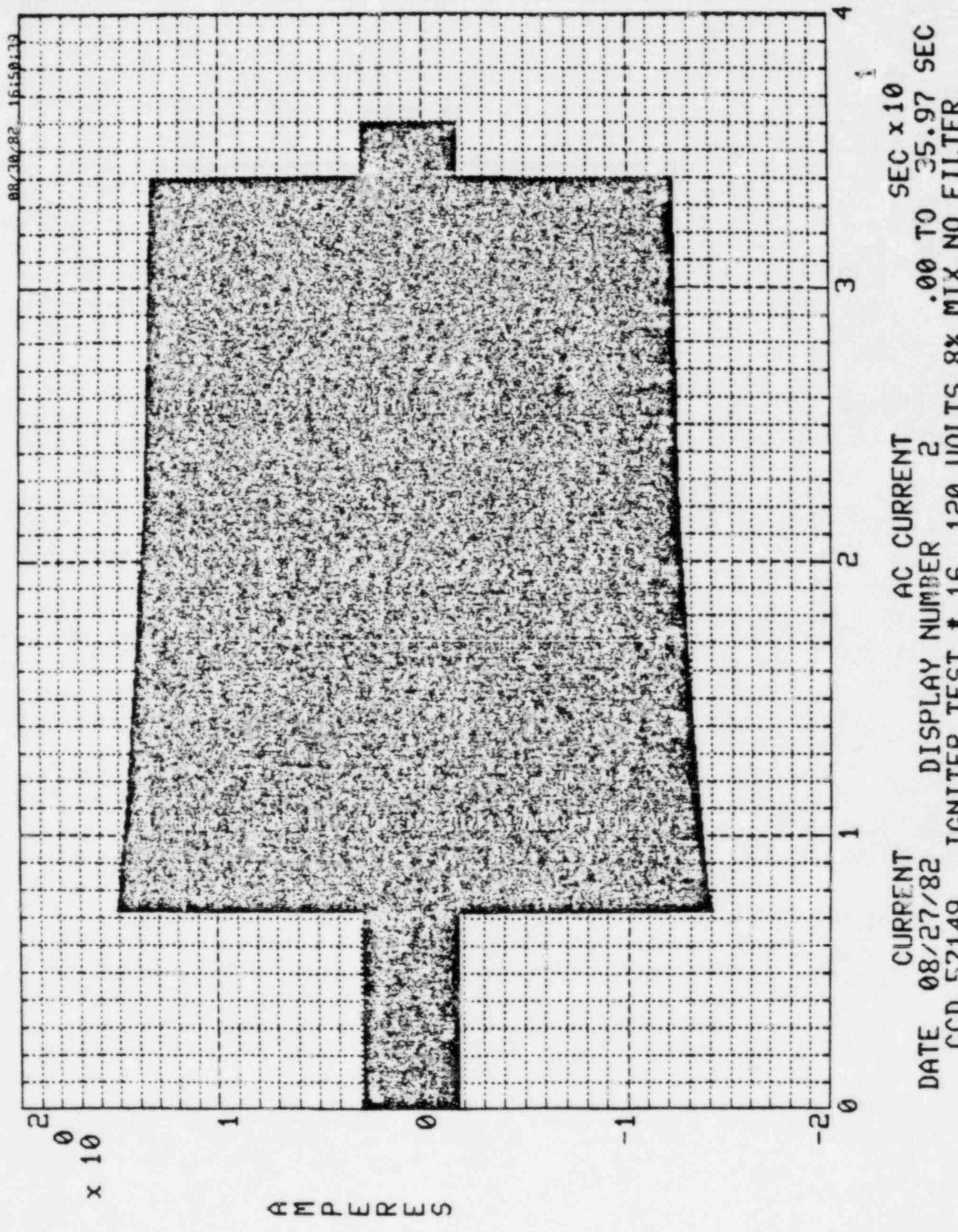

08/31/82 08:26:23
P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 15 120 VOLTS 8% MIX NO FILTER
.00 TO 37.17 SEC
SEC x10 1
P S I G
x 10 -1
10
8
6
4
2
0
-2
-4
0
1
2
3
4

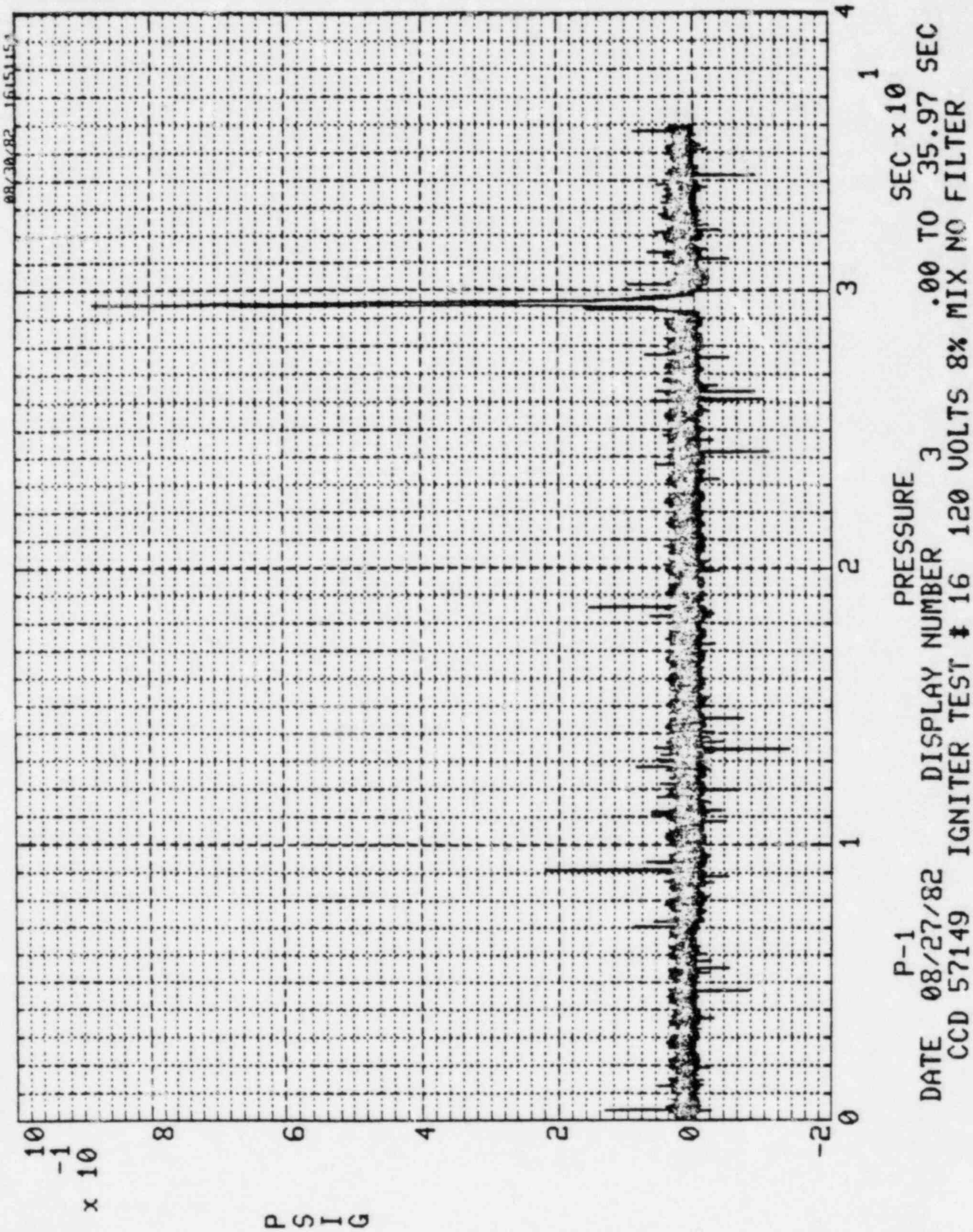

T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 15 120 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
0
1
2
3
4
DEG. F.
x 10 1
9
11
13
15
17
19

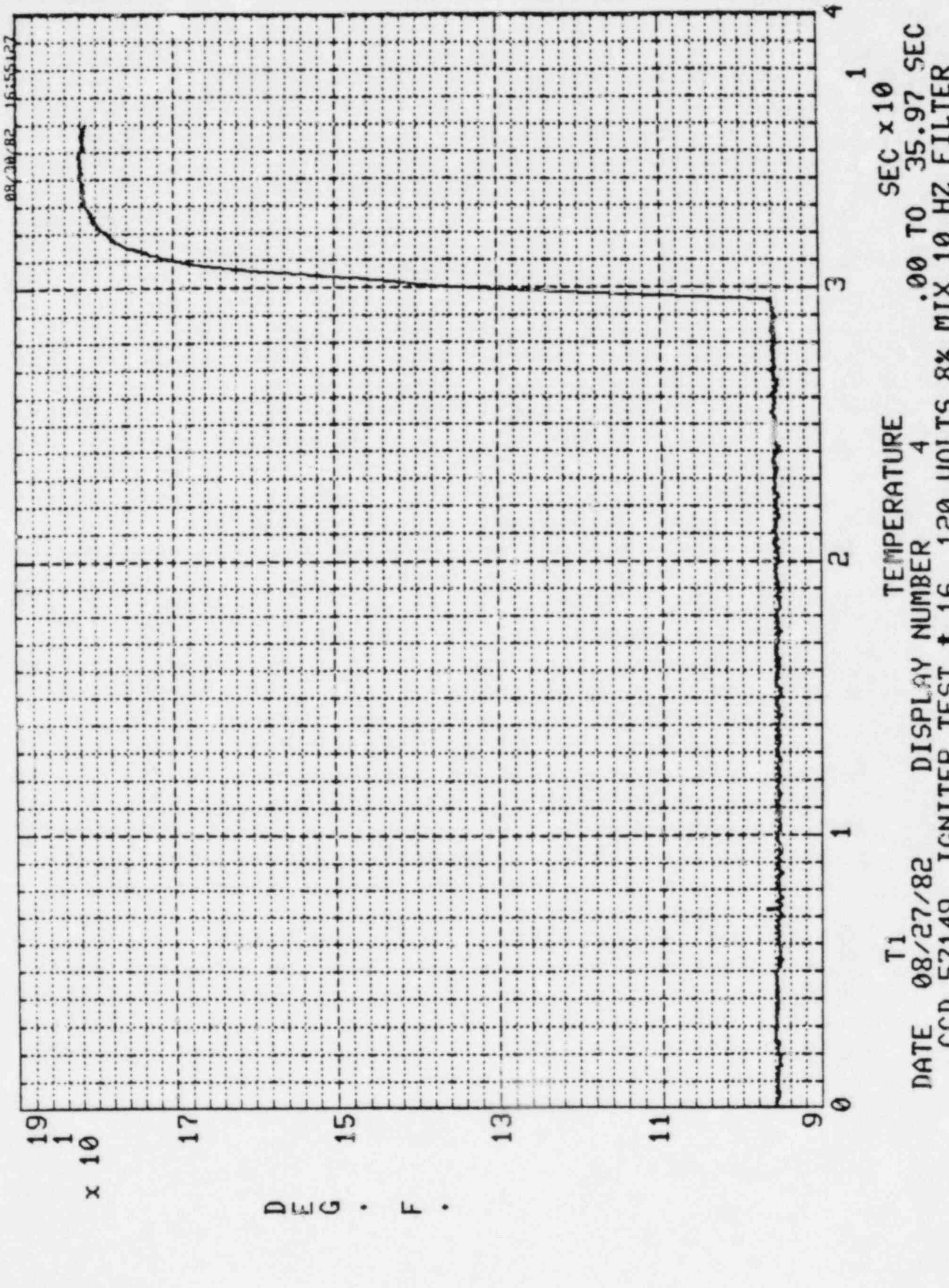

08/31/82 08:31:21
7
5
3
1
-1
-3
-5
x 10
2
DEG. F.
0
1
2
3
4
SEC x10
1
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 15 120 VOLTS 8% MIX 10 HZ FILTER

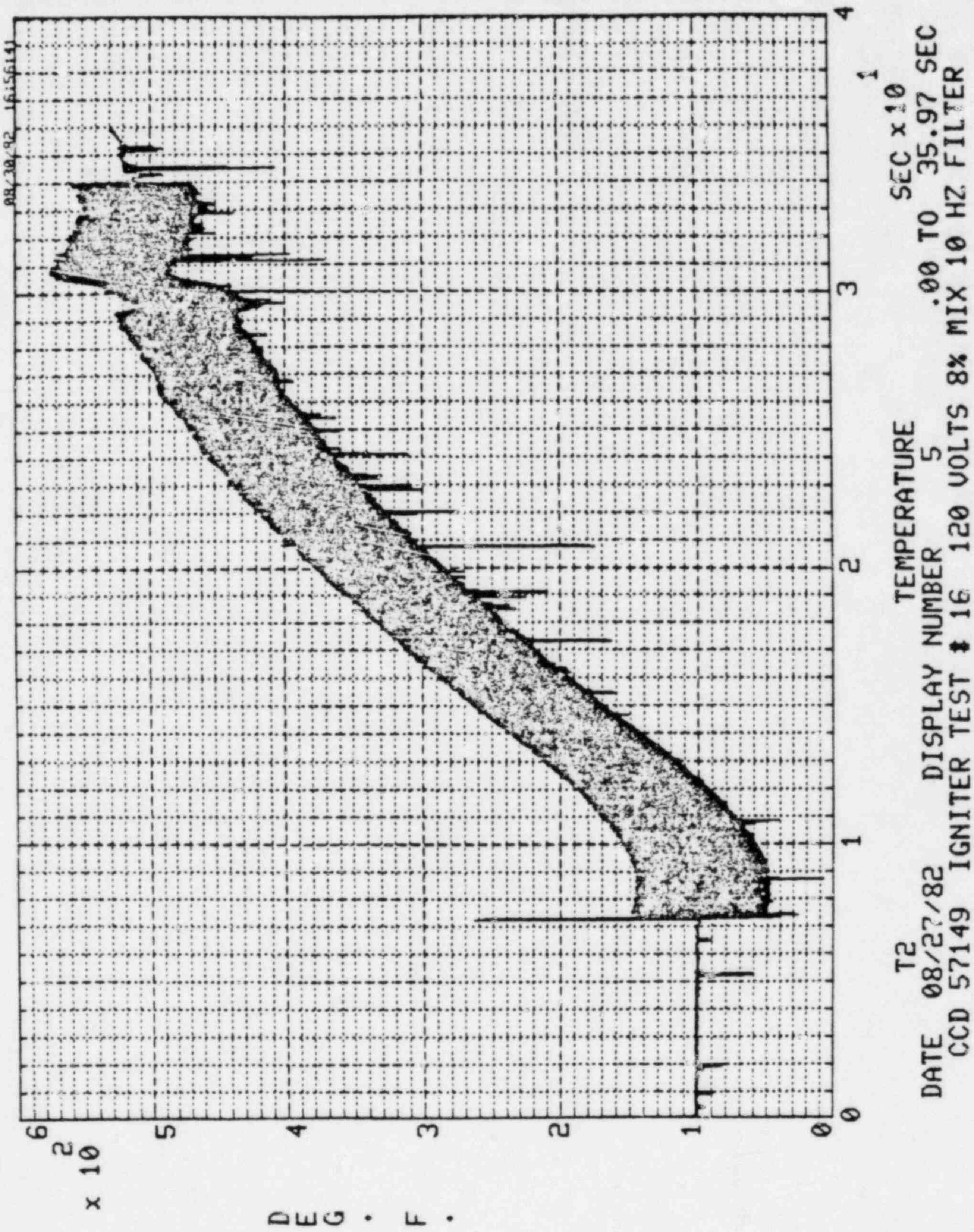

T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 15 120 VOLTS 8% MIX 10 HZ FILTER
SEC x10
.00 TO 37.17 SEC
DEG. F.
x 10
2
1
0
-1
-2
-3
-4
-5
0
1
2
3
4

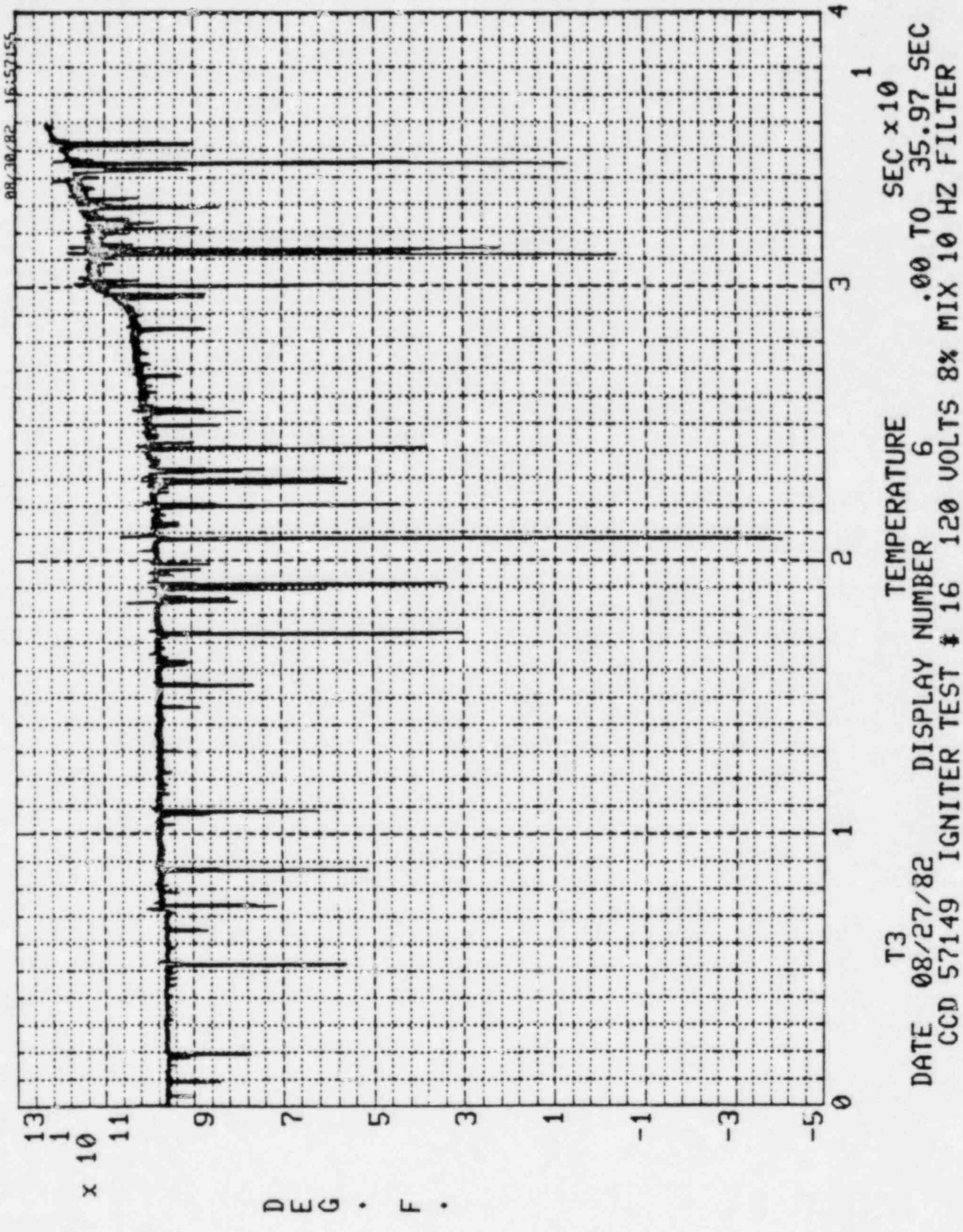

VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 16 120 VOLTS 8% MIX NO FILTER
VOLTAGE
SEC x 10 1
VOLTS
x 10 1
13
11
9
7
5
3
1
-1
0
1
2
3
4

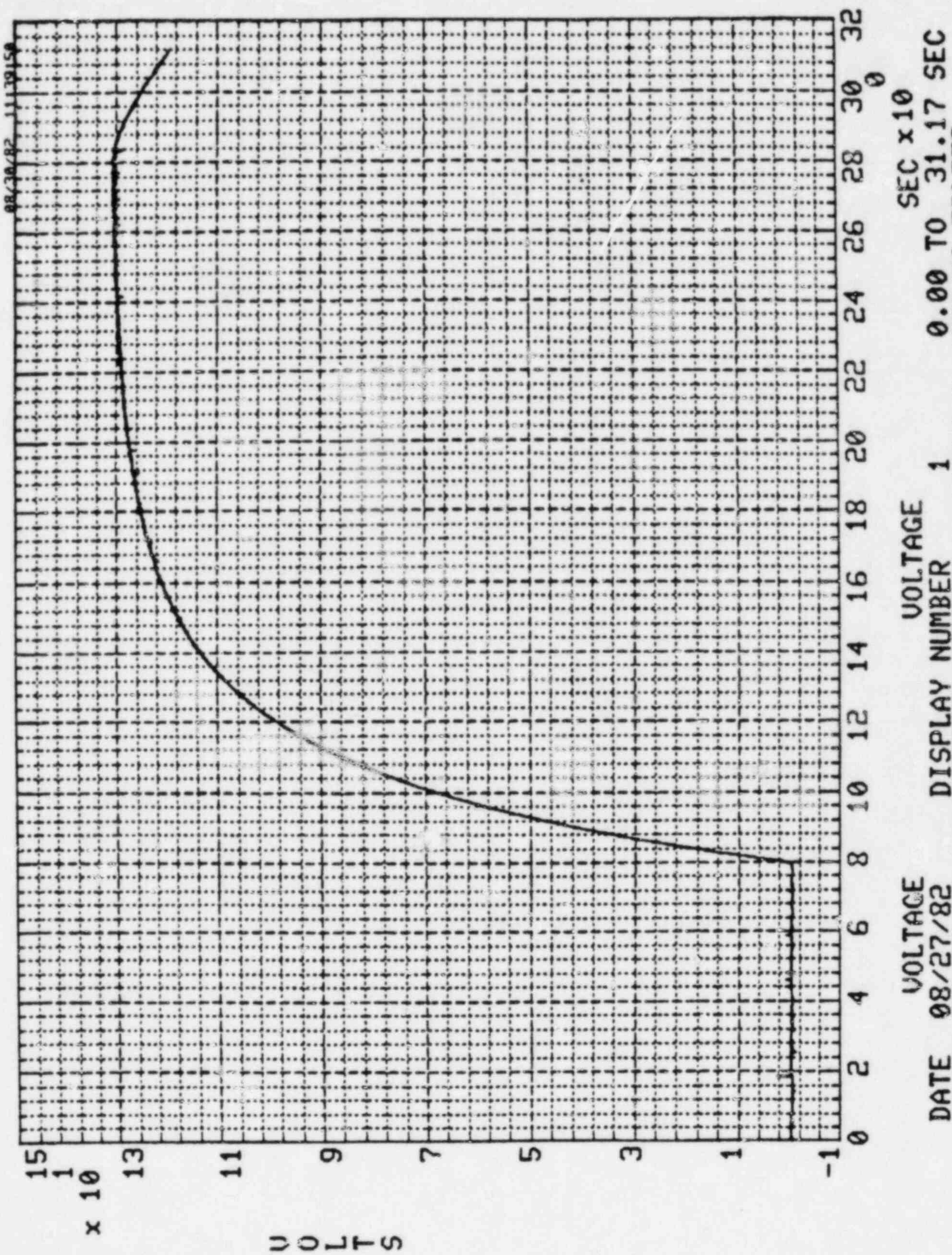

08/30/82 16:50:33
2
1
0
-1
-2
x 10⁰
AMPERES
0
1
2
3
4
CURRENT AC CURRENT SEC x 10
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 16 120 VOLTS 8% MIX NO FILTER

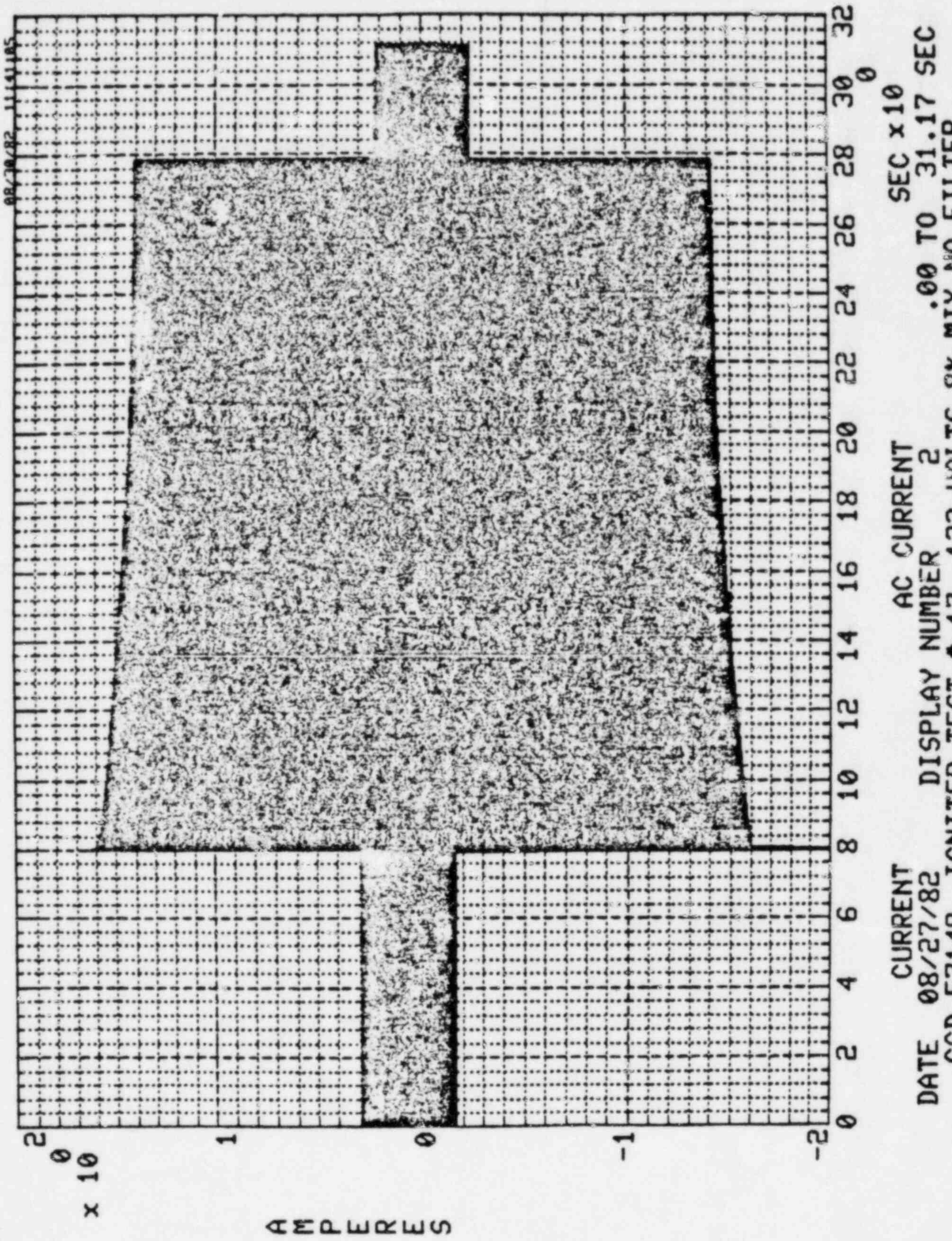

P-1
PRESSURE
DATE 08/27/82
DISPLAY NUMBER 3
.00 TO 35.97 SEC
CCD 57149
IGNITER TEST # 16
120 VOLTS 8% MIX NO FILTER
SEC x 10
1
PSIG
x 10
-1
10
8
6
4
2
0
-2
0
1
2
3
4

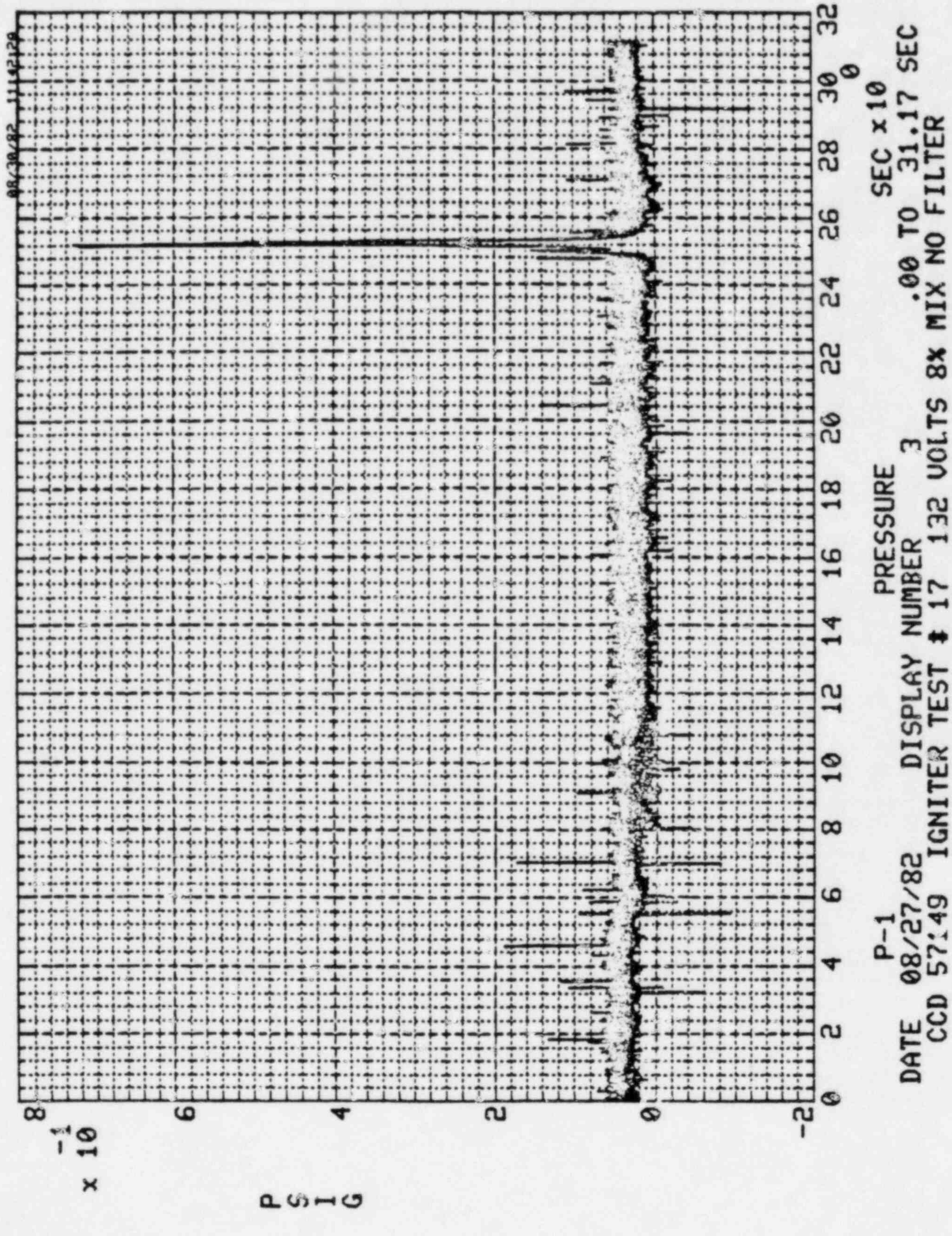

08/30/82 16:55:27
19
17
15
13
11
9
x 10 1
DEG. F.
0
1
2
3
4
SEC x10 1
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 16 120 VOLTS 8% MIX 10 HZ FILTER

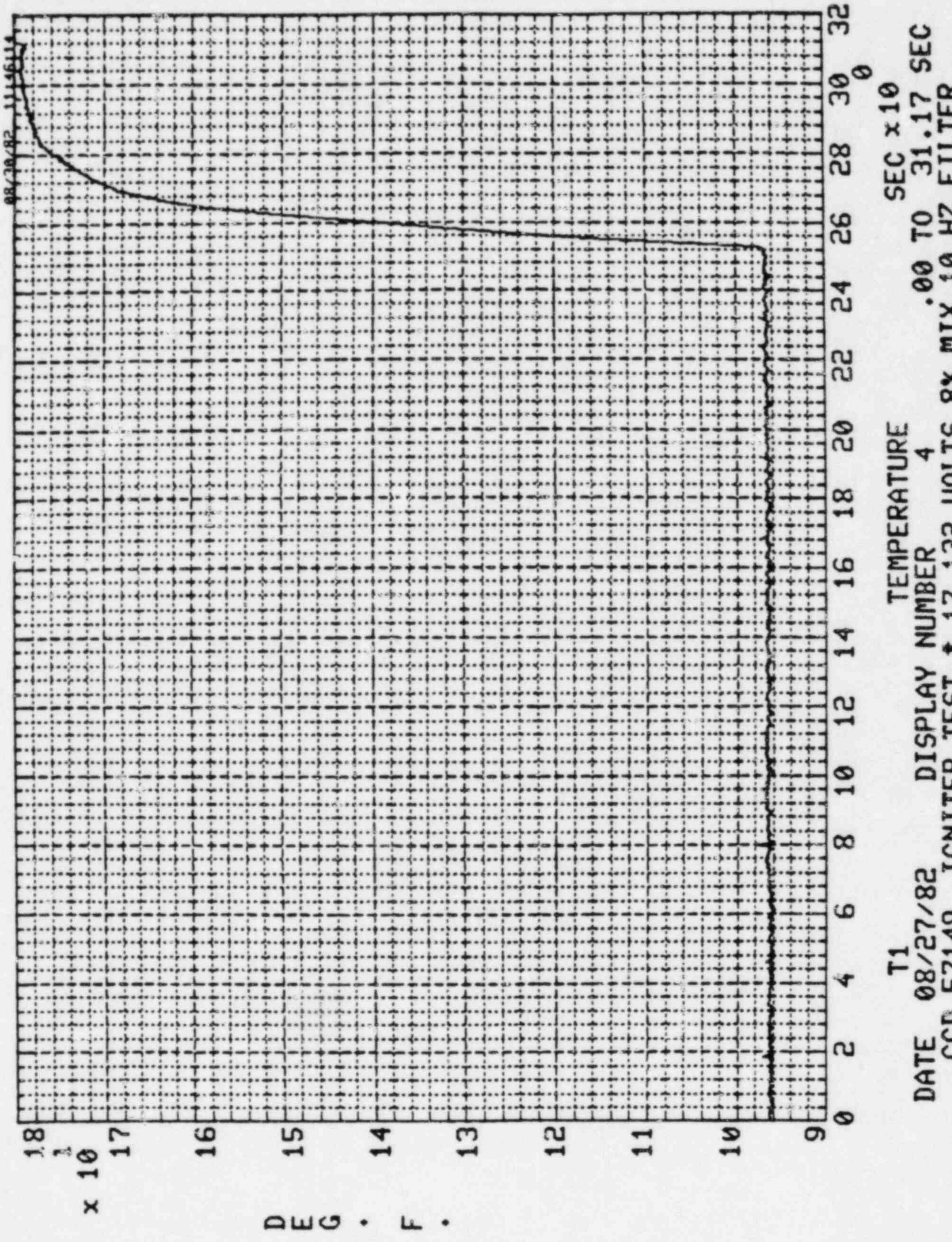

08/30/82 16:56:41
0
1
2
3
4
5
6
x 10^2
DEG. F.
0
1
2
3
4
SEC x 10^1
T2 TEMPERATURE SEC
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 35.97 SEC
CCD 57149 IGNITER TEST # 16 120 VOLTS 8% MIX 10 HZ FILTER

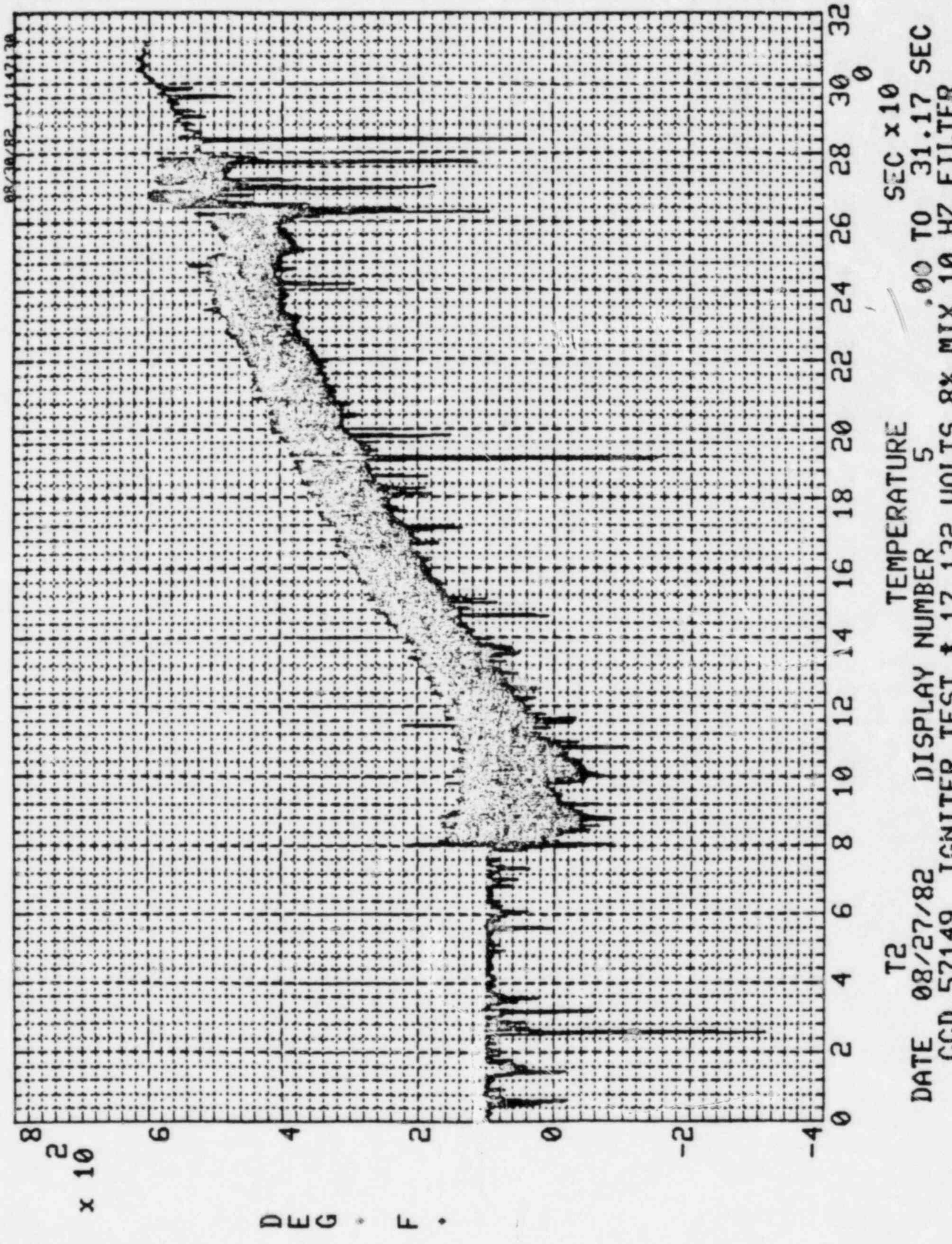

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 16 120 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
.00 TO 35.97 SEC
DEG. F
x 10 1
13
11
9
7
5
3
1
-1
-3
-5
0
1
2
3
4

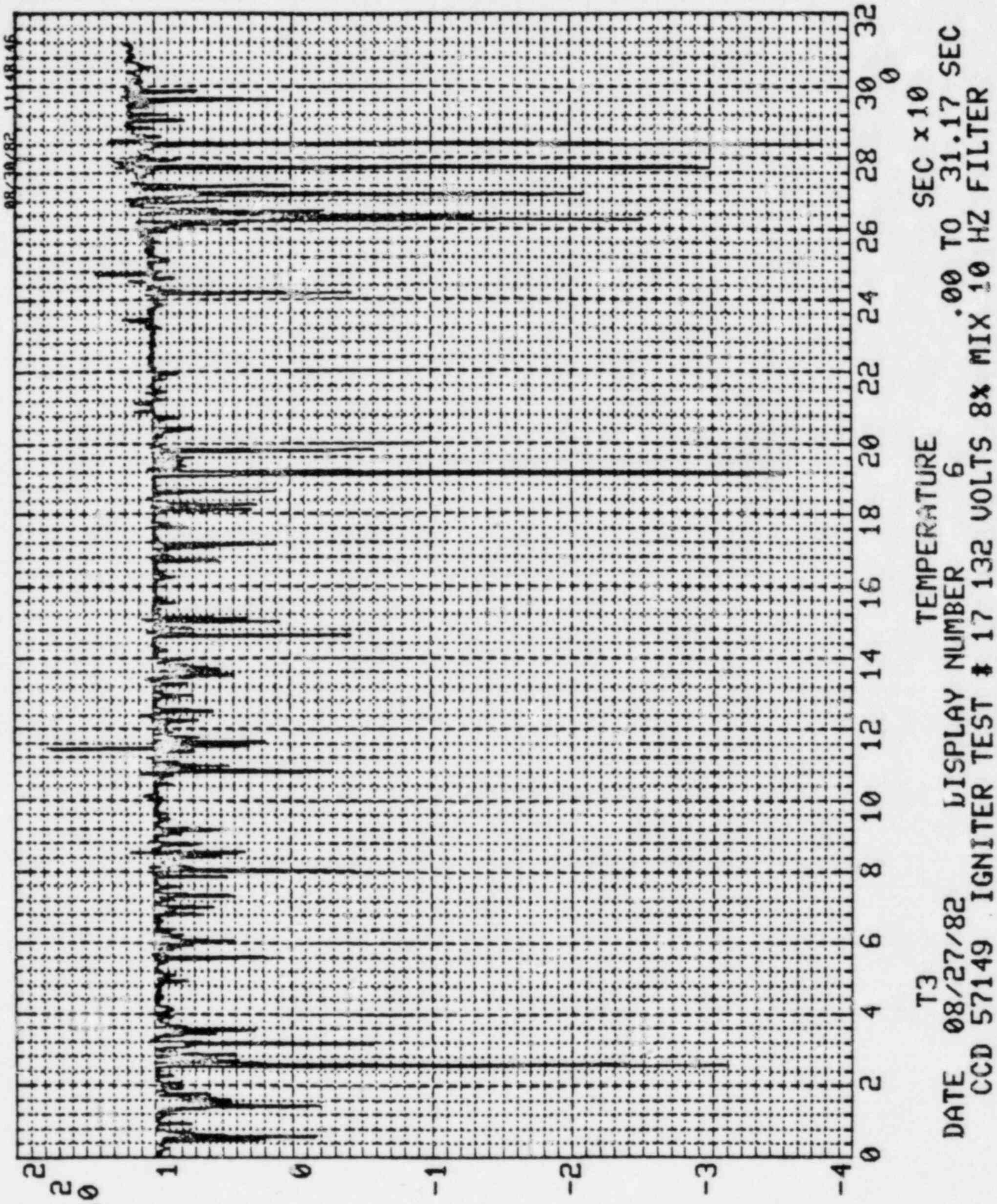

VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST # 17 132 VOLTS 8% MIX NO FILTER
VOLTAGE
SEC x10
0.00 TO 31.17 SEC
VOLTS
x 10
-1
1
3
5
7
9
11
13
15
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

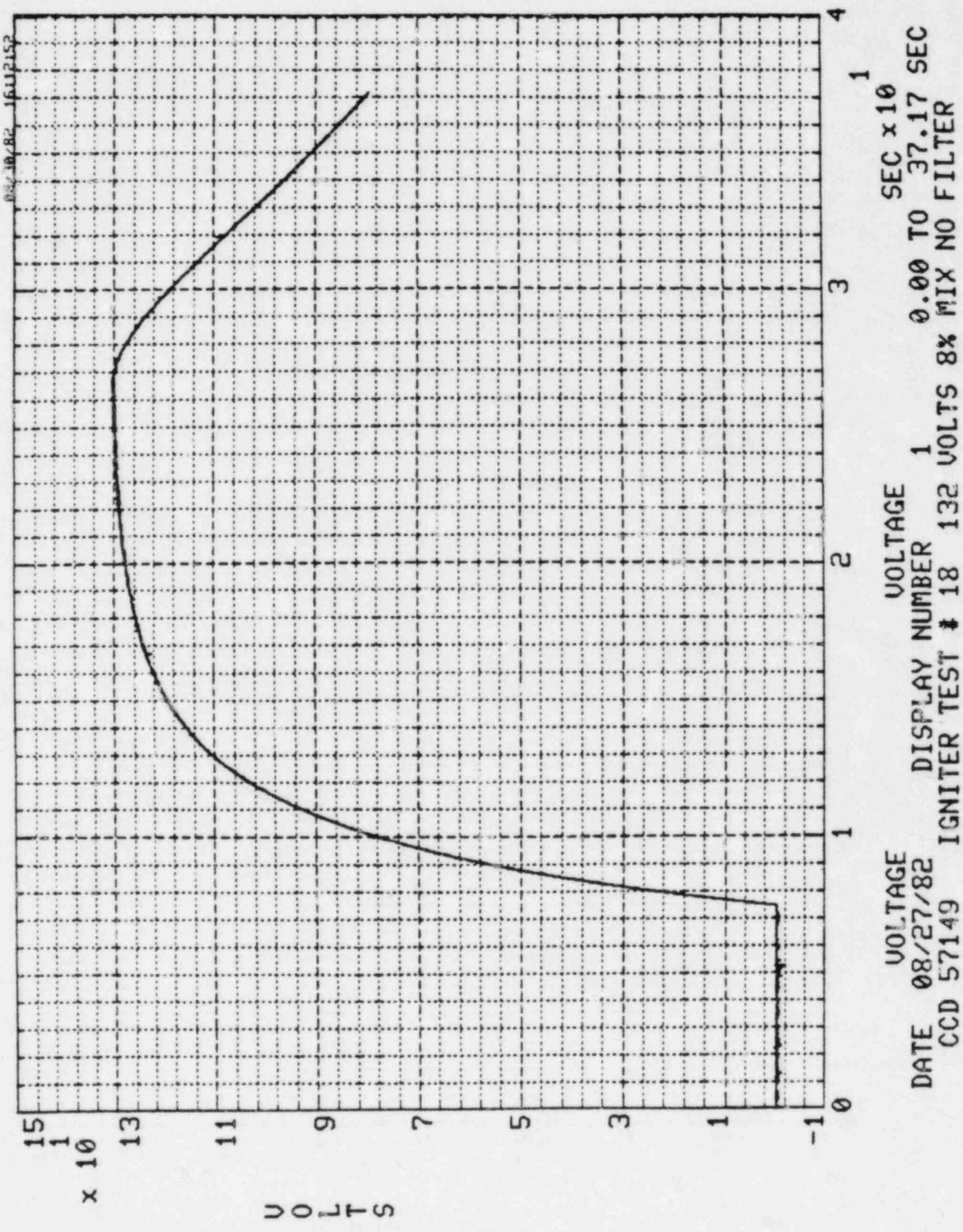

AMPERES
x 10
0
2
1
0
-1
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
SEC x10
0
CURRENT
AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
.00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 17 132 VOLTS 8% MIX NO FILTER

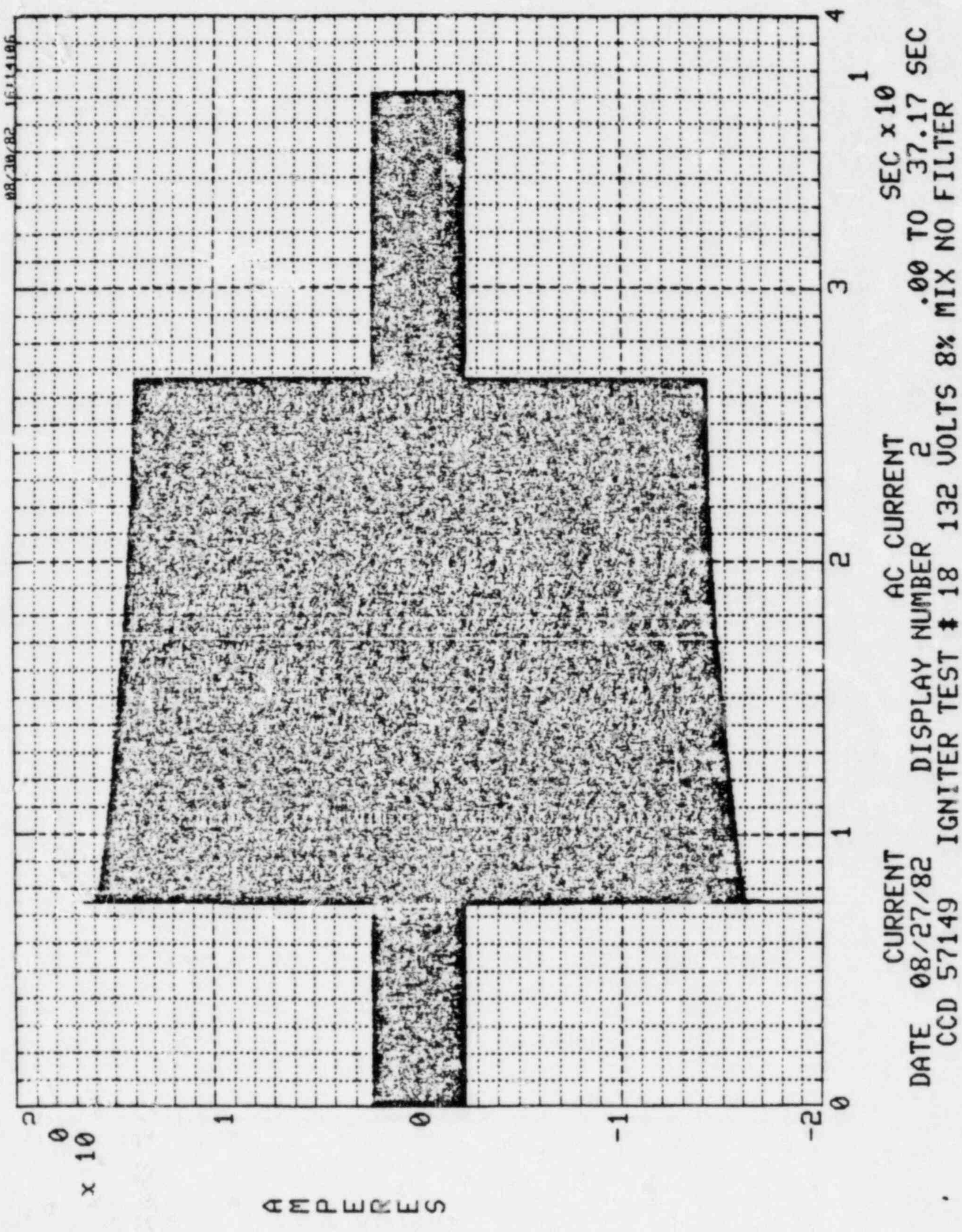

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57:49 IGNITER TEST # 17 132 VOLTS 8% MIX NO FILTER
SEC x 10^0
.00 TO 31.17 SEC
PSIG
x 10^-1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
-2 0 2 4 6 8

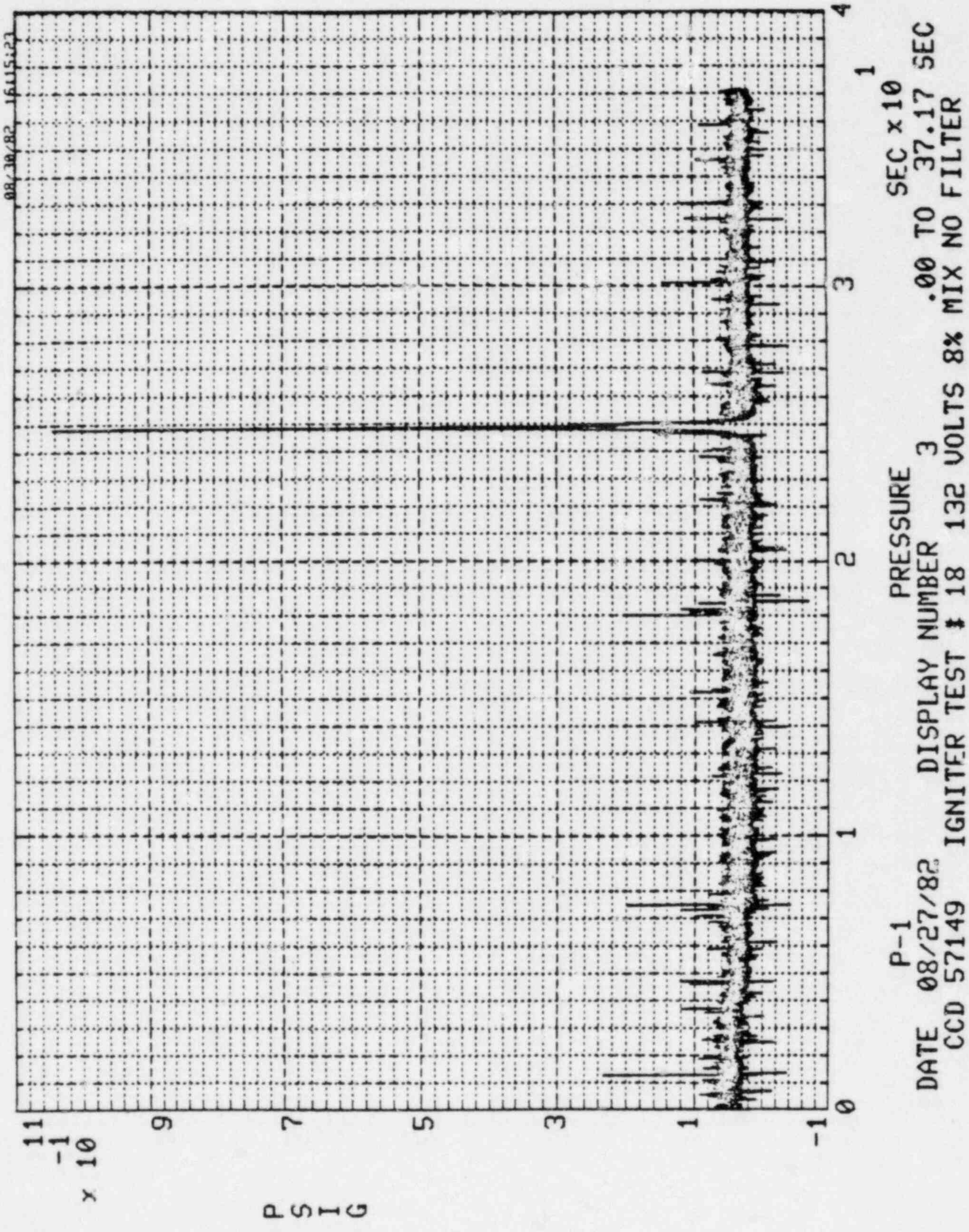

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST $ 17 132 VOLTS 8% MIX 10 HZ FILTER
SEC x10
.00 TO 31.17 SEC
DEG. F.
x 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
9 10 11 12 13 14 15 16 17 18

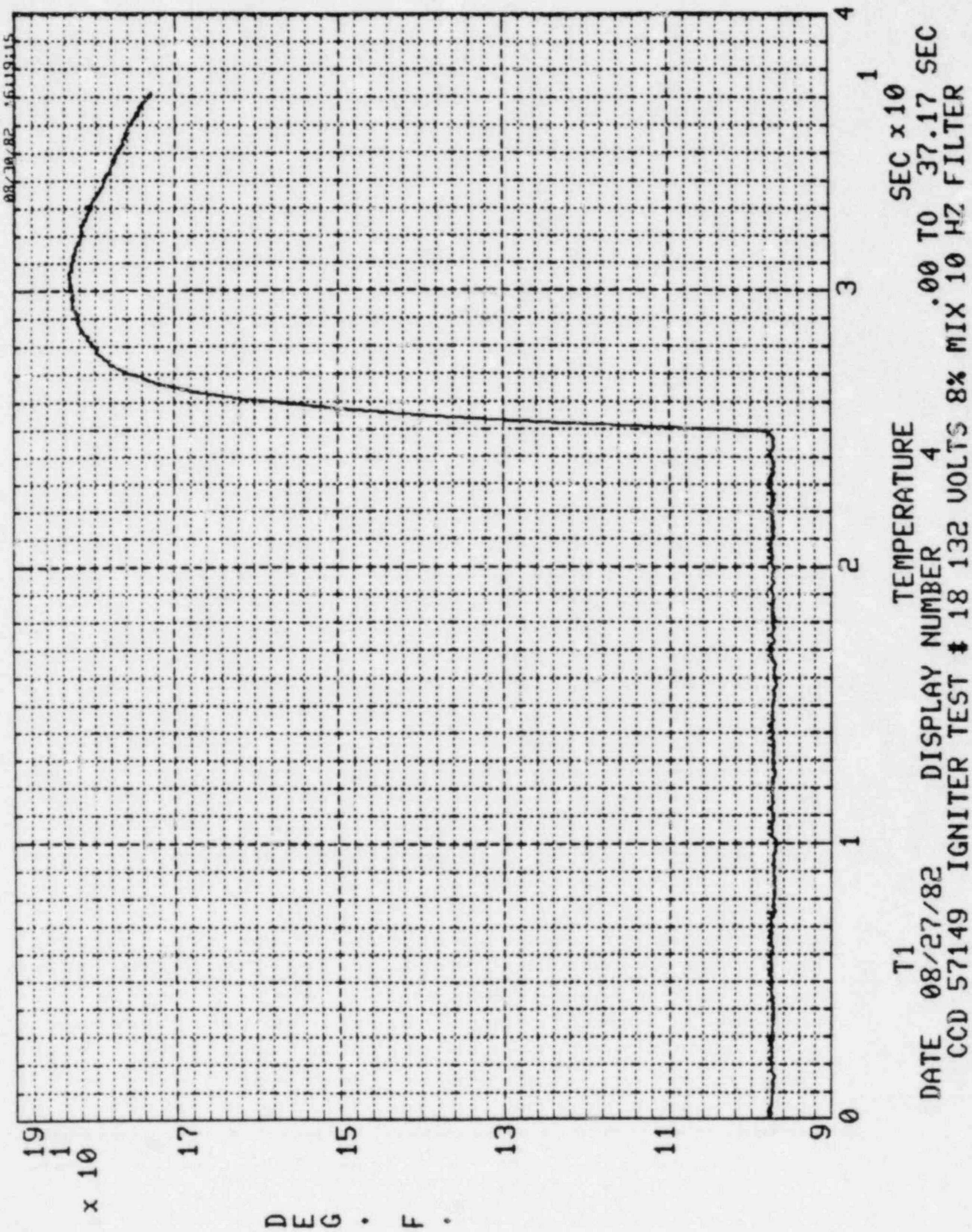

T2 TEMPERATURE SEC x 10^0
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 17 132 VOLTS 8% MIX 10 HZ FILTER
DEG. F.
x 10^2
8
6
4
2
0
-2
-4
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

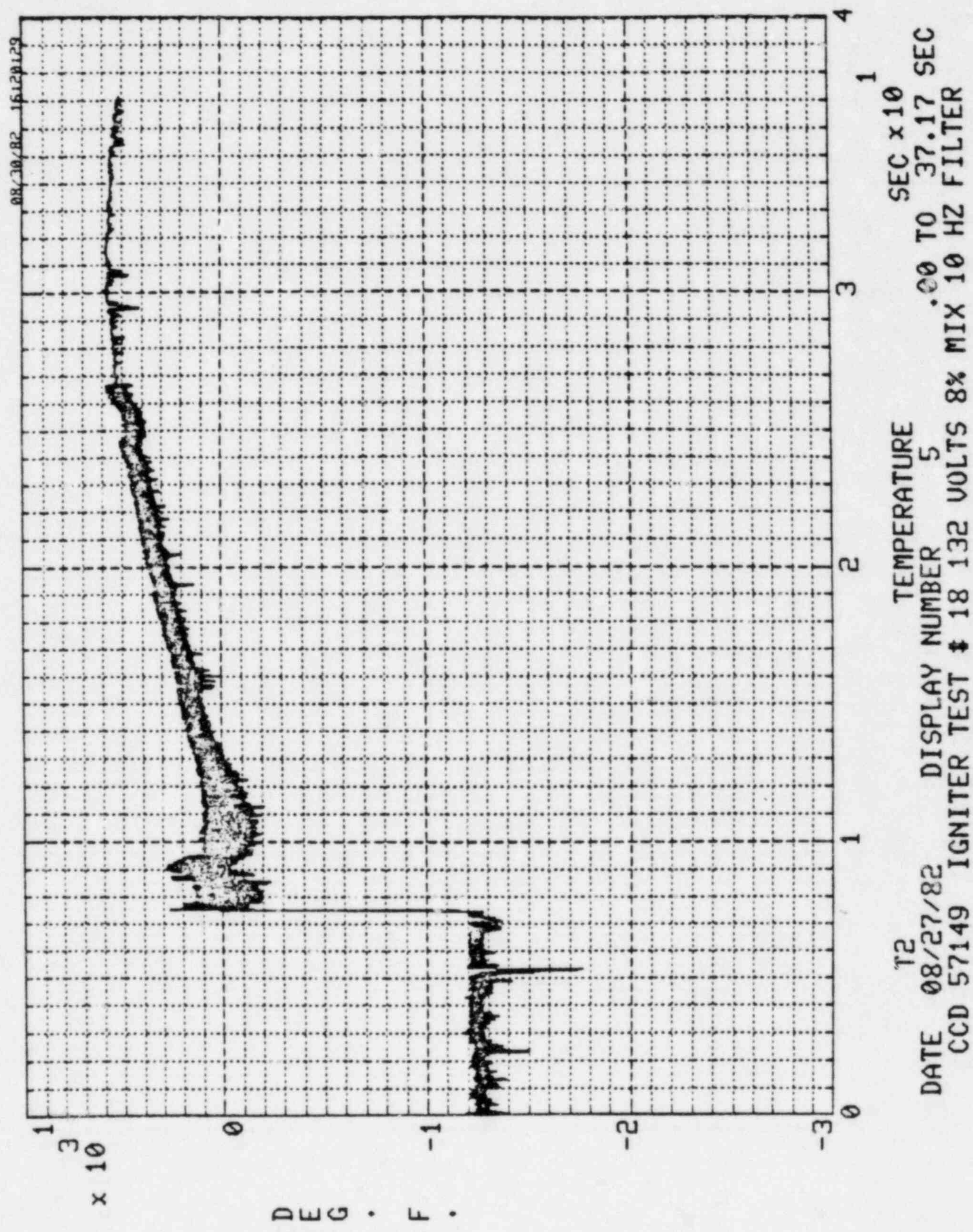

08/30/82 11:48:46
DEG. F.
x 10^2
SEC x 10^0
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 17 132 VOLTS 8% MIX 10 HZ FILTER

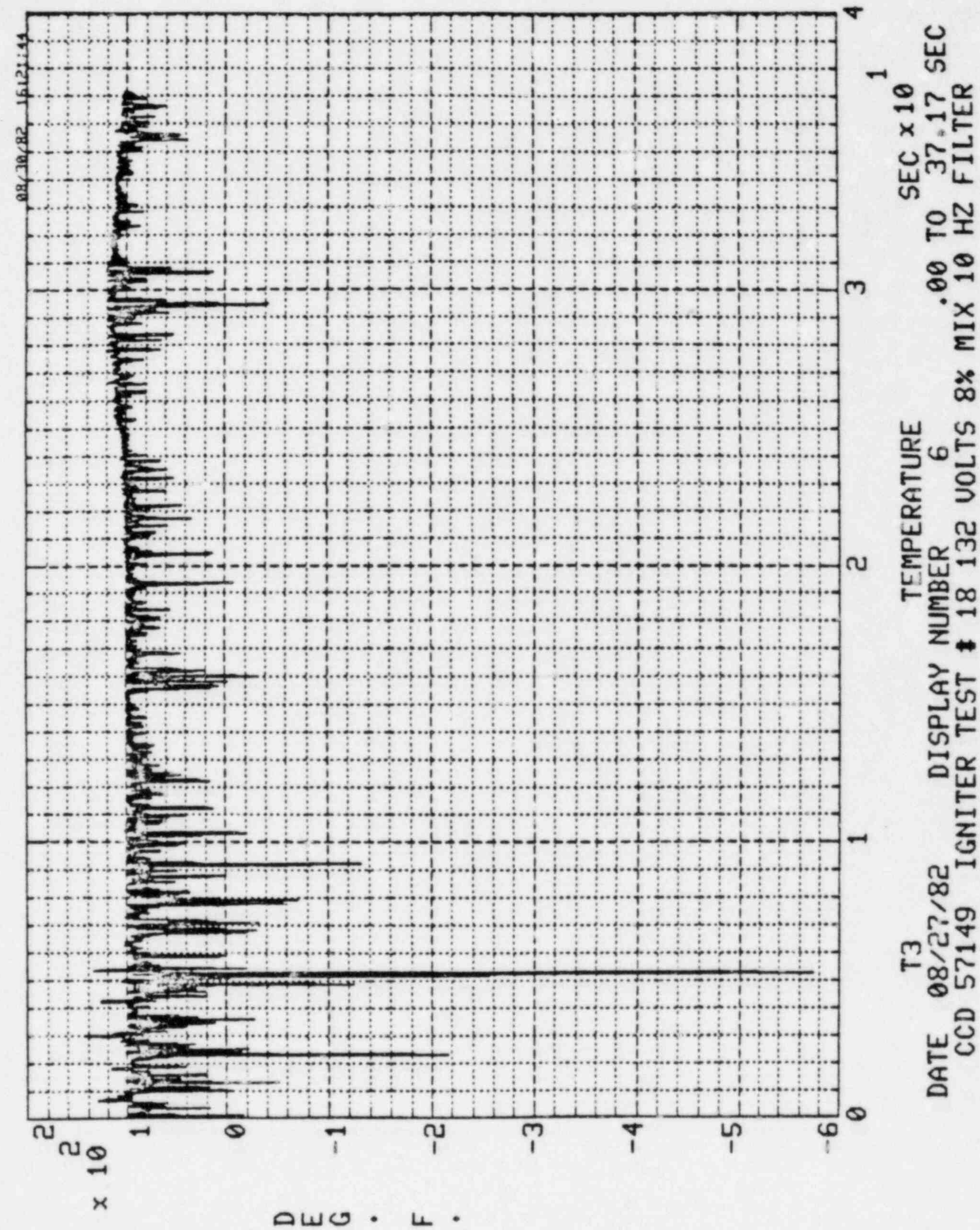

VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX NO FILTER
VOLTAGE
0.00 TO 37.17 SEC
SEC x 10 1
VOLTS x 10 1
-1 1 3 5 7 9 11 13 15
0 1 2 3 4

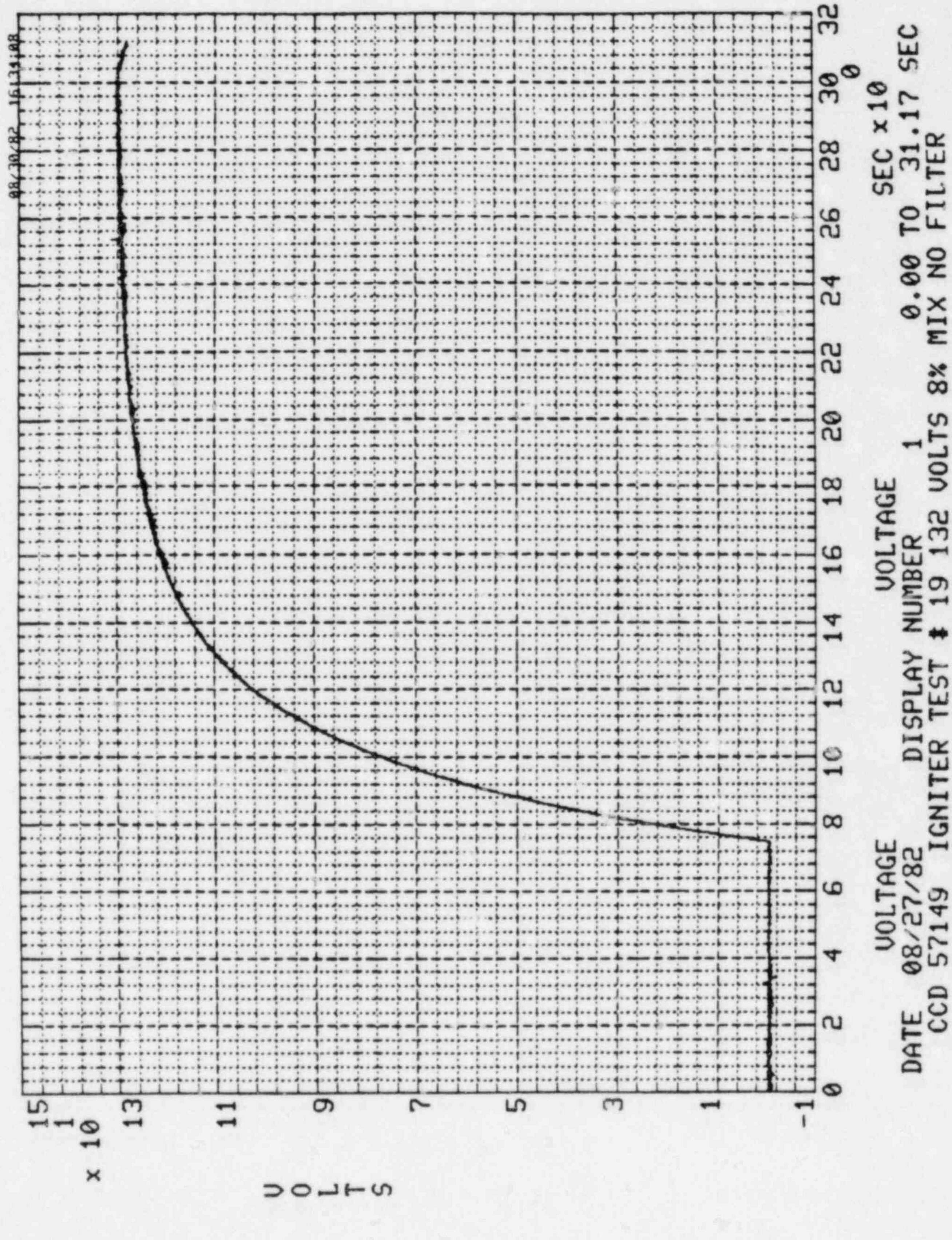

08/30/82 16:14:06
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX NO FILTER
.00 TO 37.17 SEC
SEC x10 1
0 1 2 3 4
AMPERES
x 10 0
2 1 0 -1 -2

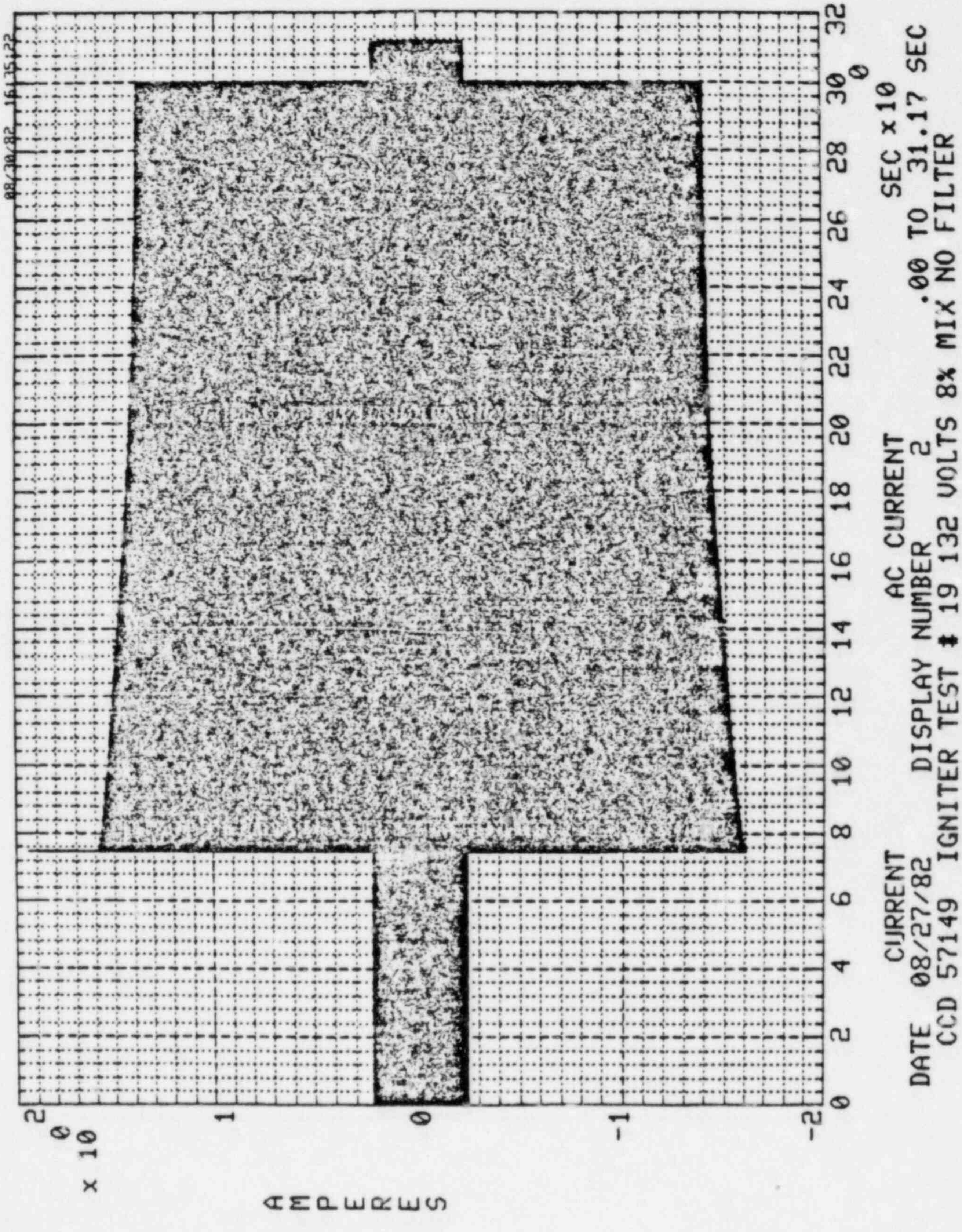

08/30/82 16:15:23
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX NO FILTER
SEC x 10^1
PSIG x 10^-1
11
9
7
5
3
1
-1
0
1
2
3
4

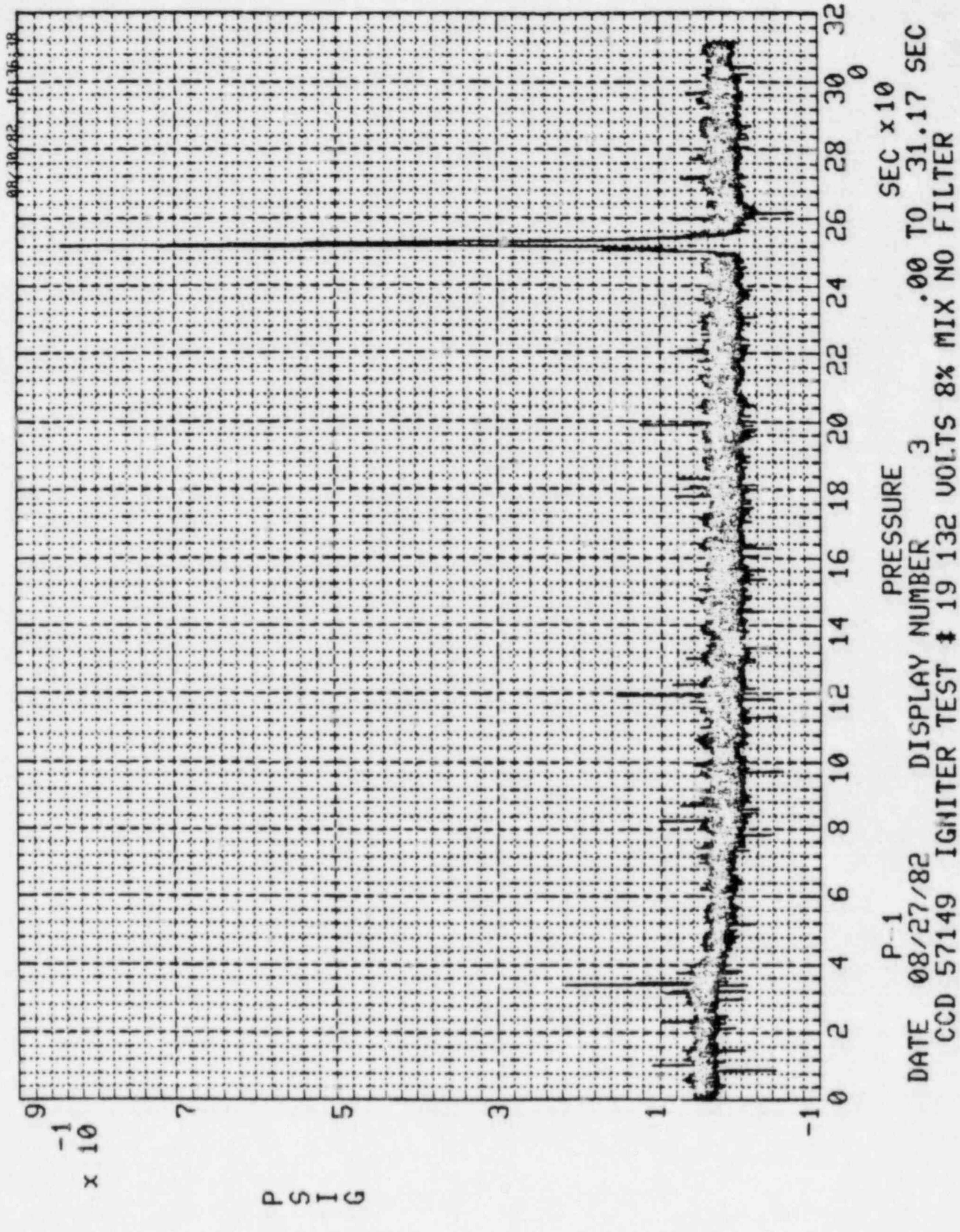

T1 TEMPERATURE SEC x 10 1
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX 10 HZ FILTER
D E G . F .
x 10 1
19
17
15
13
11
9
0
1
2
3
4
08/30/82

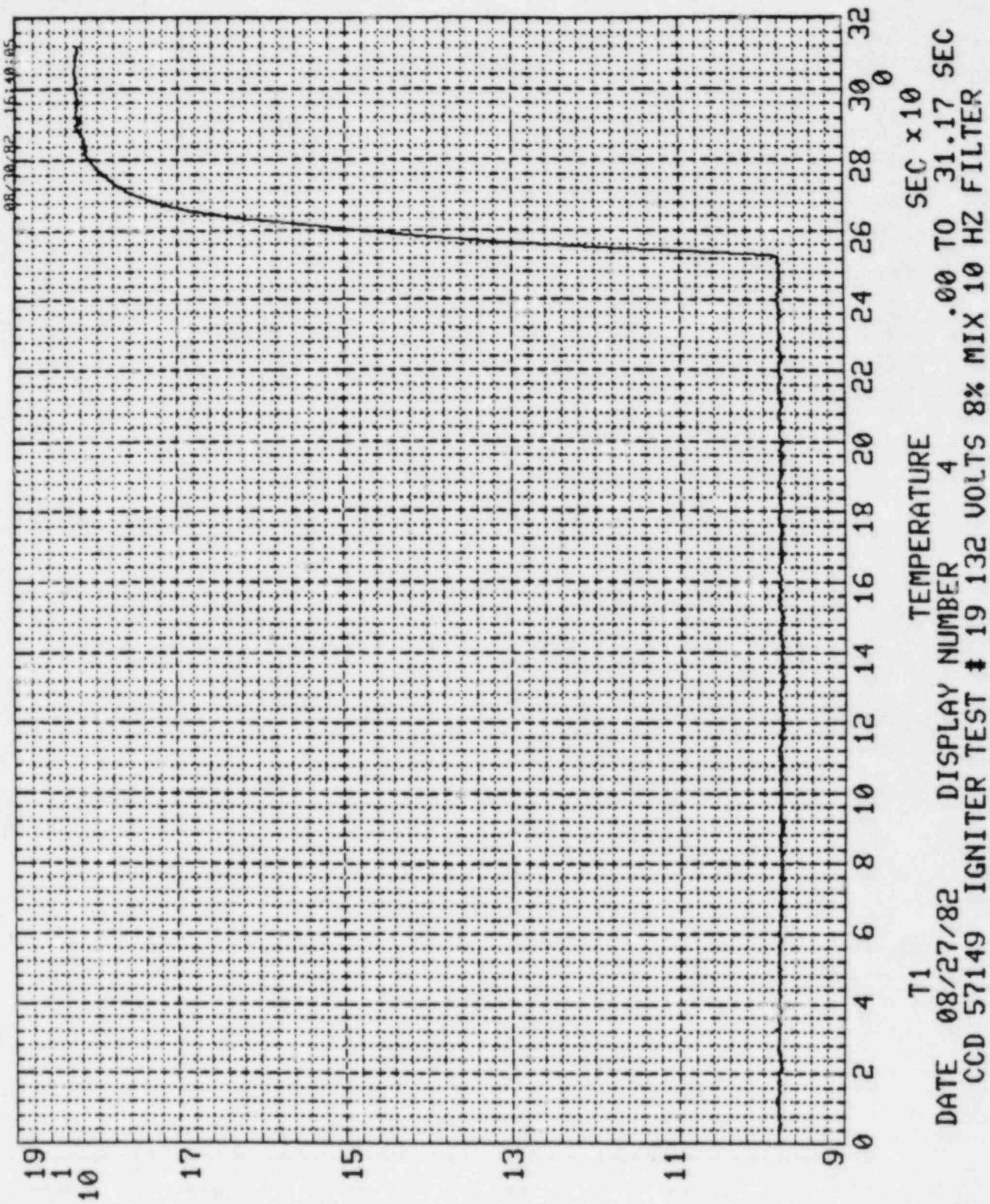

08/30/82 16:20:29
DEG. F.
x 10 3
1
0
-1
-2
-3
0
1
2
3
4
SEC x10 1
T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
.00 TO 37.17 SEC
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX 10 HZ FILTER

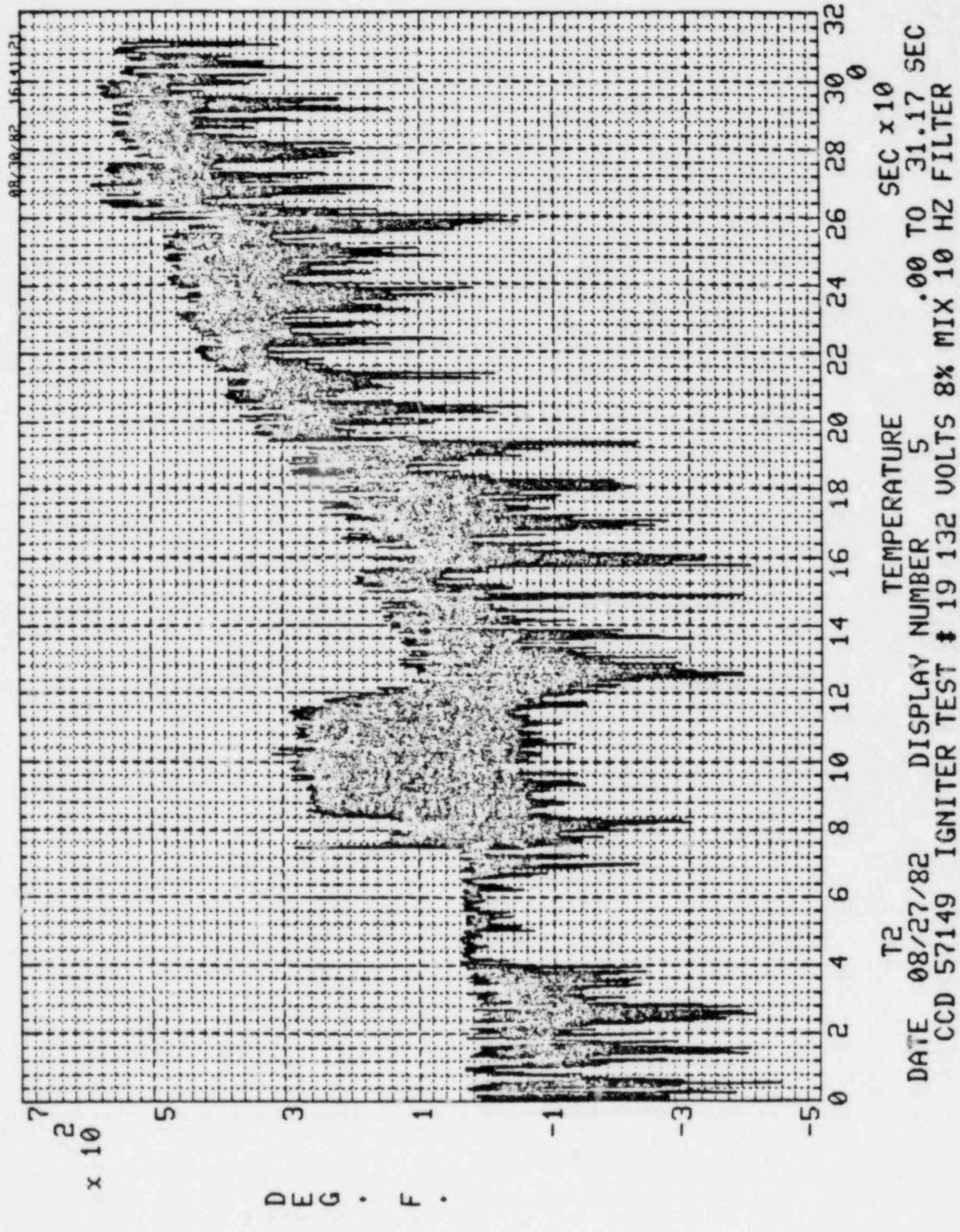

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 18 132 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
.00 TO 37.17 SEC
DEG. F.
x 10 2

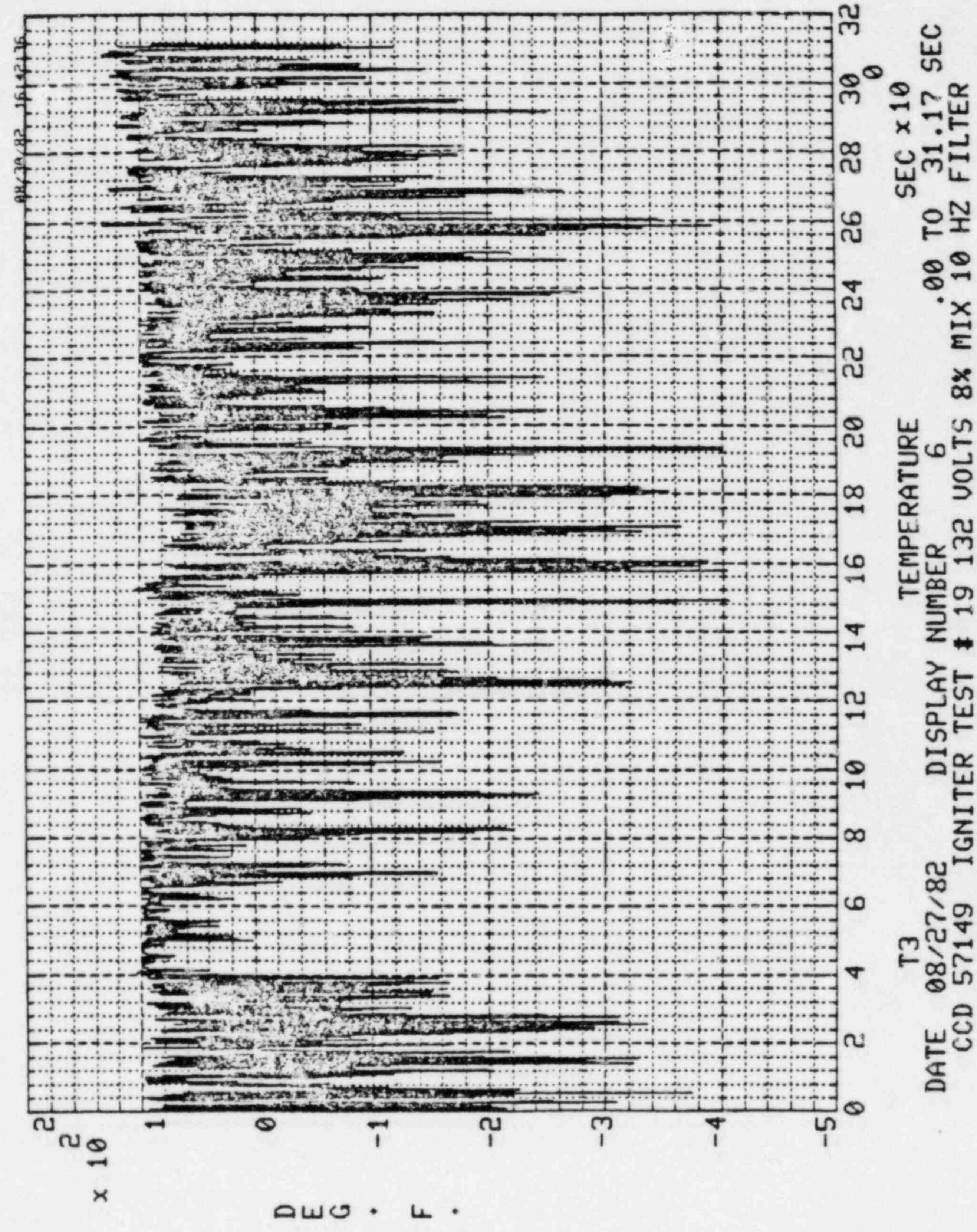

08/30/82 16:34:08
VOLTS
x 10
1
15
13
11
9
7
5
3
1
-1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
0
SEC x 10
VOLTAGE
VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX NO FILTER

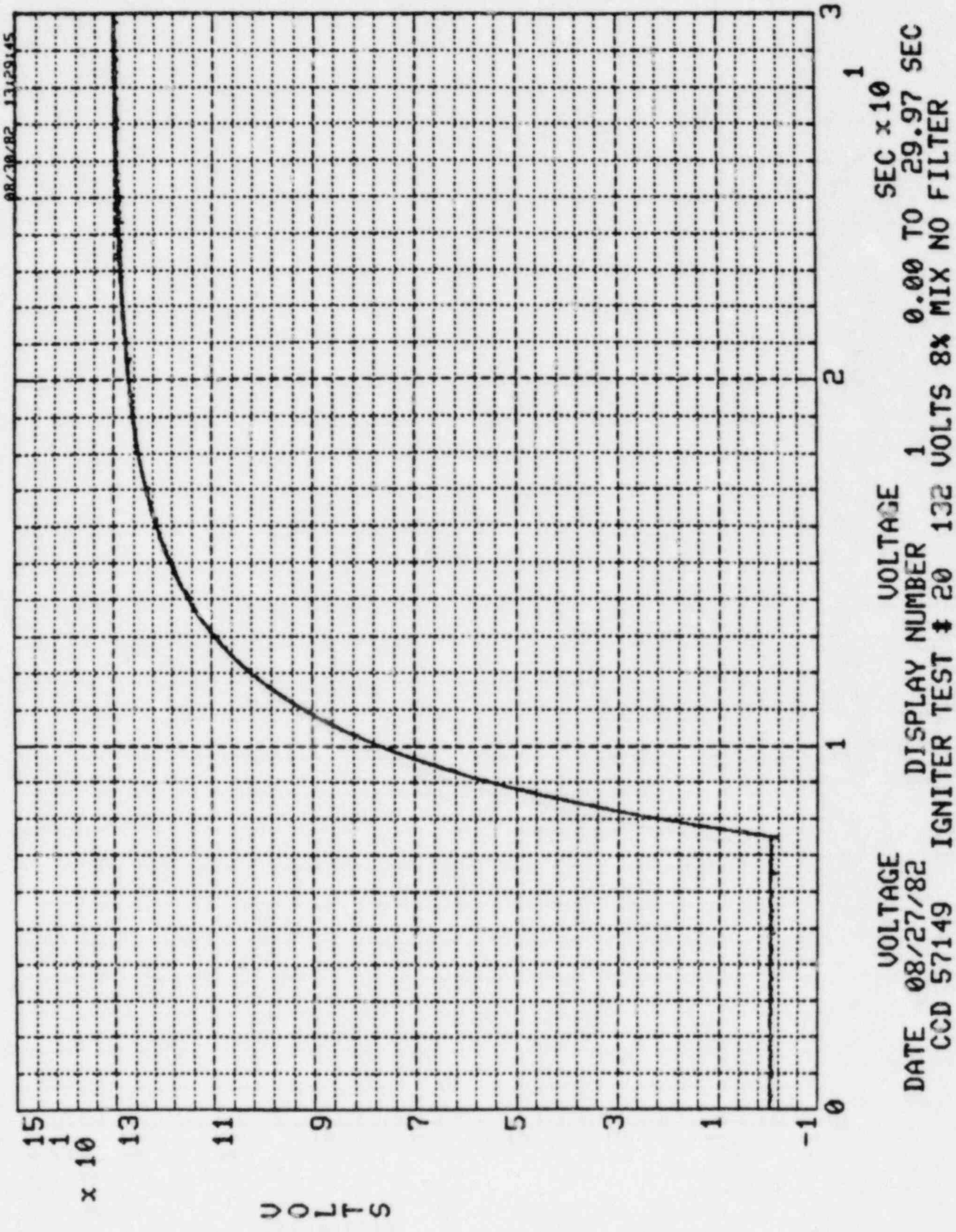

08/30/82 16:35:22
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX NO FILTER
.00 TO 31.17 SEC
SEC x 10^0
AMPERES x 10^0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
2 1 0 -1 -2

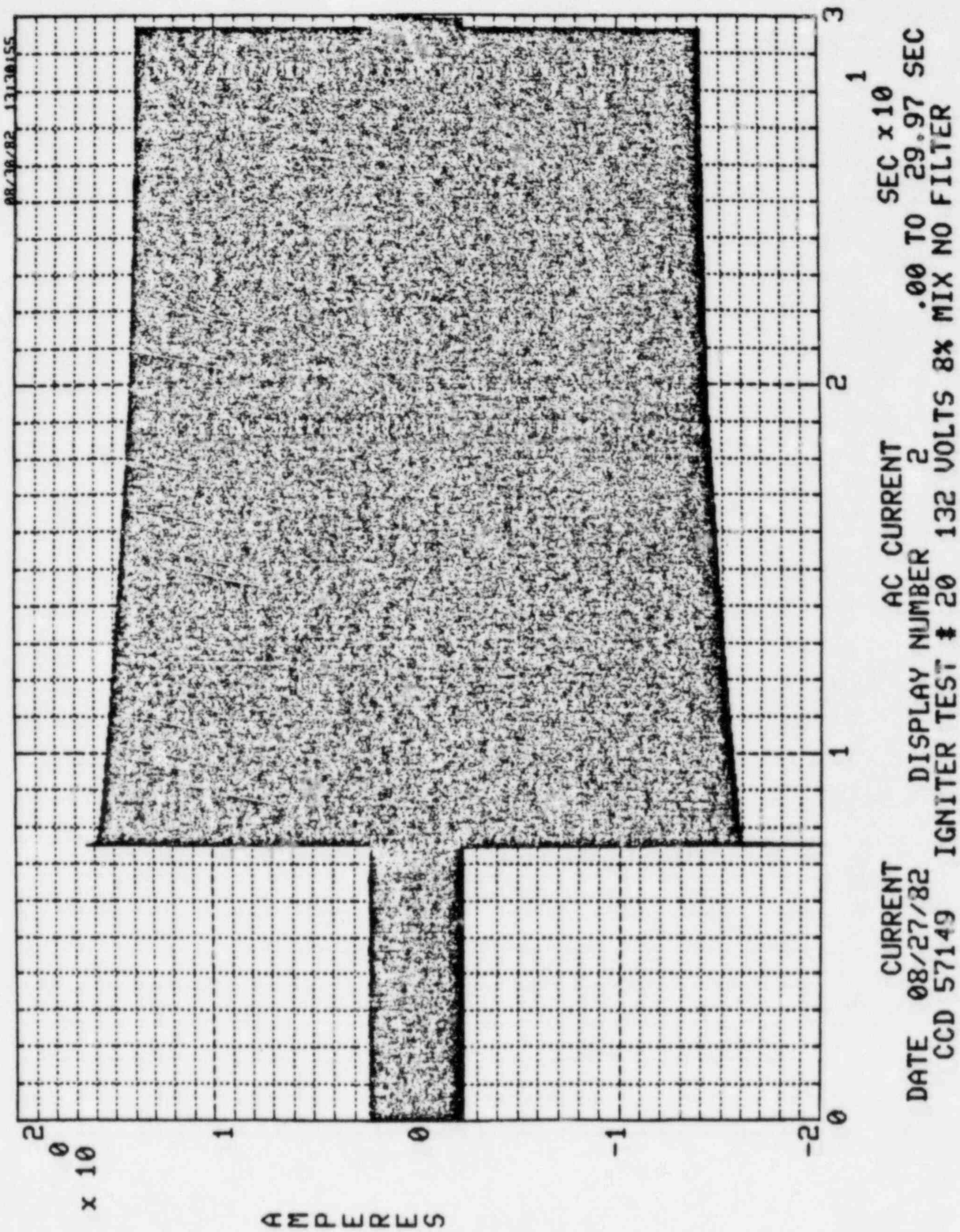

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 31.17 SEC
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX NO FILTER
SEC x10^0
PSIG x 10^-1
-1 1 3 5 7 9
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

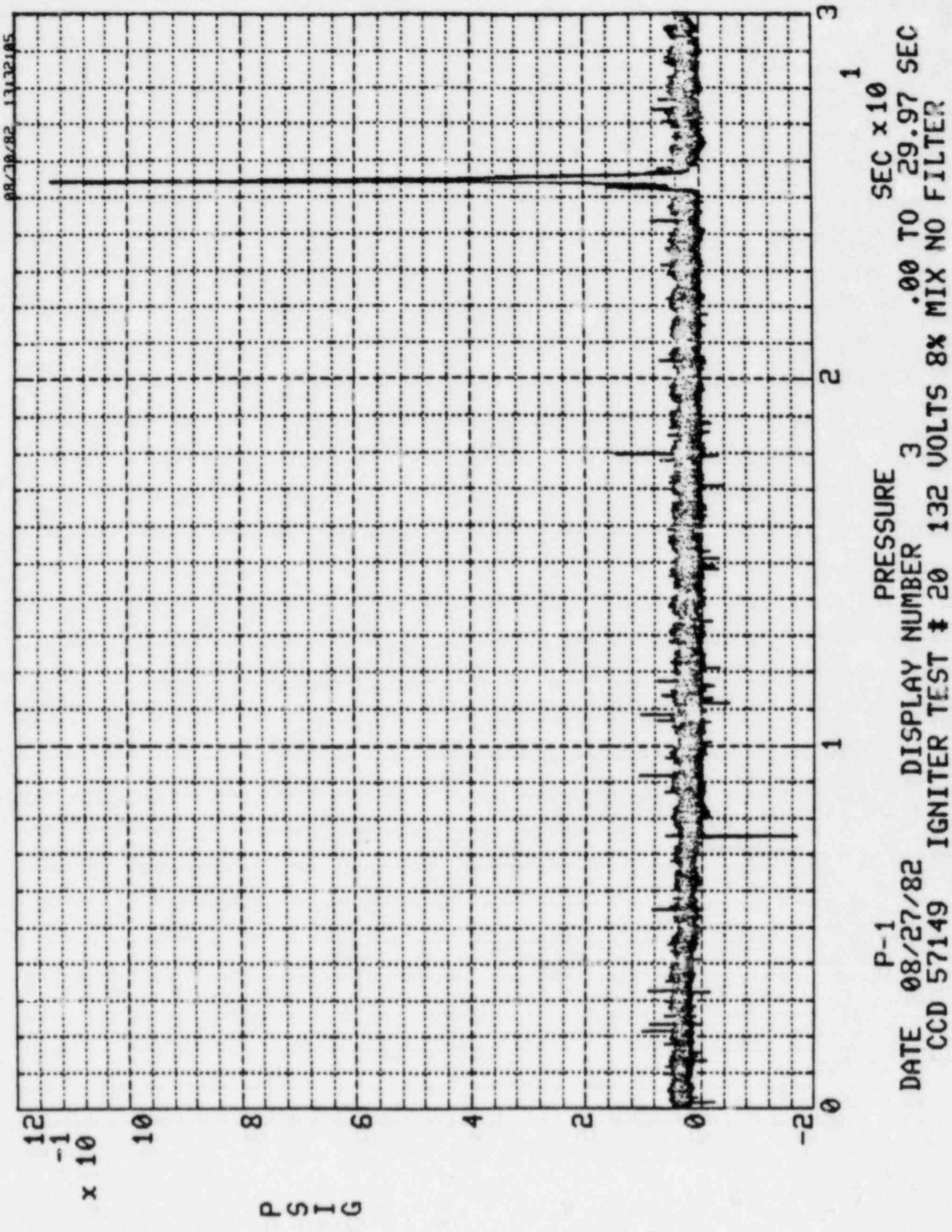

08/30/82 16:10:05
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX 10 HZ FILTER
SEC x10 0
.00 TO 31.17 SEC
DEG. F.
x 10 1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
9 11 13 15 17 19

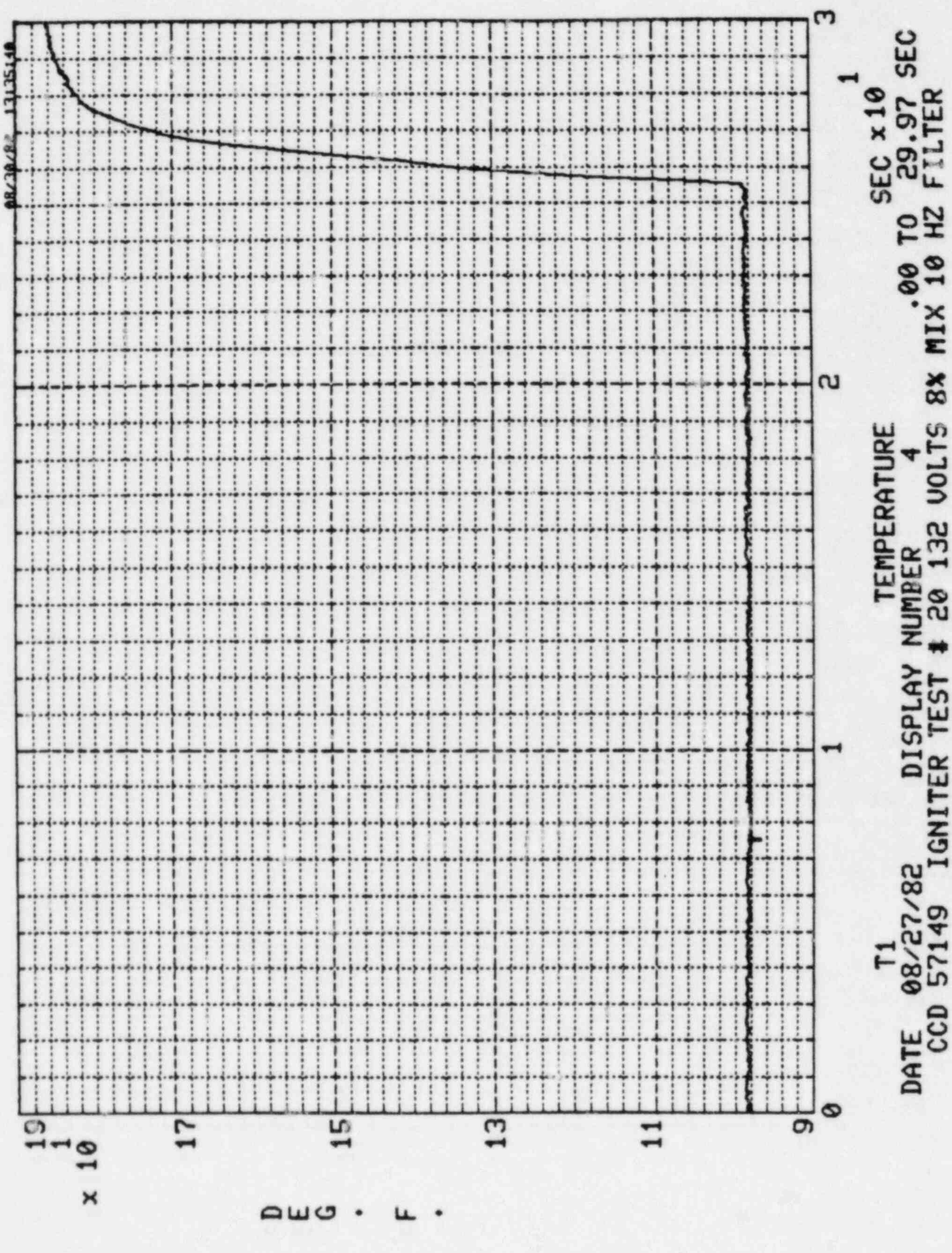

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX 10 HZ FILTER
SEC x 10 0
.00 TO 31.17 SEC
DEG. F.
x 10 2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
7 5 3 1 -1 -3 -5

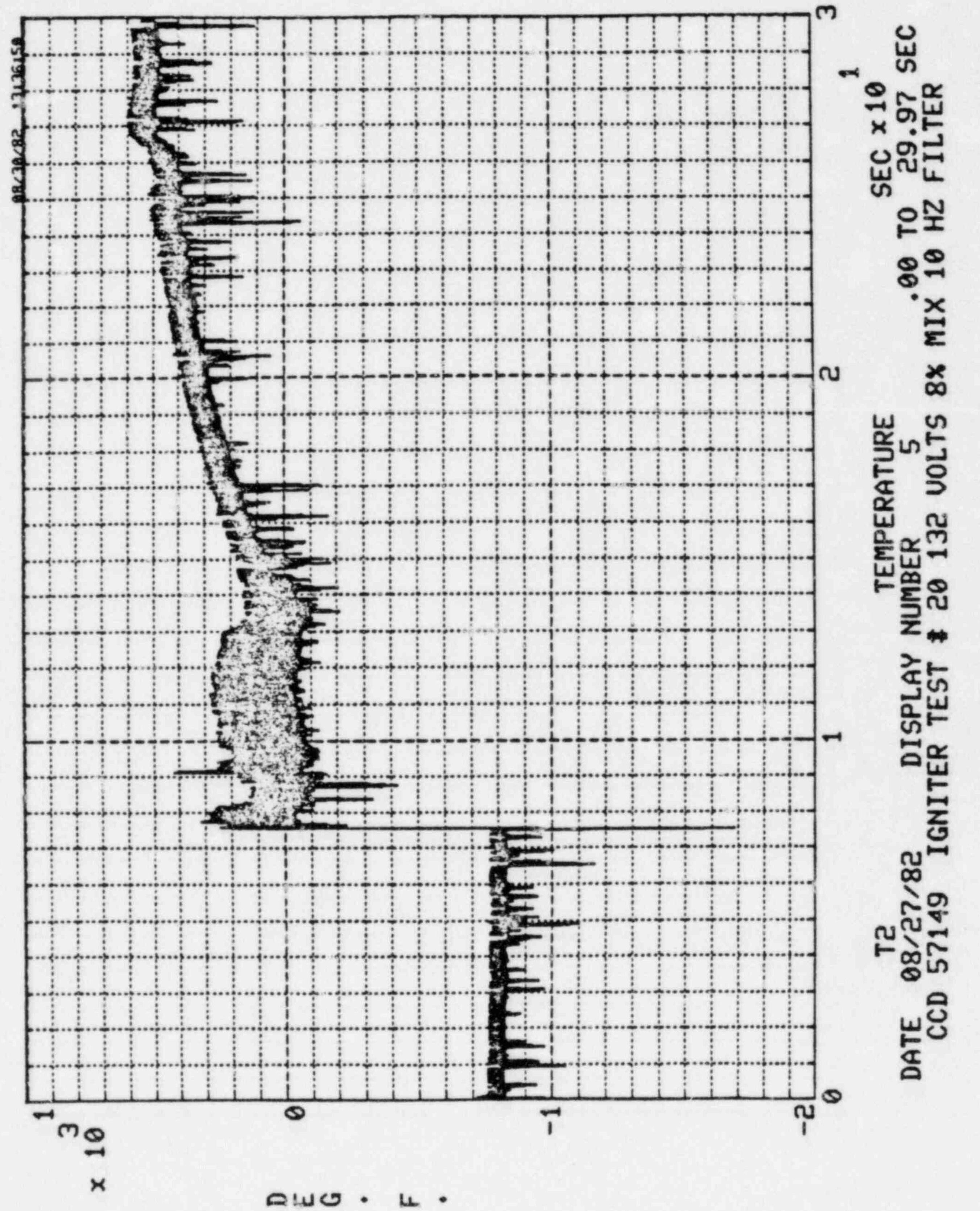

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 19 132 VOLTS 8% MIX 10 HZ FILTER
.00 TO 31.17 SEC
SEC x10
DEG. F.
x 10
2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
2
1
0
-1
-2
-3
-4
-5

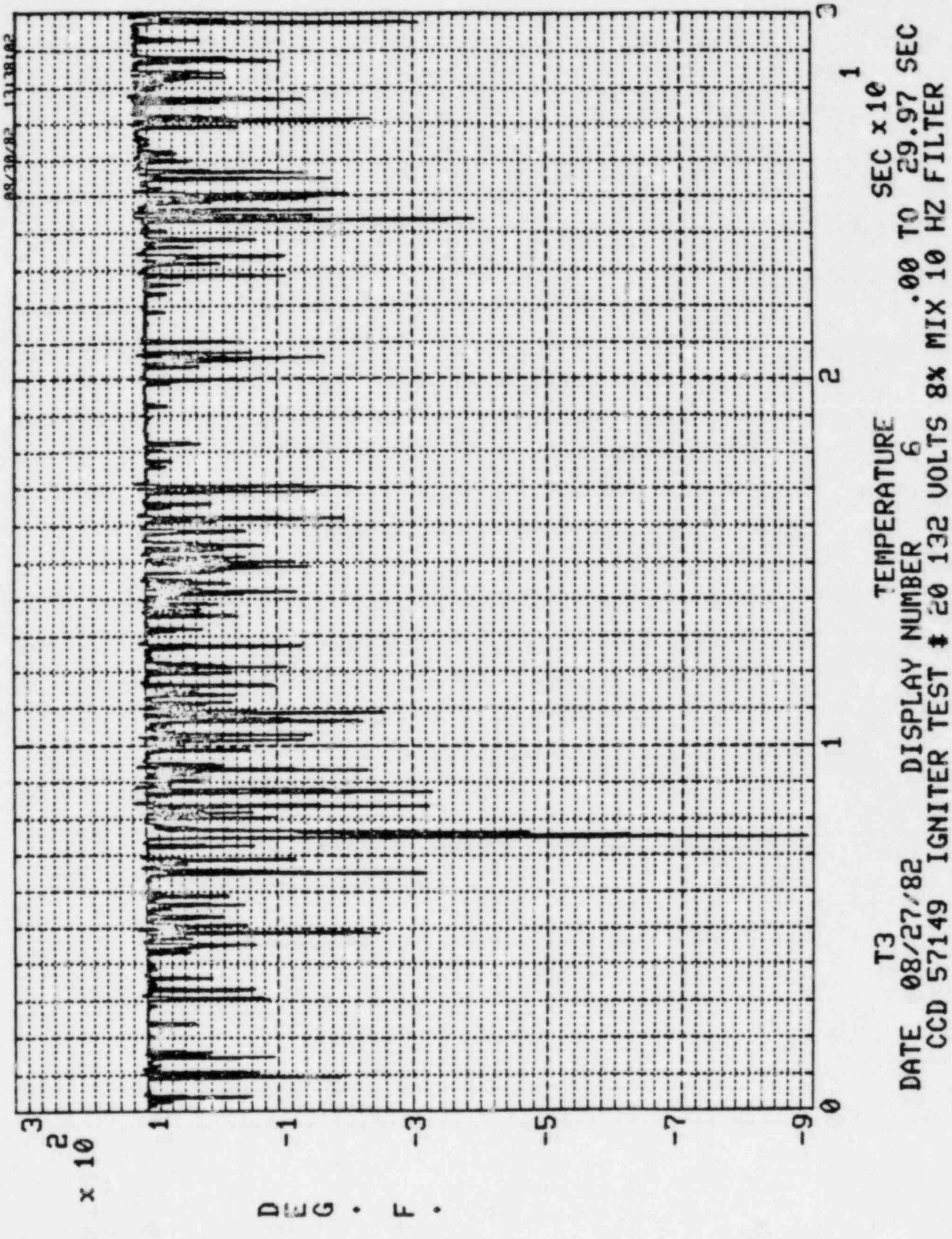

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 20 132 VOLTS 8% MIX NO FILTER
0.00 TO 29.97 SEC
SEC x10 1
VOLTS x 10 1
08/30/82 13:29:45

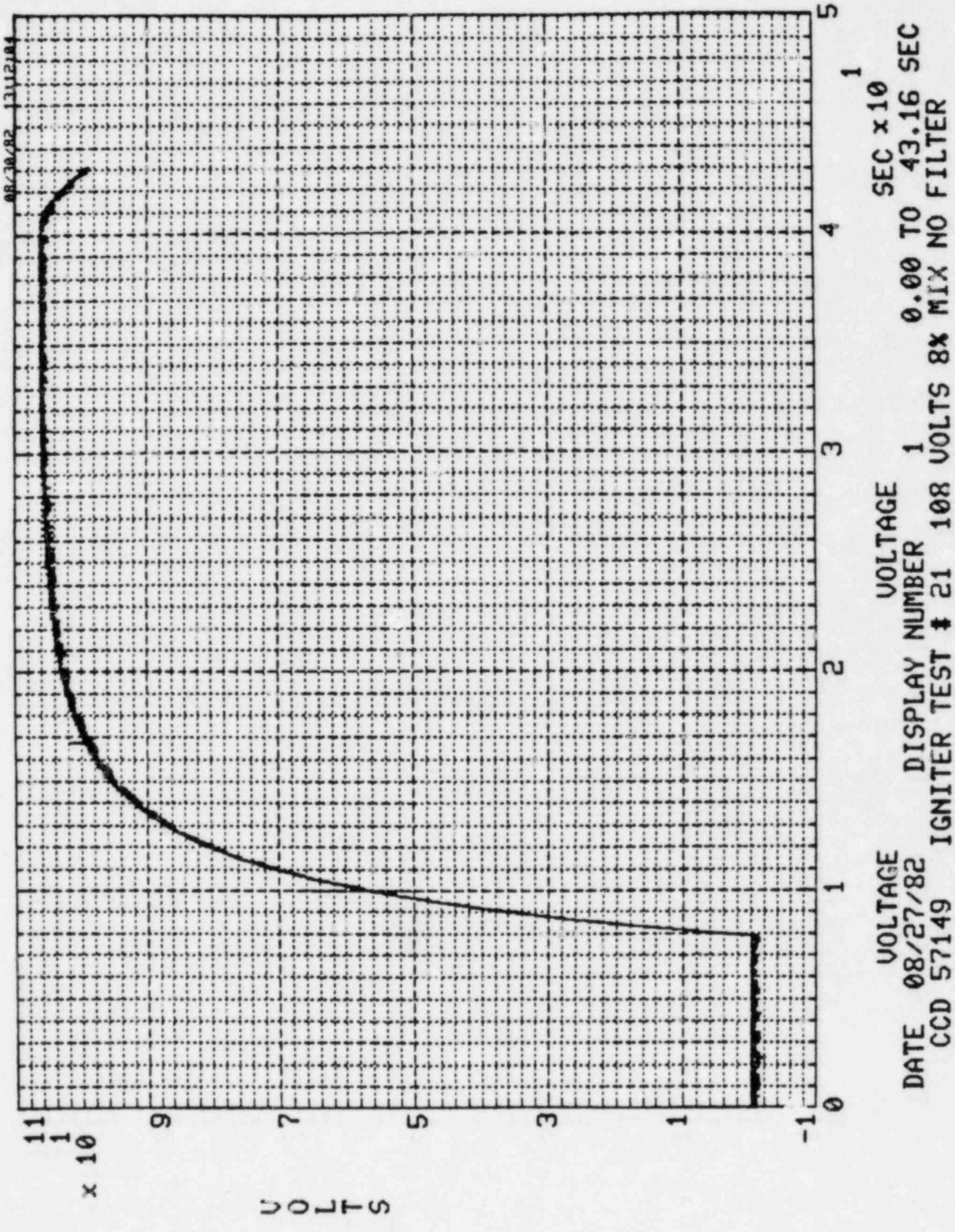

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 29.97 SEC
CCD 57149 IGNITER TEST # 20 132 VOLTS 8% MIX NO FILTER
SEC x10 1
AMPERES
x 10 0
2
1
0
-1
-2
0
1
2
3

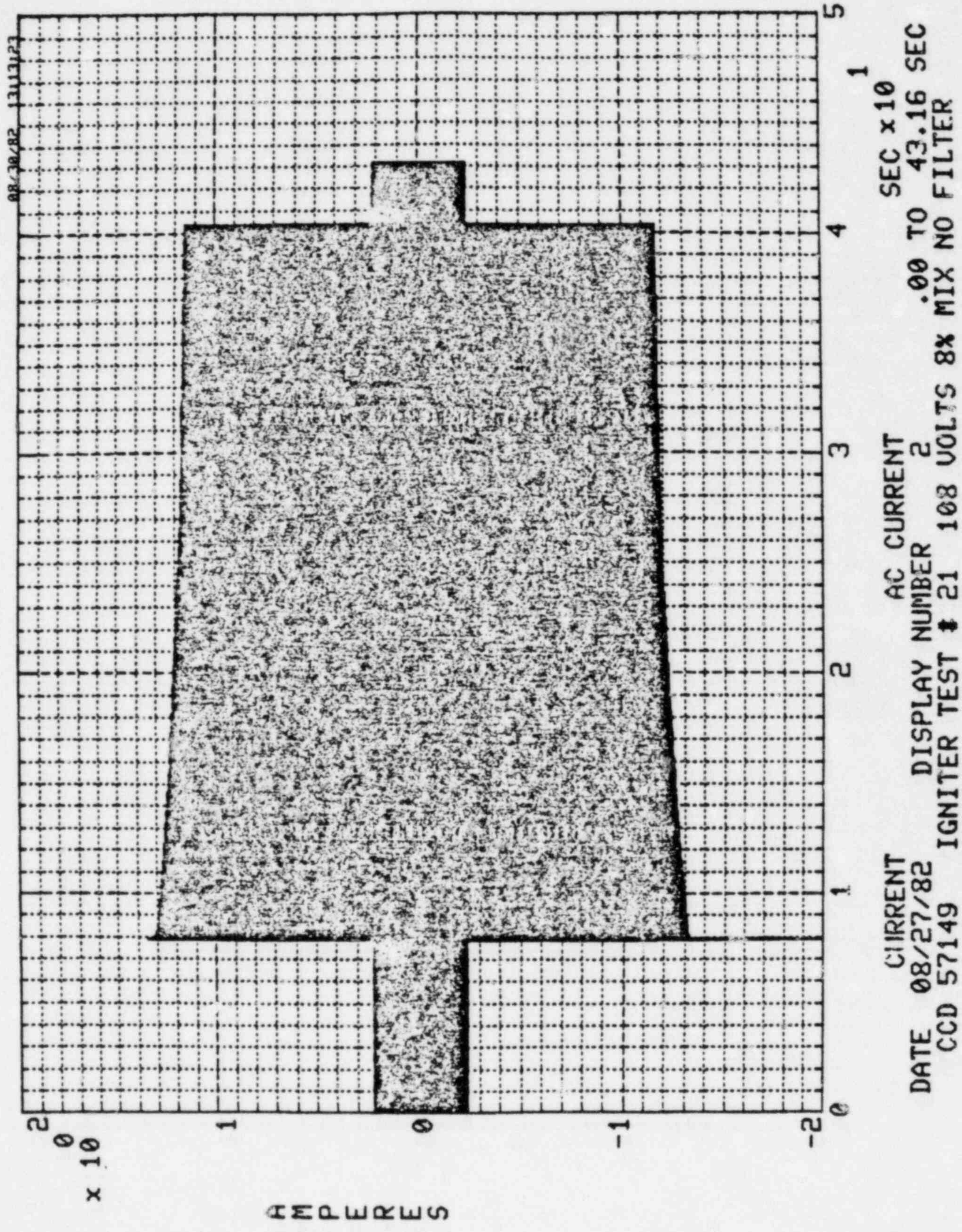

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 20 132 VOLTS 8% MIX NO FILTER
SEC x10 1 .00 TO 29.97 SEC
x 10 -1
PSIG
12
10
8
6
4
2
0
-2
0
1
2
3

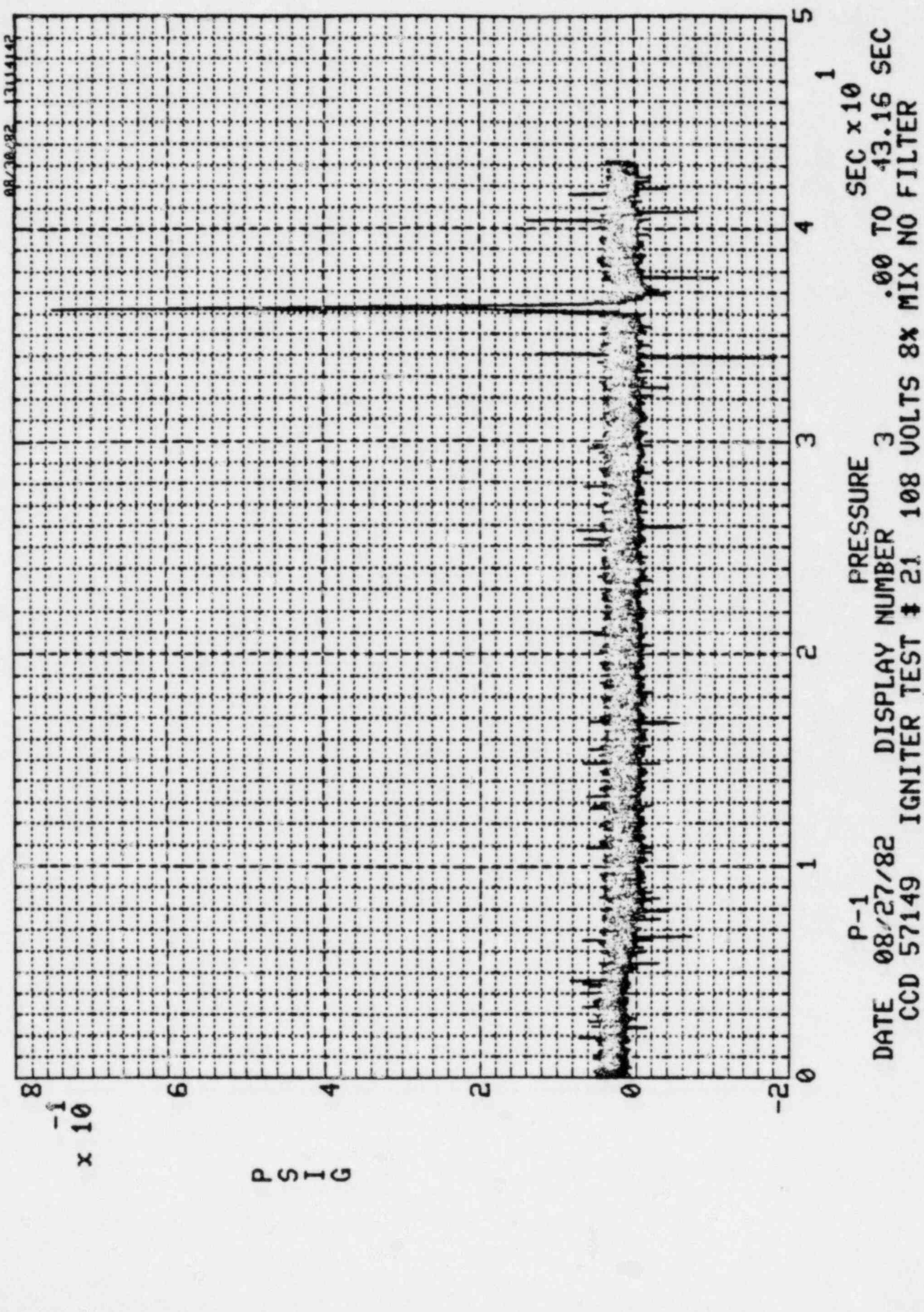

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 29.97 SEC
CCD 57149 IGNITER TEST # 20 132 VOLTS 8% MIX 10 HZ FILTER
SEC x10
1
0
1
2
3
DEG. F.
x 10
1
9
11
13
15
17
19

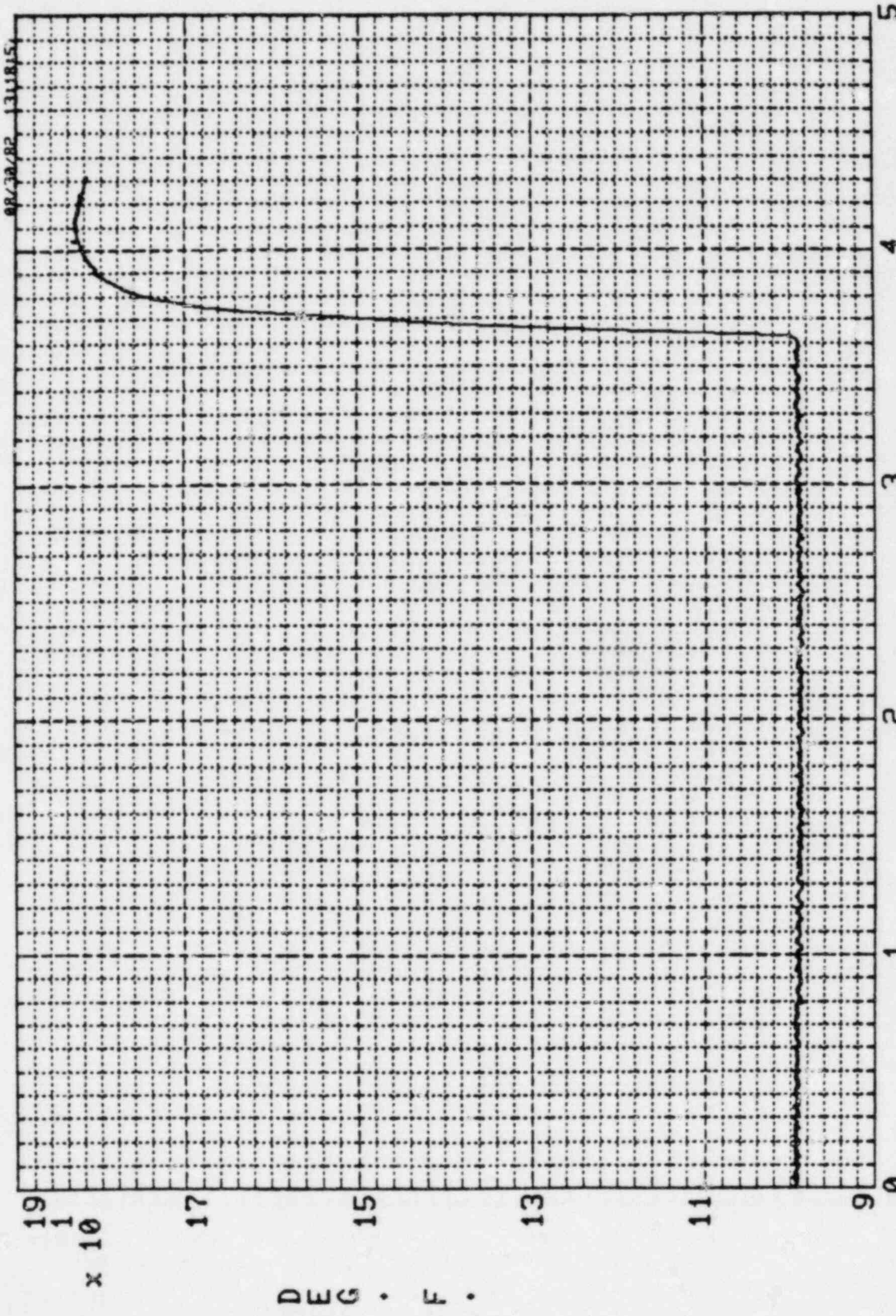

T2
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 20 132 VOLTS 8% MIX 10 HZ FILTER
TEMPERATURE
.00 TO 29.97 SEC
SEC x 10^1
DEG. F.
x 10^3
1
0
-1
-2
0
1
2
3


T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 29.97 SEC
CCD 57149 IGNITER TEST # 20 132 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
DEG. F. x 10 2
3
1
-1
-3
-5
-7
-9
0
1
2
3
08/30/82 13138182


VOLTAGE
DATE 08/27/82 CCD 57149
VOLTAGE DISPLAY NUMBER 1
IGNITER TEST # 21 108 VOLTS 8% MIX NO FILTER
SEC x10^1 0.00 TO 43.16 SEC
VOLTS x10^1
0
1
2
3
4
5
-1
1
3
5
7
9
11


08/30/82 13:13:23
CURRENT AC CURRENT SEC x 10^1
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 21 108 VOLTS 8% MIX NO FILTER
AMPERES x 10^0
2
1
0
-1
-2
0
1
2
3
4
5

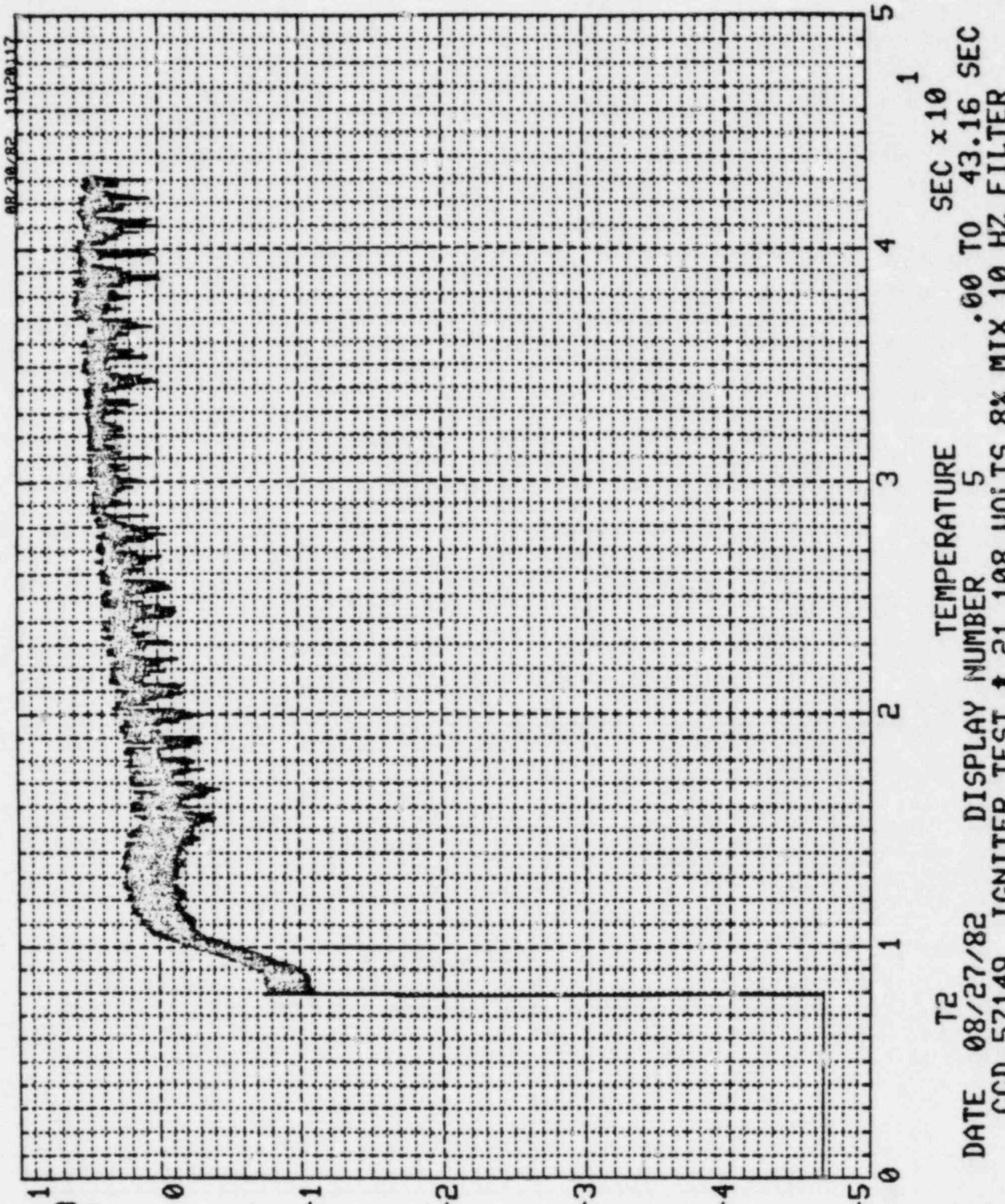

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 21 108 VOLTS 8% MIX NO FILTER
SEC x 10 1
.00 TO 43.16 SEC
PSIG
x 10 -1
8
6
4
2
0
-2
0
1
2
3
4
5
08/30/82 13114142

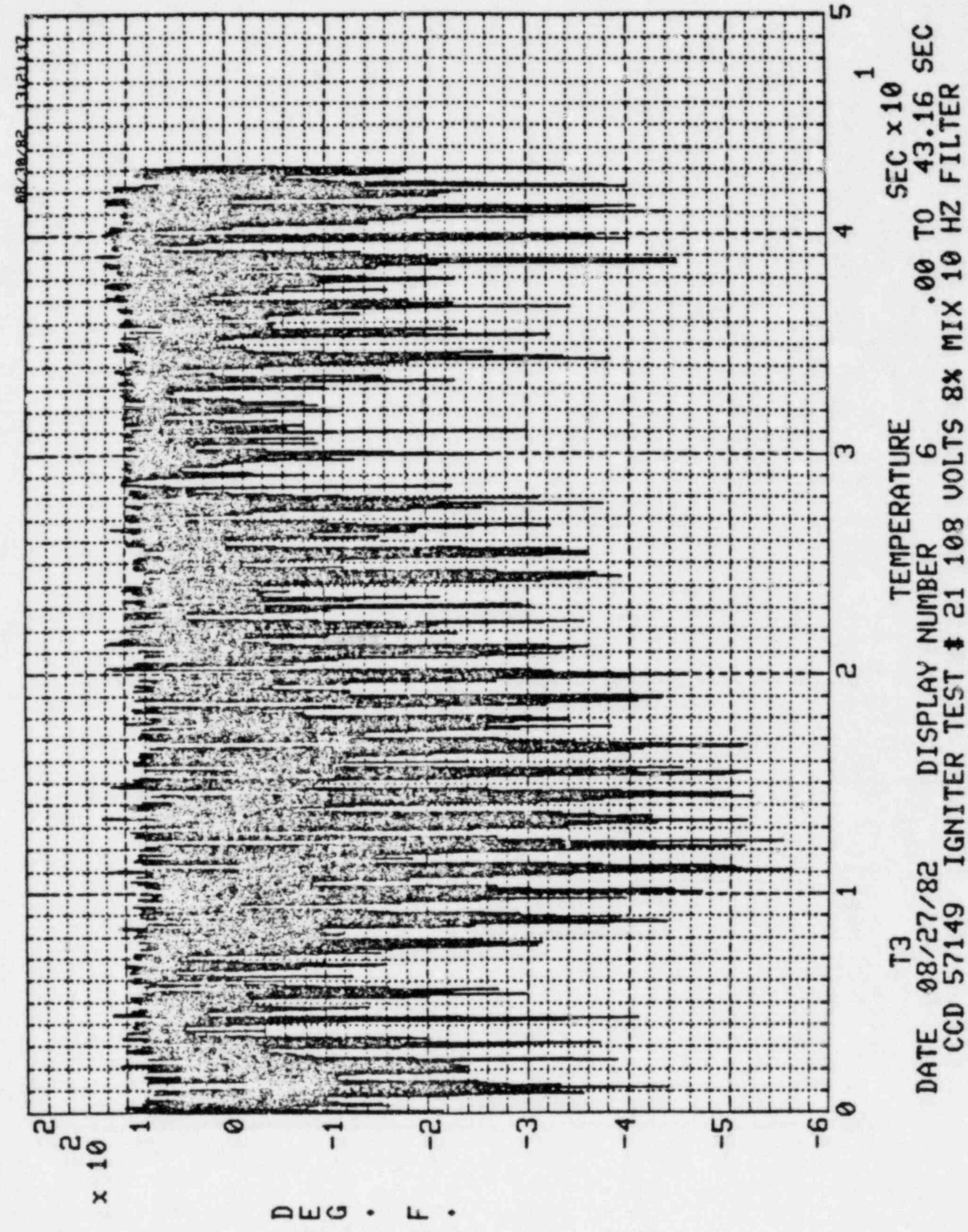


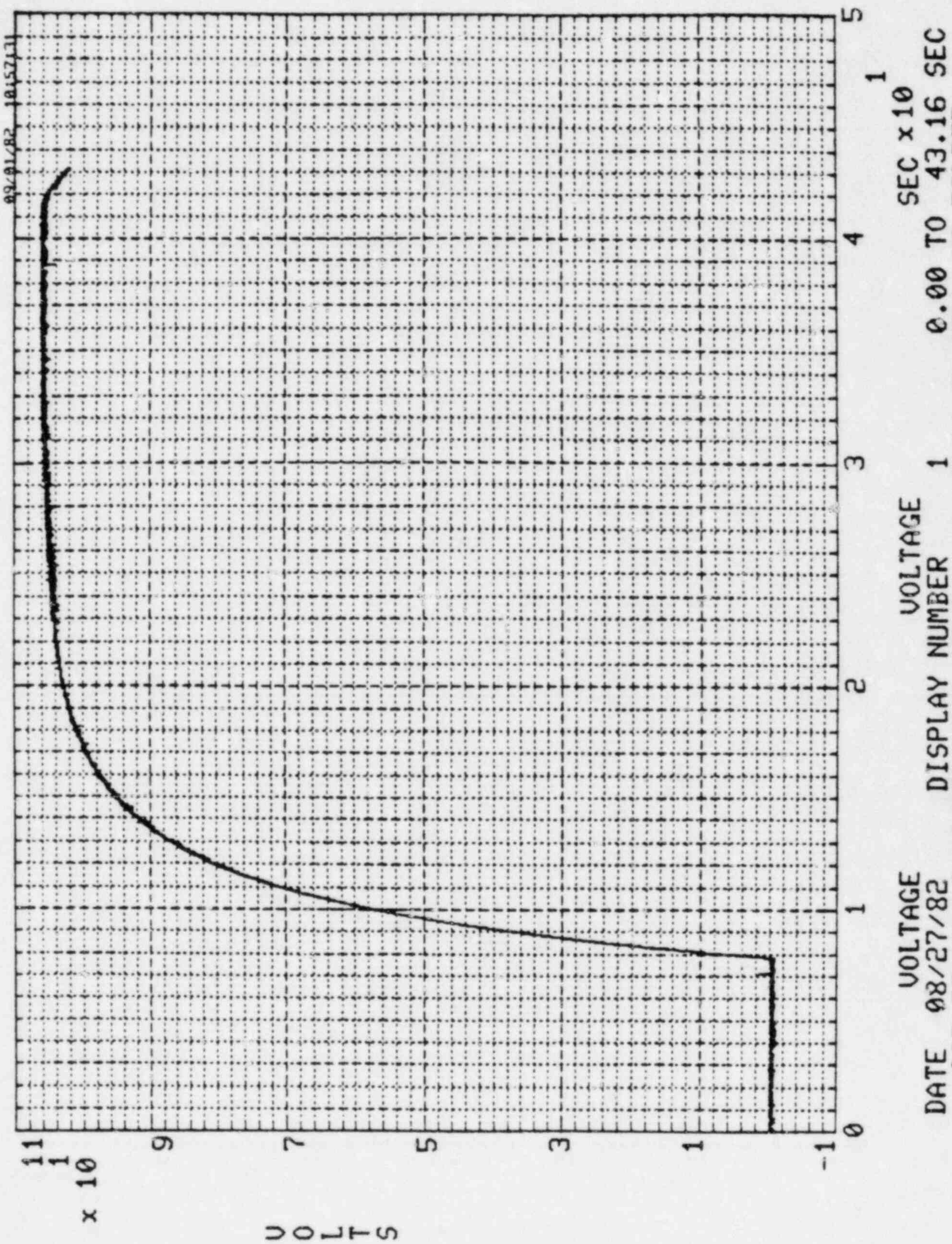
T1 TEMPERATURE

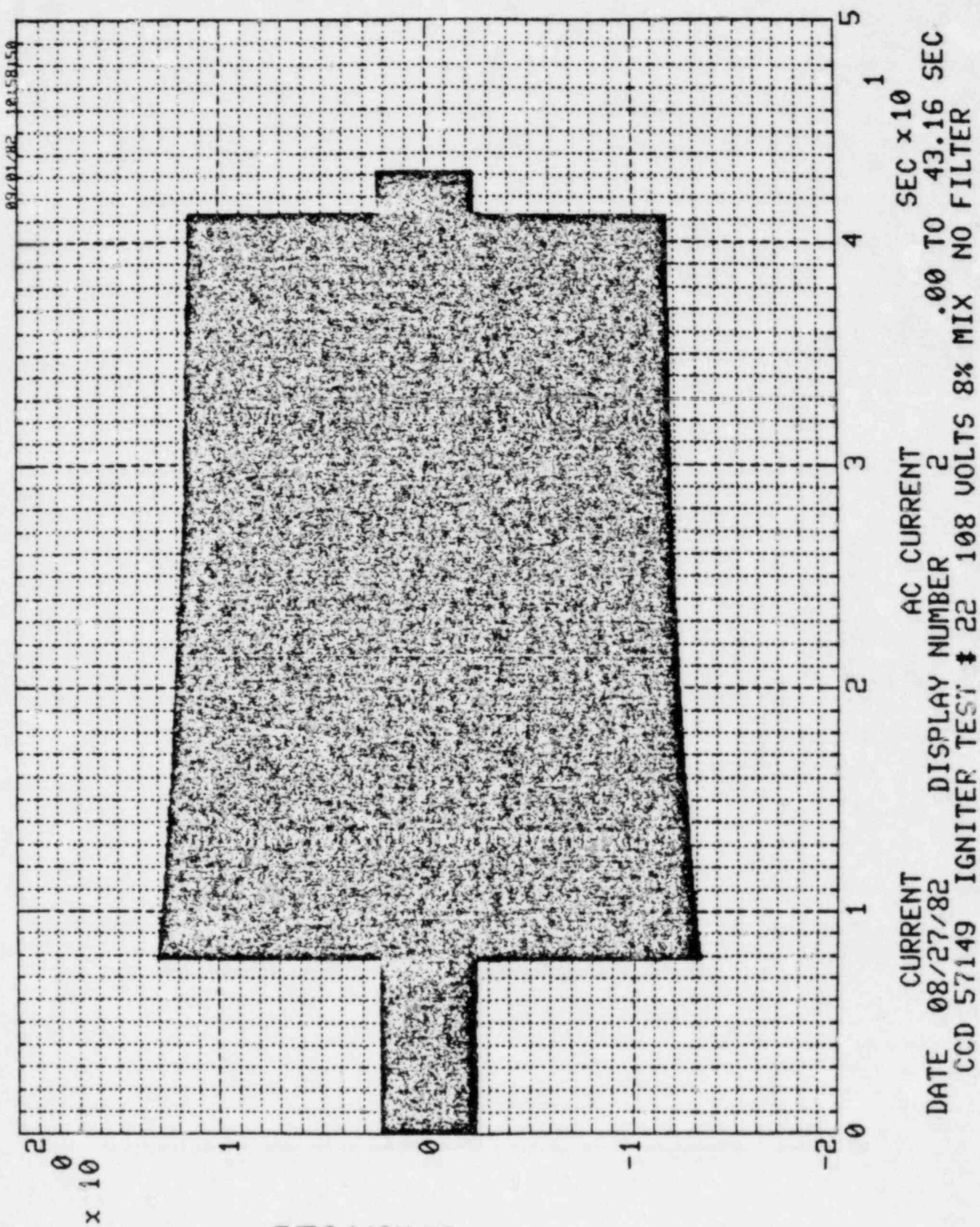
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 43.16 SEC

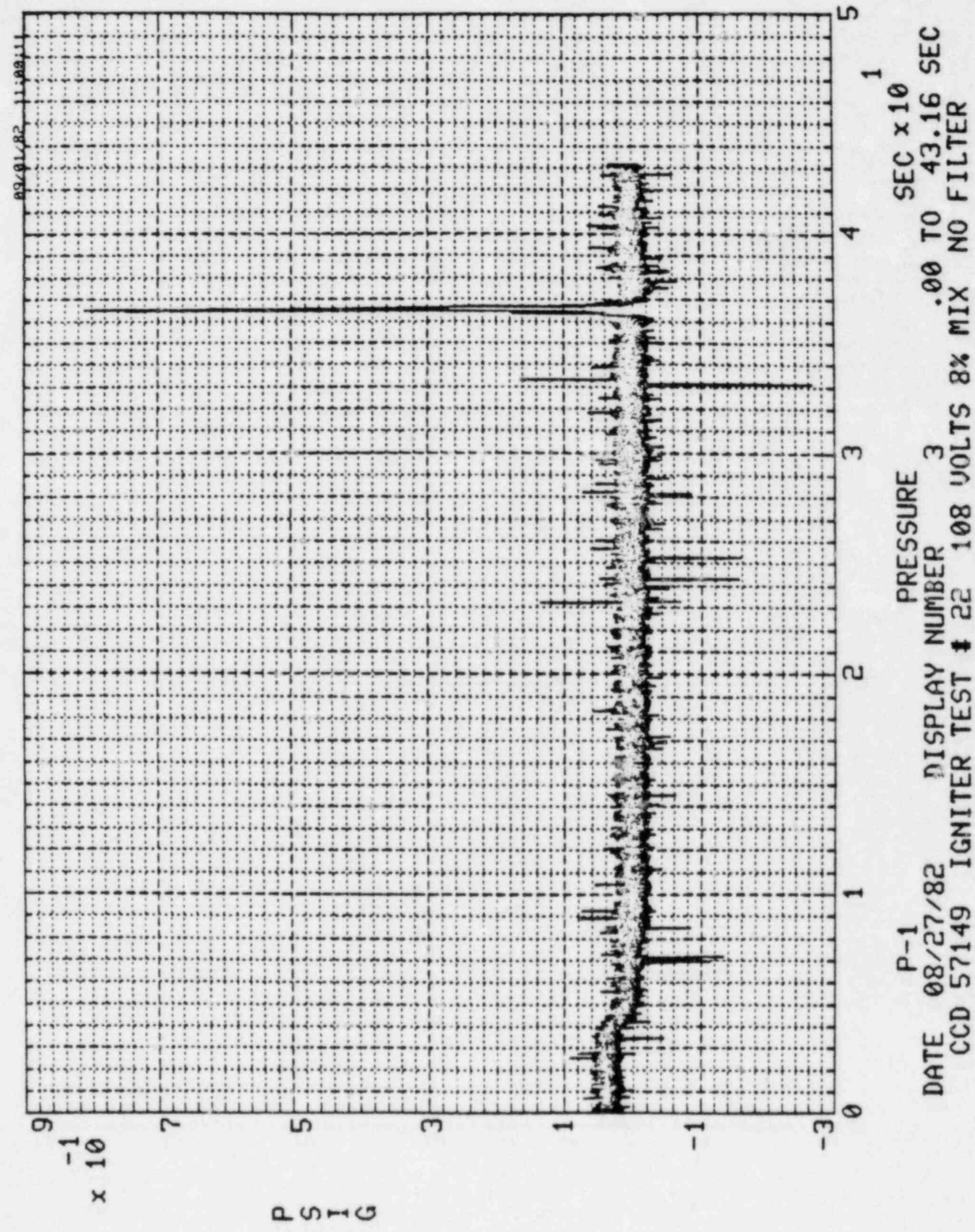
CCD 57149 IGNITER TEST # 21 108 VOLTS 8% MIX 10 HZ FILTER

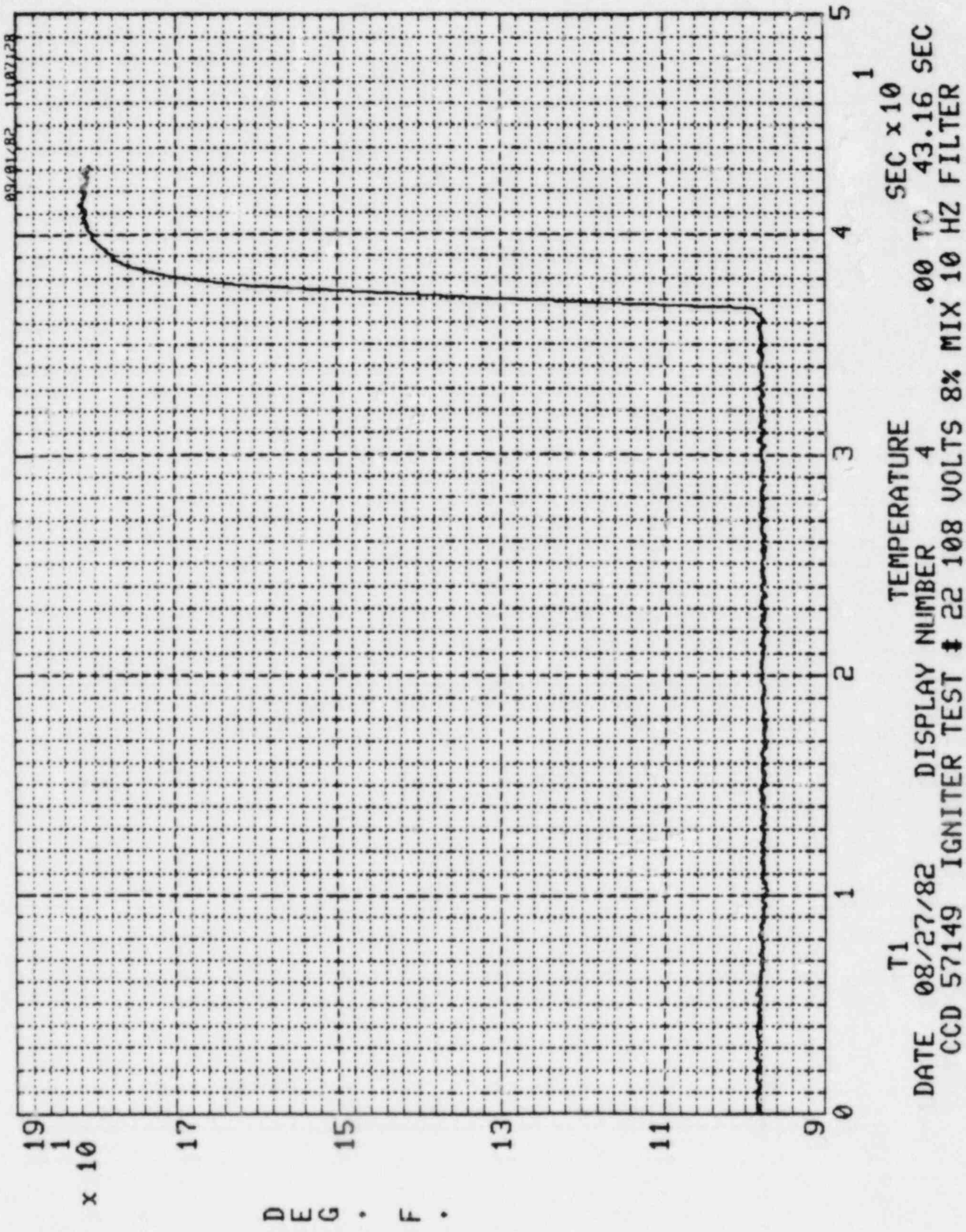

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 21 108 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
.00 TO 43.16 SEC
DEG. F.
x 10 3
0 1 2 3 4 5
1 0 -1 -2 -3 -4 -5

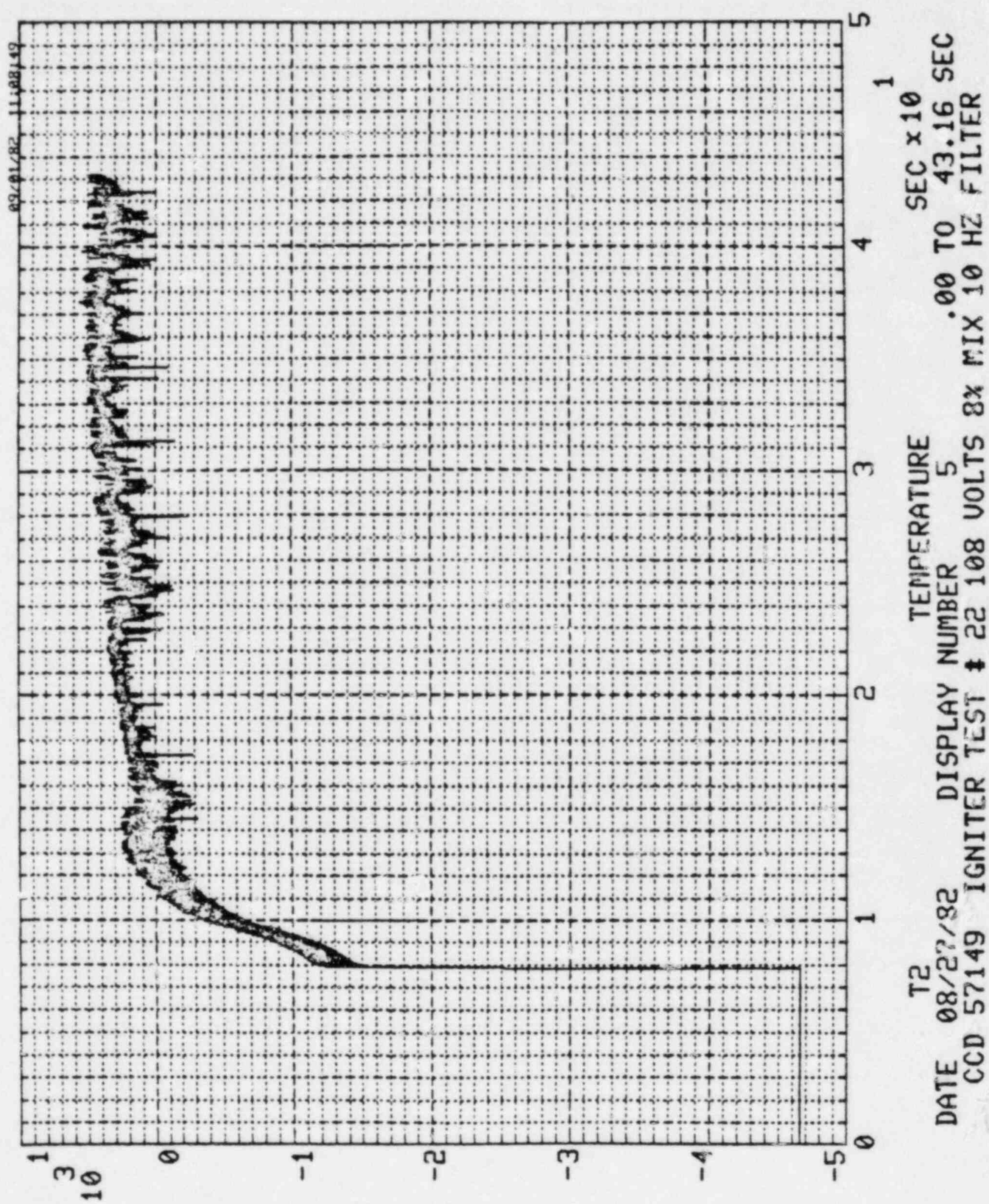

T3
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 21 108 VOLTS 8% MIX 10 HZ FILTER
TEMPERATURE
SEC x10 1
.00 TO 43.16 SEC
DEG. F.
x 10 2
0
1
2
3
4
5
2
1
0
-1
-2
-3
-4
-5
-6
08/30/82 13:21:37

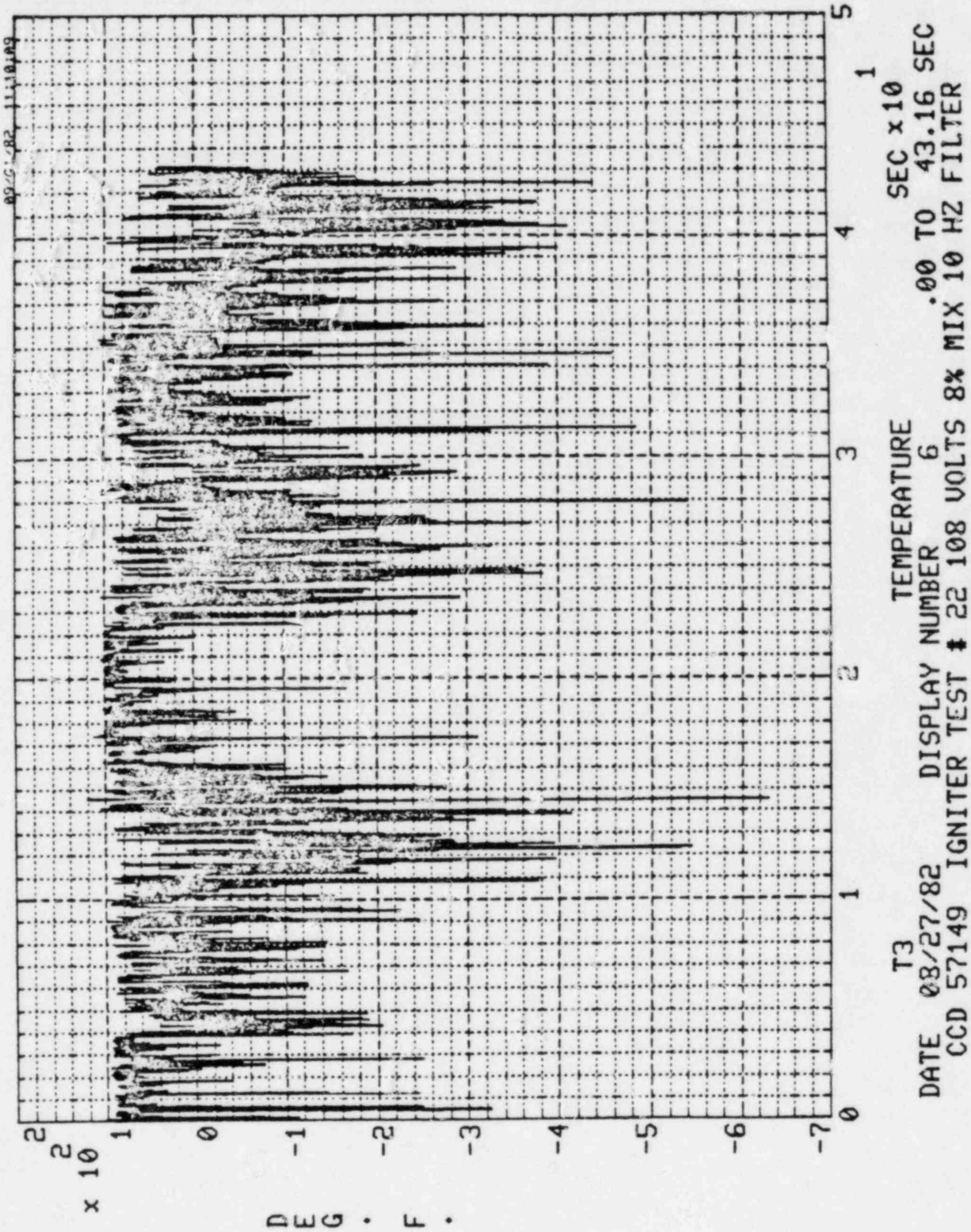

VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX NO FILTER
VOLTAGE
0.00 TO 43.16 SEC
SEC x 10^1
VOLTS x 10^1
-1
1
3
5
7
9
11
0
1
2
3
4
5

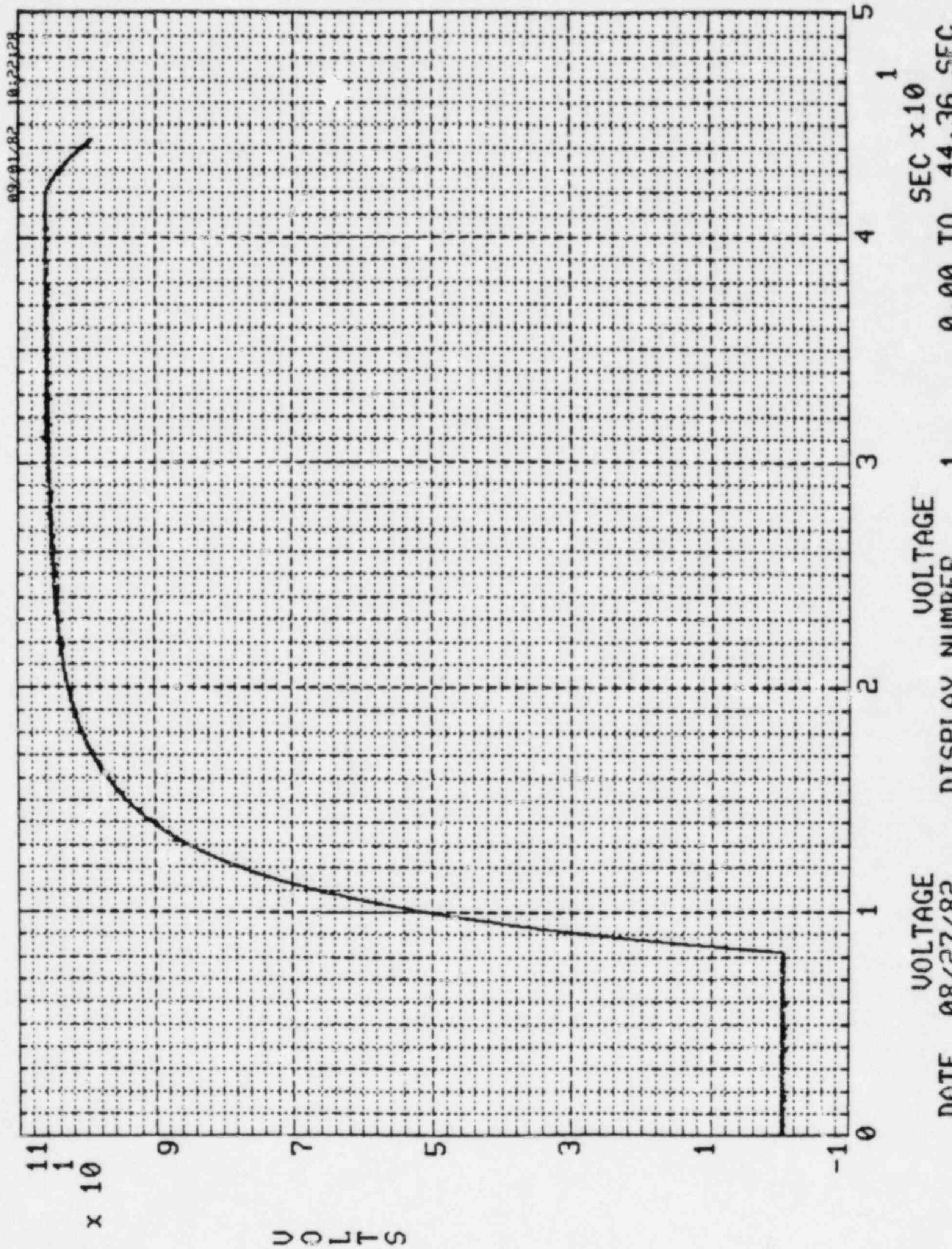

CURRENT AC CURRENT SEC x10
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 43.16 SEC
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX NO FILTER
AMPERES
x 10
0
2
1
0
-1
-2
0
1
2
3
4
5
1

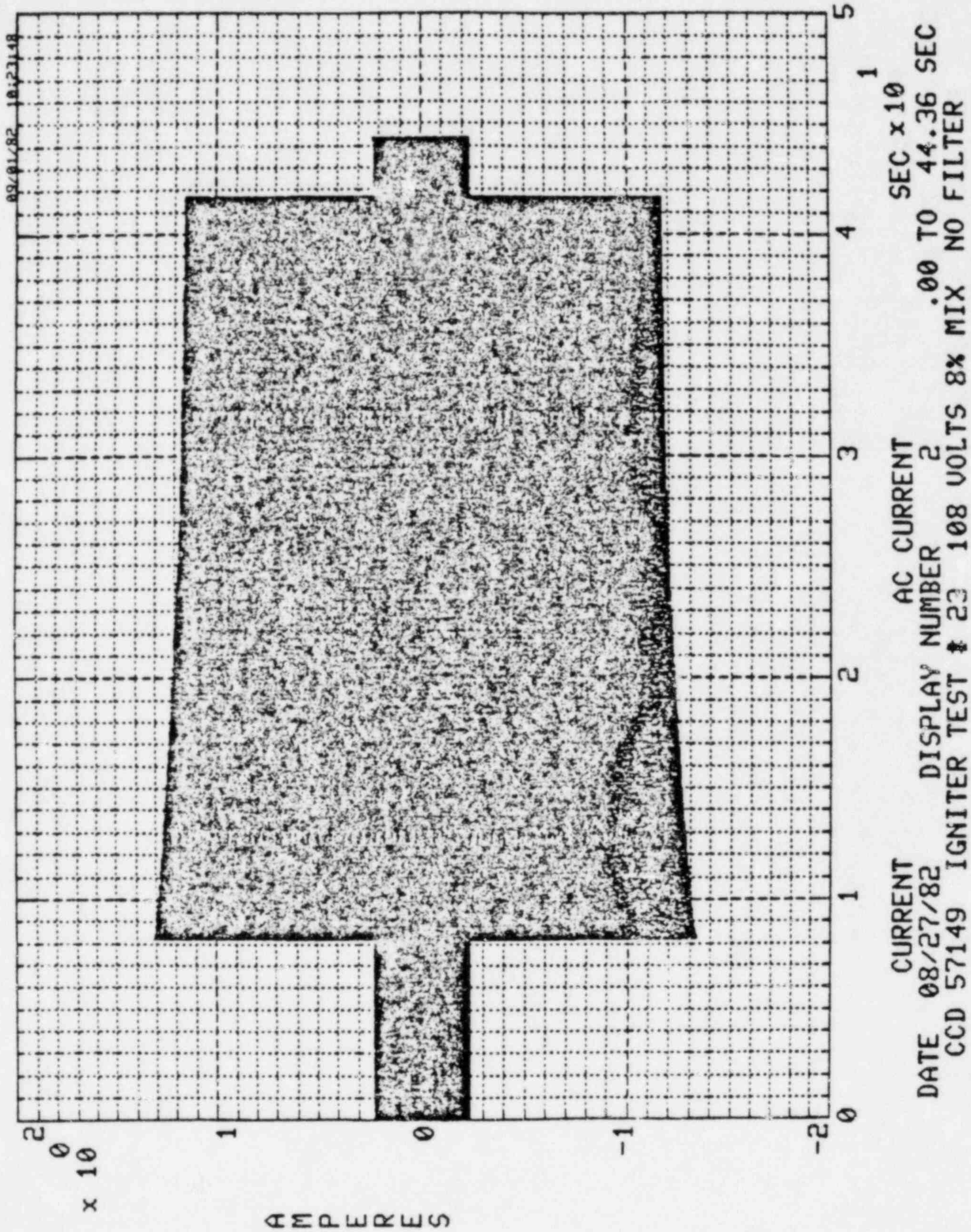

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX .00 TO 43.16 SEC NO FILTER
SEC x 10
1
PSIG
x 10
-1
9
7
5
3
1
-1
-3
0
1
2
3
4
5
09/01/82 11:03:11

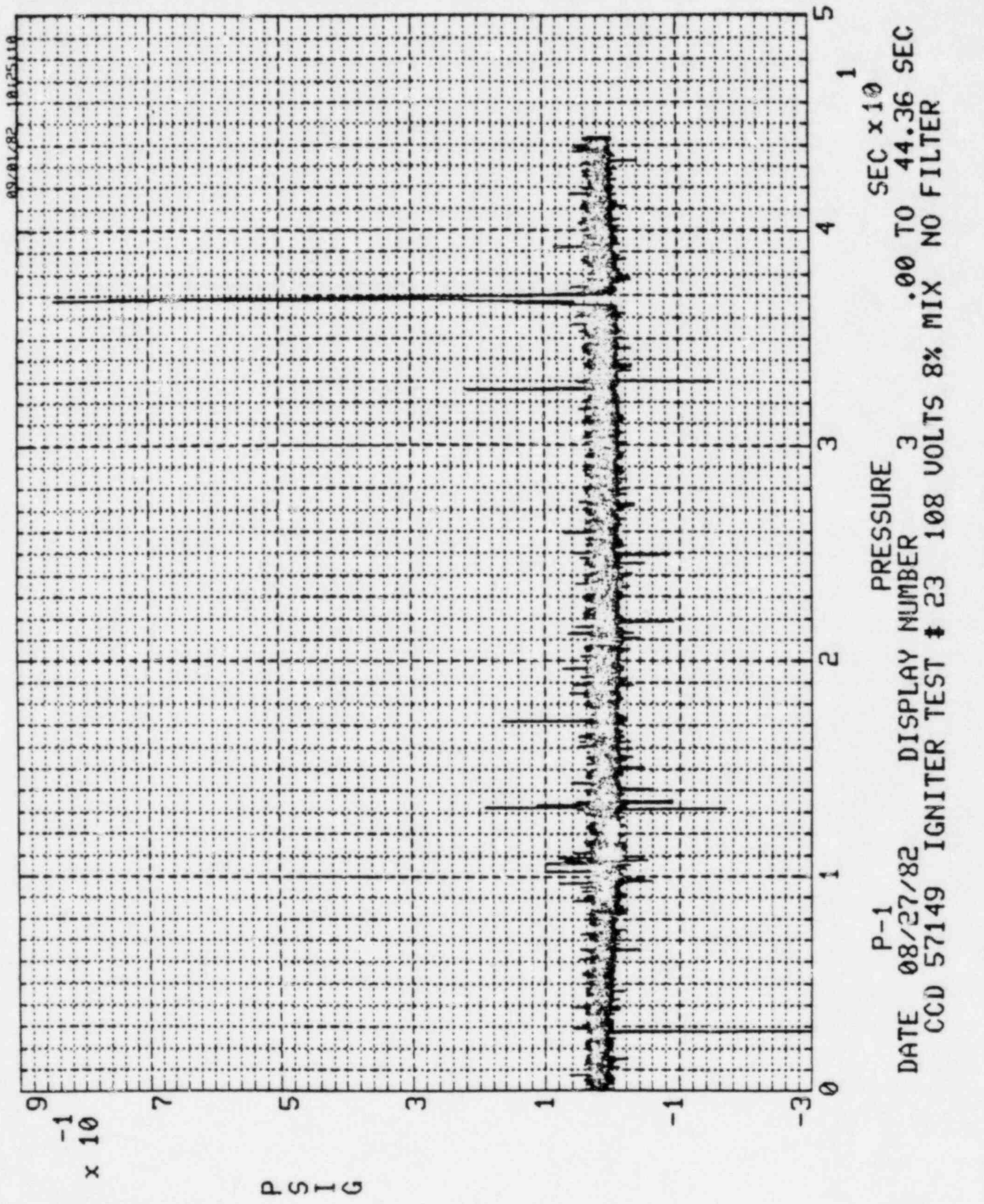

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX 10 HZ FILTER
.00 TO 43.16 SEC
SEC x10 1
0
1
2
3
4
5
9
11
13
15
17
19
x 10 1
DEG. F.
09/01/82 11:02:28

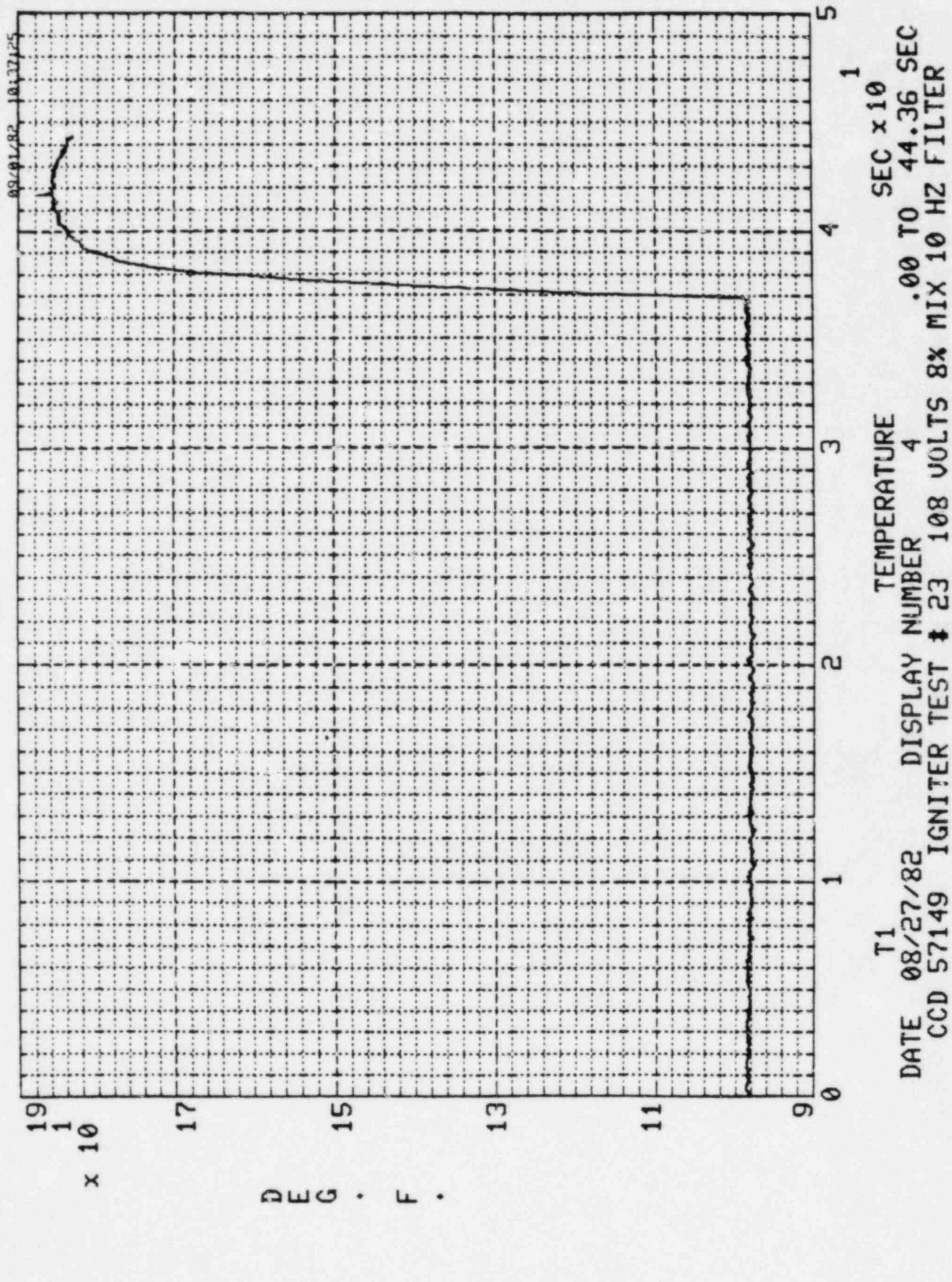

09/01/82 11:08:49
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX 10 HZ FILTER
SEC x10 1
.00 TO 43.16 SEC
DEG. F.
x 10 3
1
0
-1
-2
-3
-4
-5
0
1
2
3
4
5

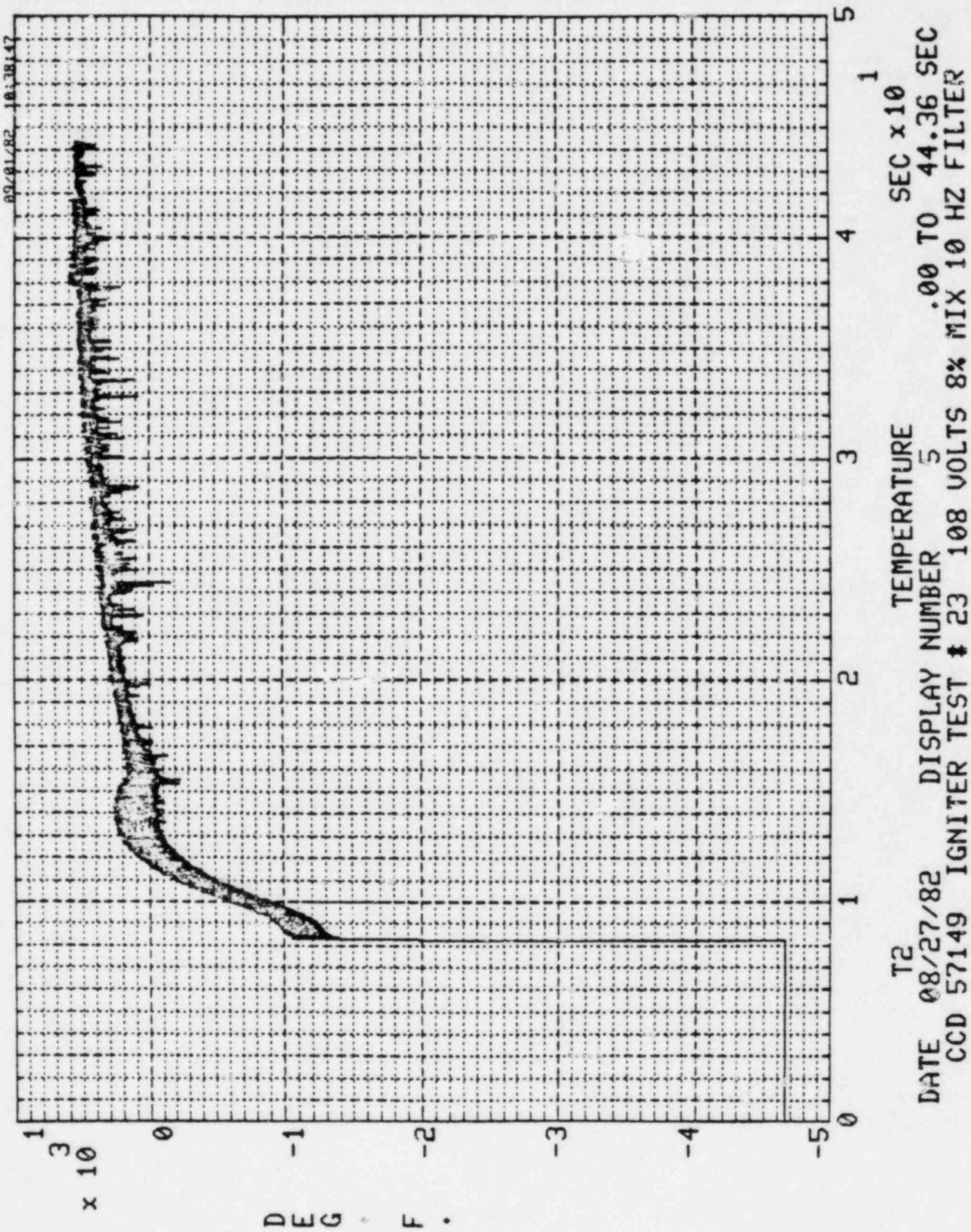

T3 TEMPERATURE
DATE 03/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 22 108 VOLTS 8% MIX 10 HZ FILTER
.00 TO 43.16 SEC
SEC x 10 1
x 10 2
DEG. F.
09/01/82 11:10:09
0
1
2
3
4
5
2
1
0
-1
-2
-3
-4
-5
-6
-7

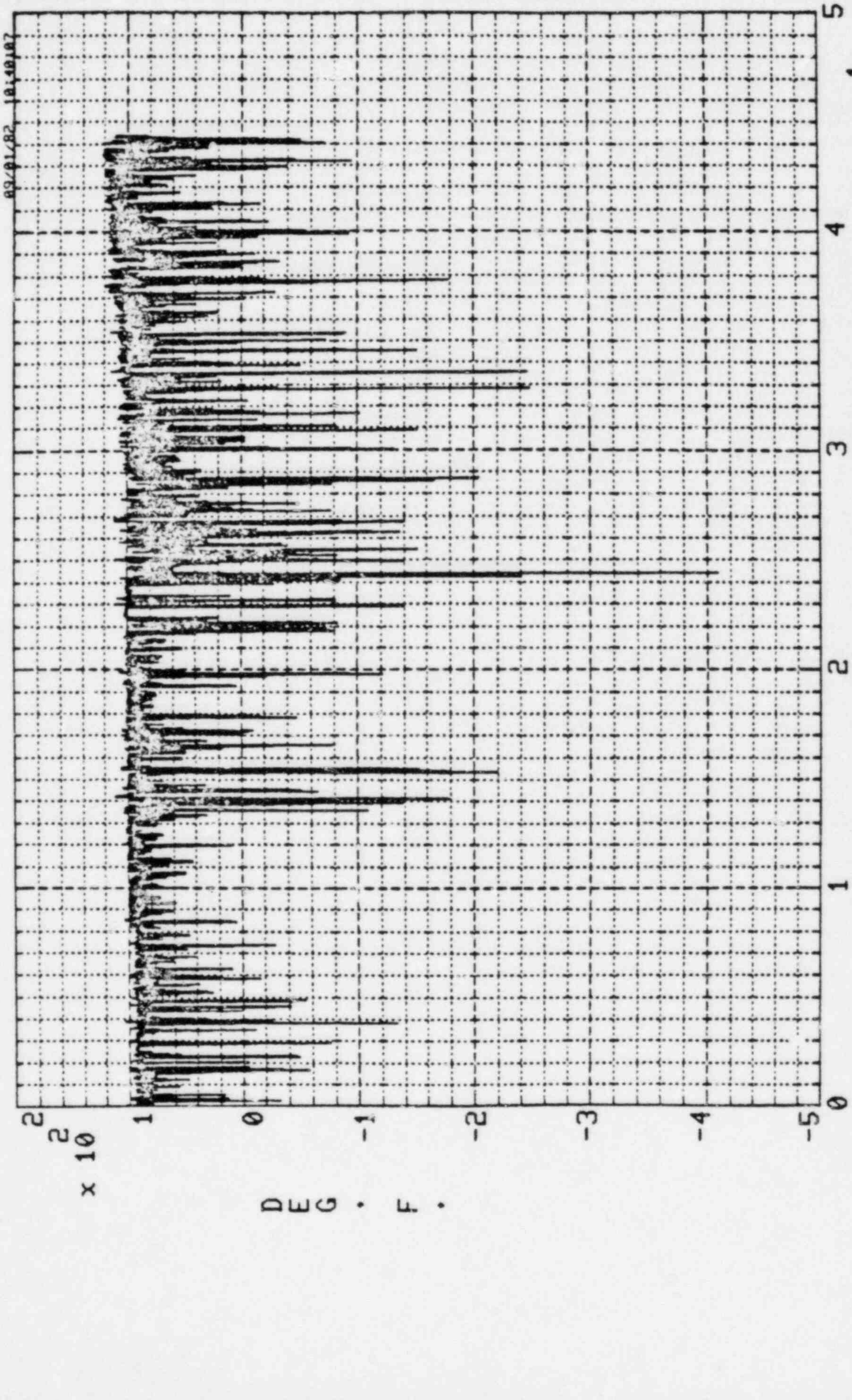

VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX NO FILTER
VOLTAGE
0.00 TO 44.36 SEC
SEC x10 1
VOLTS x 10 1
09/01/82 10:22:28
-1
1
3
5
7
9
11
0
1
2
3
4
5


CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX NO FILTER
.00 TO 44.36 SEC
SEC x 10 1
AMPERES x 10 0
0
1
2
3
4
5
2
1
0
-1
-2
09/01/82 10:23:48


09/01/82 10:25:10
PSIG
x 10^-1
9
7
5
3
1
-1
-3
0
1
2
3
4
5
SEC x10^1
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 44.36 SEC
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX NO FILTER


T1
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX 10 HZ FILTER
TEMPERATURE
.00 TO 44.36 SEC
SEC x 10 1
0
1
2
3
4
5
DEG. F.
x 10 1
9
11
13
15
17
19

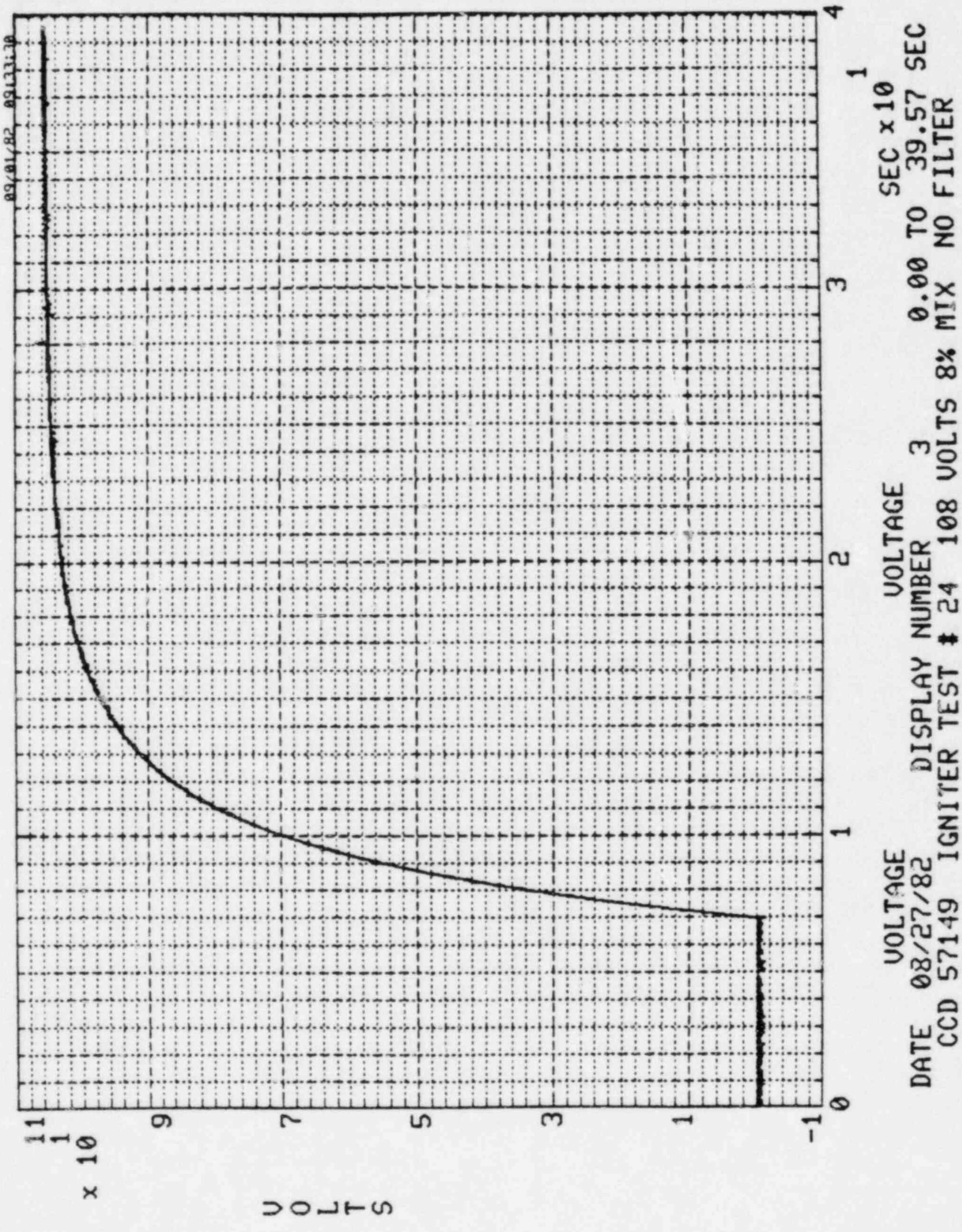

T2
DATE 08/27/82 DISPLAY NUMBER 5
TEMPERATURE
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX 10 HZ FILTER
.00 TO 44.36 SEC
SEC x 10 1
0 1 2 3 4 5
DEG F.
x 10 3
1 0 -1 -2 -3 -4 -5

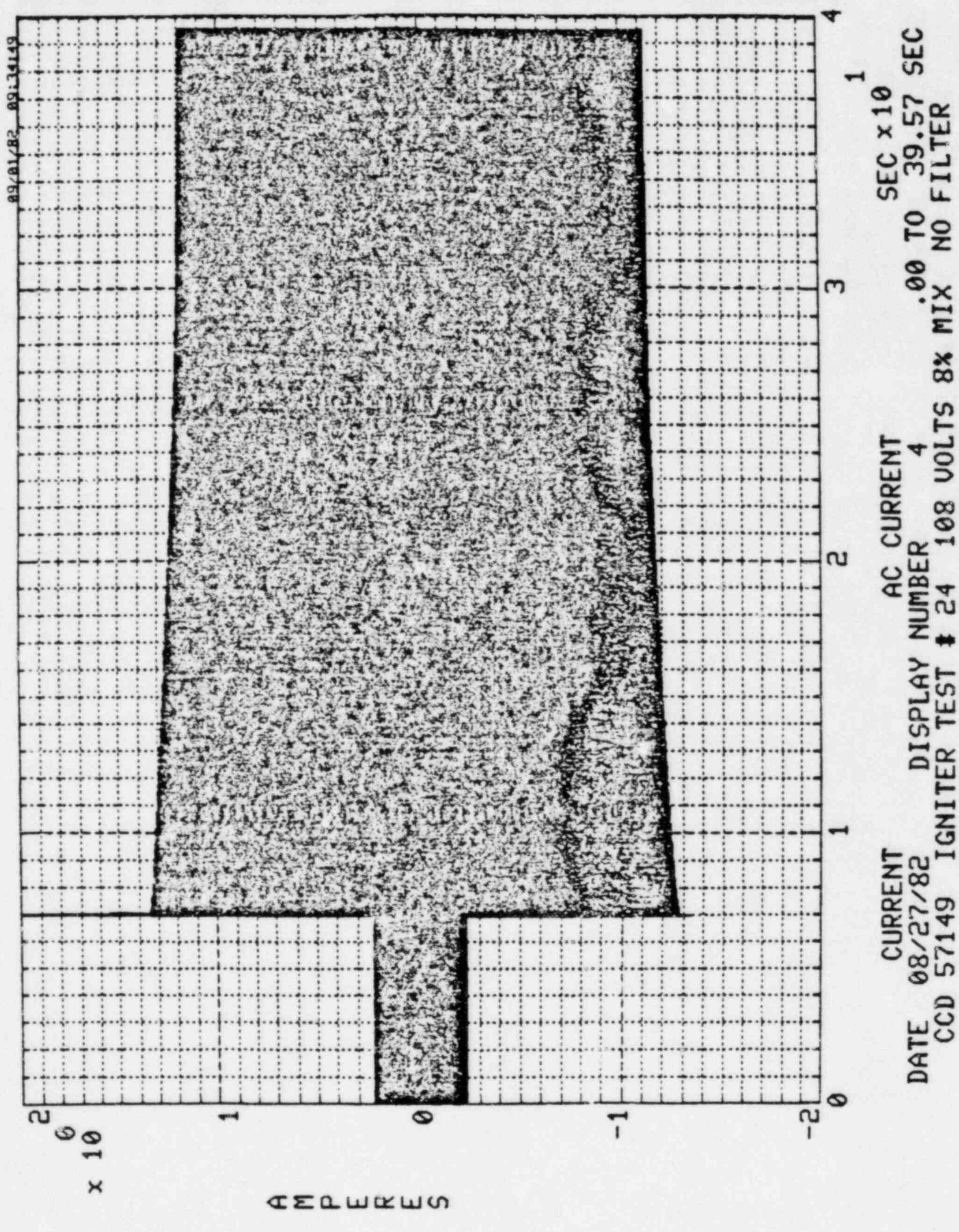


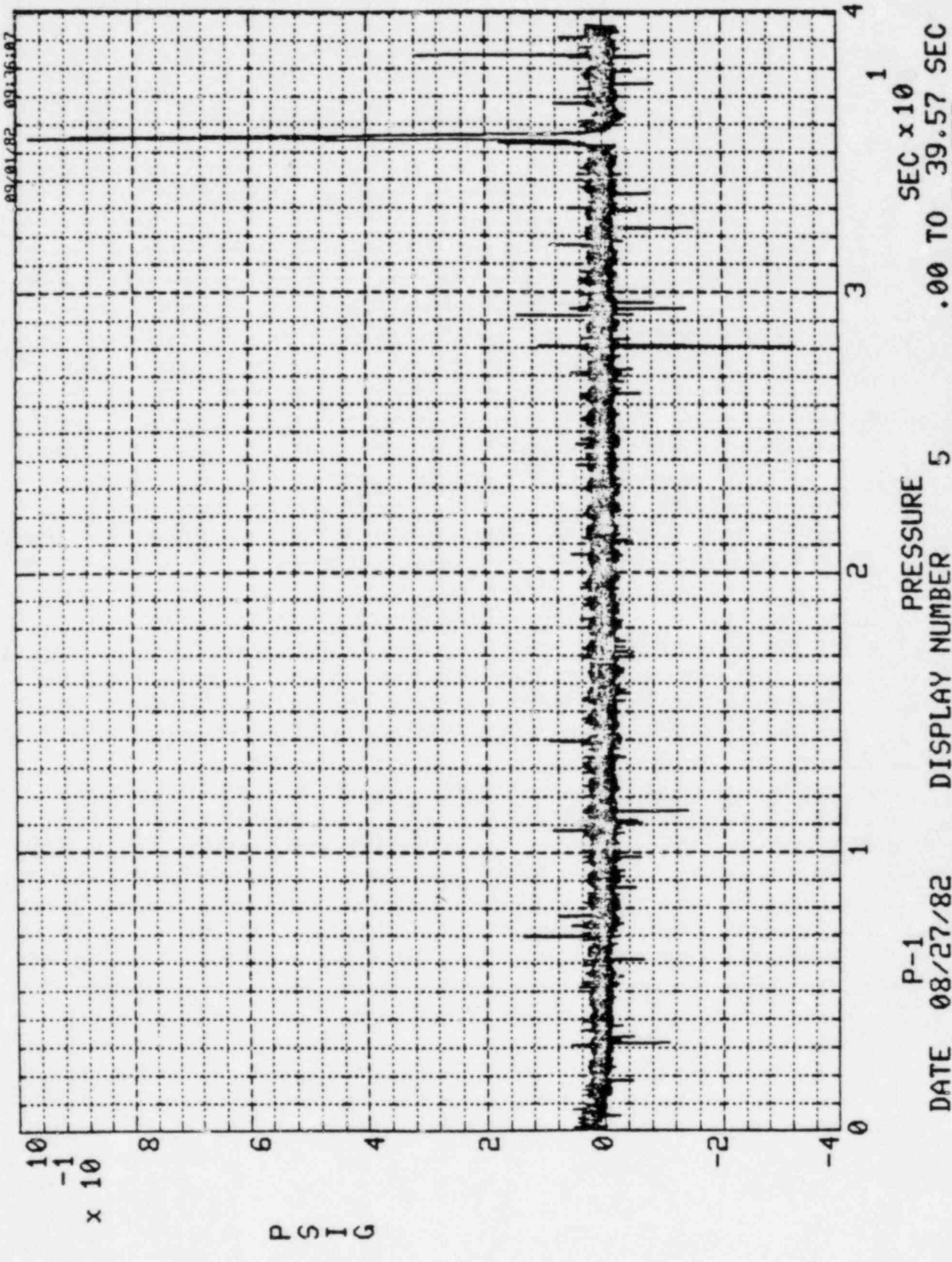
T3 TEMPERATURE SEC x10 1

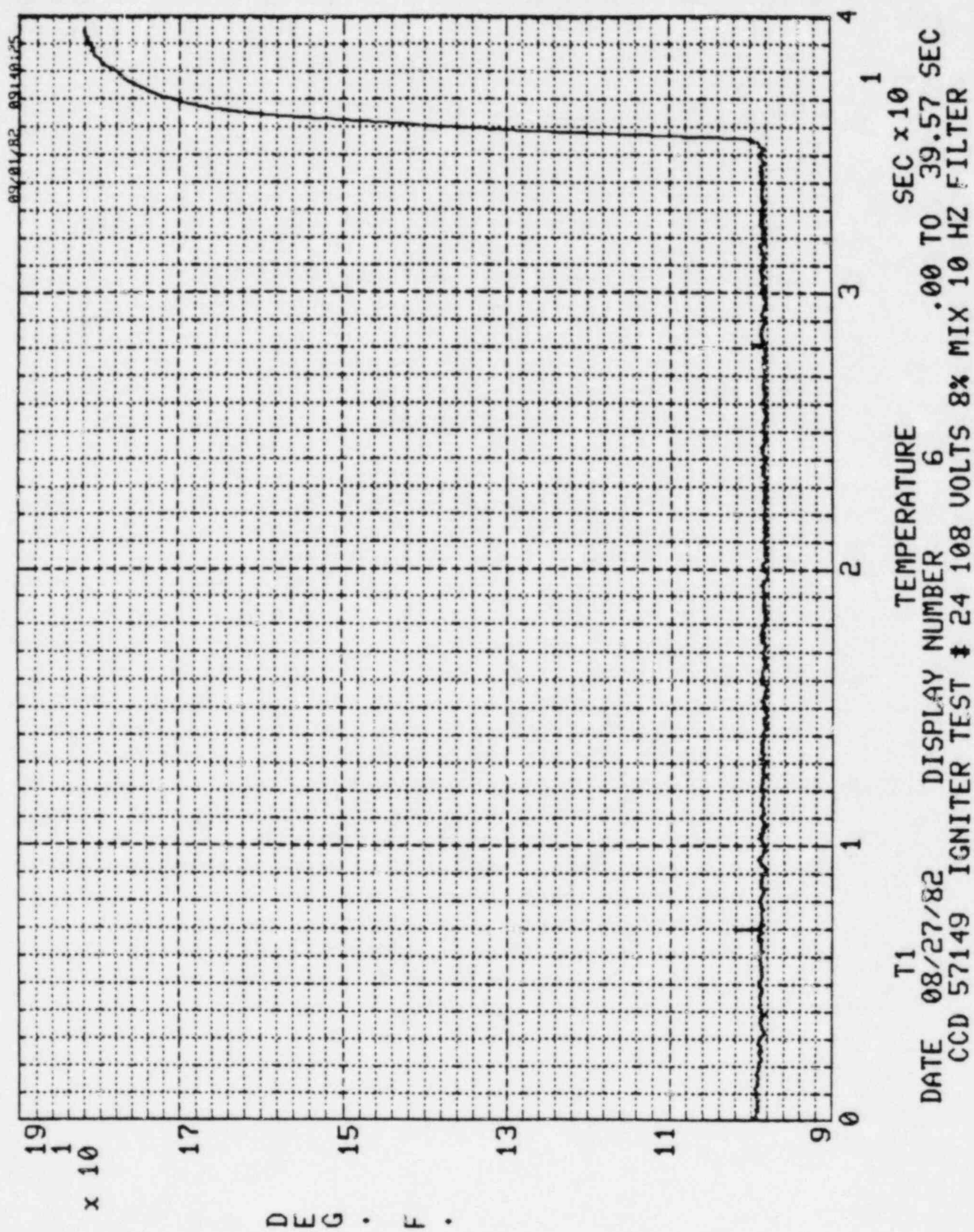
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 44.36 SEC

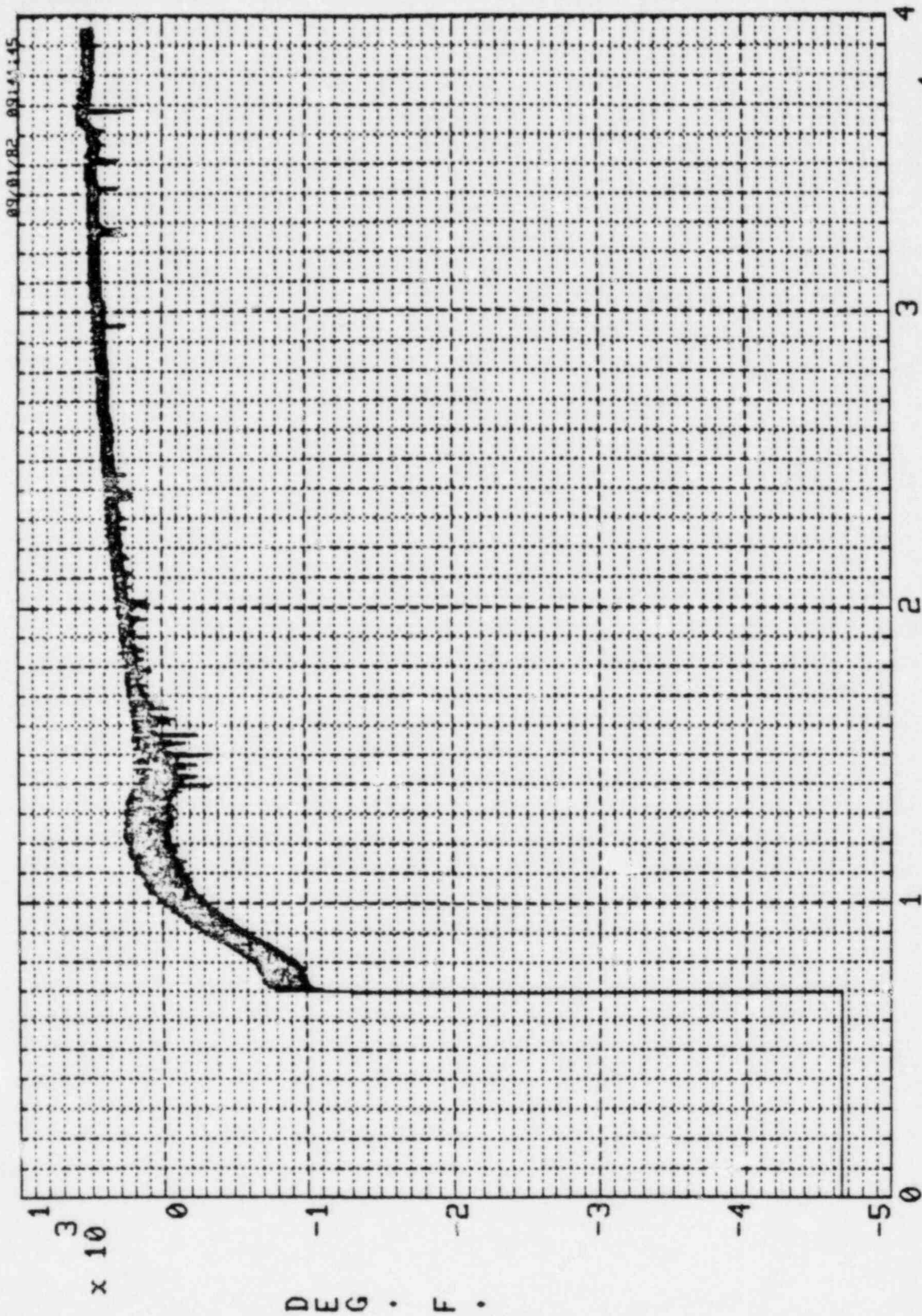
CCD 57149 IGNITER TEST # 23 108 VOLTS 8% MIX 10 HZ FILTER


VOLTAGE
DATE 08/27/82
CCD 57149 IGNITER TEST # 24
VOLTAGE
DISPLAY NUMBER 3
108 VOLTS 8% MIX
SEC x 10 1
0.00 TO 39.57 SEC
NO FILTER
VOLTS
x 10 1
11
9
7
5
3
1
-1
0
1
2
3
4
09/01/82 09:33:10


09/01/82 09:34:49
AMPERES
x 10^6
2
1
0
-1
-2
0
1
2
3
4
SEC x 10^1
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 24 108 VOLTS 8% MIX NO FILTER


09/01/82 09:36:07
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 24 108 VOLTS 8% MIX .00 TO 39.57 SEC NO FILTER
SEC x 10^1
PSIG
x 10^-1
10
8
6
4
2
0
-2
-4
0
1
2
3
4


T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 24 108 VOLTS 8% MIX 10 HZ FILTER
.00 TO 39.57 SEC
SEC x 10
1
DEG. F.
x 10
1
19
17
15
13
11
9
0
1
2
3
4
09/01/82 09:40:25

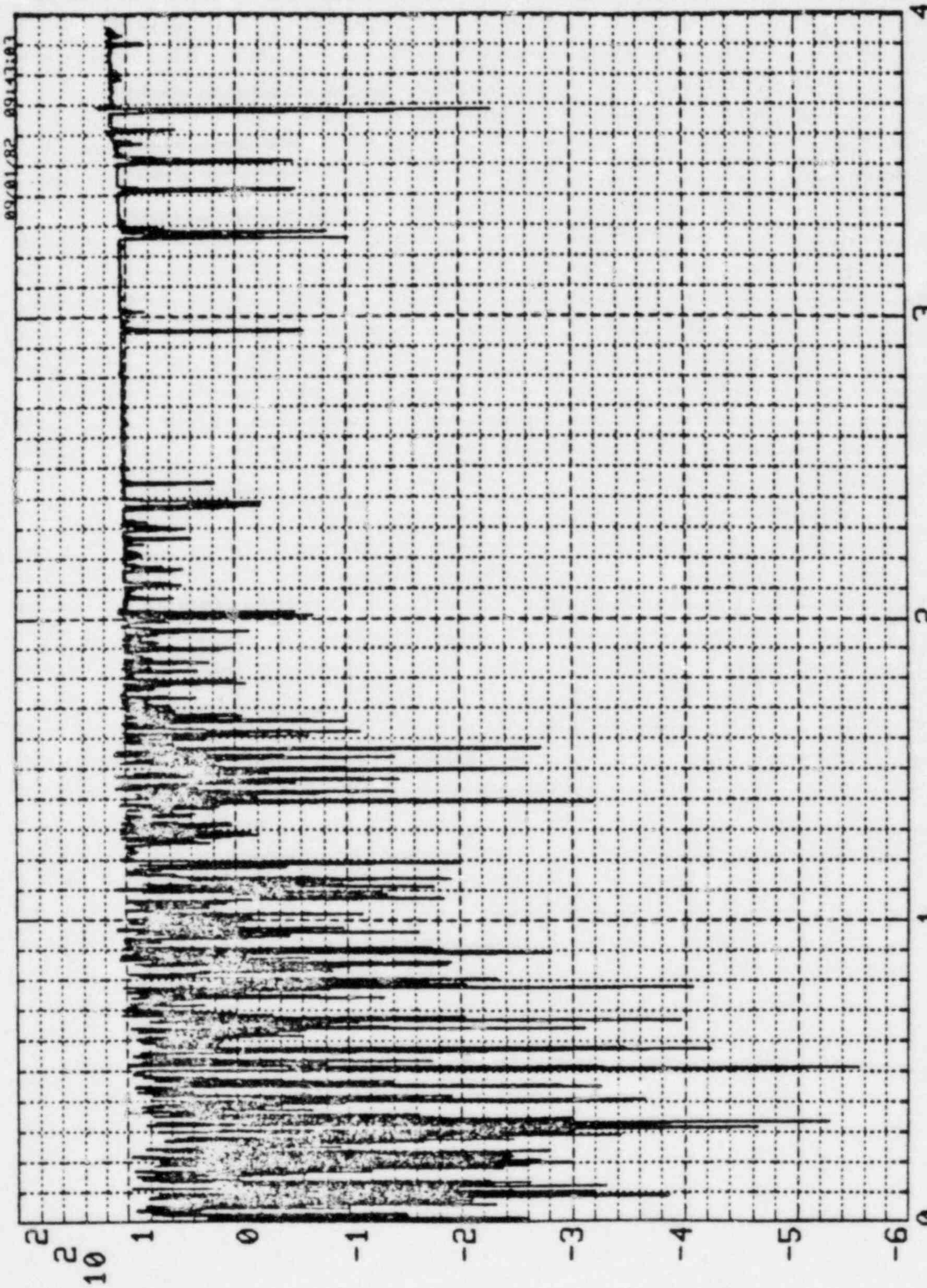


SEC x 10^1

T2 TEMPERATURE

DATE 08/27/82 DISPLAY NUMBER 7 .00 TO 39.57 SEC

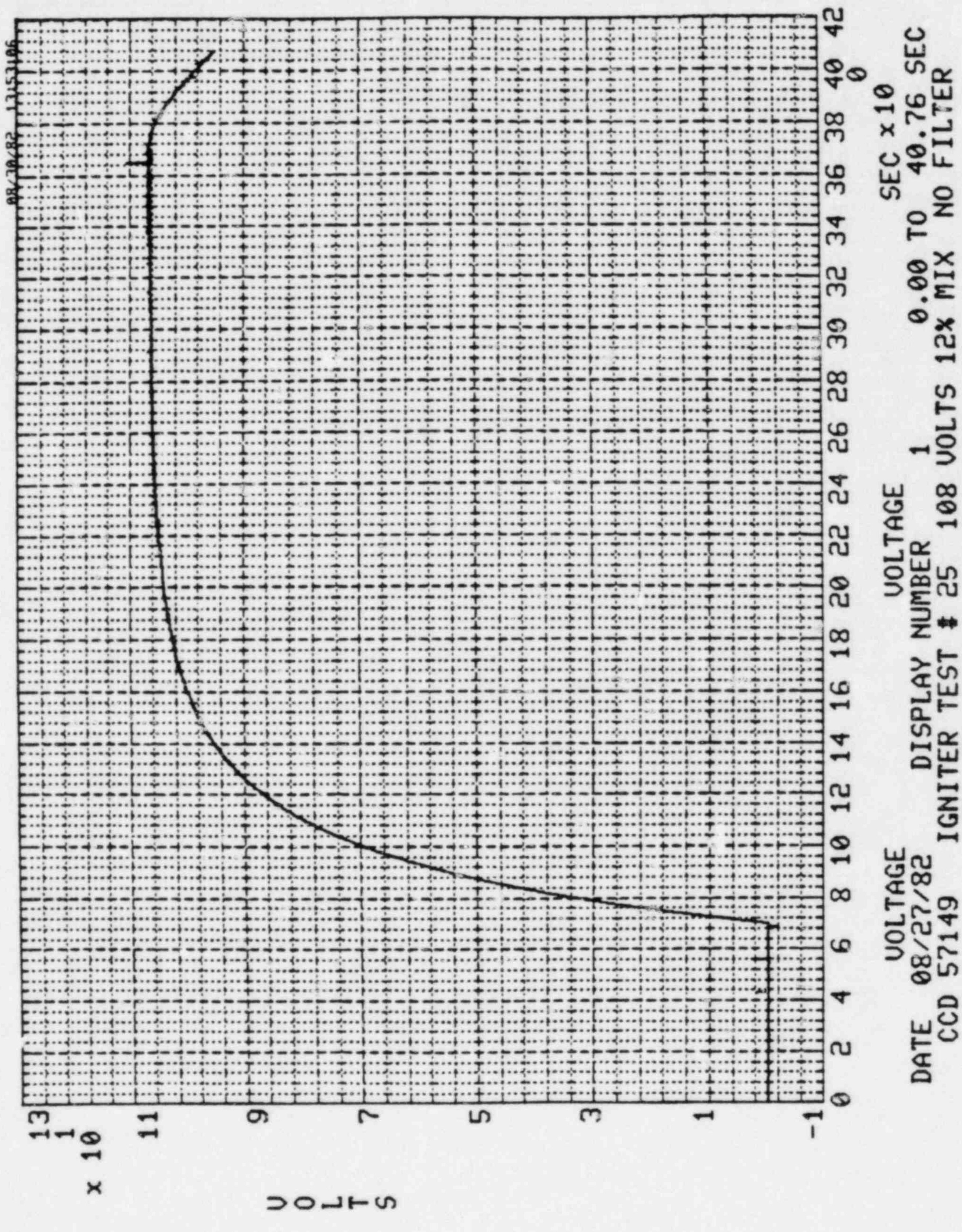
CCD 57149 IGNITER TEST # 24 108 VOLTS 8% MIX 10 HZ FILTER

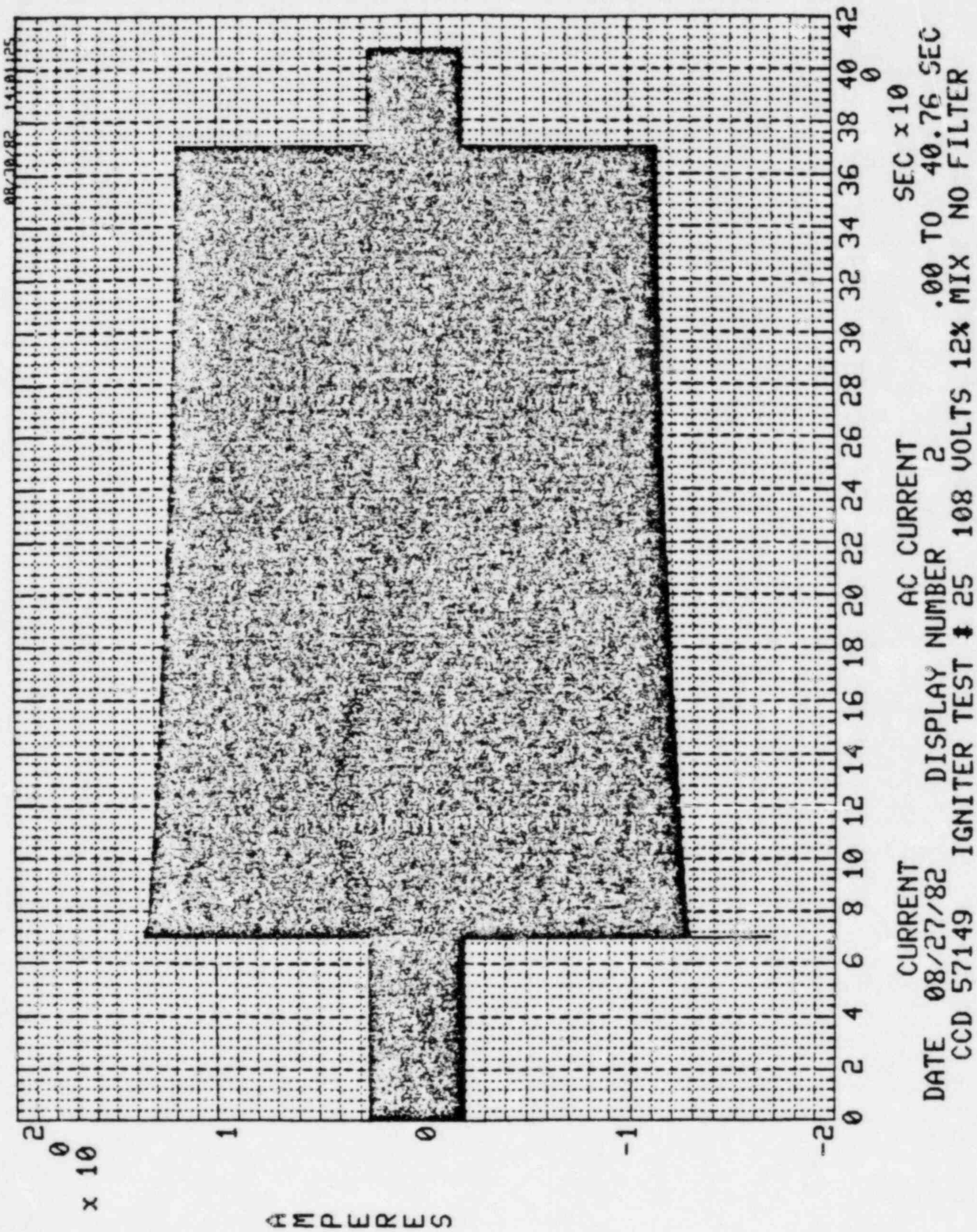


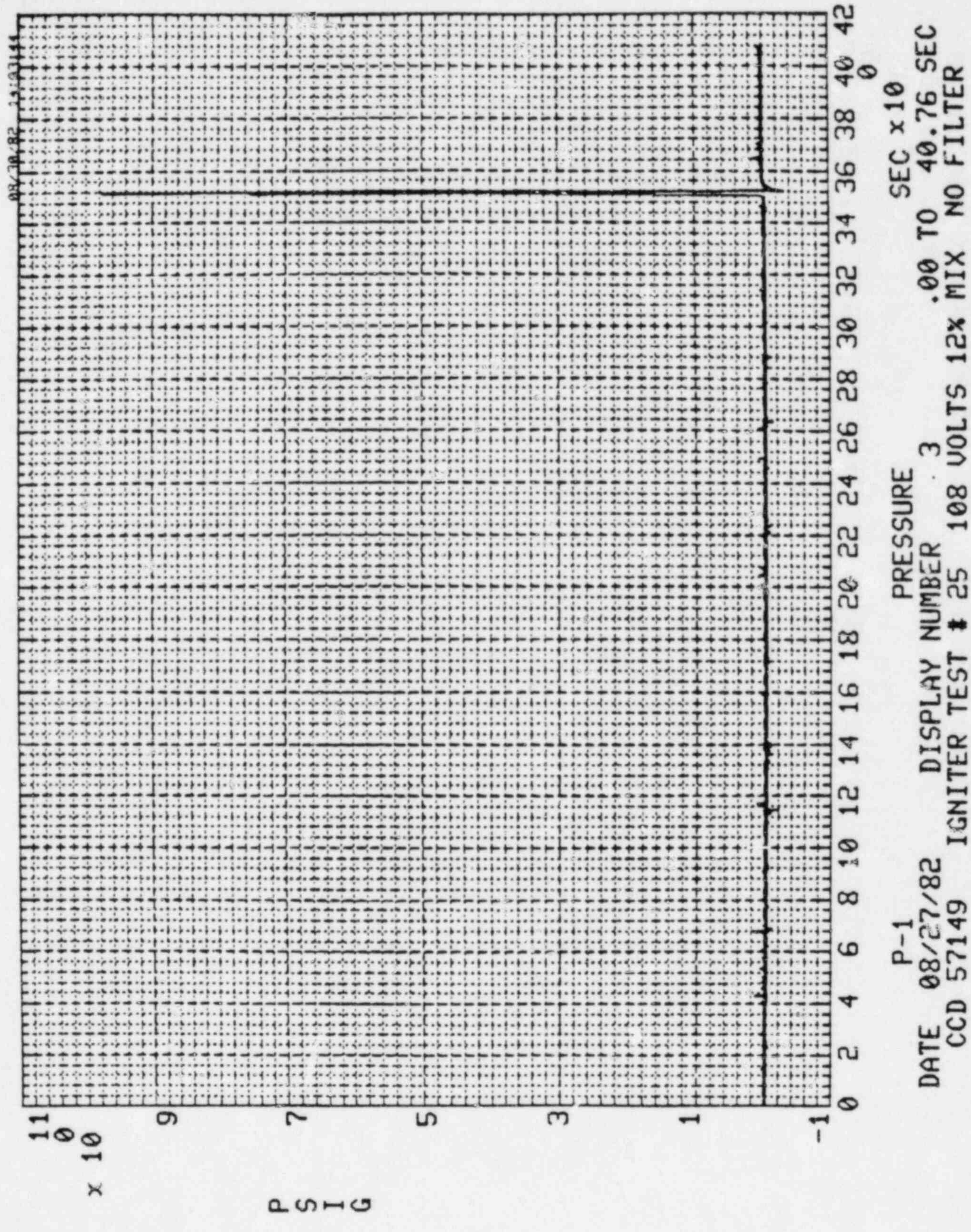
T3 TEMPERATURE

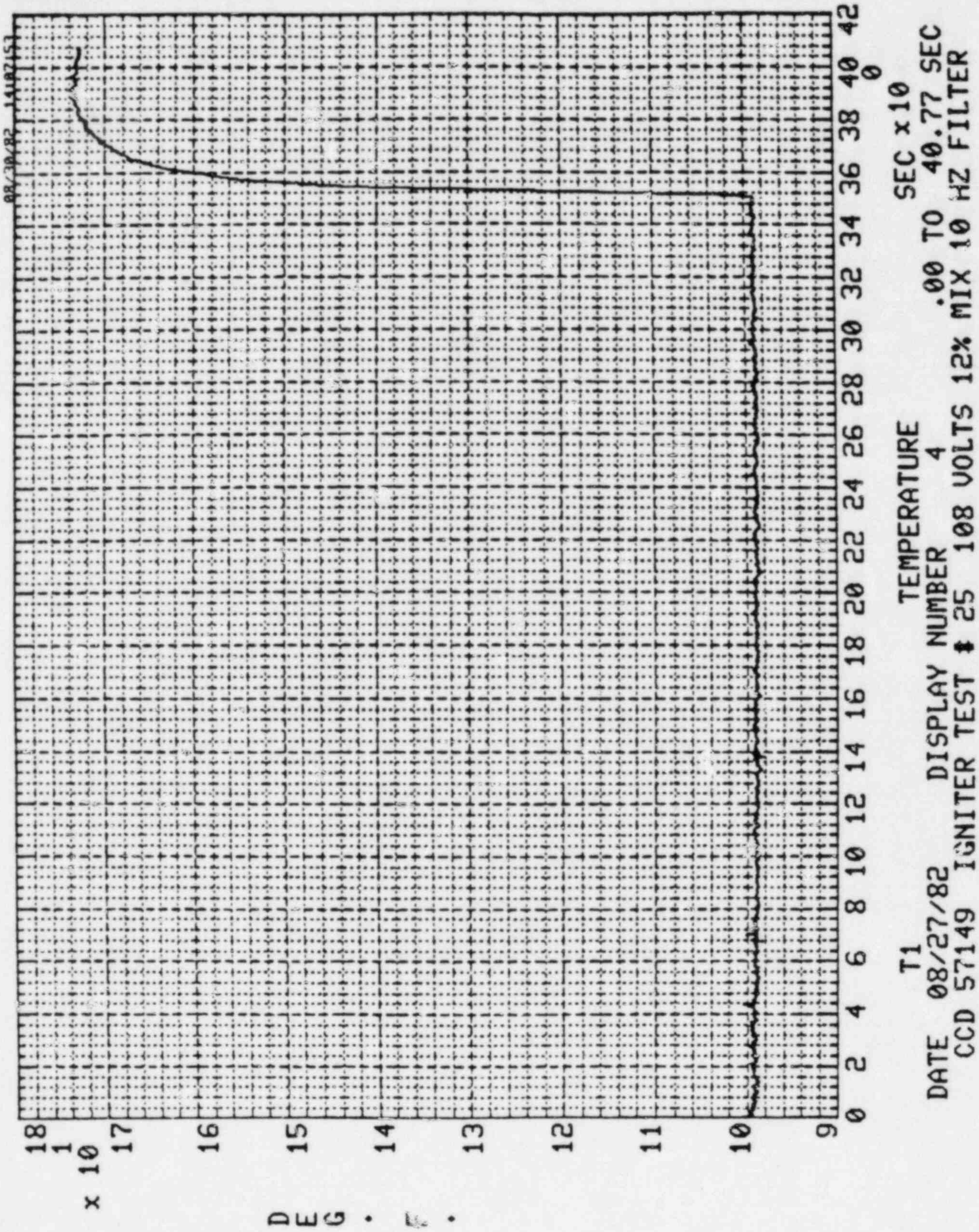
DATE 08/27/82 DISPLAY NUMBER 8 .00 TO 39.57 SEC

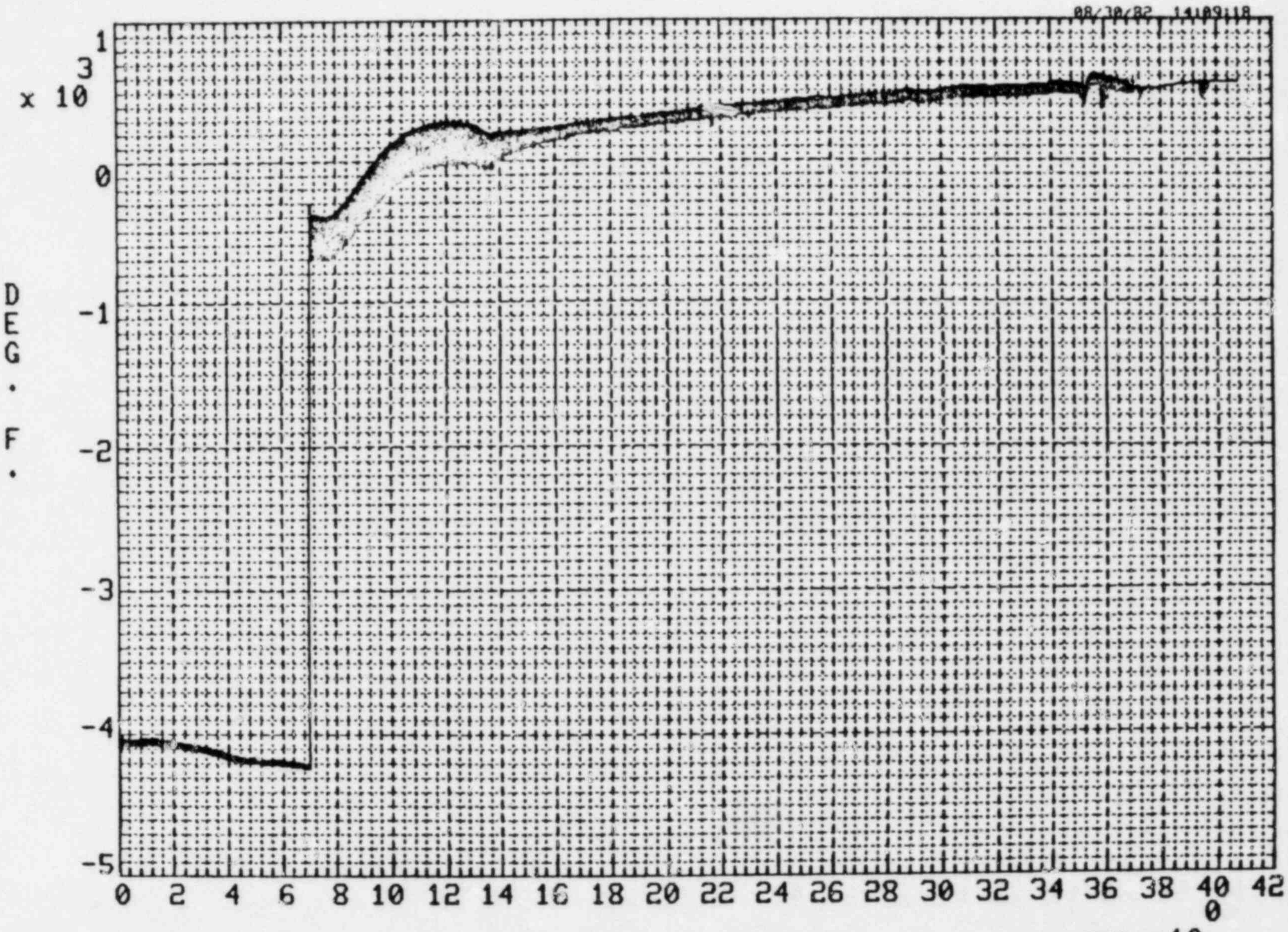
CCD 57149 IGNITER TEST # 24 108 VOLTS 8% MIX 10 HZ FILTER


VOLTS x 10^1
SEC x10^0
VOLTAGE
VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 40.76 SEC
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX NO FILTER

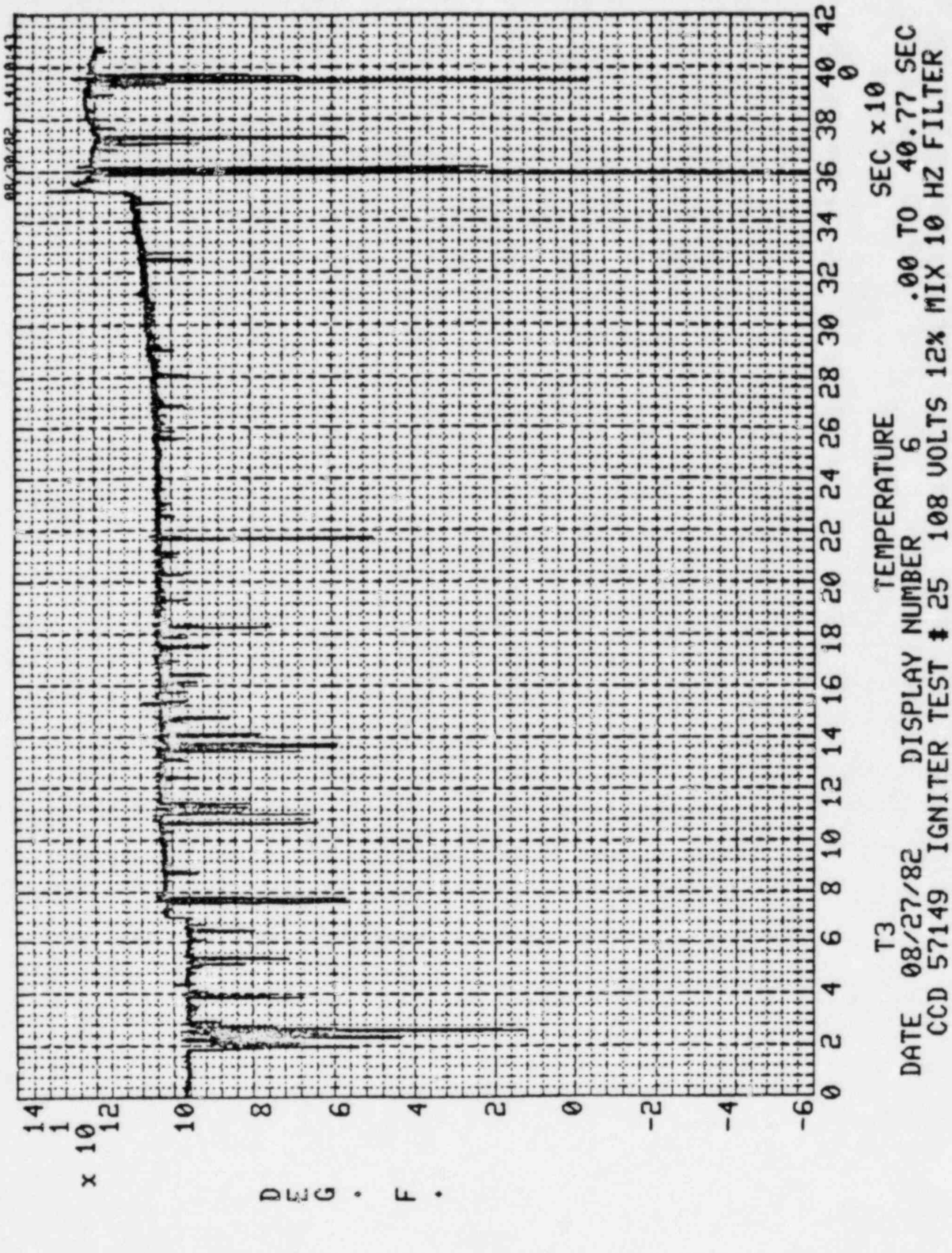

CURRENT AC CURRENT SEC x10
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 40.76 SEC
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX NO FILTER
AMPERES
x 10
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
2 1 0 -1 -2

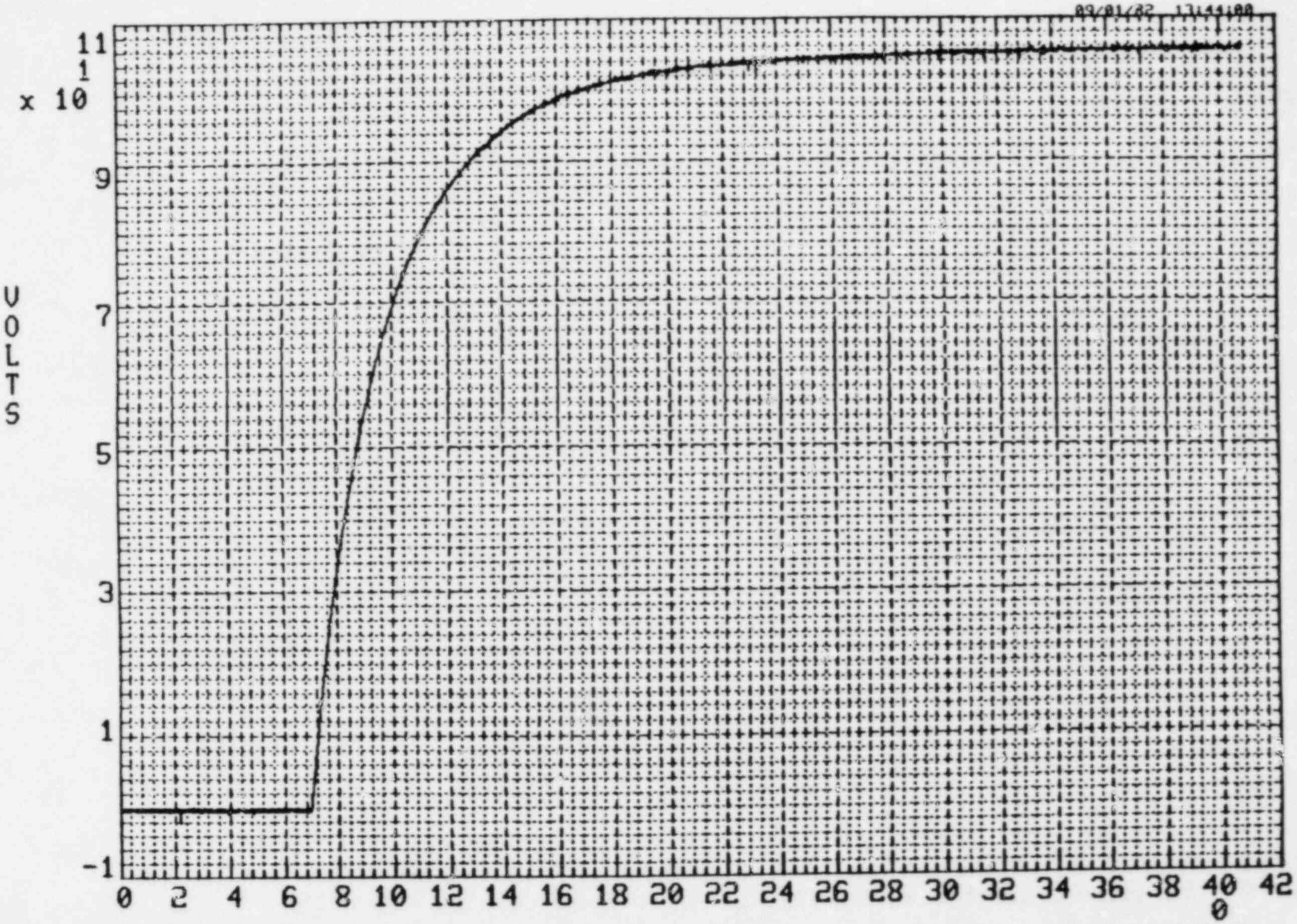

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX NO FILTER
.00 TO 40.76 SEC
SEC x10
P S I G
x 10


T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10
.00 TO 40.77 SEC
x 10
DEG.
08/30/82 14:07:53



T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX 10 HZ FILTER

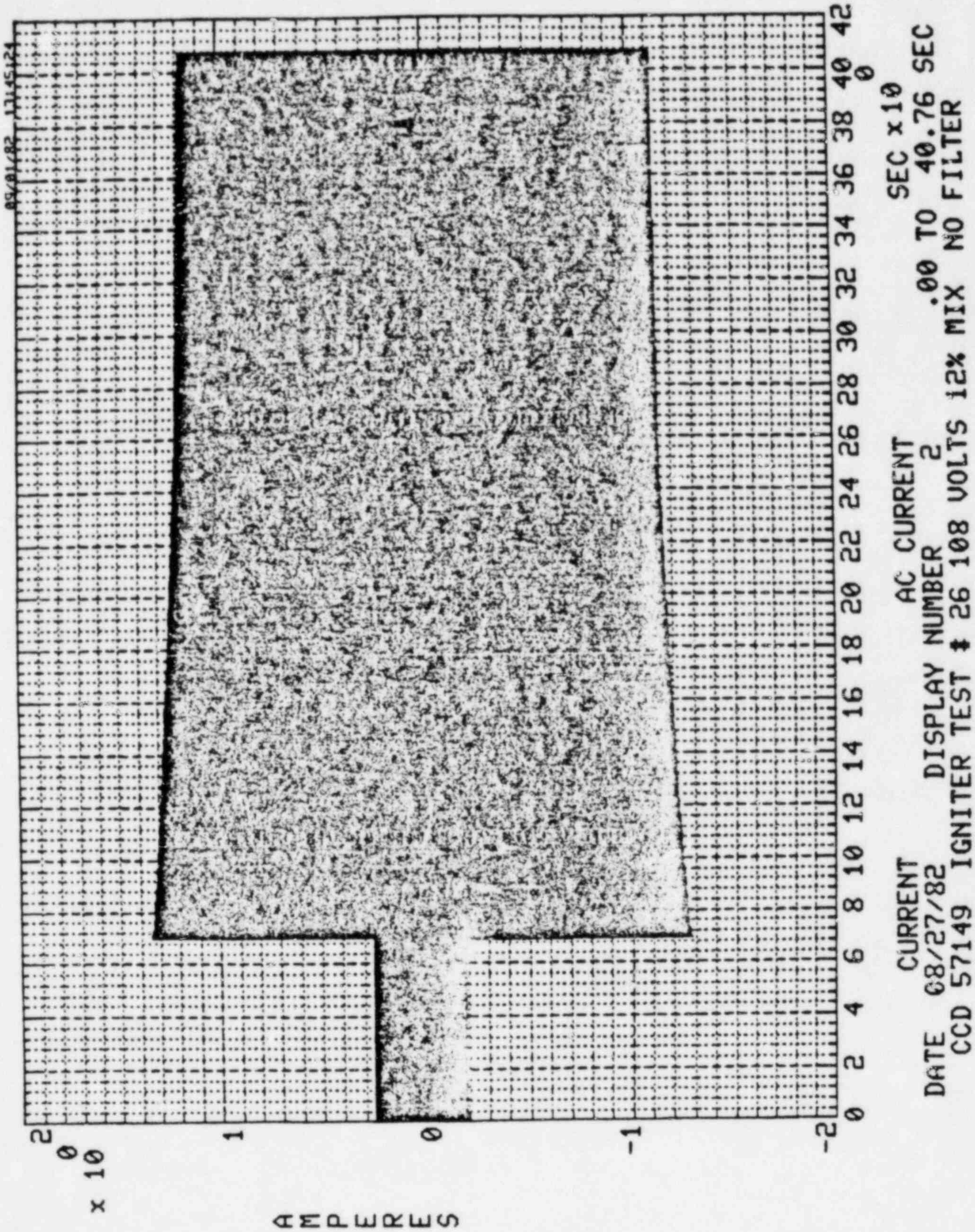

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 25 108 VOLTS 12% MIX 10 HZ FILTER
SEC x 10
.00 TO 40.77 SEC
DEG. F.
x 10

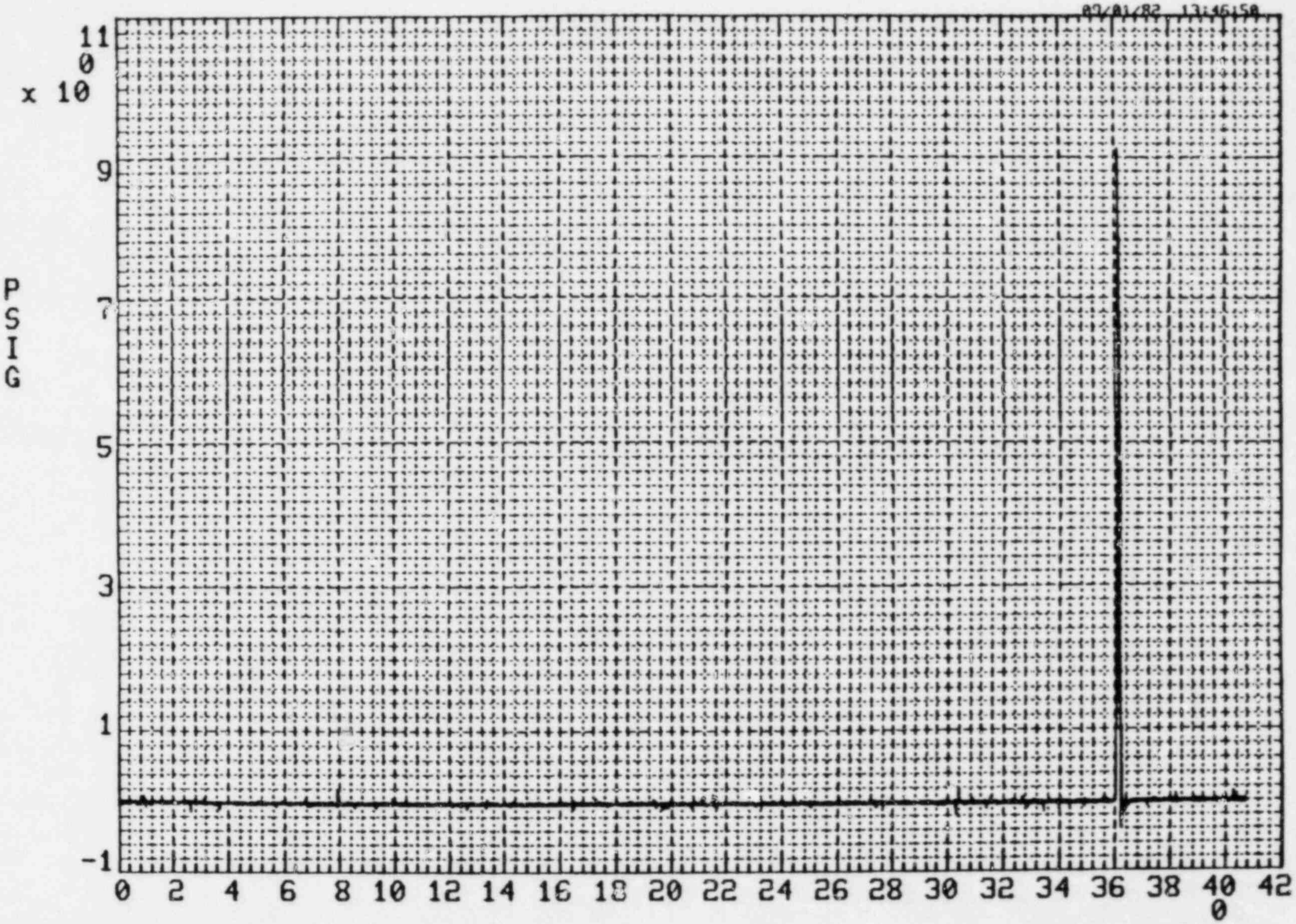


VOLTAGE VOLTAGE

DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 40.76 SEC

CCD 57149 IGNITER TEST # 26 108 VOLTS 12% MIX NO FILTER

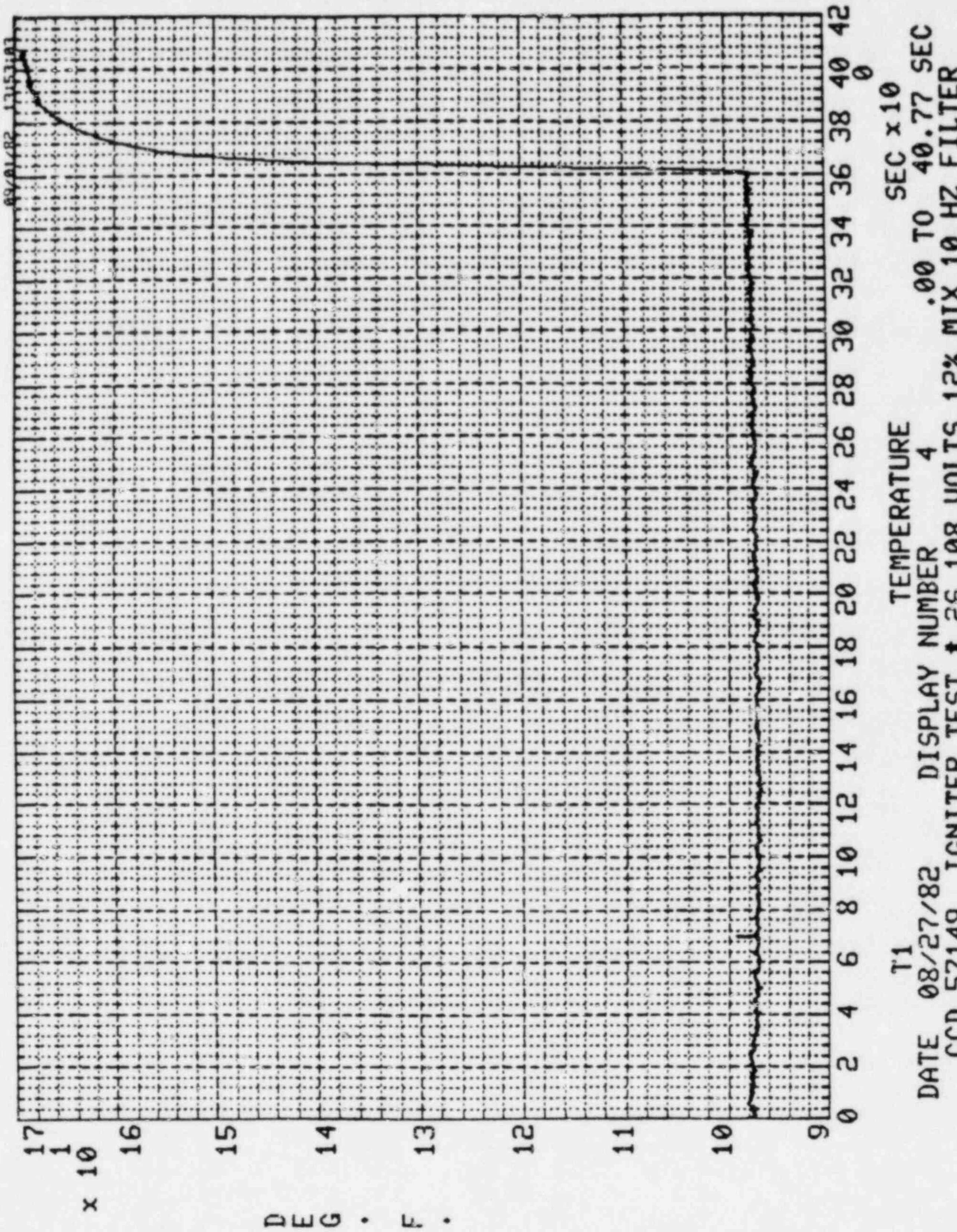

CURRENT AC CURRENT SEC x10^0
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 40.76 SEC
CCD 57149 IGNITER TEST # 26 108 VOLTS 12% MIX NO FILTER
AMPERES
x 10^0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
2 1 0 -1 -2

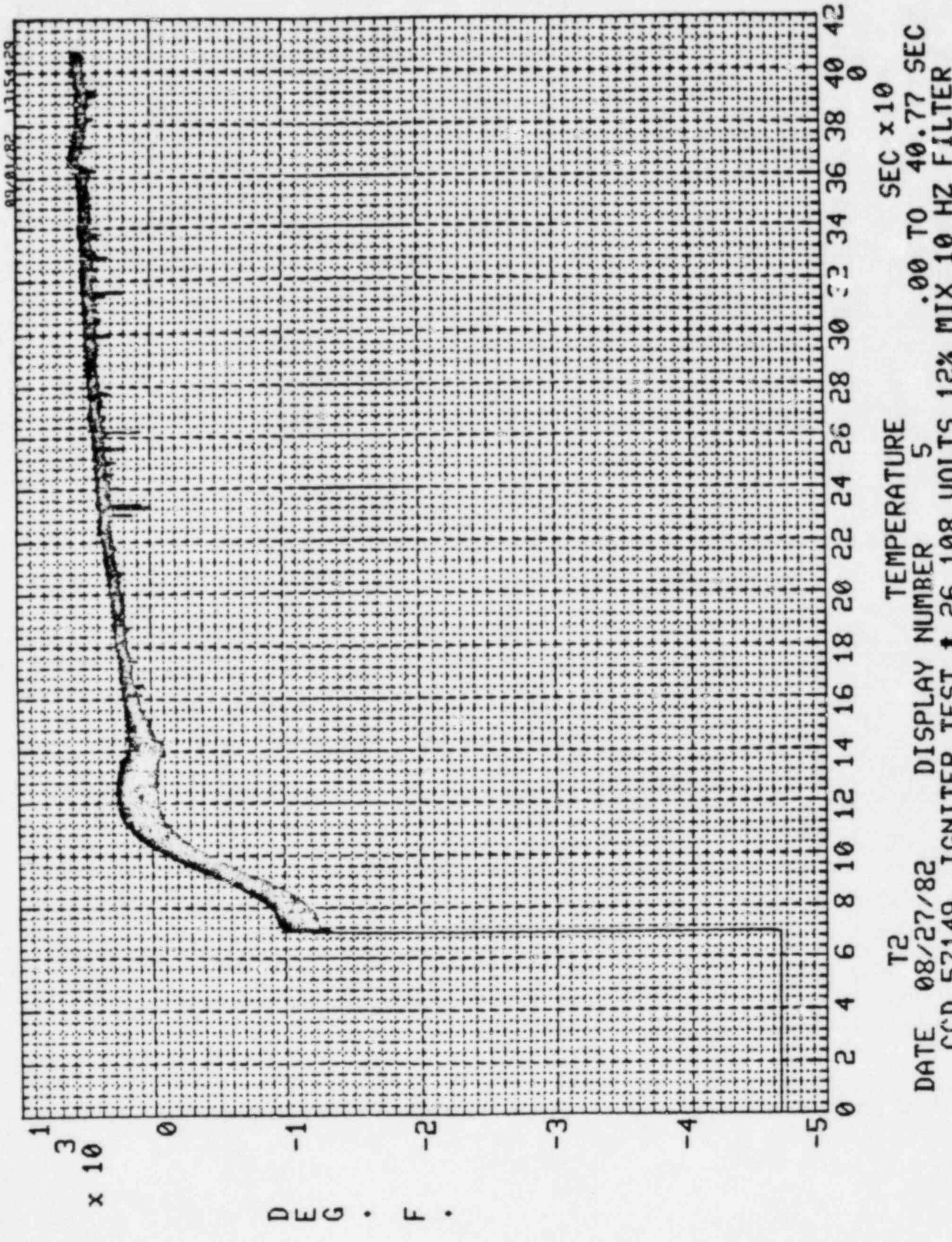


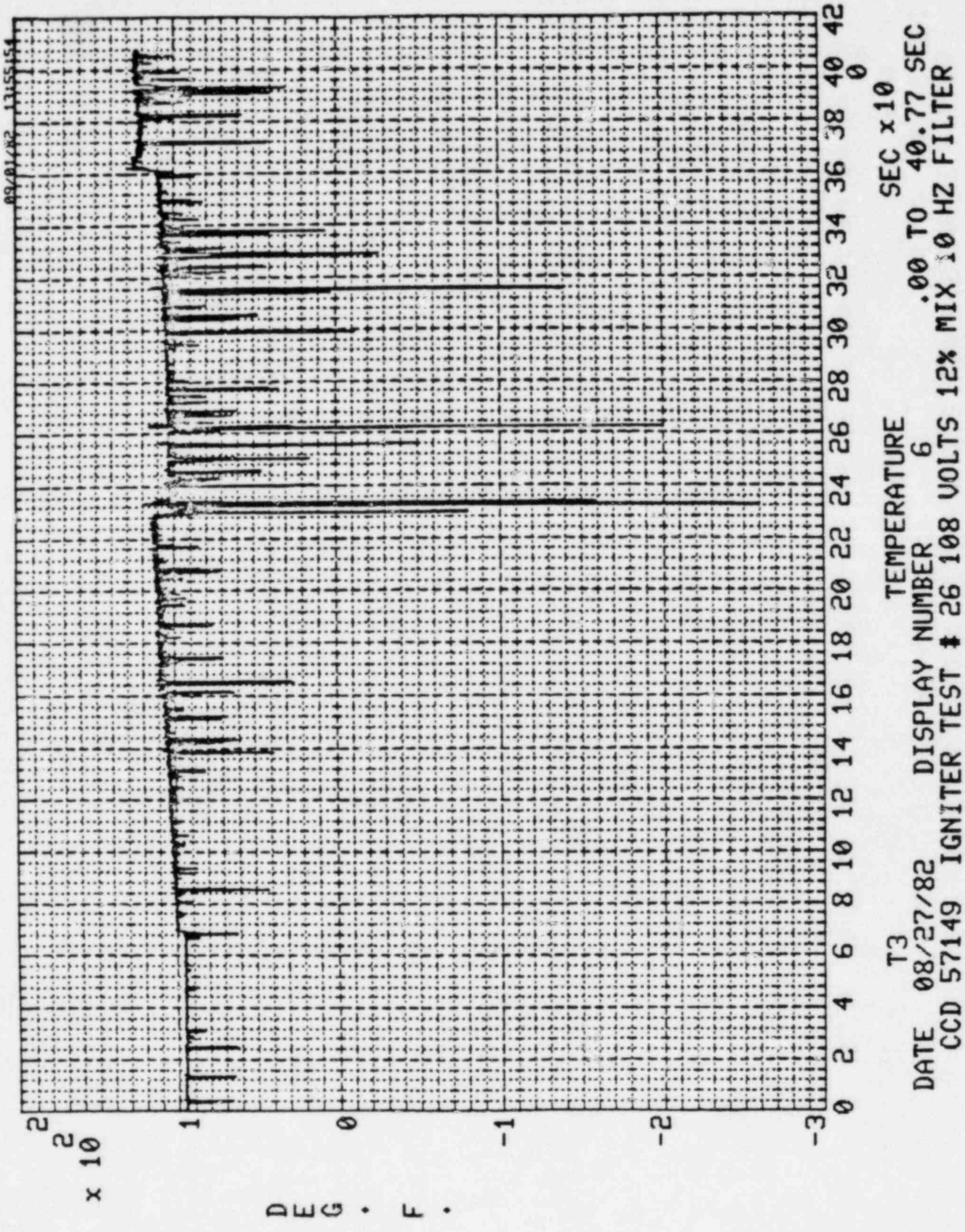
P-1 PRESSURE

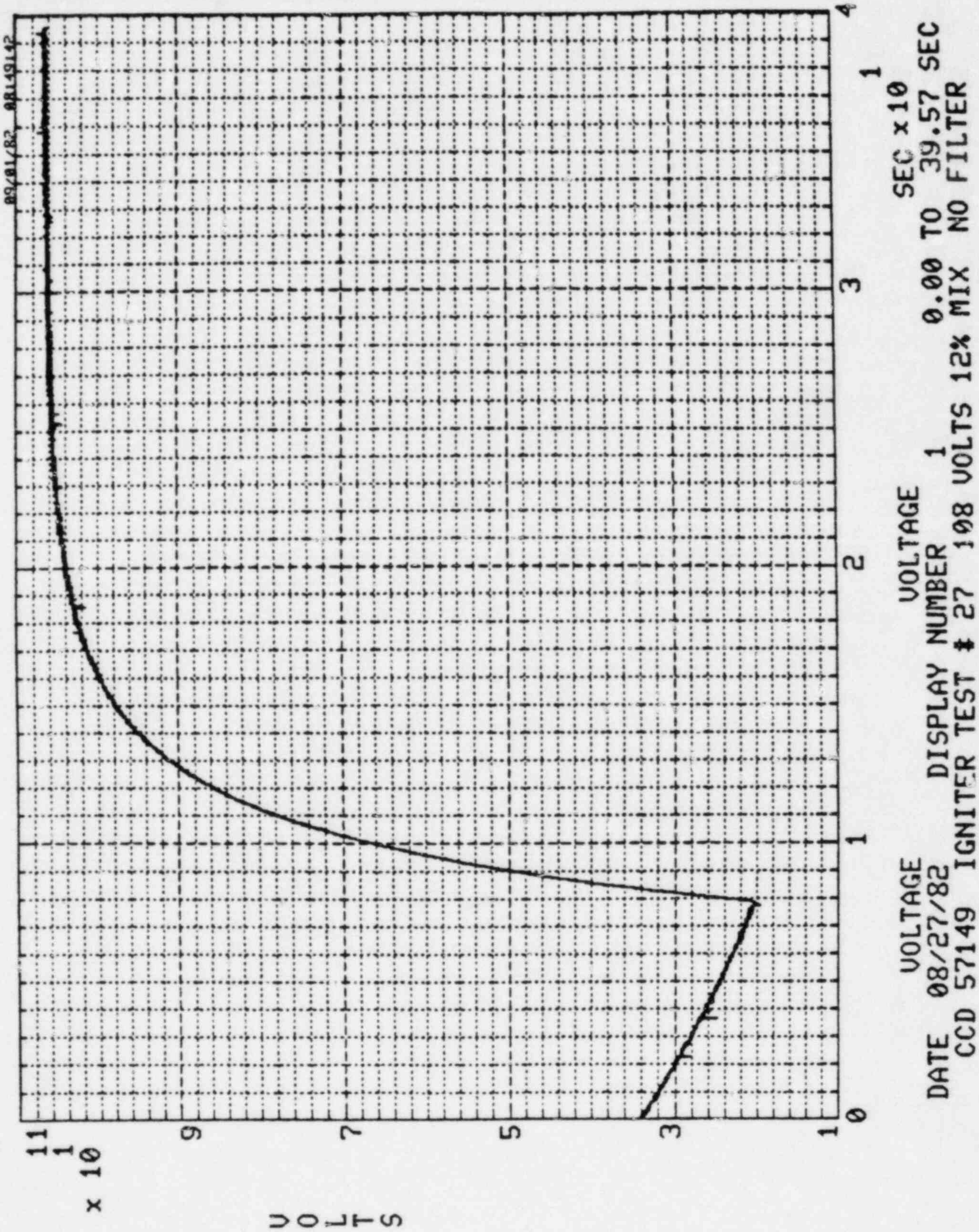
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 40.76 SEC

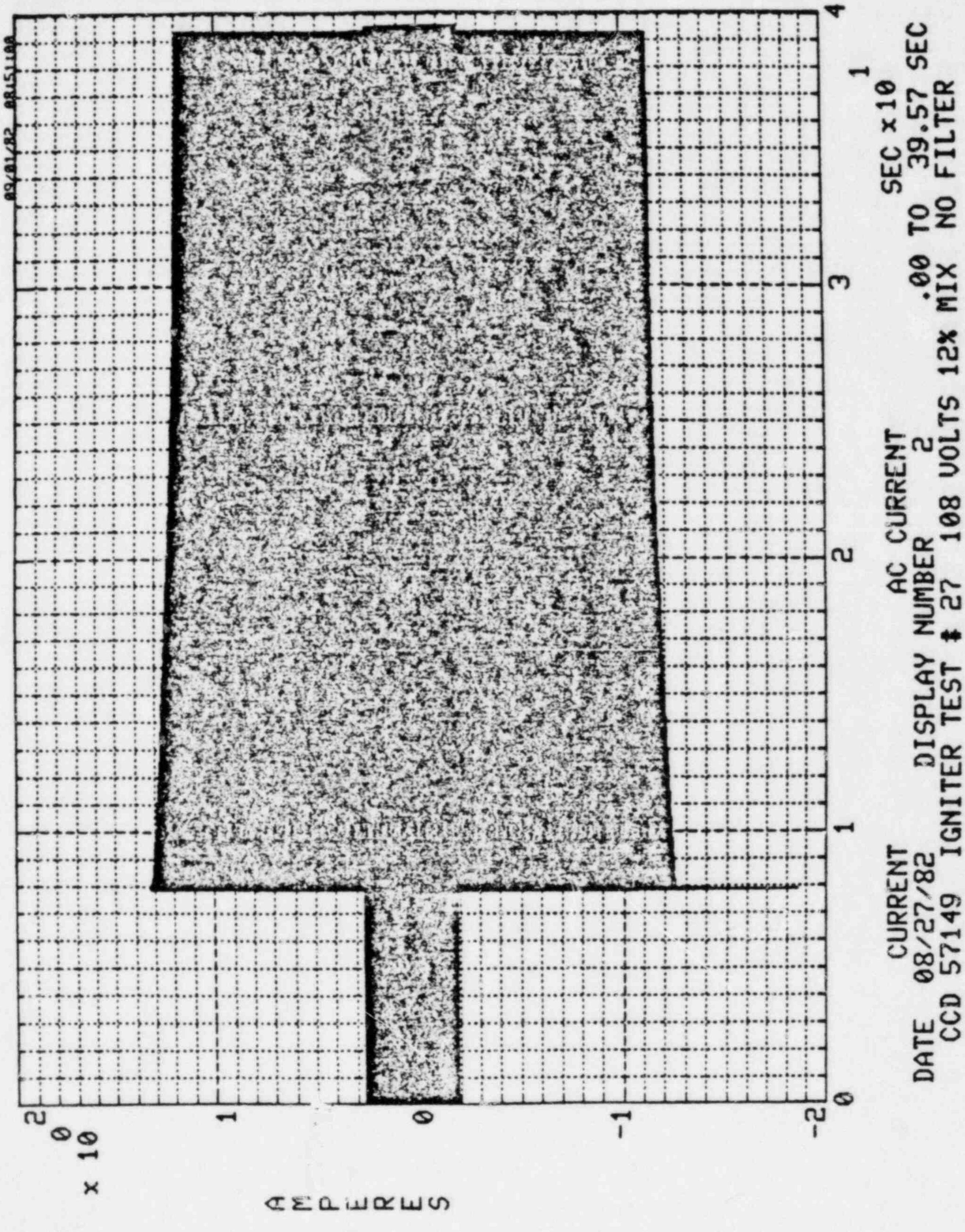
CCD 57149 IGNITER TEST # 26 108 VOLTS 12% MIX NO FILTER

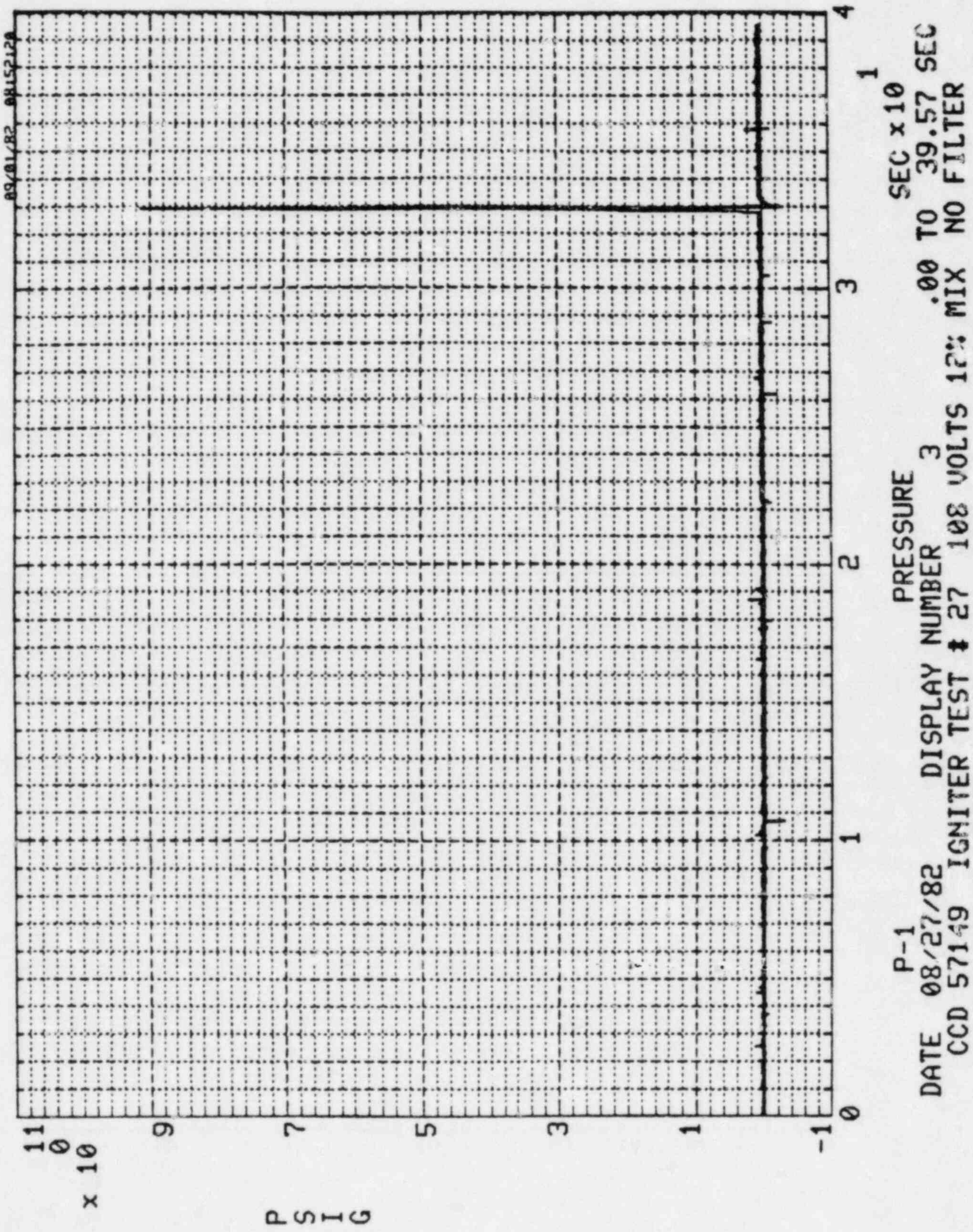

17
16
15
14
13
12
11
10
9
x 10 1
DEG. F.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
SEC x10 0
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX 10 HZ FILTER

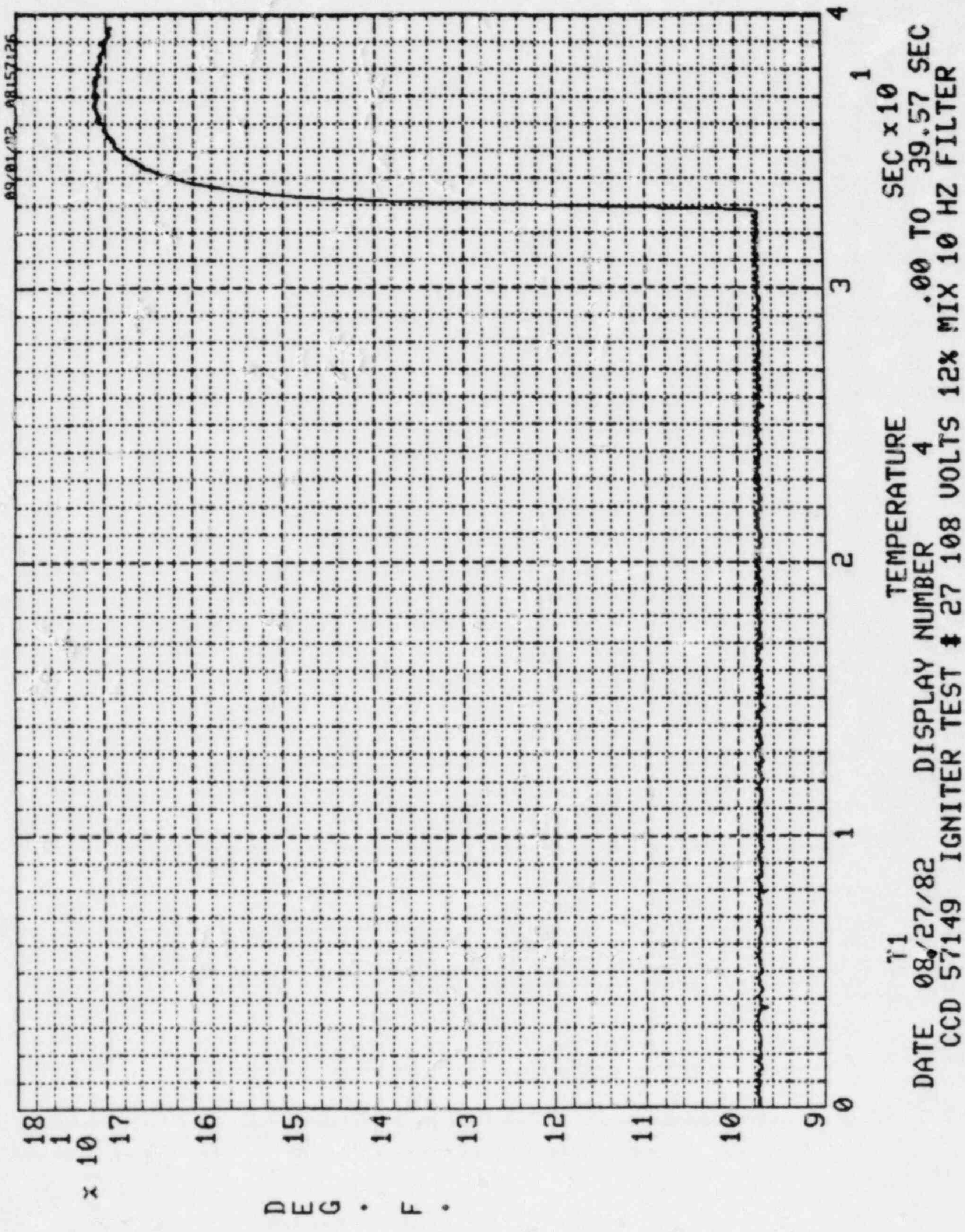

T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
.00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 26 108 VOLTS 12% MIX 10 HZ FILTER
SEC x 10
DEG. F.
x 10 3
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
1 0 -1 -2 -3 -4 -5

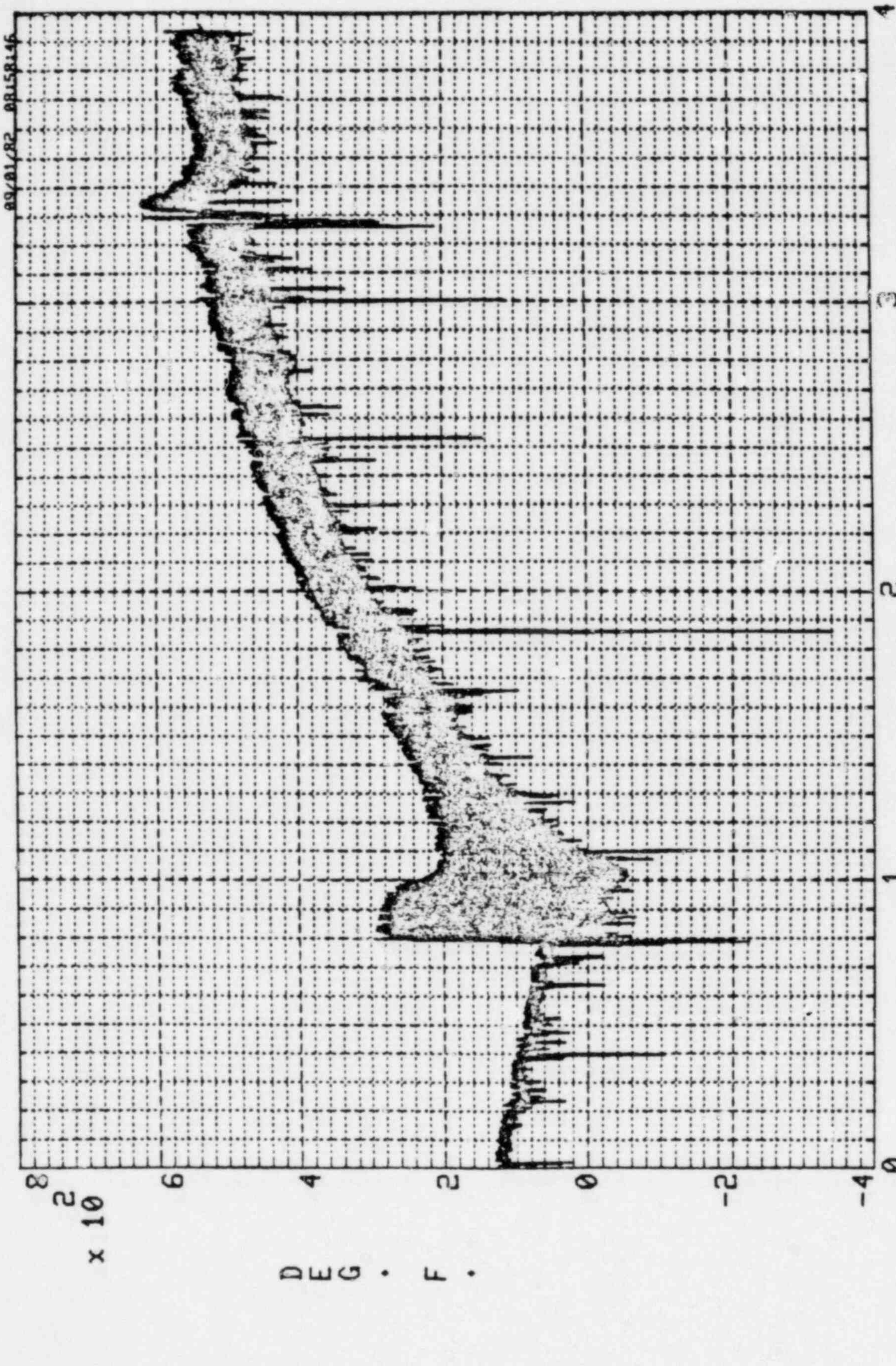

T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 40.77 SEC
CCD 57149 IGNITER TEST # 26 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10
D E G . F .
x 10
2


VOLTAGE
DATE 08/27/82
CCD 57149 IGNITER TEST # 27 108 VOLTS 12% MIX
VOLTAGE
DISPLAY NUMBER 1
0.00 TO 39.57 SEC
NO FILTER
SEC x10 1
VOLTS
x 10 1
0
1
2
3
4
1
3
5
7
9
11


09/01/82 08:51:08
CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 27 108 VOLTS 12% MIX
.00 TO 39.57 SEC
NO FILTER
SEC x10 1
AMPERES
x 10 0
0
1
2
3
4
-2
-1
0
1
2


09/01/82 0815120
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 27 108 VOLTS 12% MIX NO FILTER
SEC x 10
1
PSIG
x 10
0
11
9
7
5
3
1
-1
0
1
2
3
4

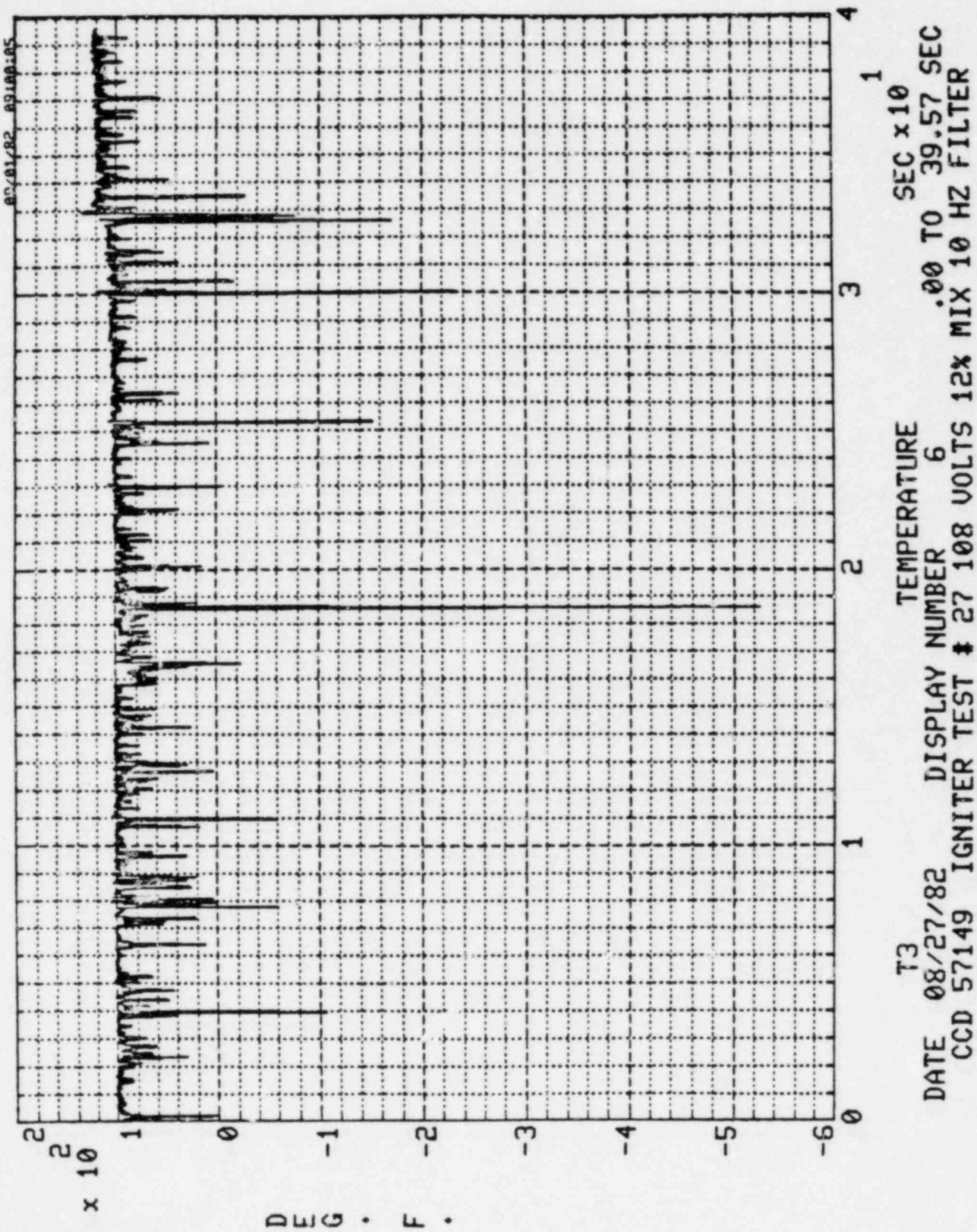

T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 39.57 SEC
CCD 57149 IGNITER TEST # 27 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10
1
D E G . F .
x 10
1
09/01/82 08157126
0
1
2
3
4
9
10
11
12
13
14
15
16
17
18

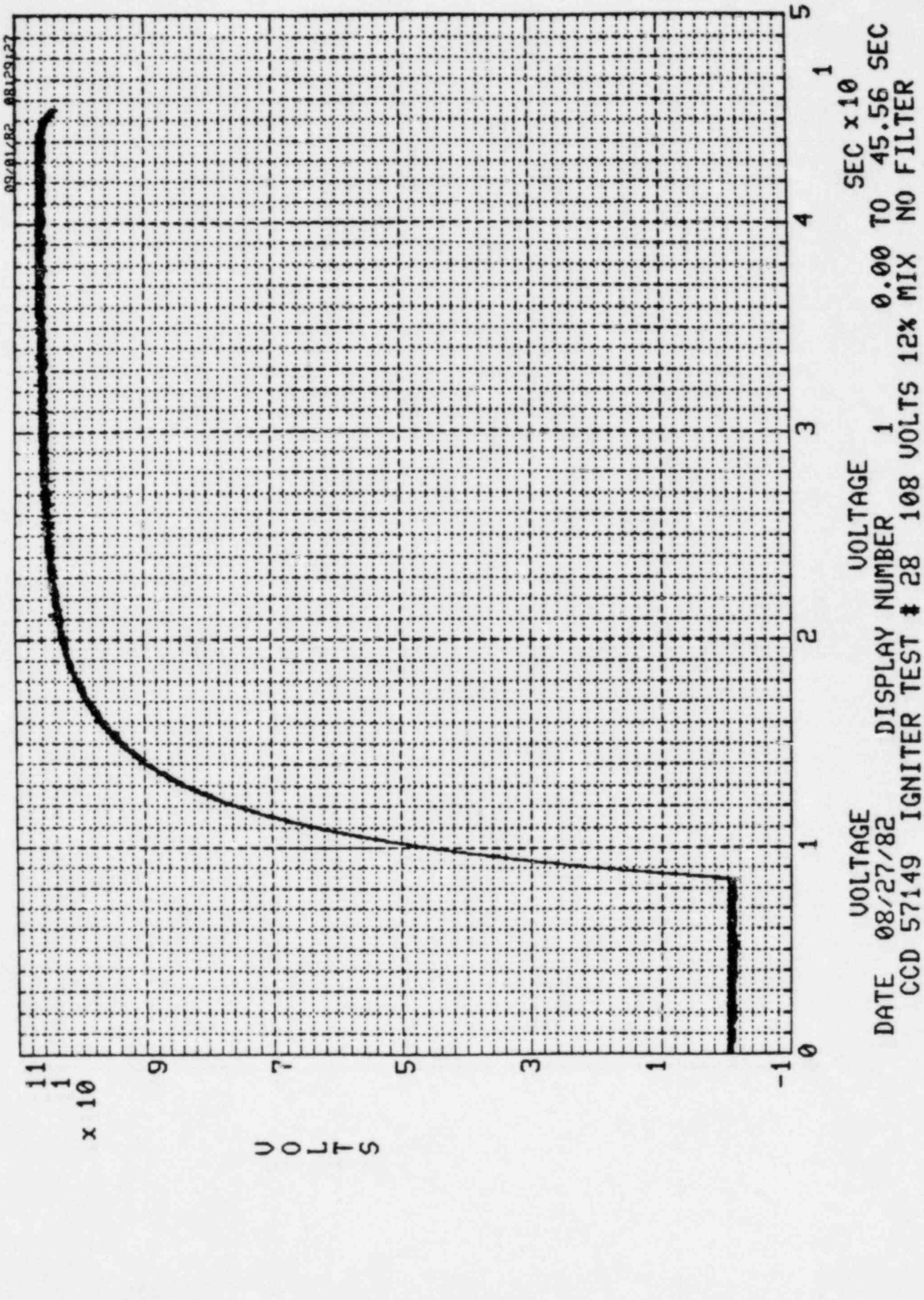


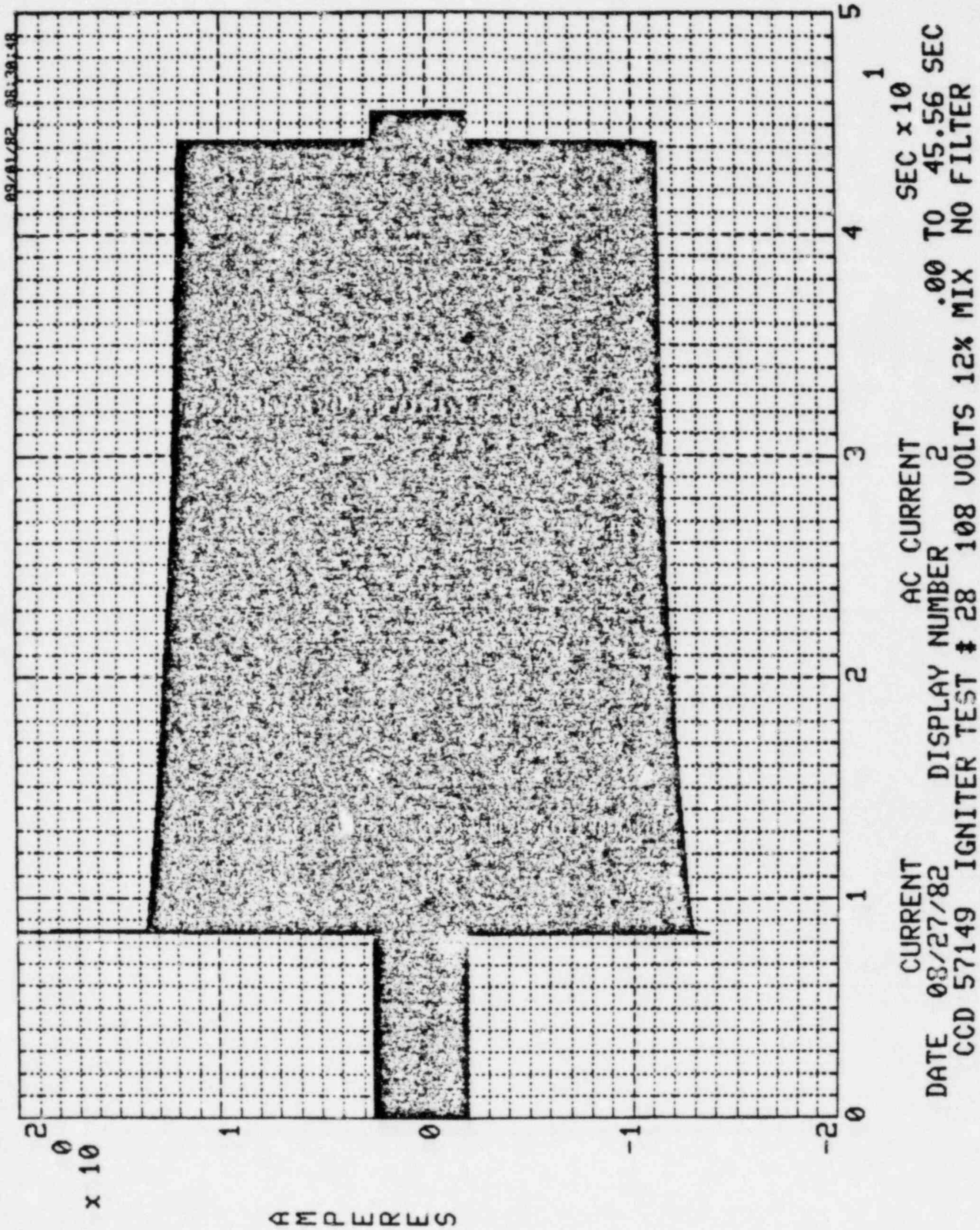
T2 TEMPERATURE SEC x 10^1

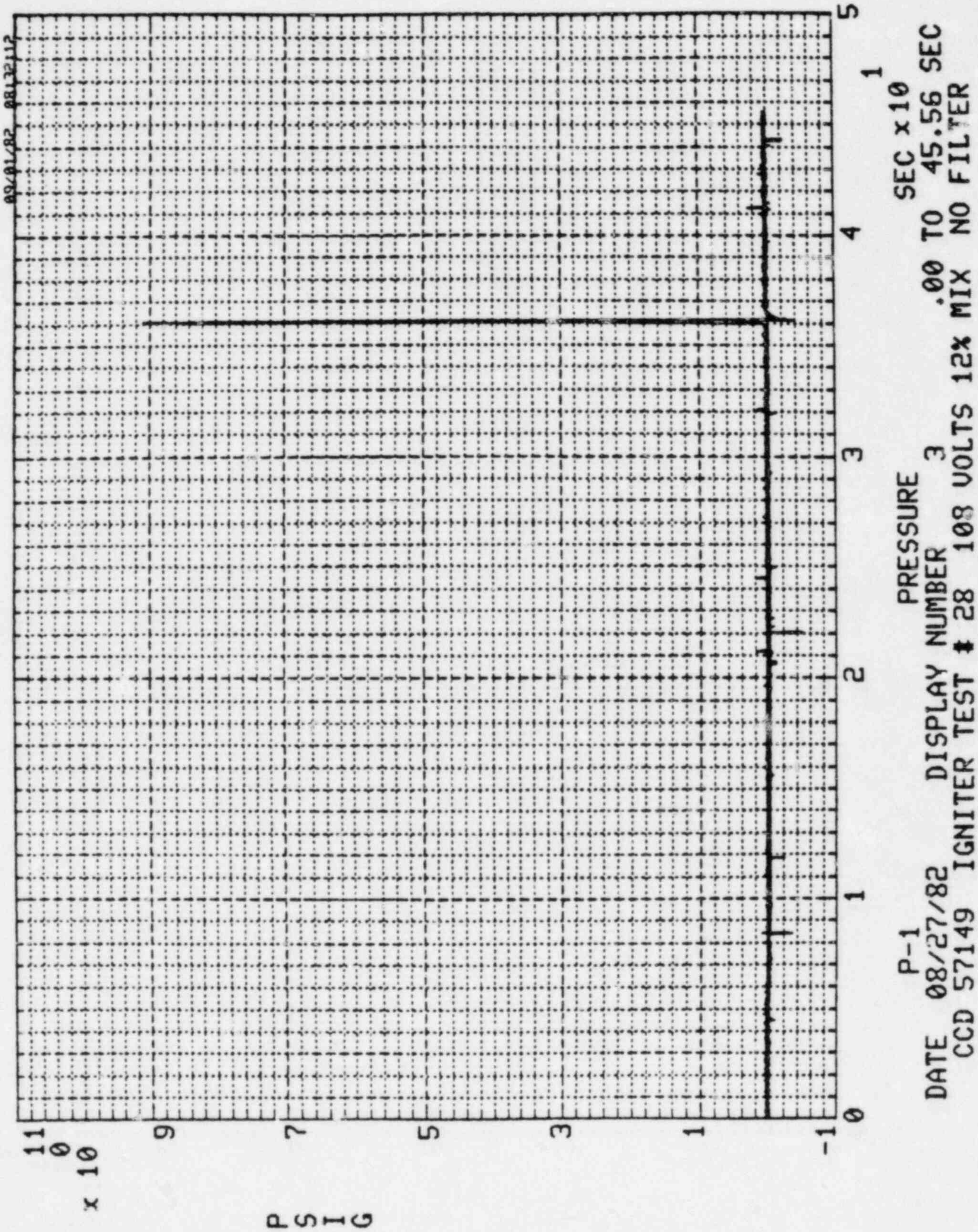
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 39.57 SEC

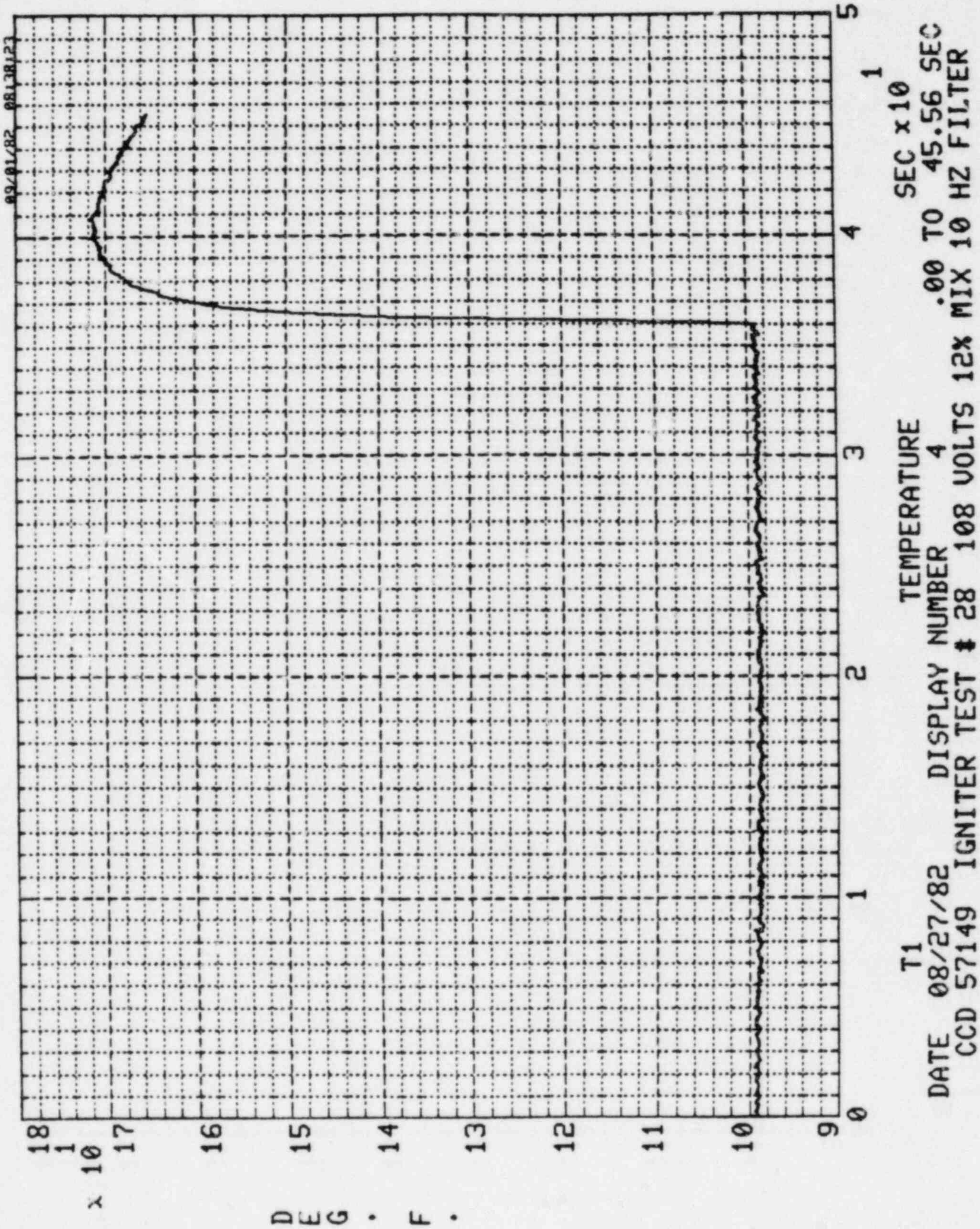
CCD 57149 IGNITER TEST # 27 108 VOLTS 12% MIX 10 HZ FILTER

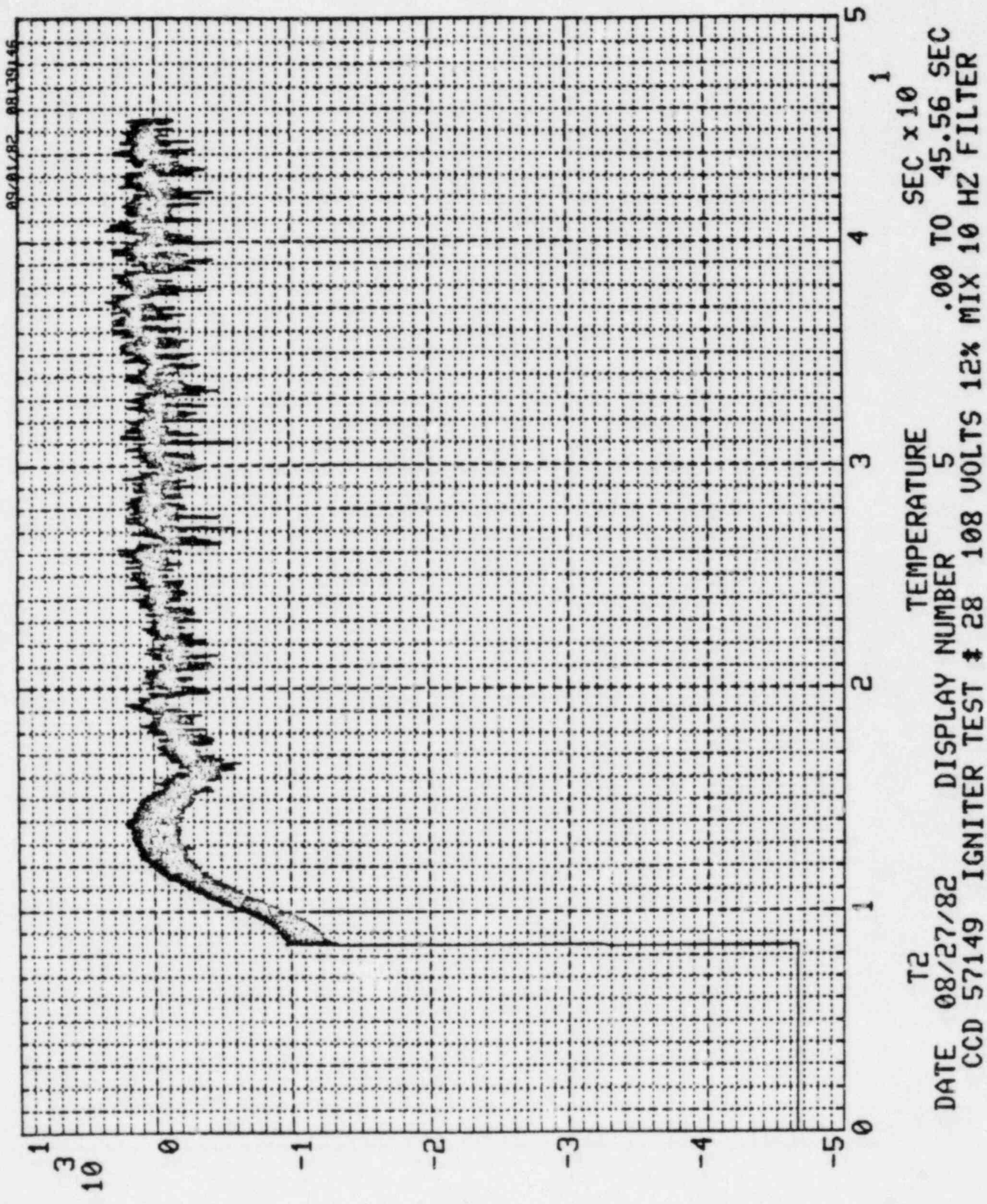

T3
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 27 108 VOLTS 12% MIX 10 HZ FILTER
TEMPERATURE
SEC x10 1
.00 TO 39.57 SEC
DEG. F.
x 10 2
2
1
0
-1
-2
-3
-4
-5
-6
0
1
2
3
4

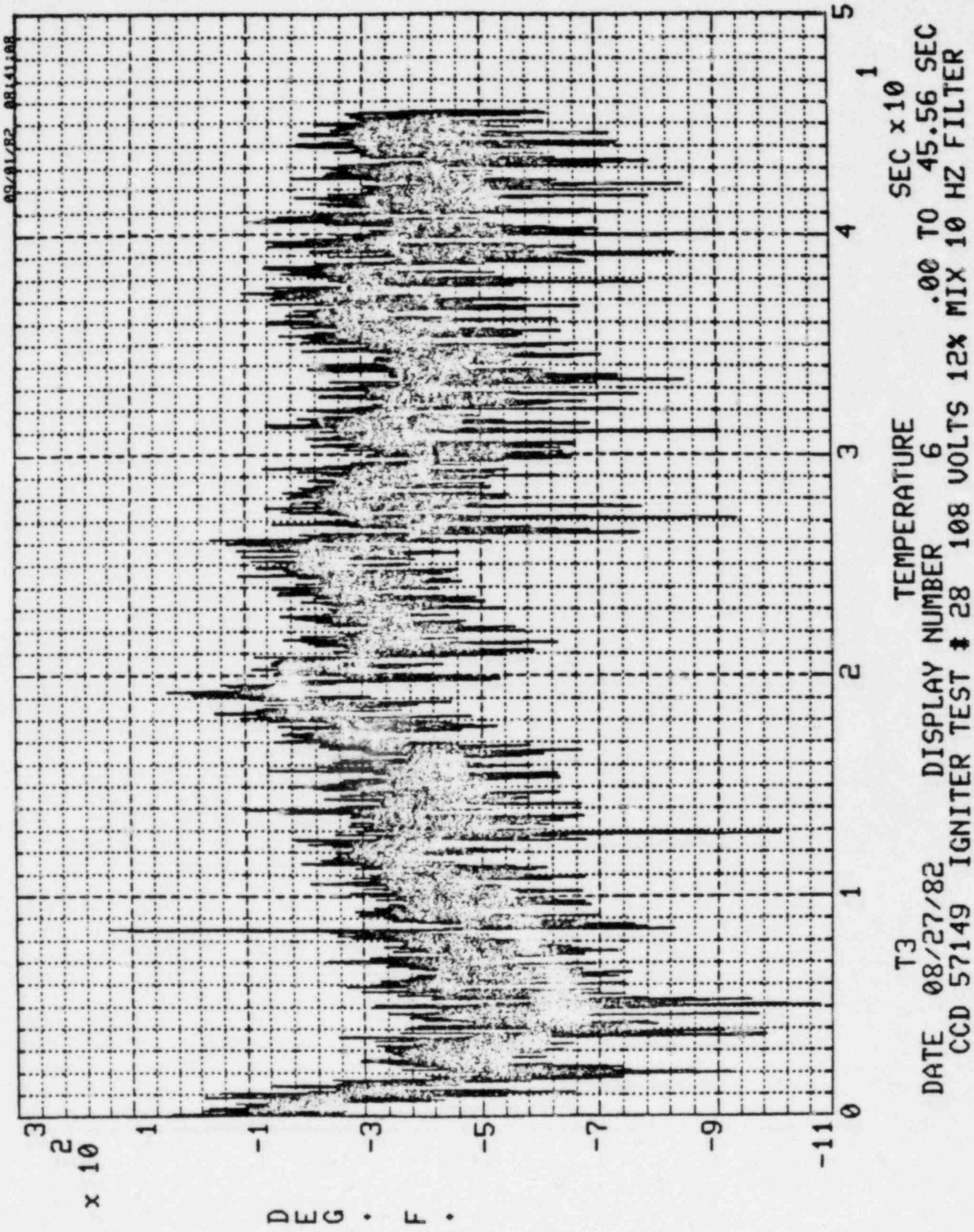

VOLTAGE
VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 45.56 SEC
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX NO FILTER
SEC x 10^1
VOLTS x 10^1
0 1 2 3 4 5
-1 1 3 5 7 9 11

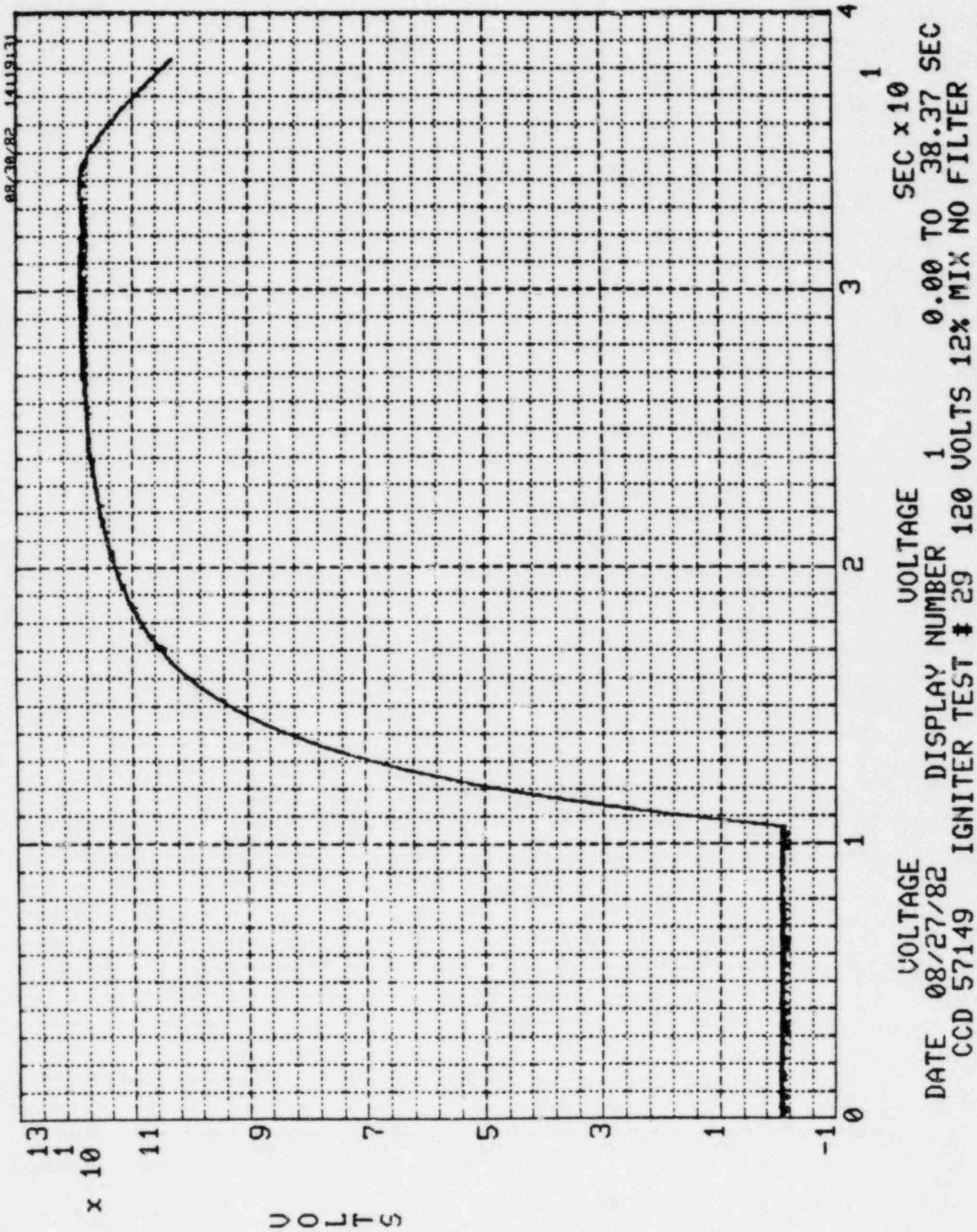

CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 28 108 VOLTS 12% MIX
SEC x10 1
.00 TO 45.56 SEC
NO FILTER
AMPERES
x 10 0
2
1
0
-1
-2
0
1
2
3
4
5

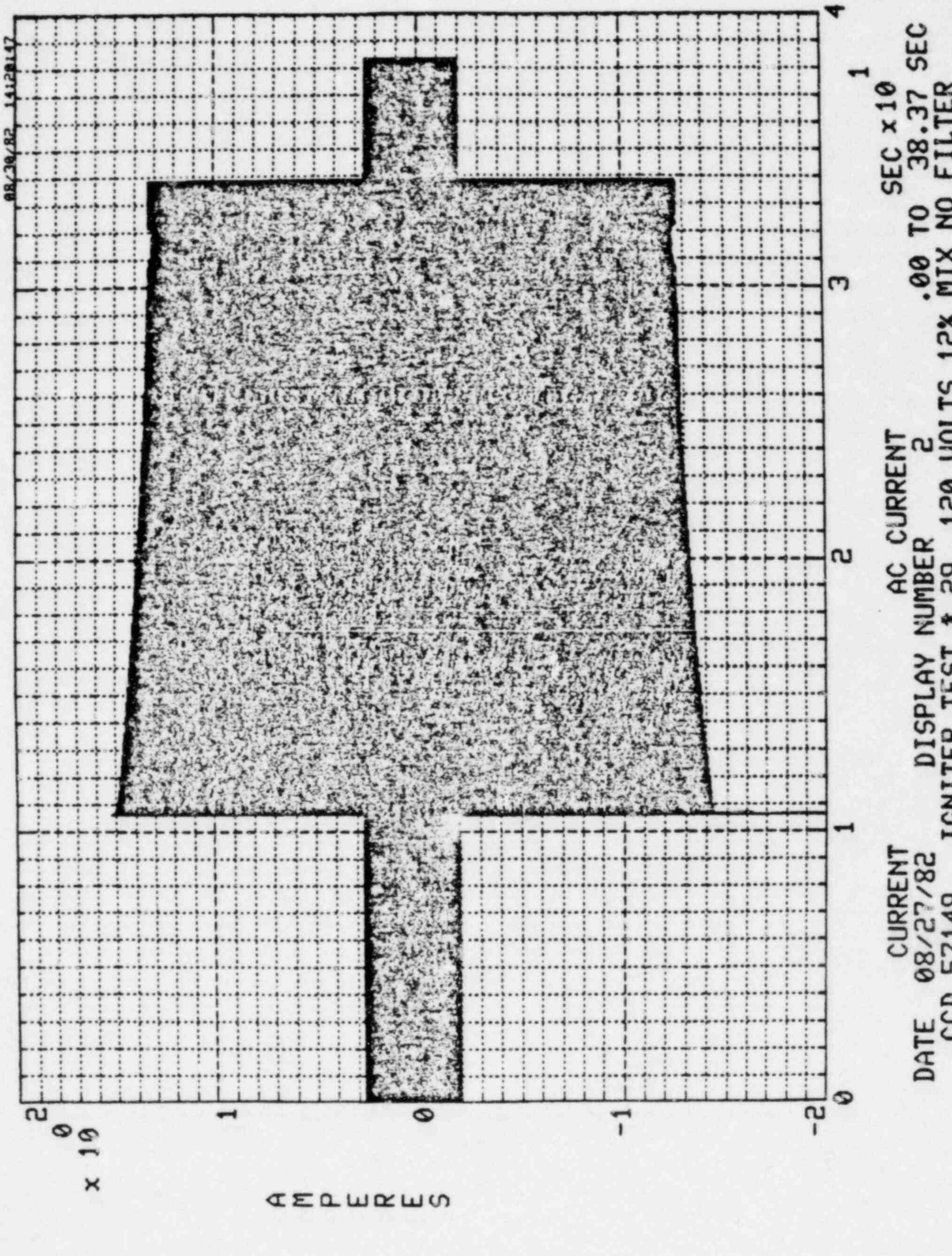

P-1
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX NO FILTER
PRESSURE
SEC x10 1
.00 TO 45.56 SEC
PSIG
x 10 0
11
9
7
5
3
1
-1
0
1
2
3
4
5

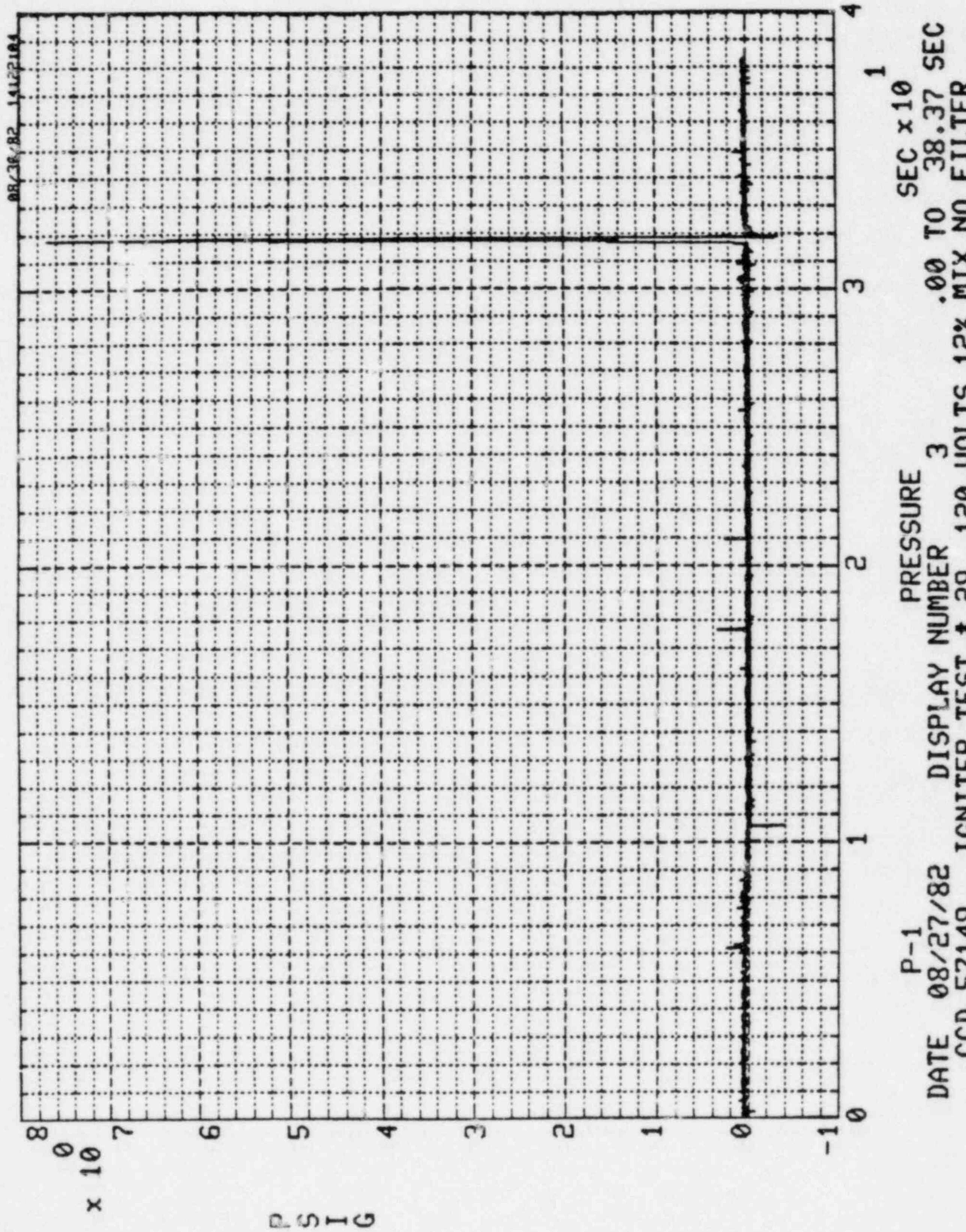

T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
.00 TO 45.56 SEC
DEG. F. x 10 1
0
1
2
3
4
5
9
10
11
12
13
14
15
16
17
18

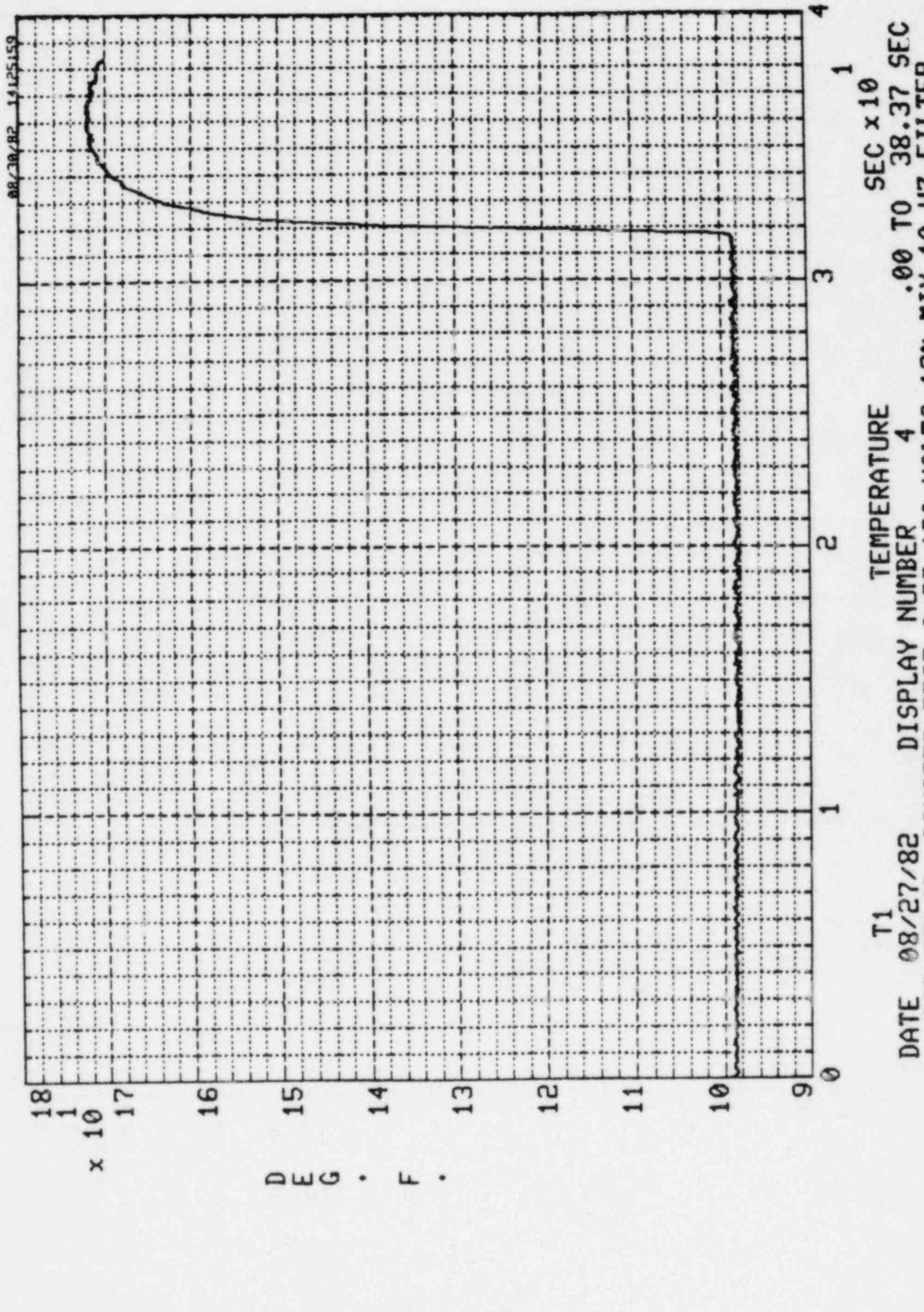

T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 45.56 SEC
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
DEG. F.
x 10 3
1
0
-1
-2
-3
-4
-5
0
1
2
3
4
5
09/01/82 08:39:46


T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 45.56 SEC
CCD 57149 IGNITER TEST # 28 108 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
DEG. F. x 10 2
3
1
-1
-3
-5
-7
-9
-11
0
1
2
3
4
5
09/01/82 08:41:08

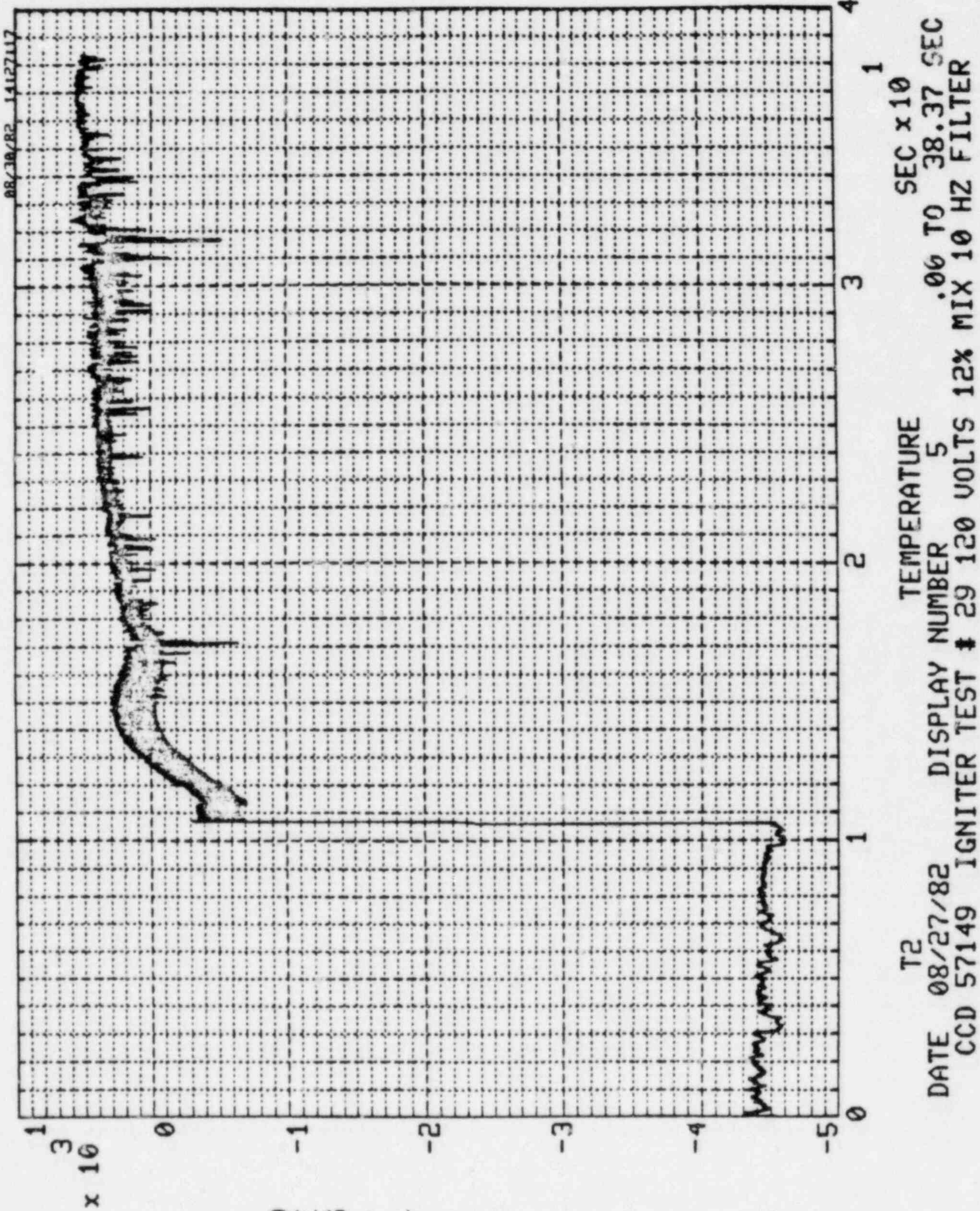

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 29 120 VOLTS 12% MIX NO FILTER
SEC x10 1
0.00 TO 38.37 SEC
VOLTS x 10 1
13
11
9
7
5
3
1
-1
0
1
2
3
4
08/30/82

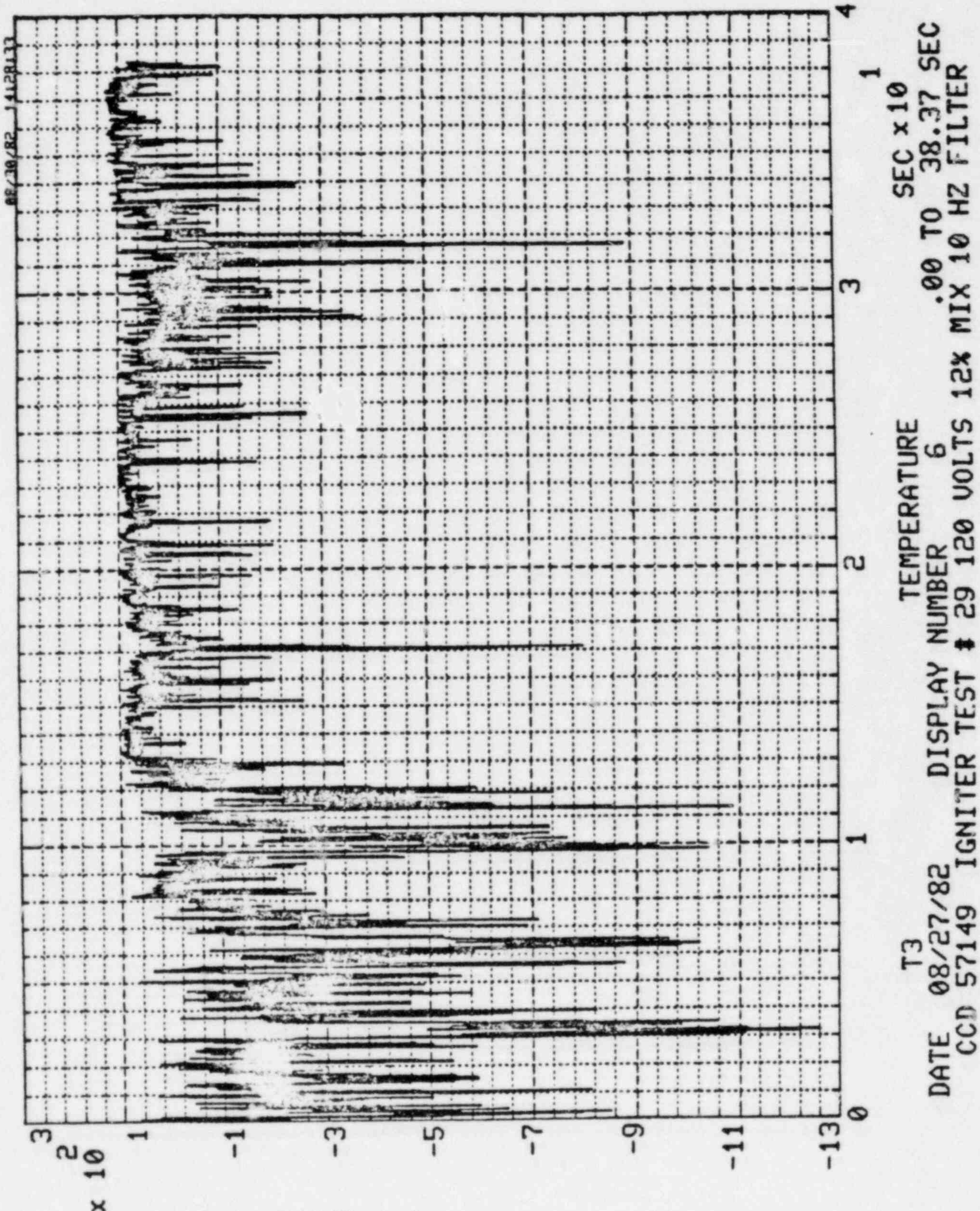

08/30/82 14:20:47
CURRENT AC CURRENT SEC x 10 1
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 38.37 SEC
CCD 57149 IGNITER TEST # 29 120 VOLTS 12% MIX NO FILTER
AMPERES x 10 0
2
1
0
-1
-2
0
1
2
3
4

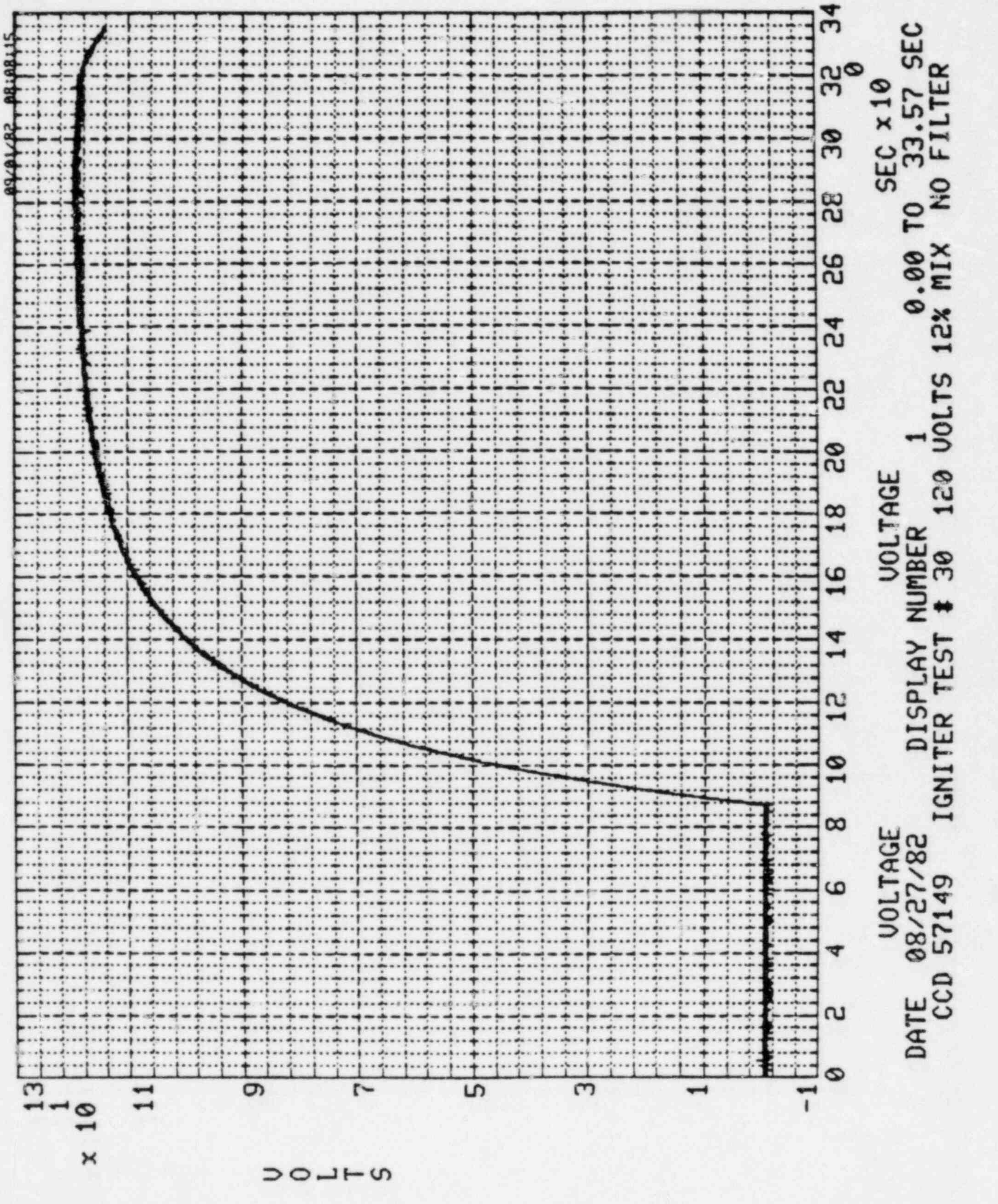

P-1
PRESSURE
DATE 08/27/82
DISPLAY NUMBER 3
CCD 57149
IGNITER TEST # 29
120 VOLTS 12% MIX NO FILTER
.00 TO 38.37 SEC
SEC x10 1
PSIG
x 10 0

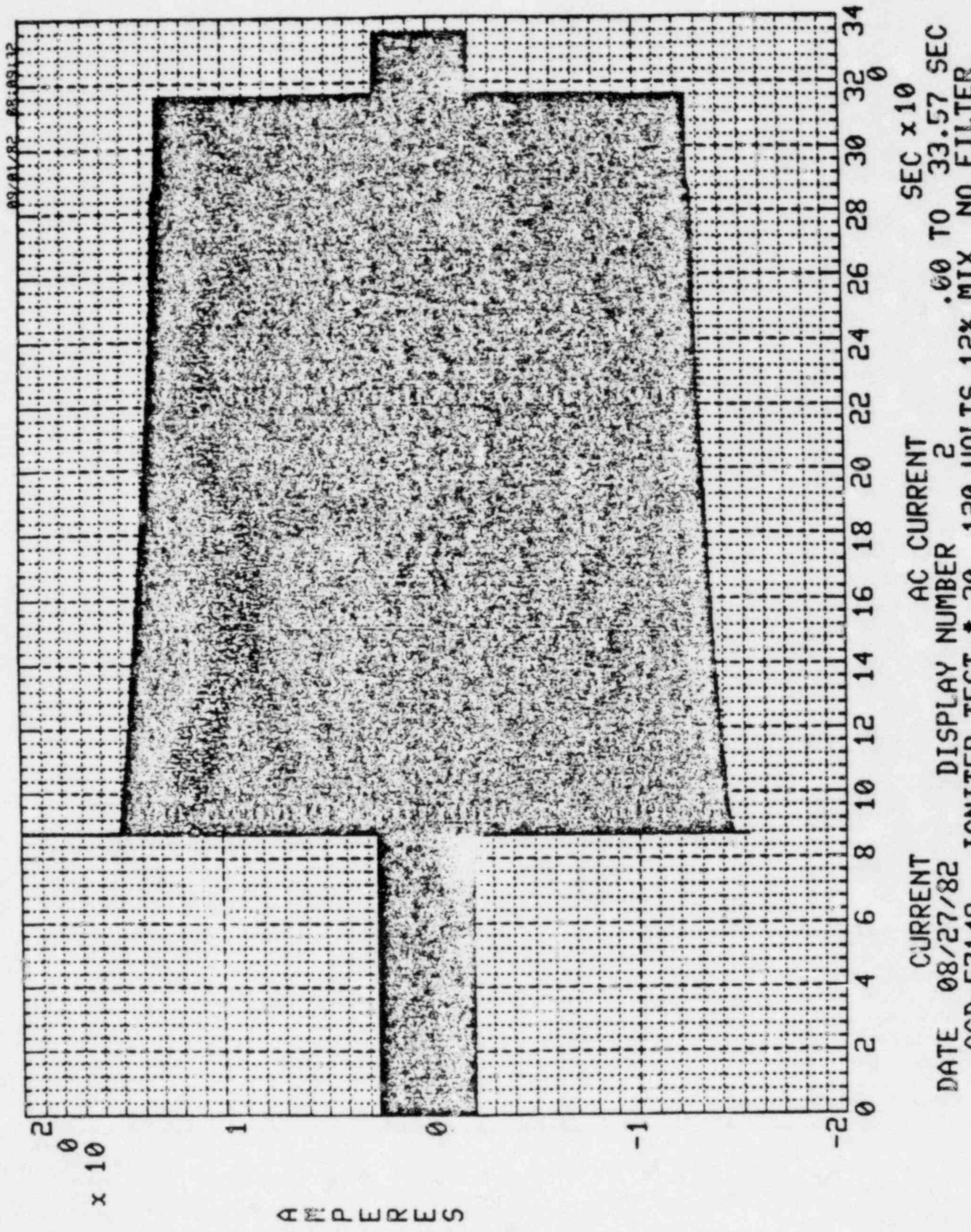


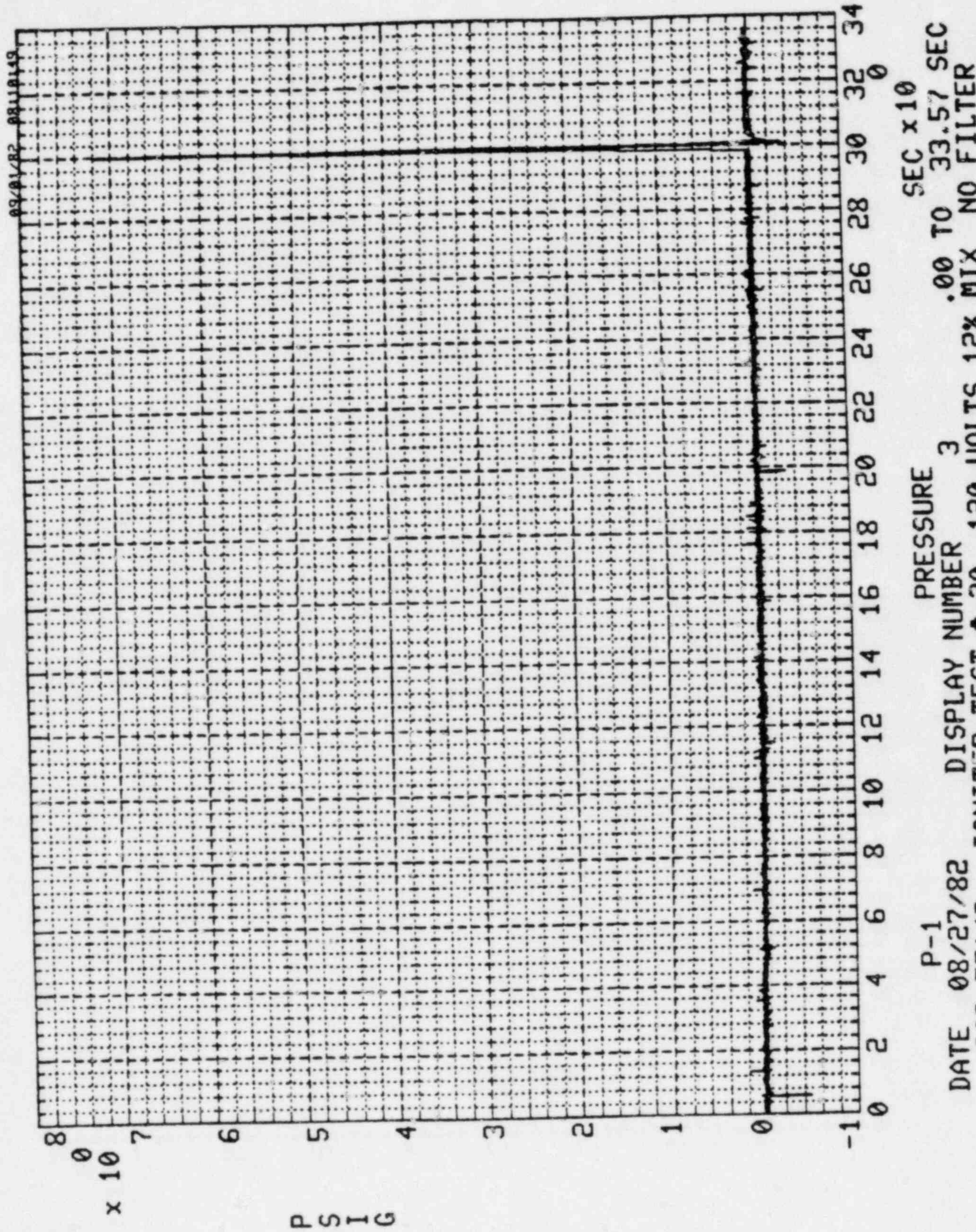
08/30/82 14:25:59
DEG. F. x 10^1
18
17
16
15
14
13
12
11
10
9
0
1
2
3
4
SEC x 10^1
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 38.37 SEC
CCD 57149 IGNITER TEST # 29 120 VOLTS 12% MIX 10 HZ FILTER

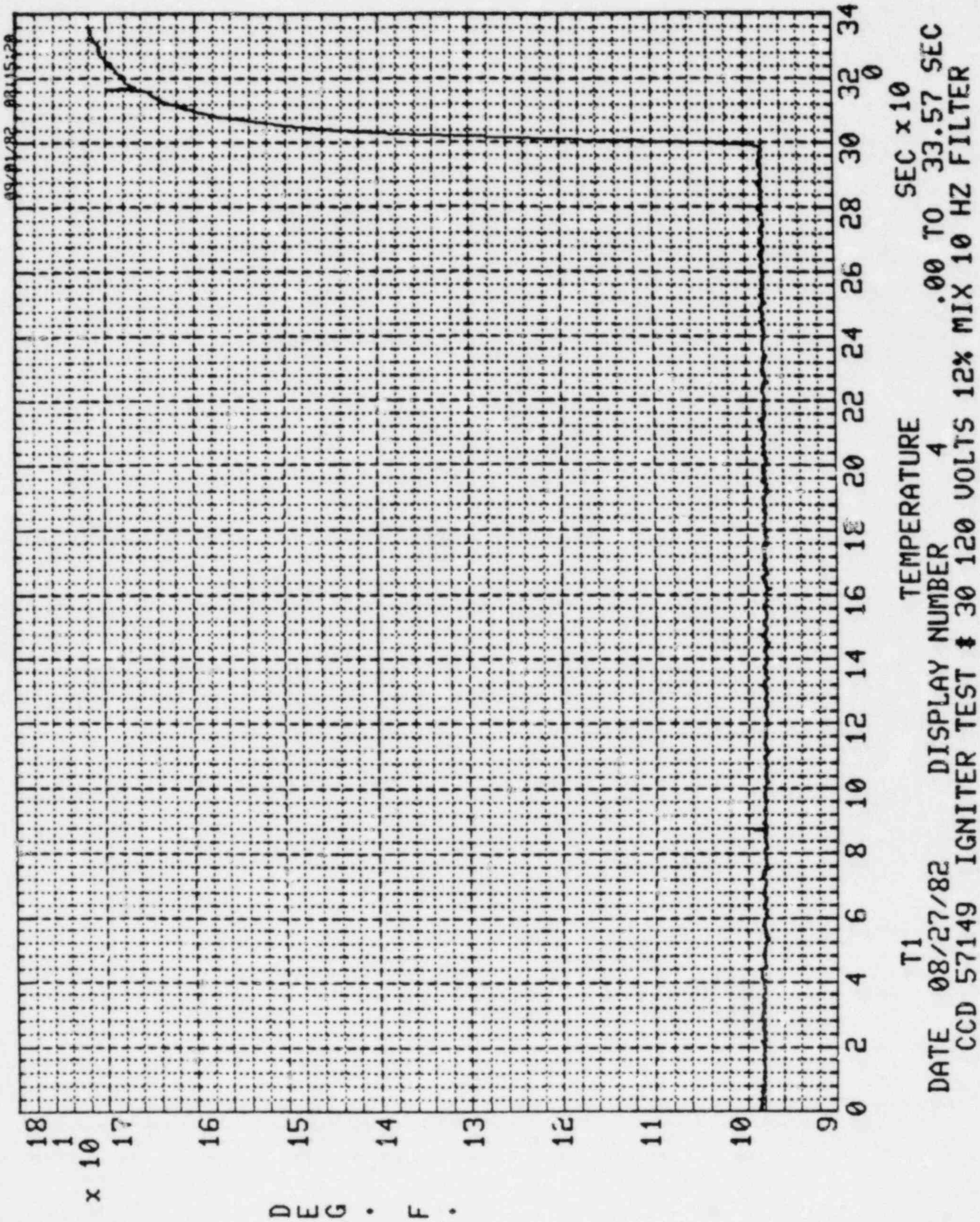

08/30/82 14127117
T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 29 120 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
.06 TO 38.37 SEC
0
1
2
3
4
x 10 3
D E G . F .
1
0
-1
-2
-3
-4
-5

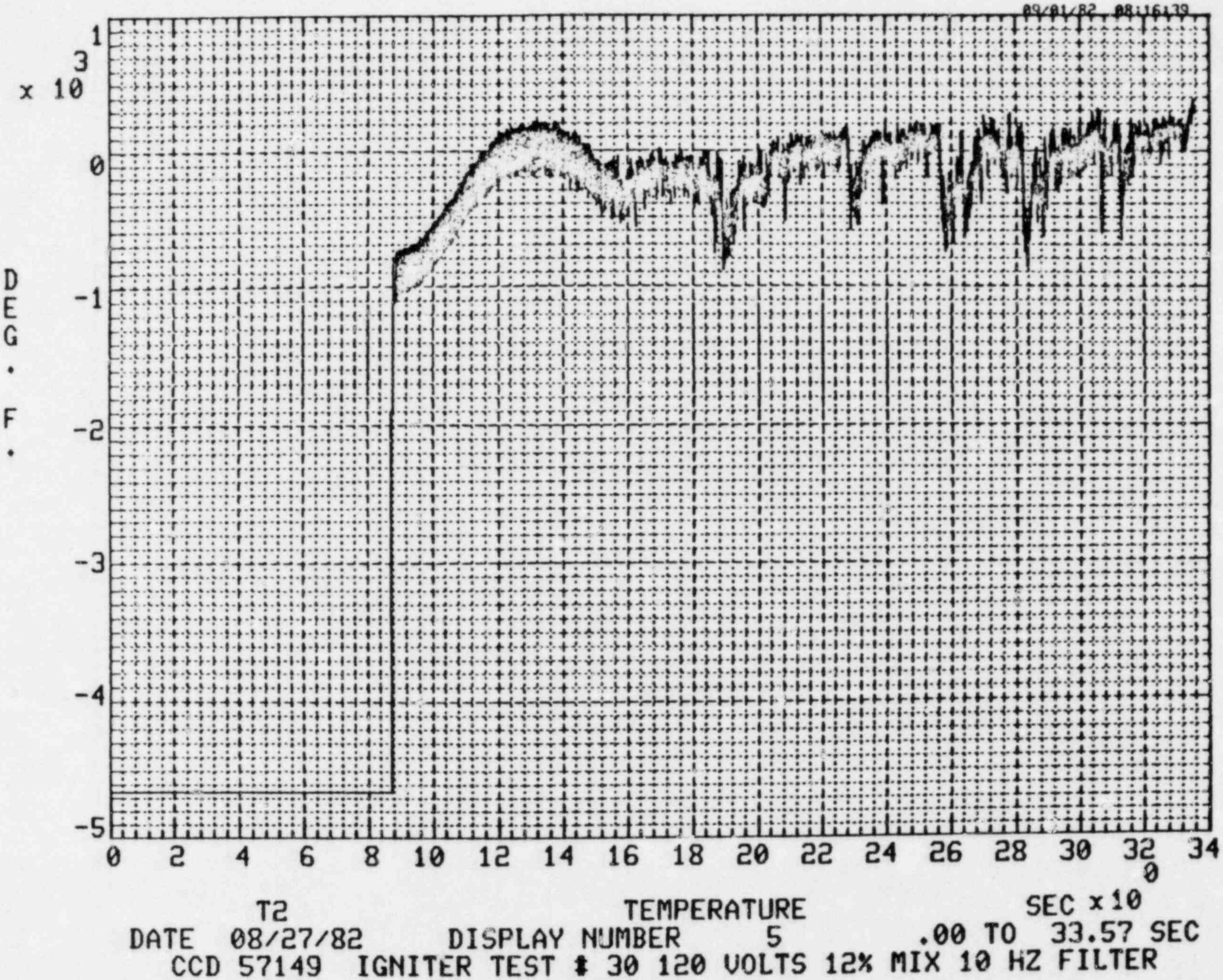

08/30/82 14:28:33
T3
DATE 08/27/82 DISPLAY NUMBER 6
TEMPERATURE
CCD 57149 IGNITER TEST # 29 120 VOLTS 12% MIX 10 HZ FILTER
.00 TO 38.37 SEC
SEC x 10 1
0
1
2
3
4
DEG. F.
x 10 2
3
1
-1
-3
-5
-7
-9
-11
-13


VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 0.00 TO 33.57 SEC
CCD 57149 IGNITER TEST # 30 120 VOLTS 12% MIX NO FILTER
VOLTAGE
SEC x10 0
VOLTS x 10 1
09/01/82 08:08:15
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
-1 1 3 5 7 9 11 13

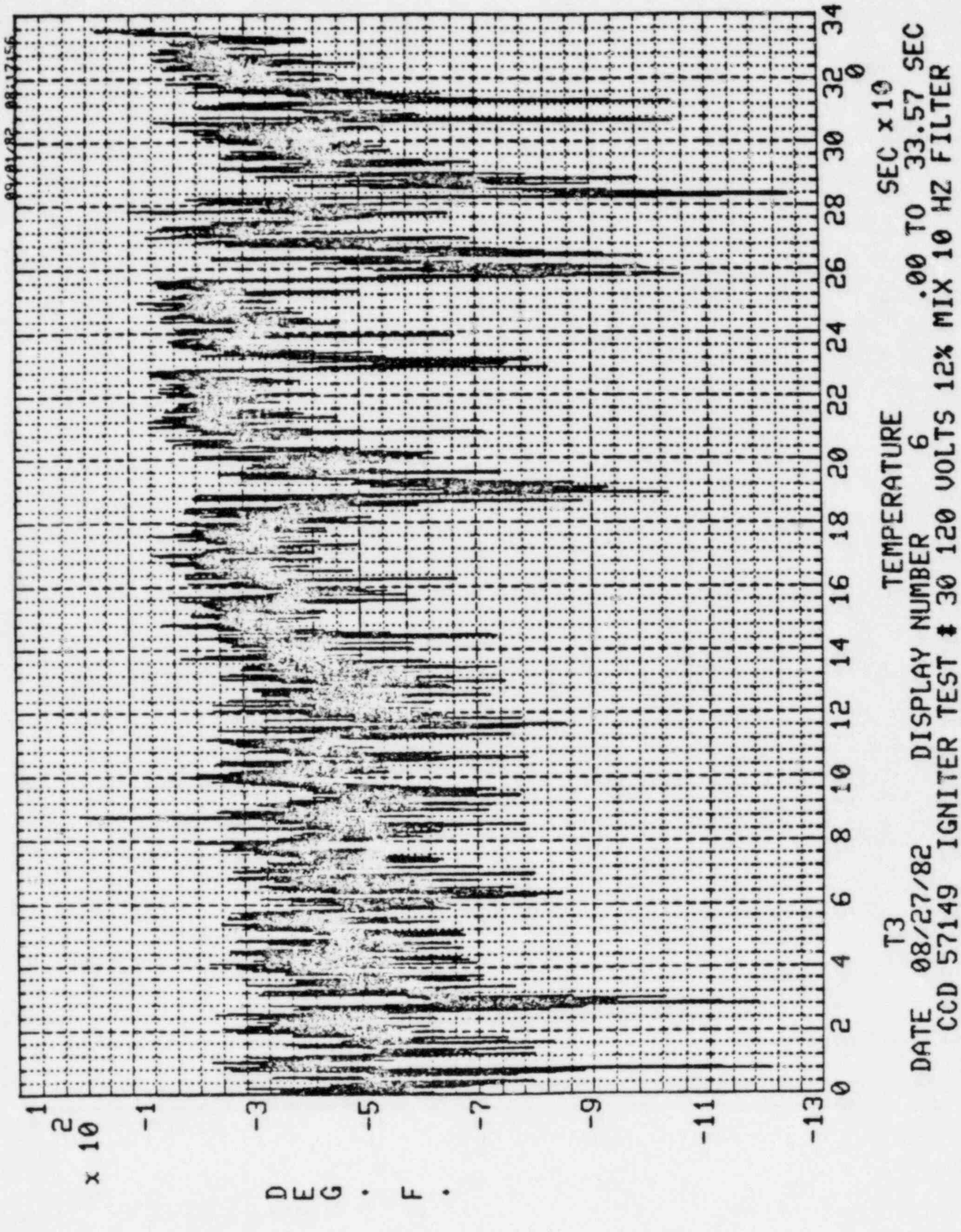

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 30 120 VOLTS 12% MIX NO FILTER
SEC x10 0
.00 TO 33.57 SEC
AMPERES
x 10 0
2
1
0
-1
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34

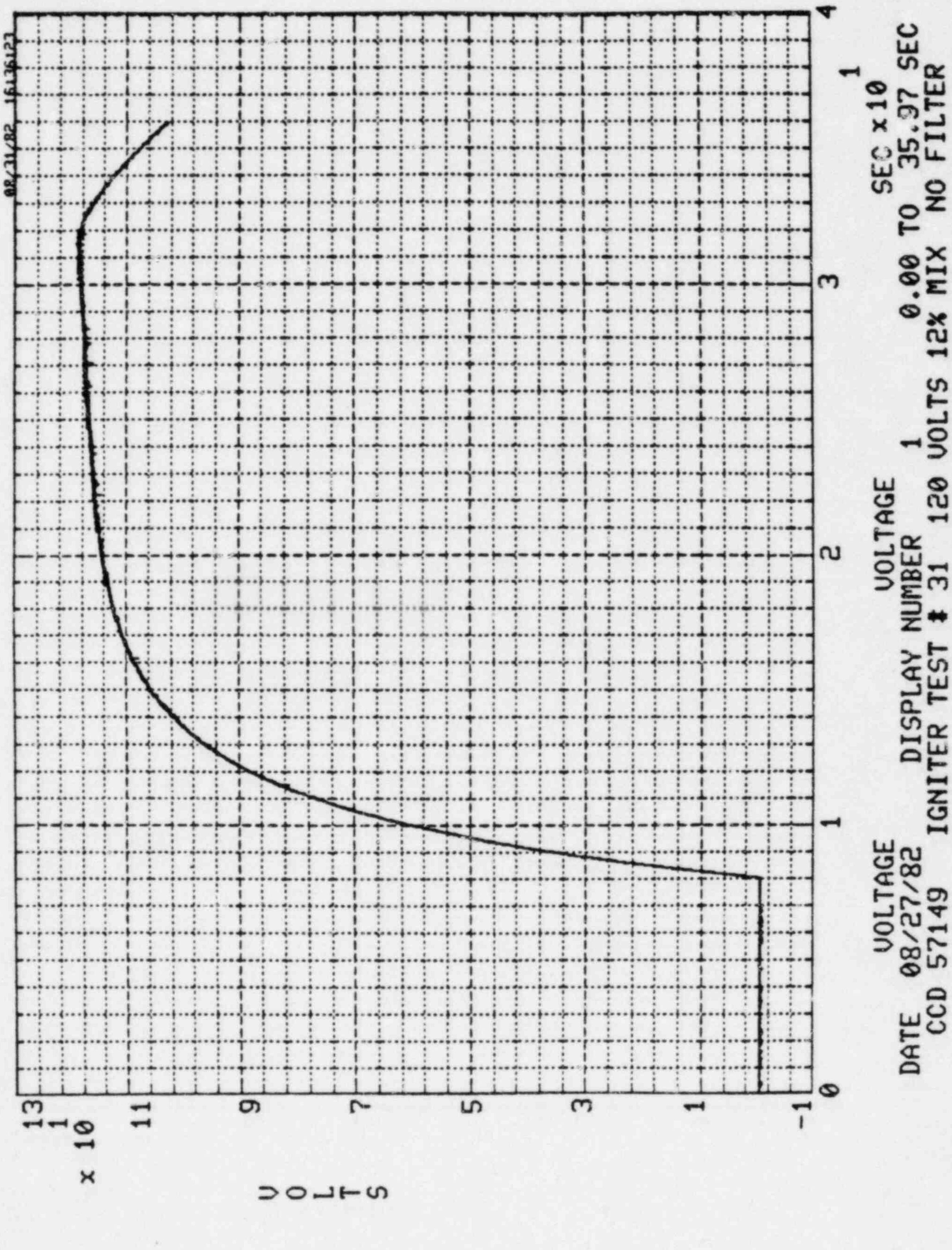

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 30 120 VOLTS 12% MIX NO FILTER
SEC x10 0
.00 TO 33.57 SEC
PSIG x 10 0
09/01/82 08:10:49
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
-1 0 1 2 3 4 5 6 7 8

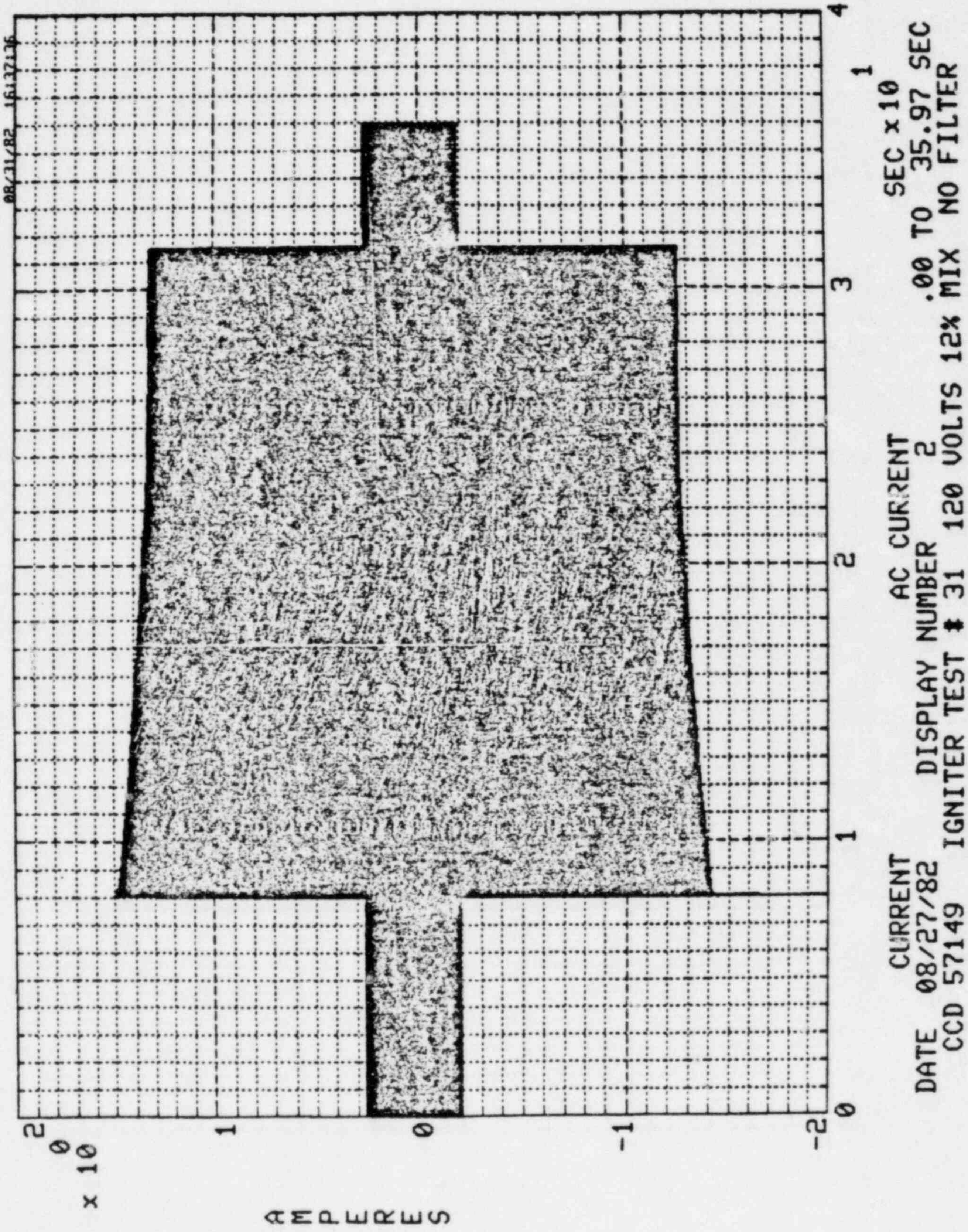

09/01/82 08:15:28
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
SEC x10
.00 TO 33.57 SEC
CCD 57149 IGNITER TEST $ 30 120 VOLTS 12% MIX 10 HZ FILTER
D E G . F .
x 10 1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
9 10 11 12 13 14 15 16 17 18

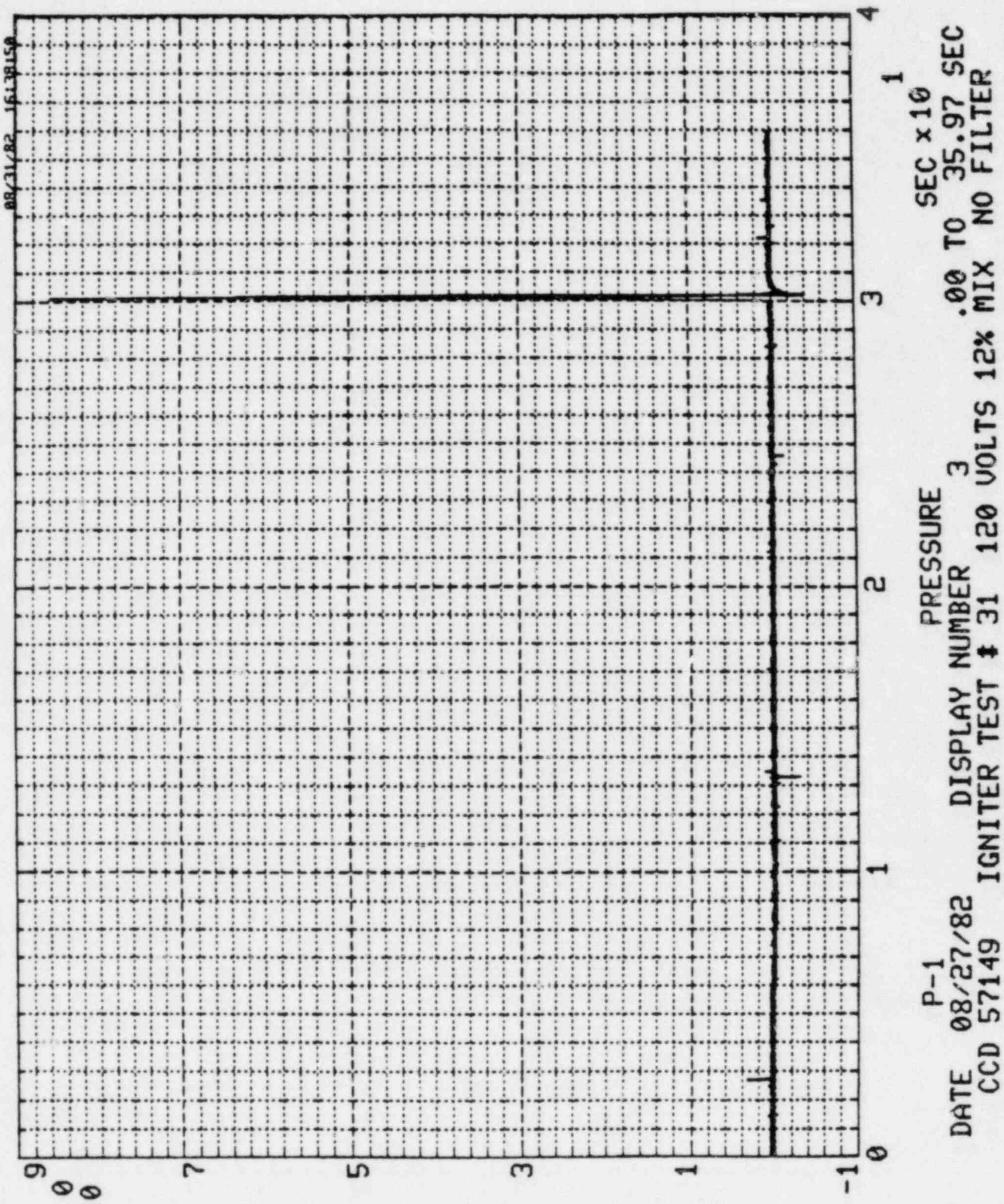


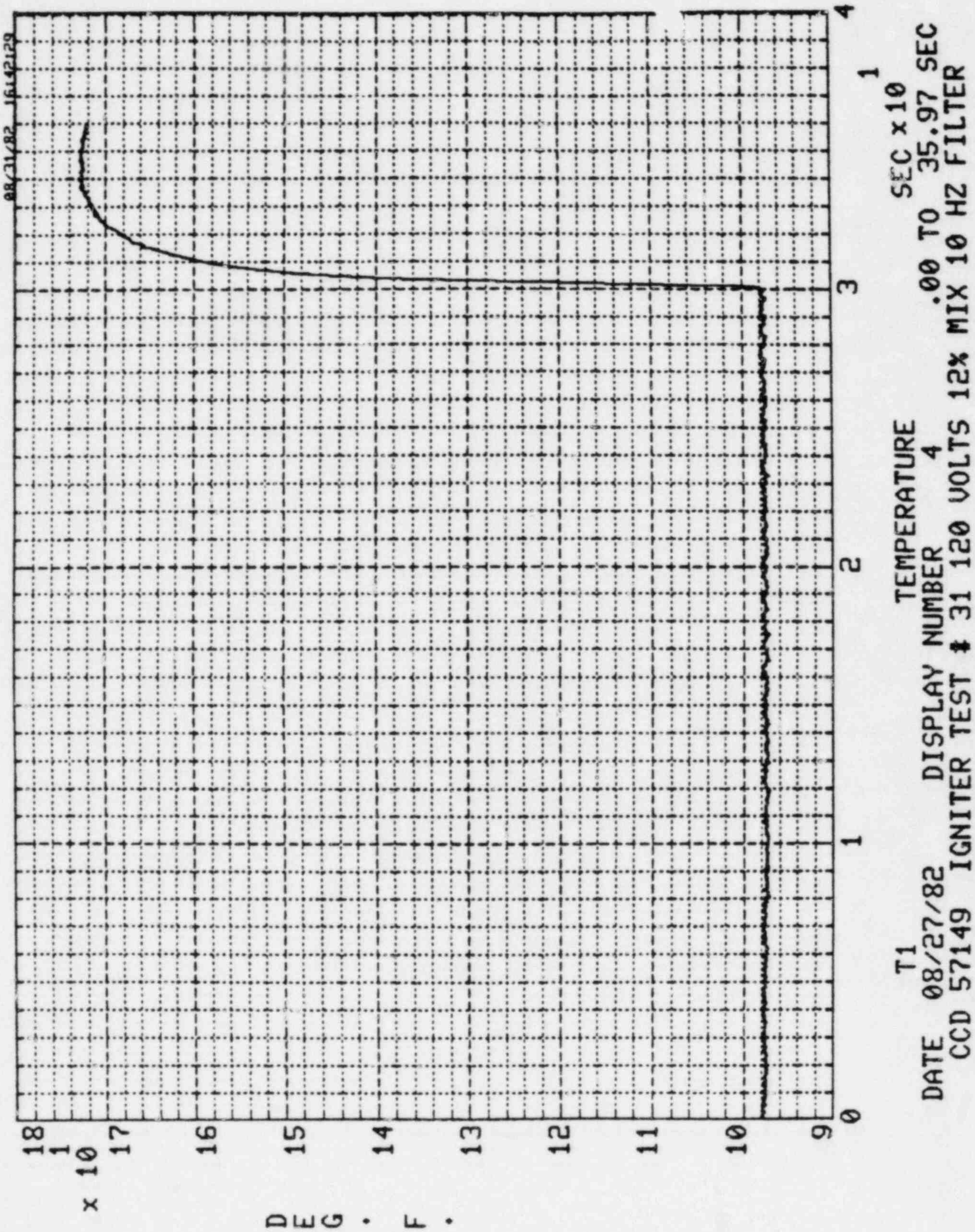
Report No. 57149

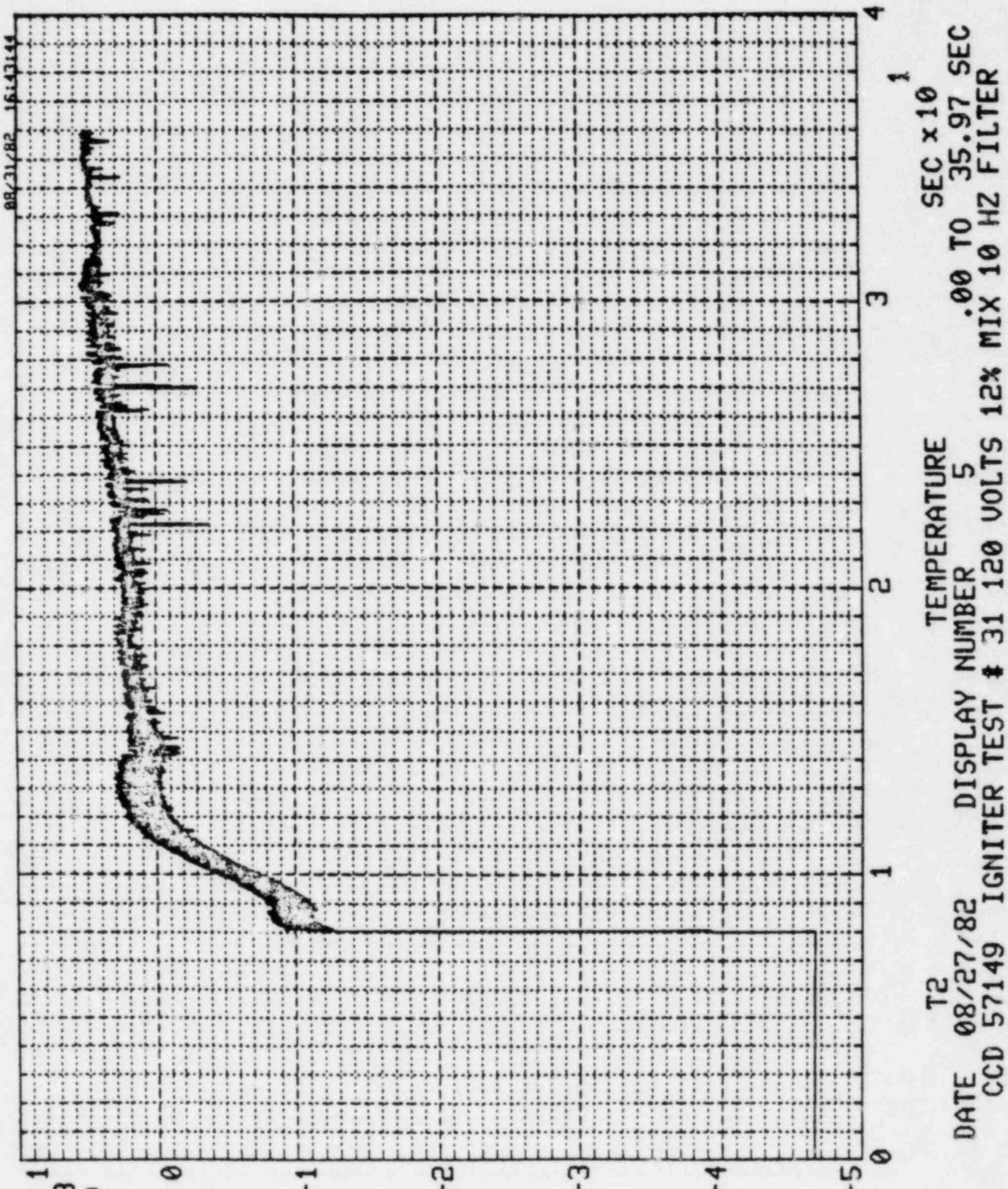

09/01/82 08:17:56
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 30 120 VOLTS 12% MIX 10 HZ FILTER
SEC x10^0
.00 TO 33.57 SEC
DEG. F.
x 10^2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
1 -1 -3 -5 -7 -9 -11 -13

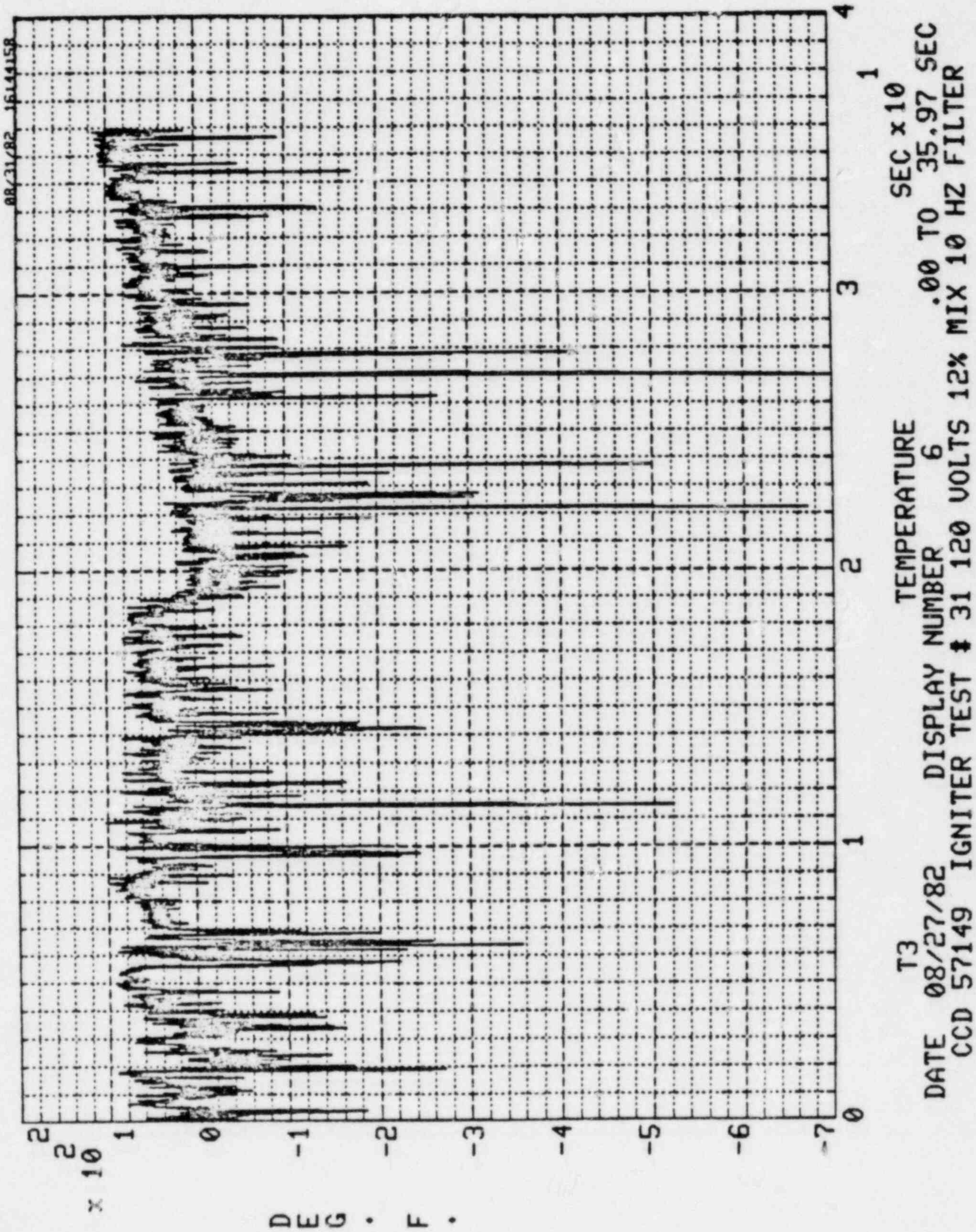

08/31/82 16:36:23
13
11
9
7
5
3
1
-1
x 10 1
VOLTS
0
1
2
3
4
SEC x10 1
VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 31
0.00 TO 35.97 SEC
120 VOLTS 12% MIX NO FILTER

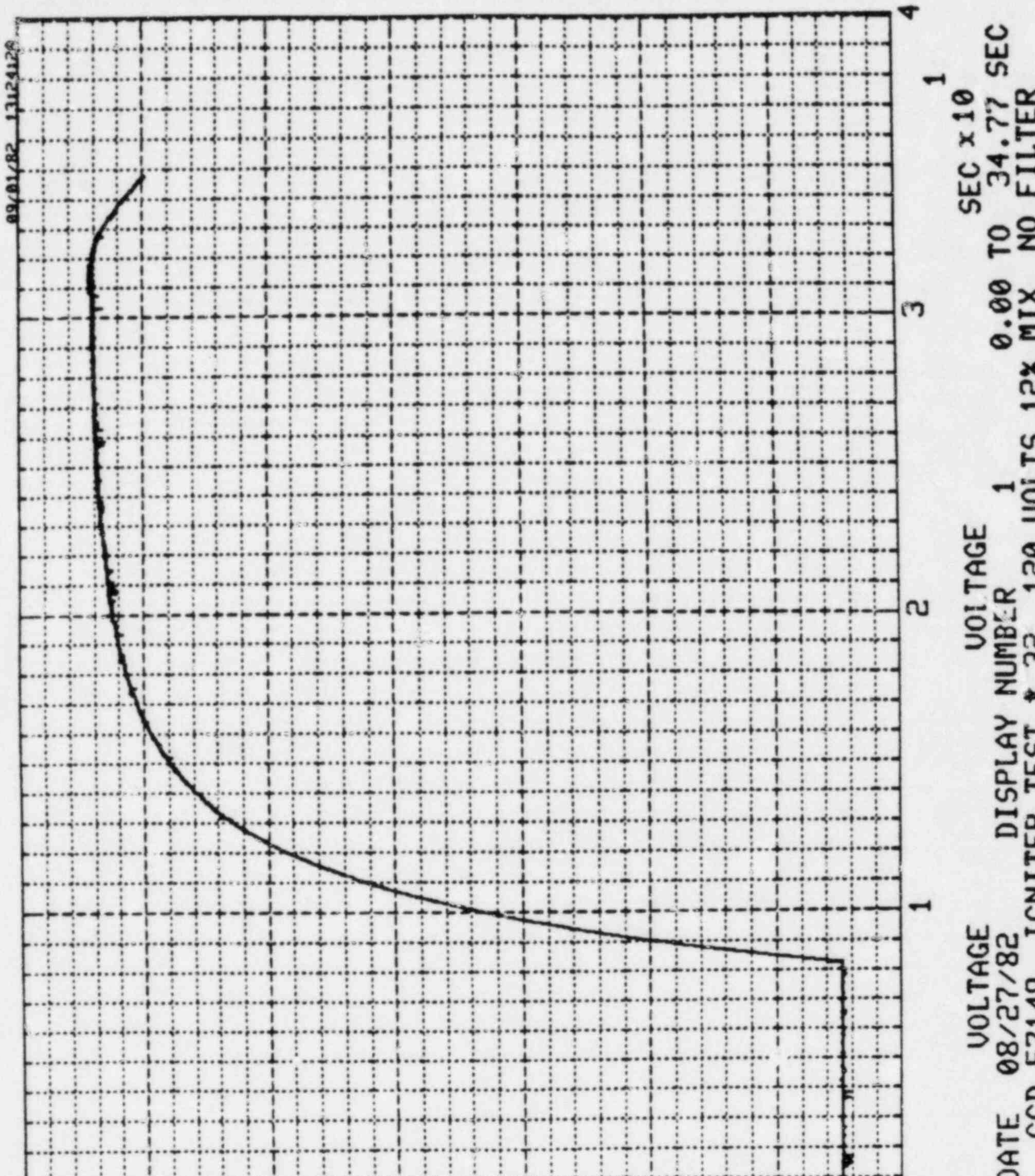

08/31/82 16:37:36
CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 31 120 VOLTS 12% MIX NO FILTER
.00 TO 35.97 SEC
SEC x 10 1
AMPERES
x 10 0
0
1
2
3
4
2
1
0
-1
-2

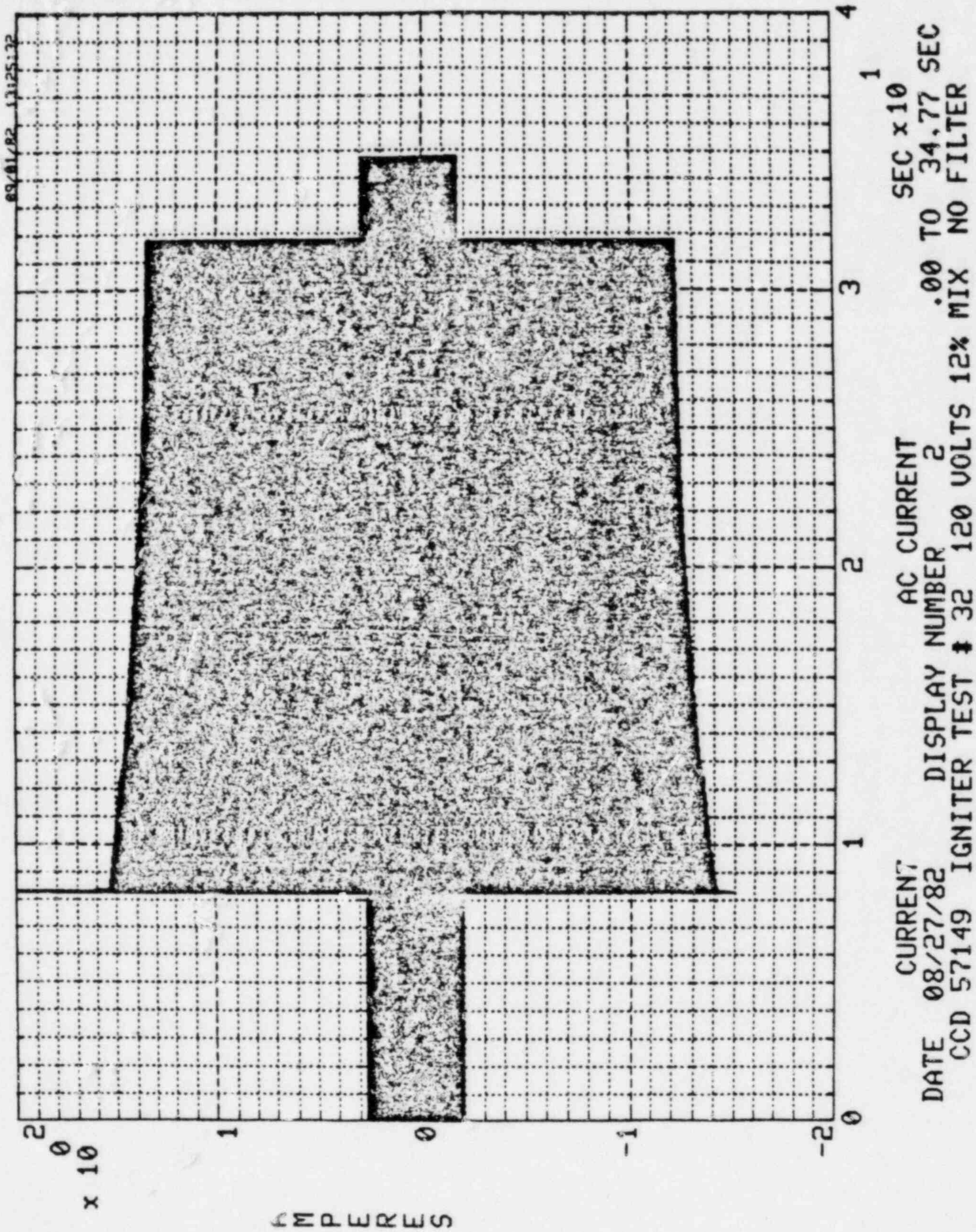

P-1
PRESSURE
DATE 08/27/82
DISPLAY NUMBER 3
CCD 57149
IGNITER TEST # 31 120 VOLTS 12% MIX
SEC x 10 1
.00 TO 35.97 SEC
NO FILTER
P S I G
x 10 0
9
7
5
3
1
-1
0
1
2
3
4

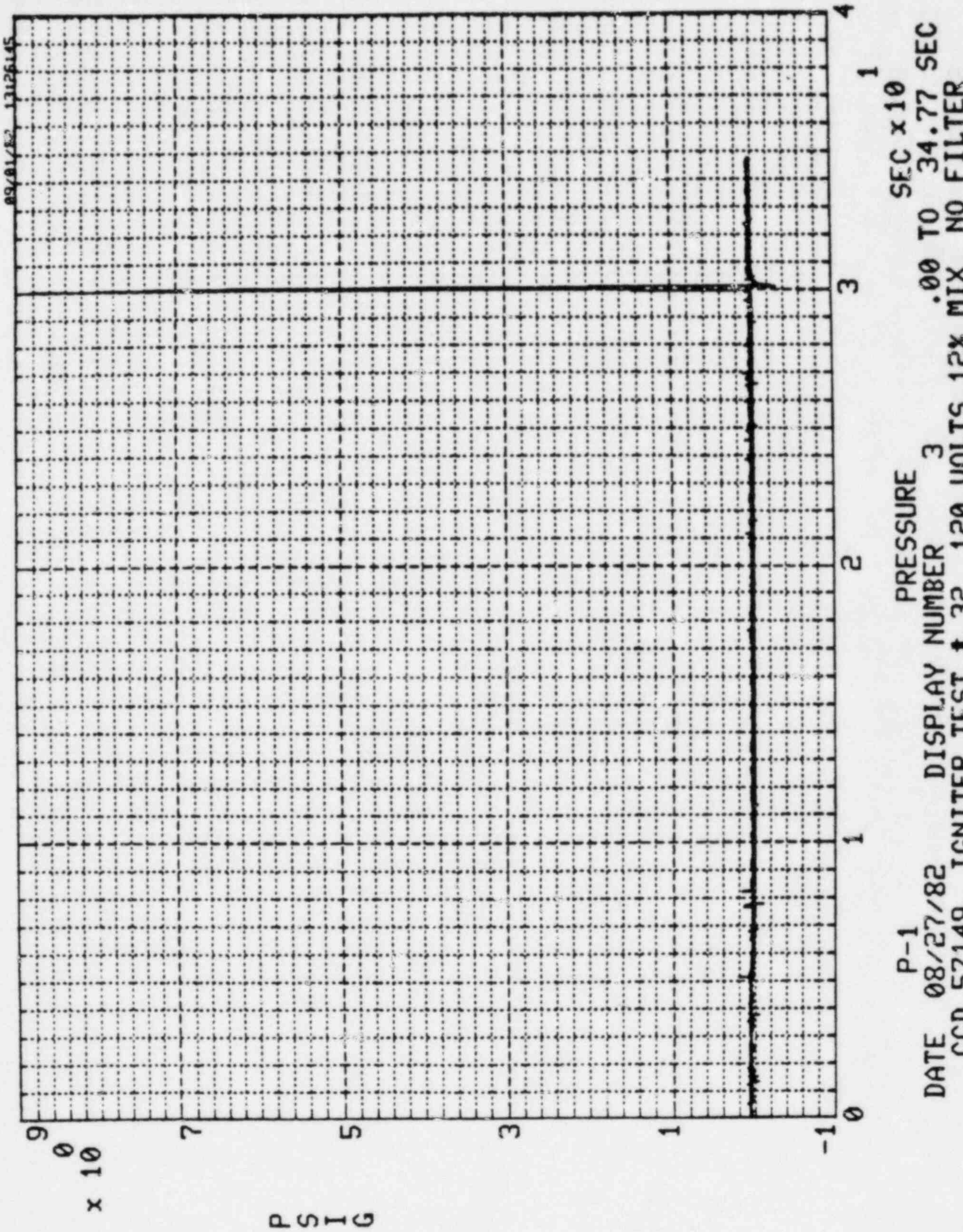

T1
DATE 08/27/82 DISPLAY NUMBER 4
TEMPERATURE
CCD 57149 IGNITER TEST # 31 120 VOLTS 12% MIX 10 HZ FILTER
.00 TO 35.97 SEC
SEC x10 1
DEG. F. x 10 1
08/31/82 16:42:29
0
1
2
3
4
9
10
11
12
13
14
15
16
17
18

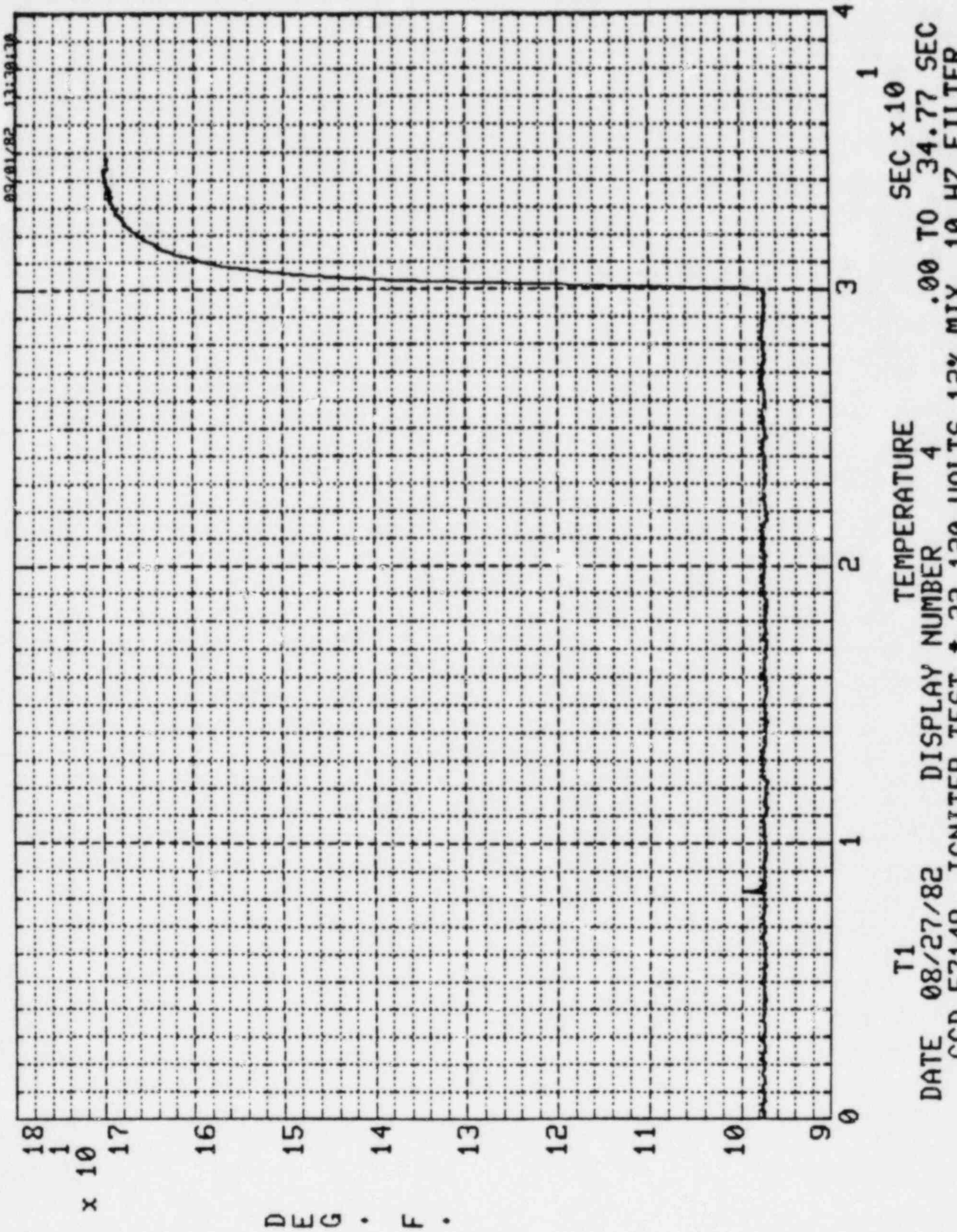

08/31/82 16:43:44
T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST # 31 120 VOLTS 12% MIX 10 HZ FILTER
.00 TO 35.97 SEC
SEC x10 1
0
1
2
3
4
x 10 3
DEG. F.
1
0
-1
-2
-3
-4
-5

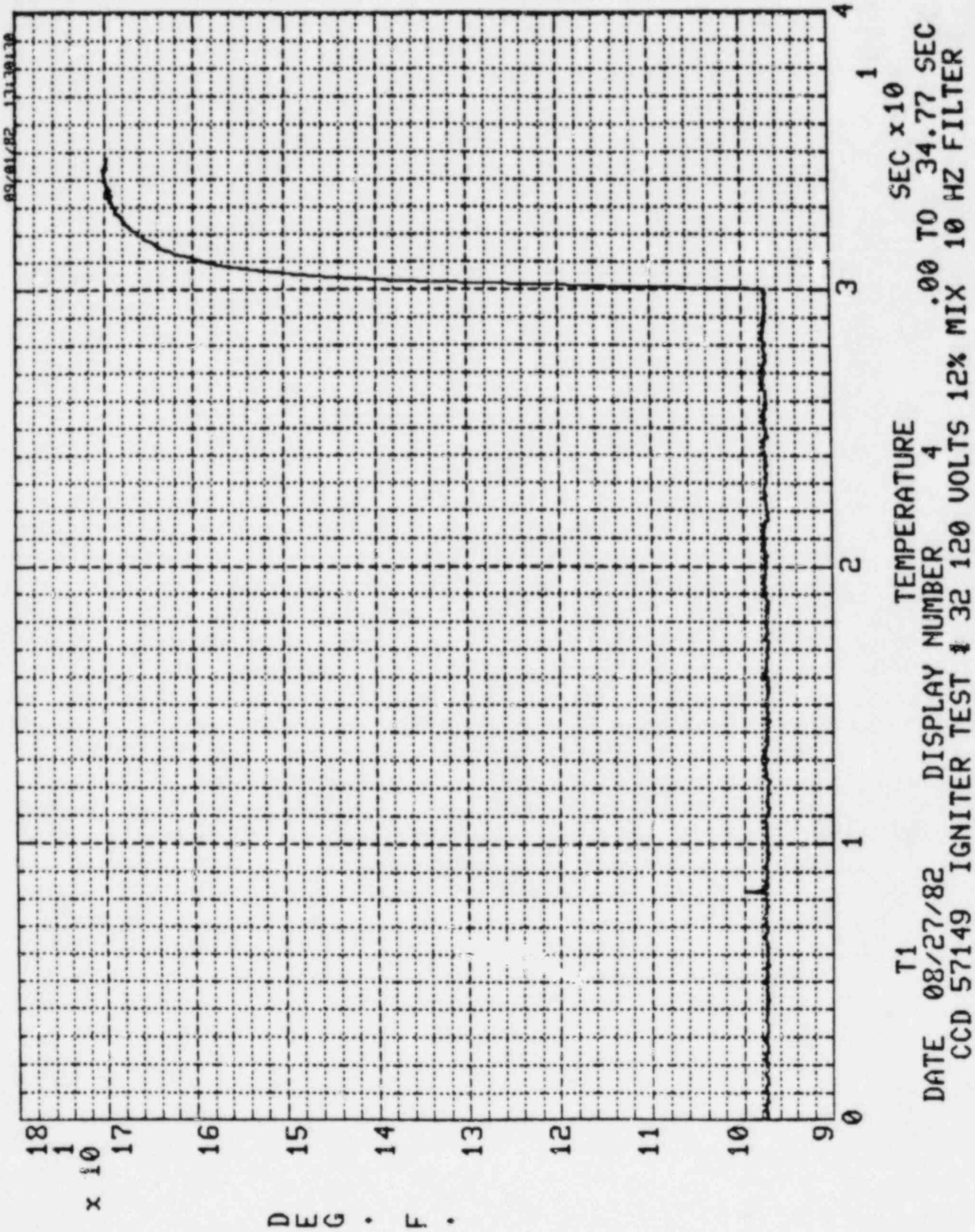

T3
DATE 08/27/82 DISPLAY NUMBER 6
TEMPERATURE
CCD 57149 IGNITER TEST # 31 120 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
.00 TO 35.97 SEC
DEG. F.
x 10 2
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
1
2
3
4

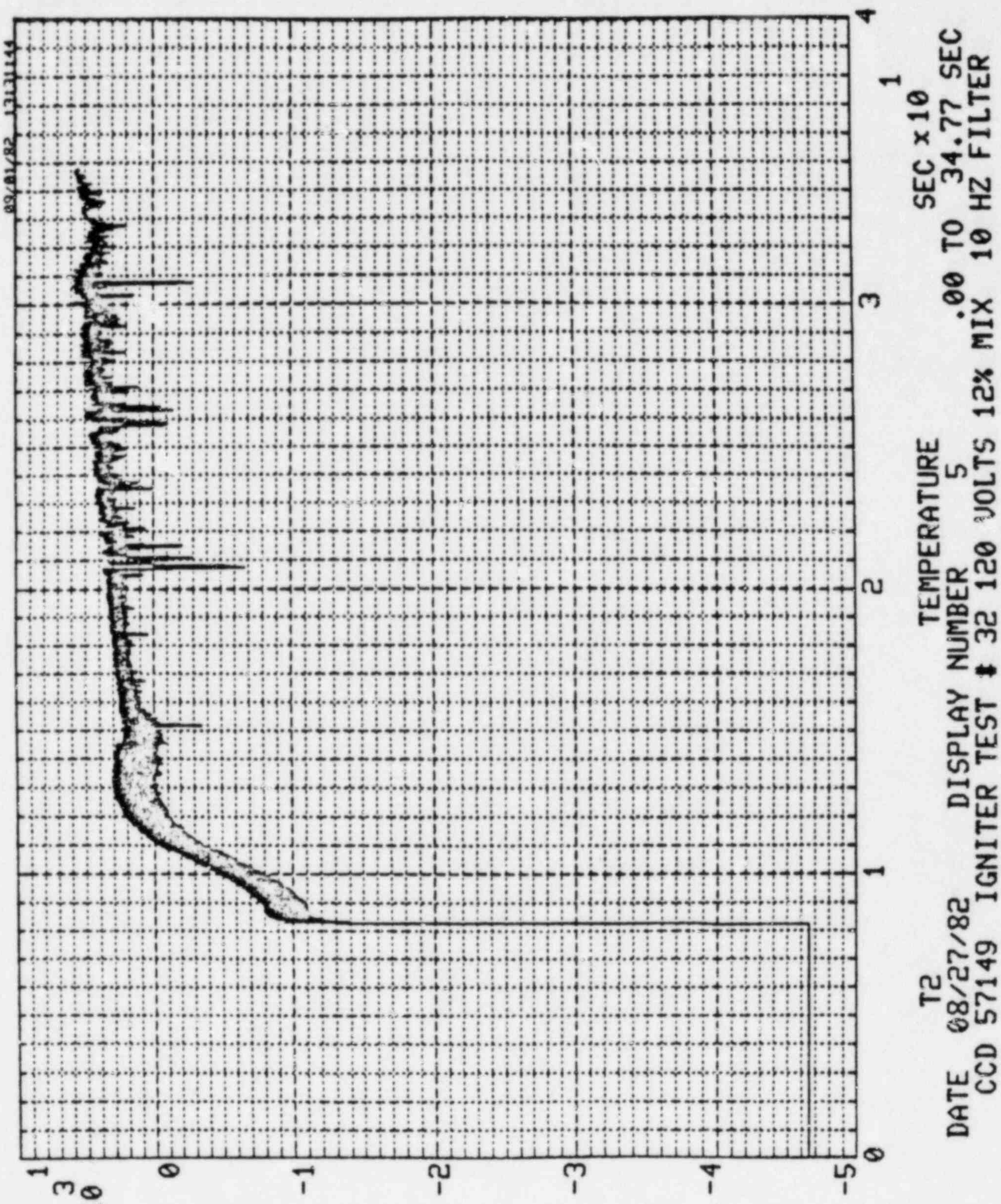

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 32 120 VOLTS 12% MIX
SEC x 10
1
0.00 TO 34.77 SEC
NO FILTER
0
1
2
3
4
VOLTS
x 10
1
13
11
9
7
5
3
1
-1

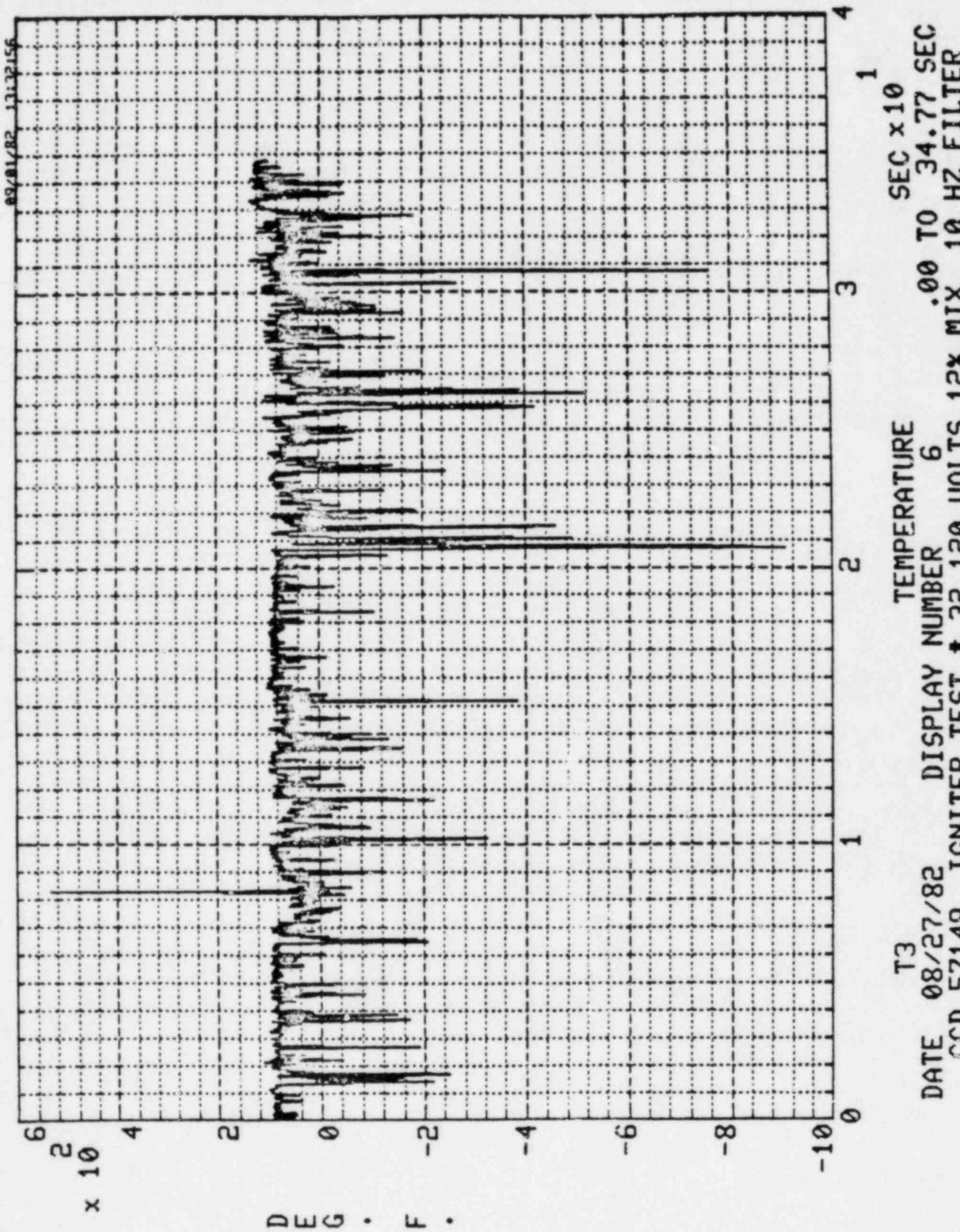

CURRENT
AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX
SEC x10 1
.00 TO 34.77 SEC
NO FILTER
AMPERES
x 10 0
0
1
2
3
4
-2
-1
0
1
2

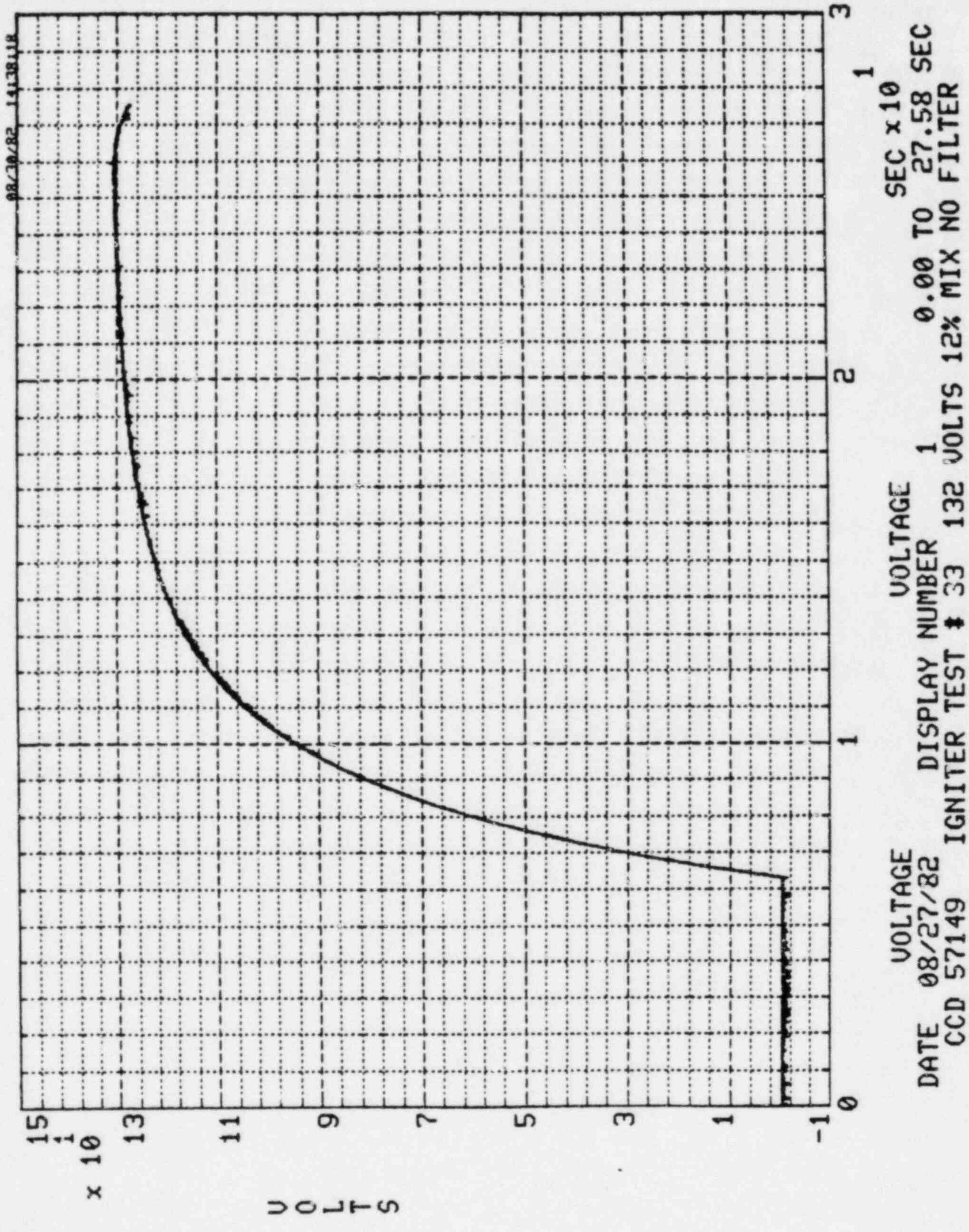

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 34.77 SEC
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX NO FILTER
SEC x 10
1
0
1
2
3
4
P
S
I
G
x 10
0
9
7
5
3
1
-1

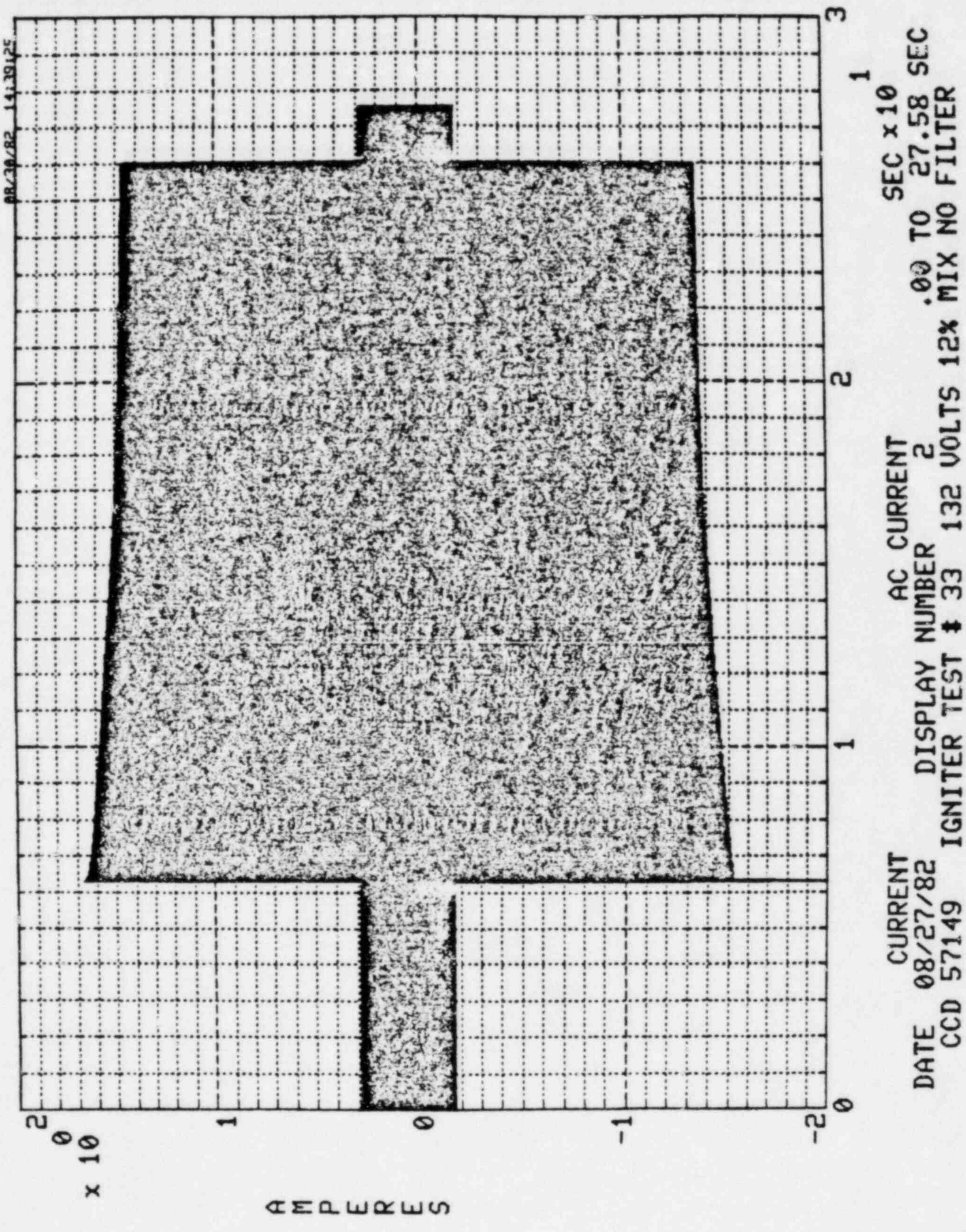

08/01/82 13:30:30
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX
SEC x10[1]
.00 TO 34.77 SEC
10 HZ FILTER
0
1
2
3
4
9
10
11
12
13
14
15
16
17
18
x 10[1]
DEG. F.

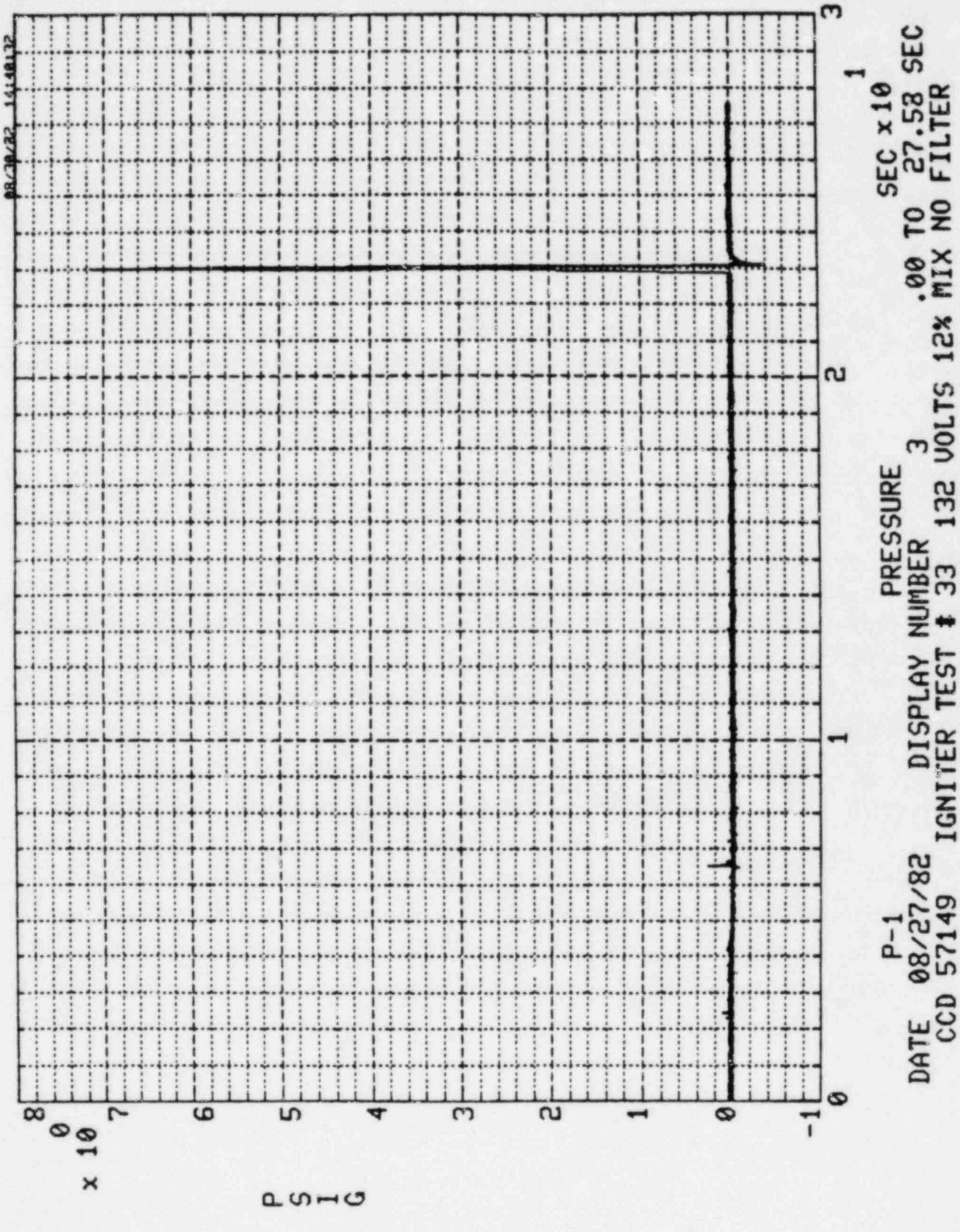

T1
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 34.77 SEC
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX 10 HZ FILTER
TEMPERATURE
SEC x 10 1
DEG. F. x 10 1
0
1
2
3
4
9
10
11
12
13
14
15
16
17
18

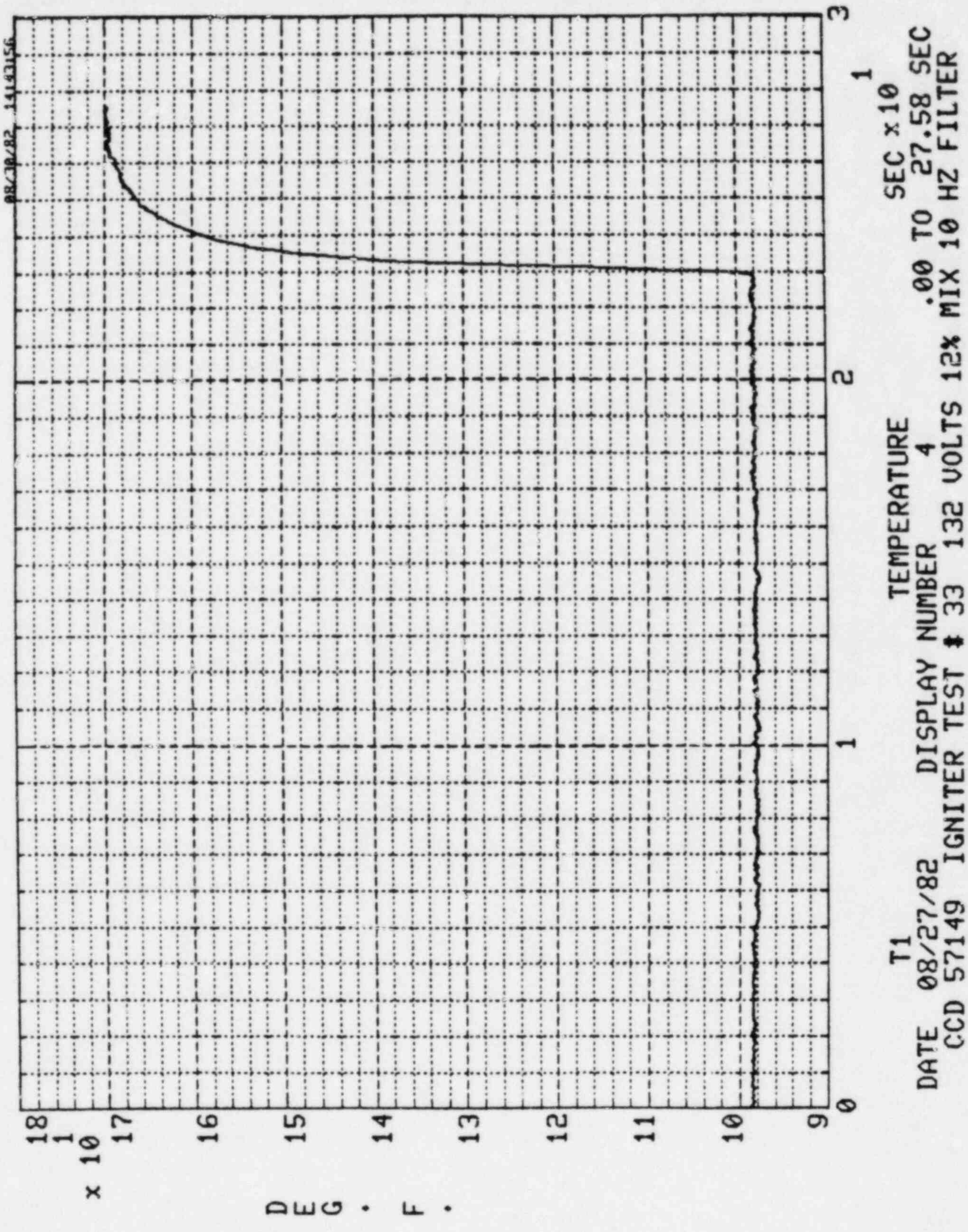

T2
DATE 08/27/82 DISPLAY NUMBER 5
TEMPERATURE
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX 10 HZ FILTER
.00 TO 34.77 SEC
SEC x10 1
DEG. F. x 10 3
1
0
-1
-2
-3
-4
-5
0
1
2
3
4

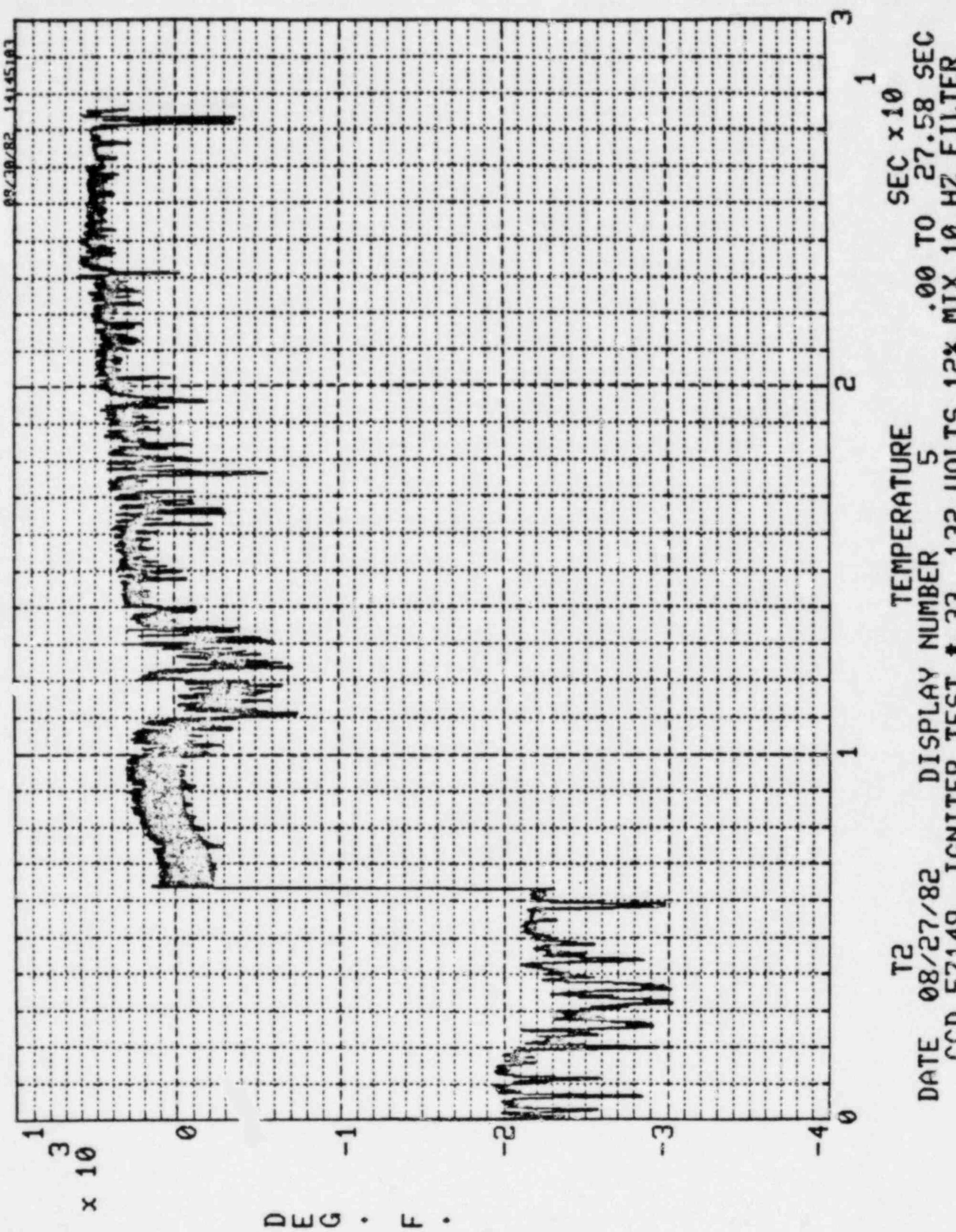

09/01/82 13:32:56
6
4
2
0
-2
-4
-6
-8
-10
x 10 2
DEG. F.
0
1
2
3
4
SEC x10 1
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 34.77 SEC
CCD 57149 IGNITER TEST # 32 120 VOLTS 12% MIX 10 HZ FILTER

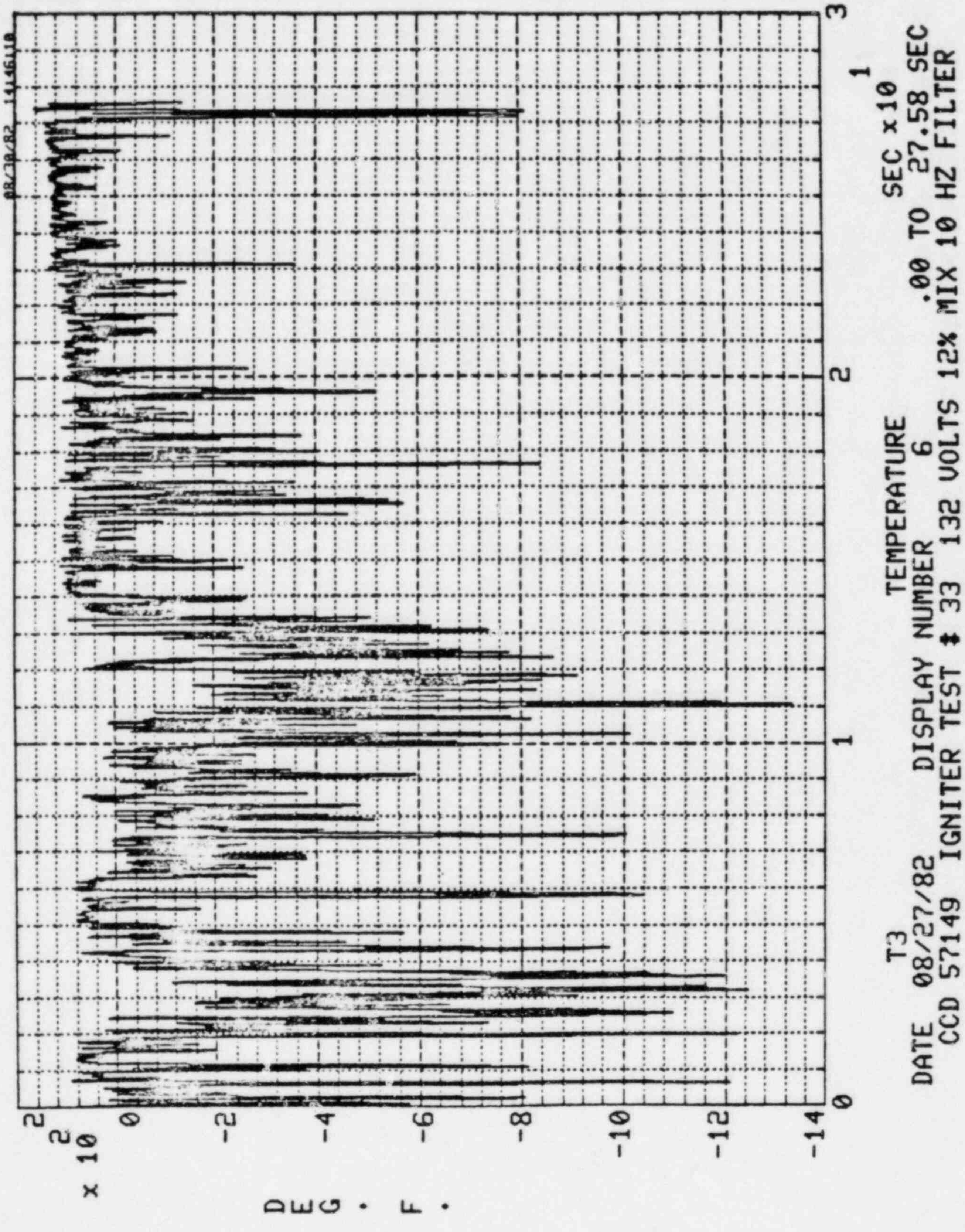

08/30/82 14:38:18
VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 33 132 VOLTS 12% MIX NO FILTER
0.00 TO 27.58 SEC
SEC x 10^1
VOLTS x 10^1
15
13
11
9
7
5
3
1
-1
0
1
2
3

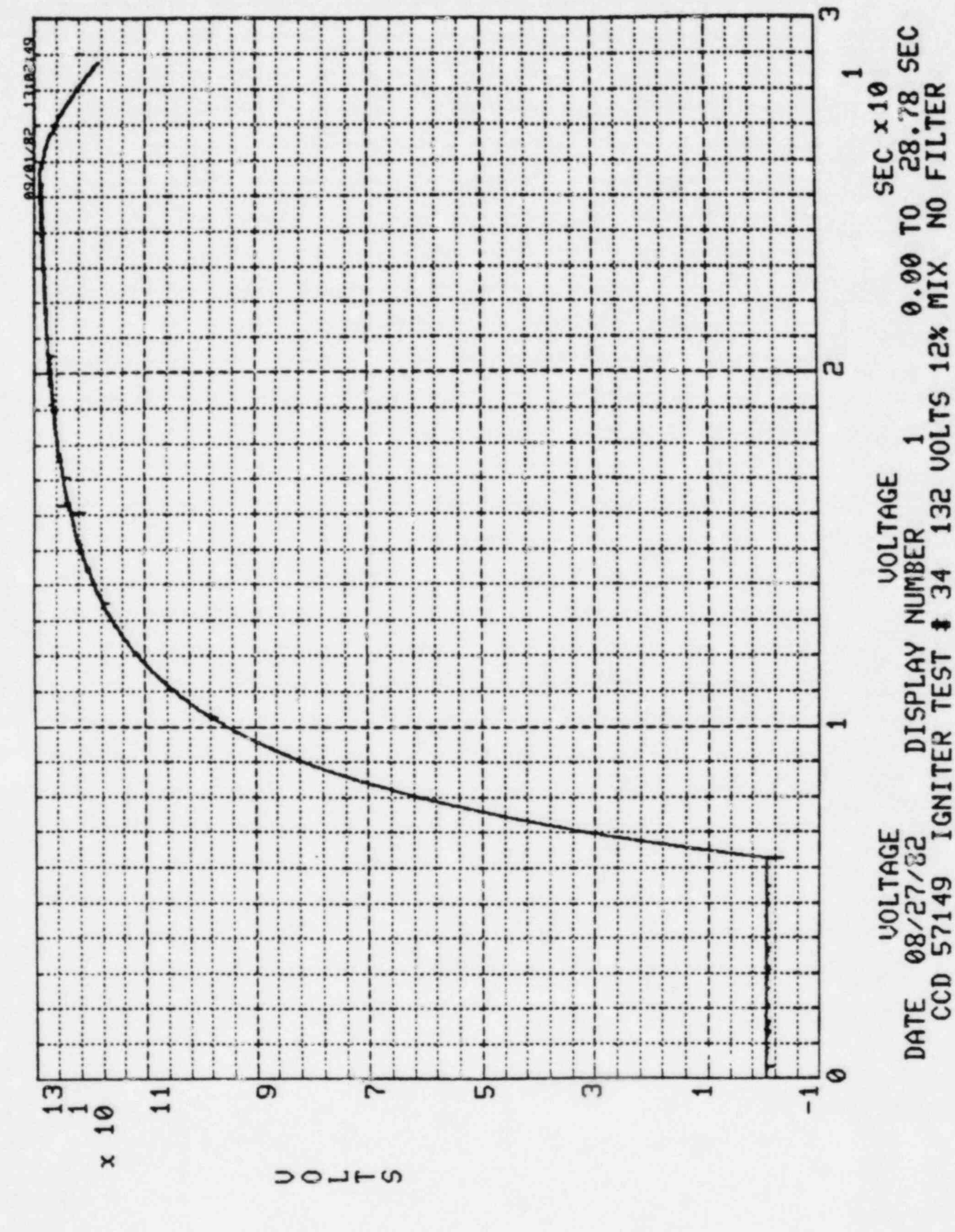

CURRENT AC CURRENT SEC x10 1
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 27.58 SEC
CCD 57149 IGNITER TEST # 33 132 VOLTS 12% MIX NO FILTER
AMPERES
x 10 0
2
1
0
-1
-2
0
1
2
3
08/30/82 14:39:25

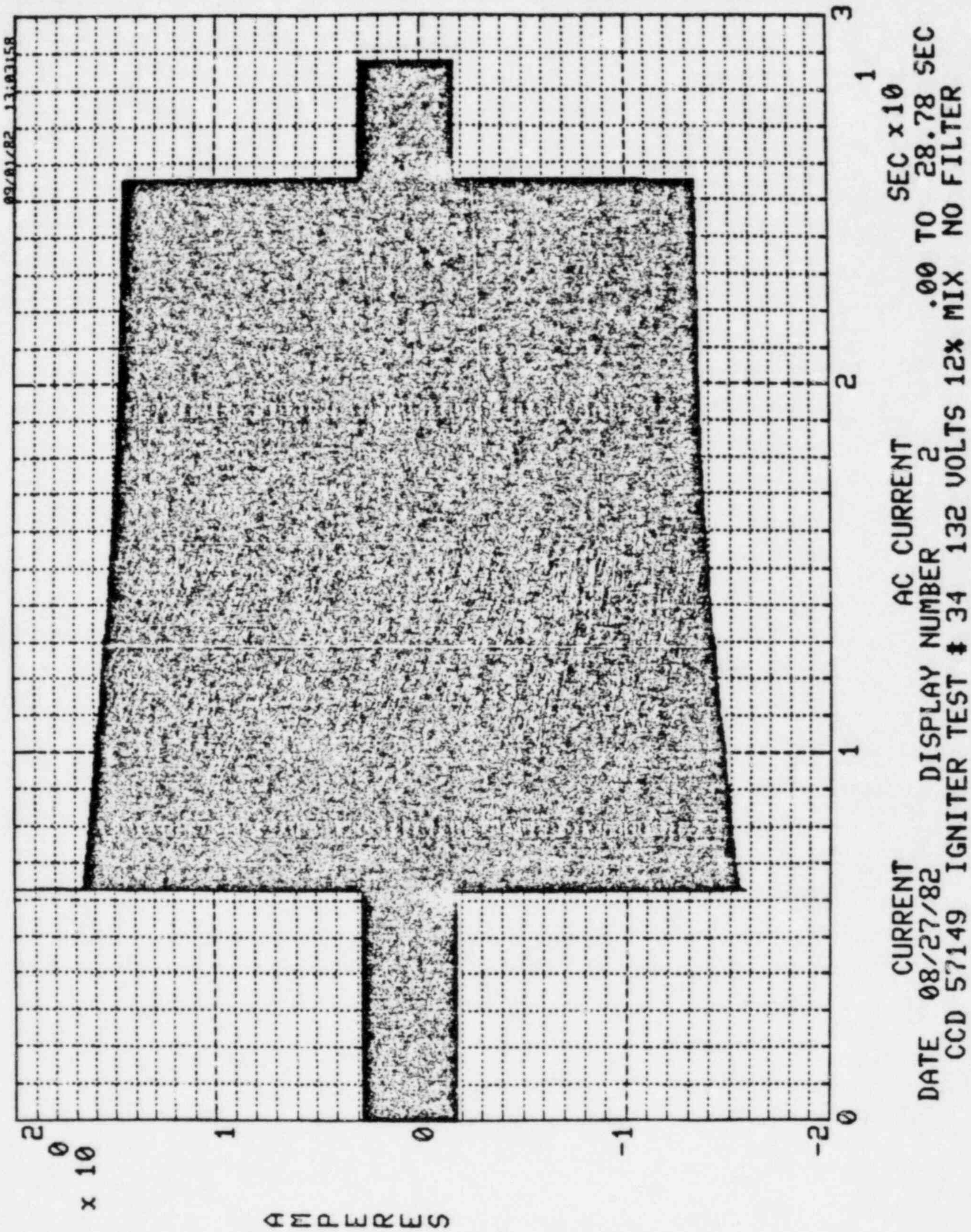

08/30/82 14:48:32
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 33 132 VOLTS 12% MIX NO FILTER
SEC x10^1
.00 TO 27.58 SEC
PSIG
x 10^0

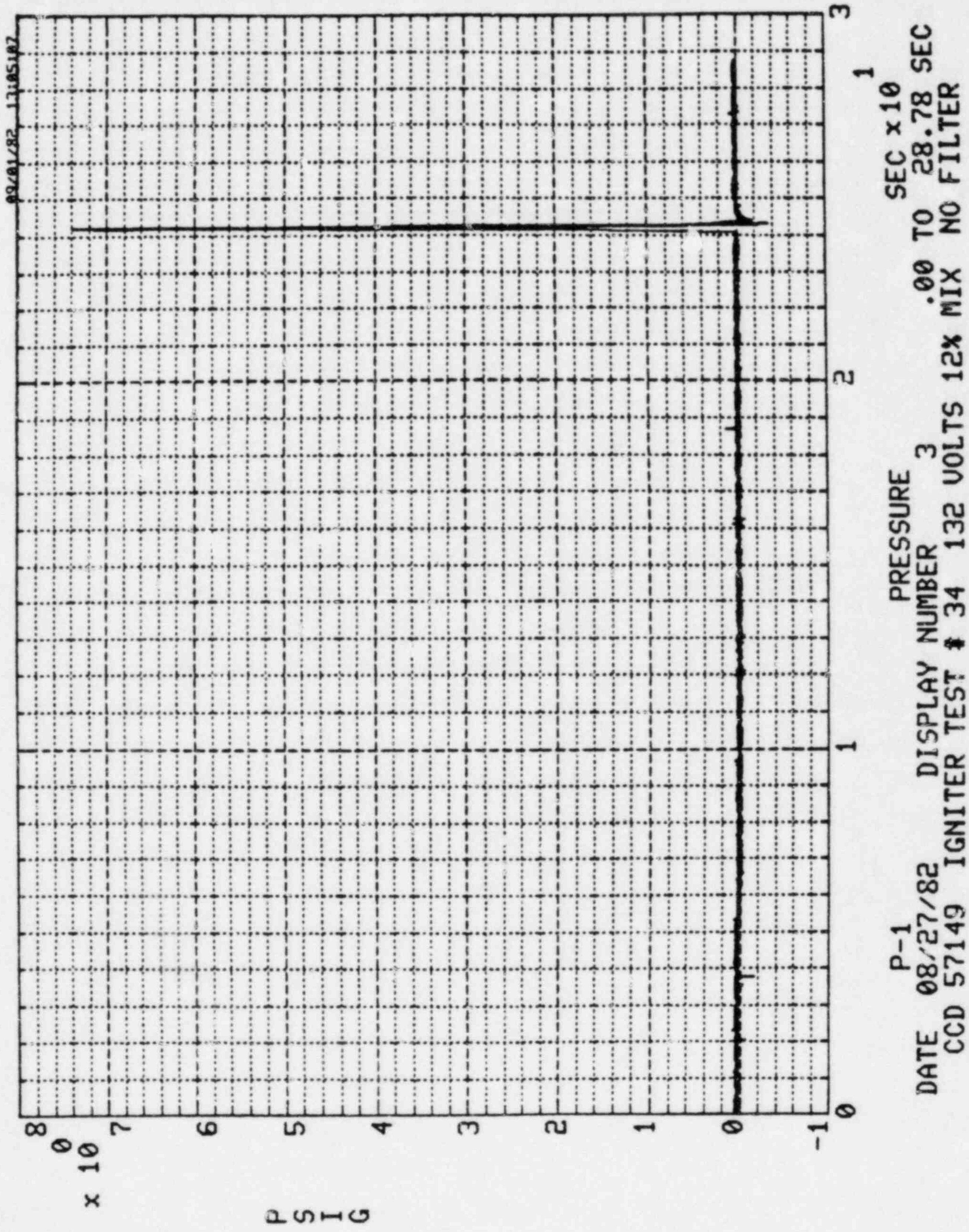

08/30/82 14:43:56
18
17
16
15
14
13
12
11
10
9
x 10^1
DEG. F.
0
1
2
3
SEC x 10^1
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 27.58 SEC
CCD 57149 IGNITER TEST # 33 132 VOLTS 12% MIX 10 HZ FILTER

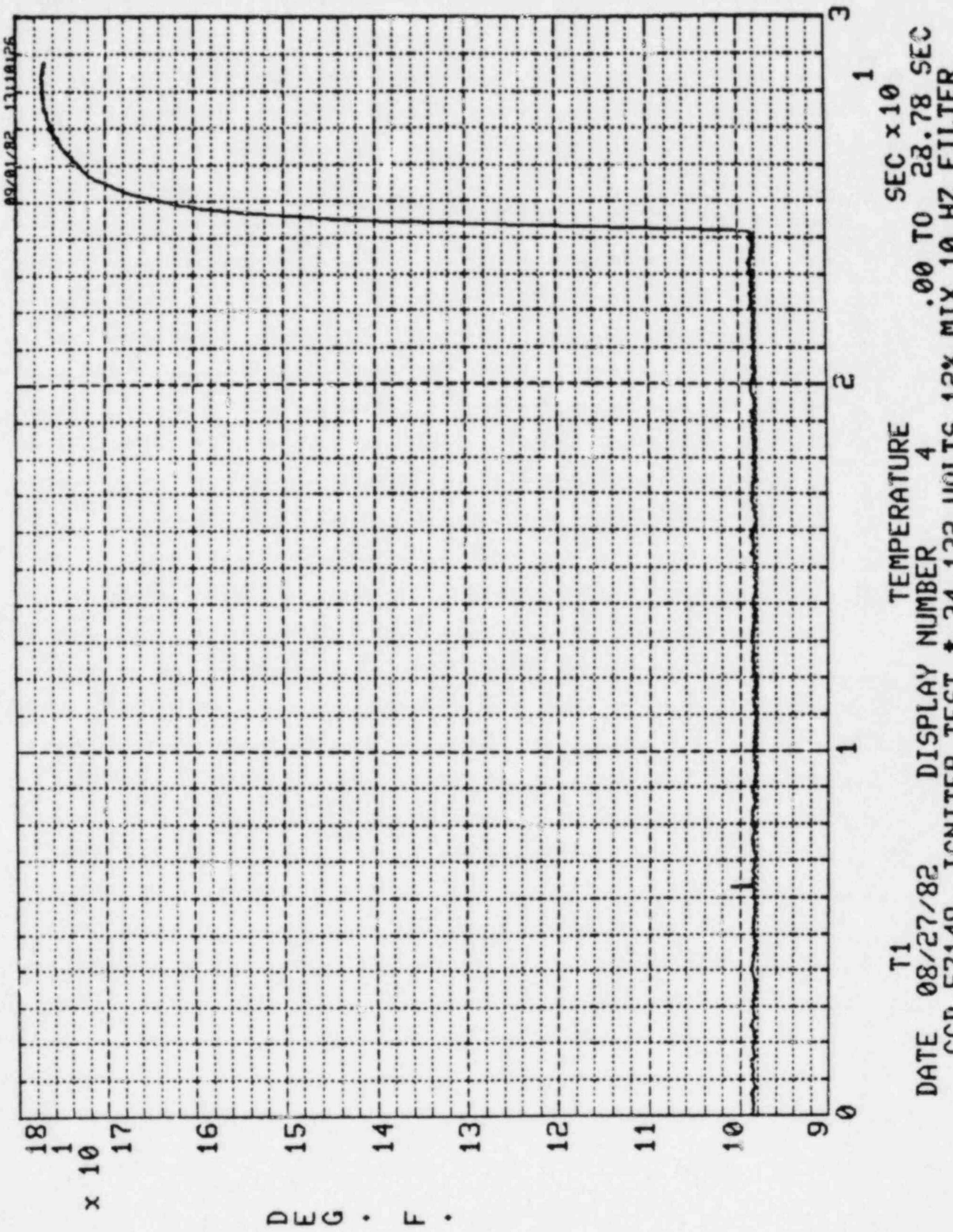

DEG. F.
x 10 3
SEC x10 1
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 27.58 SEC
CCD 57149 IGNITER TEST # 33 132 VOLTS 12% MIX 10 HZ FILTER

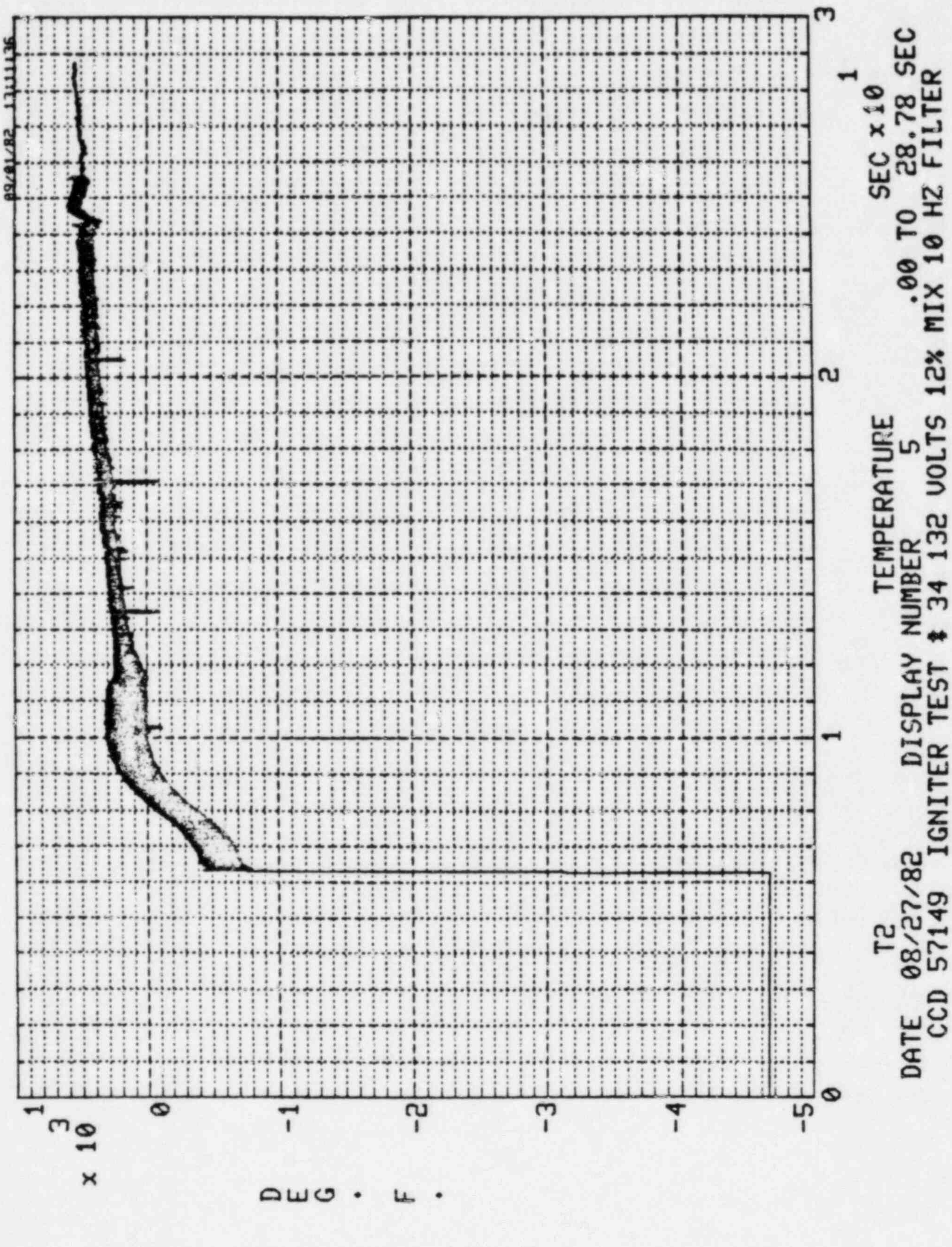

x 10^2
DEG. F.
2
0
-2
-4
-6
-8
-10
-12
-14
0
1
2
3
SEC x10^1
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 27.58 SEC
CCD 57149 IGNITER TEST # 33 132 VOLTS 12% MIX 10 HZ FILTER


VOLTAGE
DATE 08/27/82 DISPLAY NUMBER 1 VOLTAGE 0.00 TO 28.78 SEC
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX NO FILTER
SEC x10 1
VOLTS x 10 1
0
1
2
3
-1
1
3
5
7
9
11
13

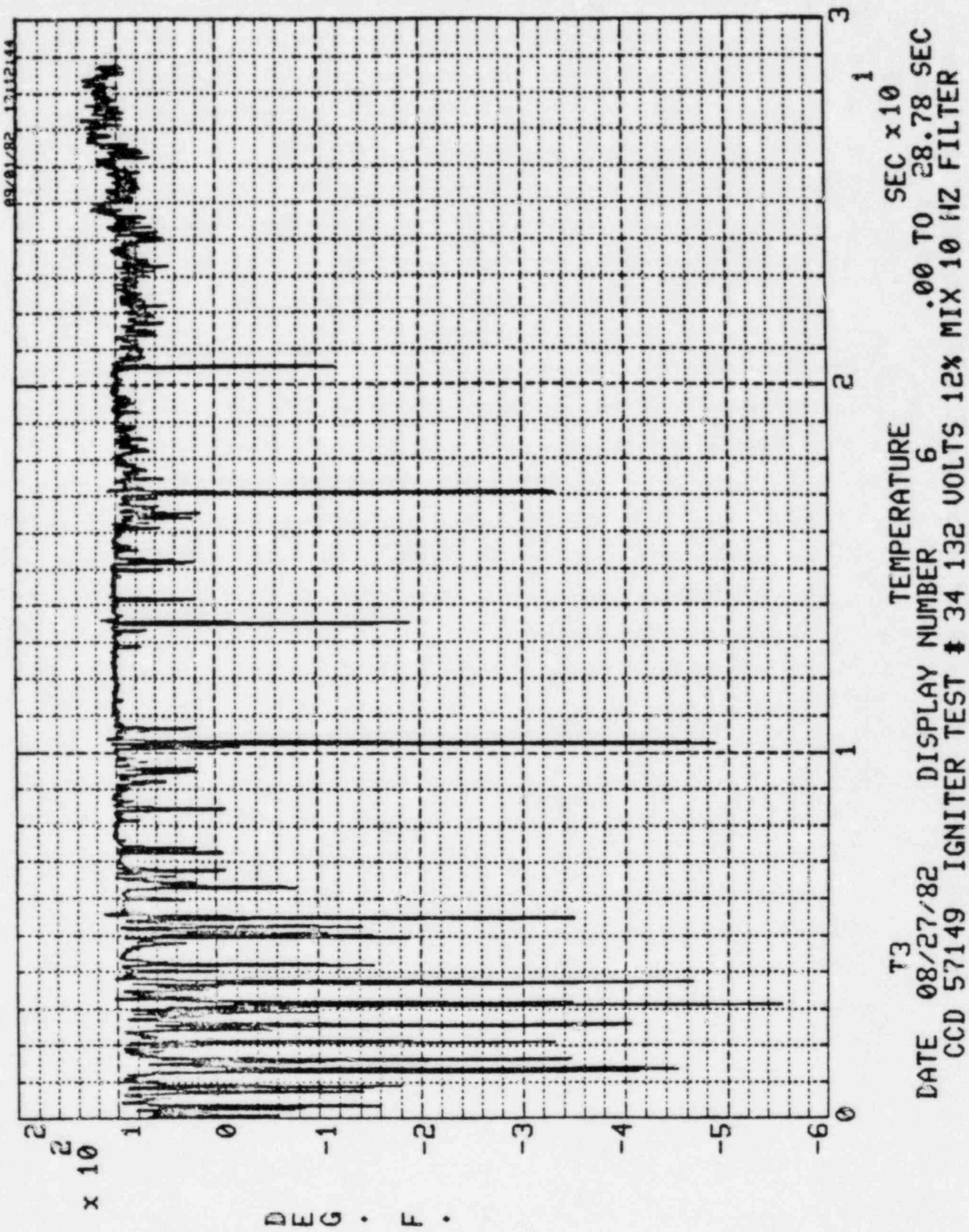

CURRENT AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX .00 TO 28.78 SEC NO FILTER
SEC x10 1
AMPERES x 10 0
2
1
0
-1
-2
0
1
2
3

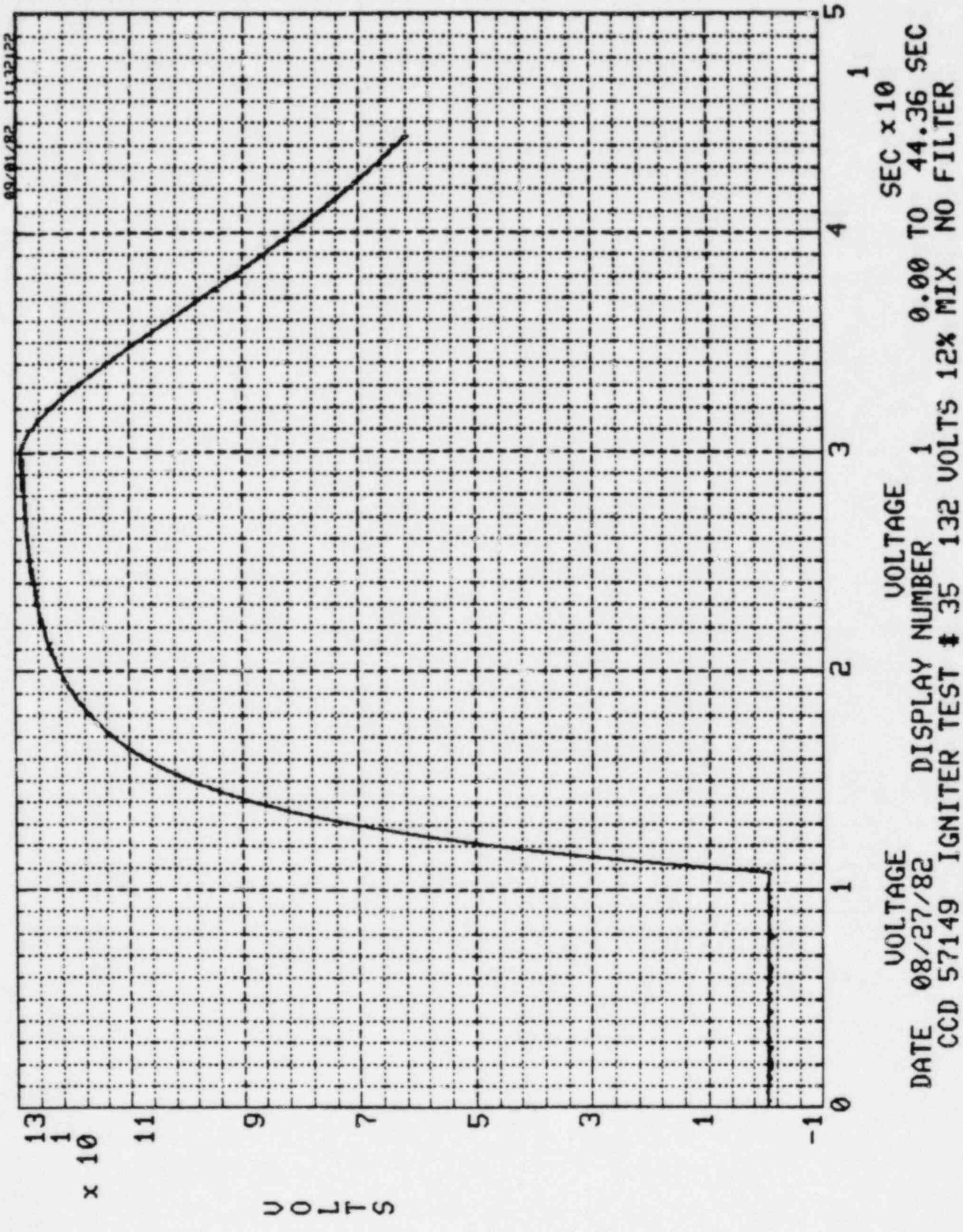

P-1
PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX
.00 TO 28.78 SEC
NO FILTER
SEC x10 1
PSIG
x 10 0
8
7
6
5
4
3
2
1
0
-1
0
1
2
3

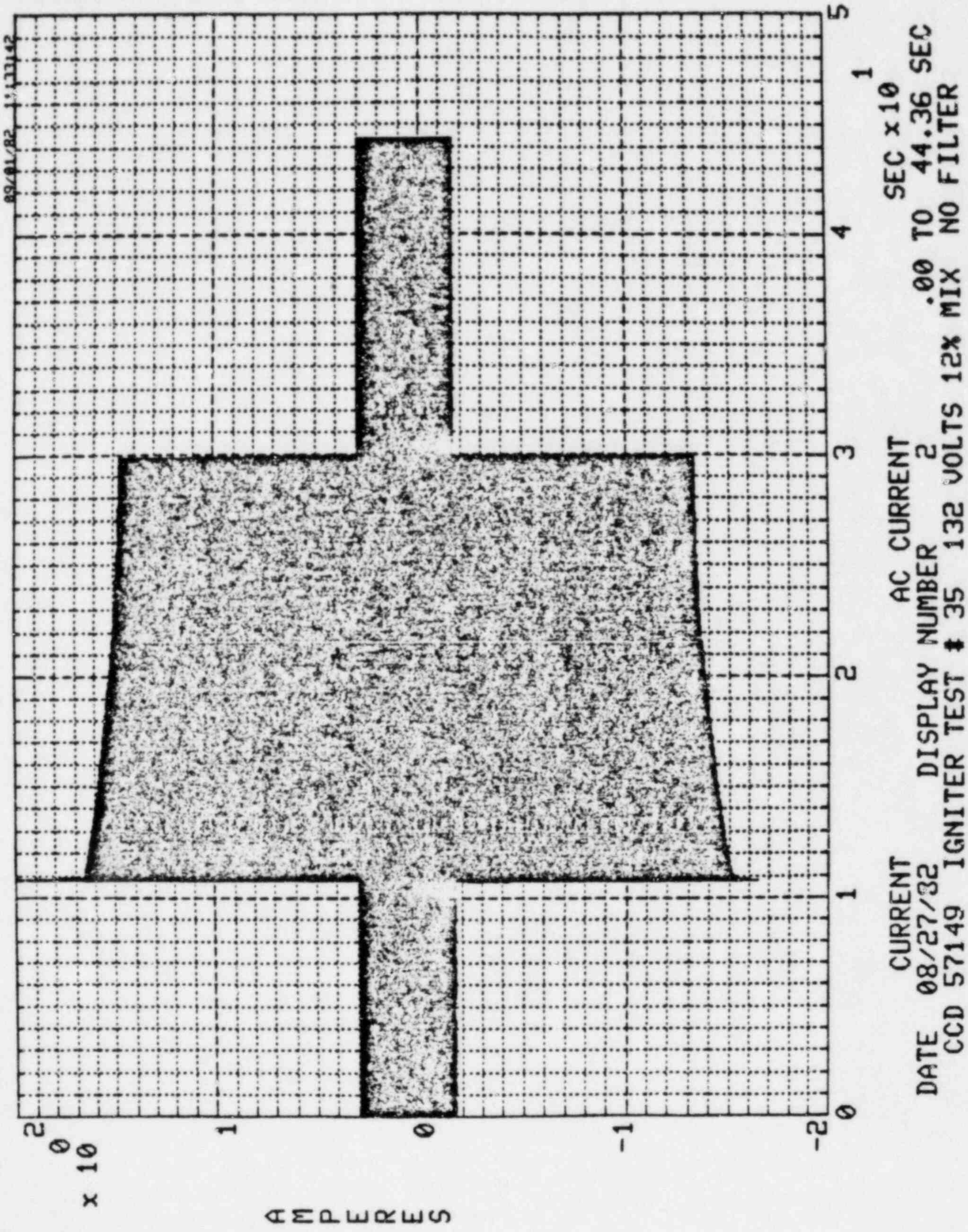

09/01/82 13:18:26
T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4 .00 TO 28.78 SEC
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX 10 HZ FILTER
SEC x10 1
0
1
2
3
DEG. F.
x 10 1
9
10
11
12
13
14
15
16
17
18

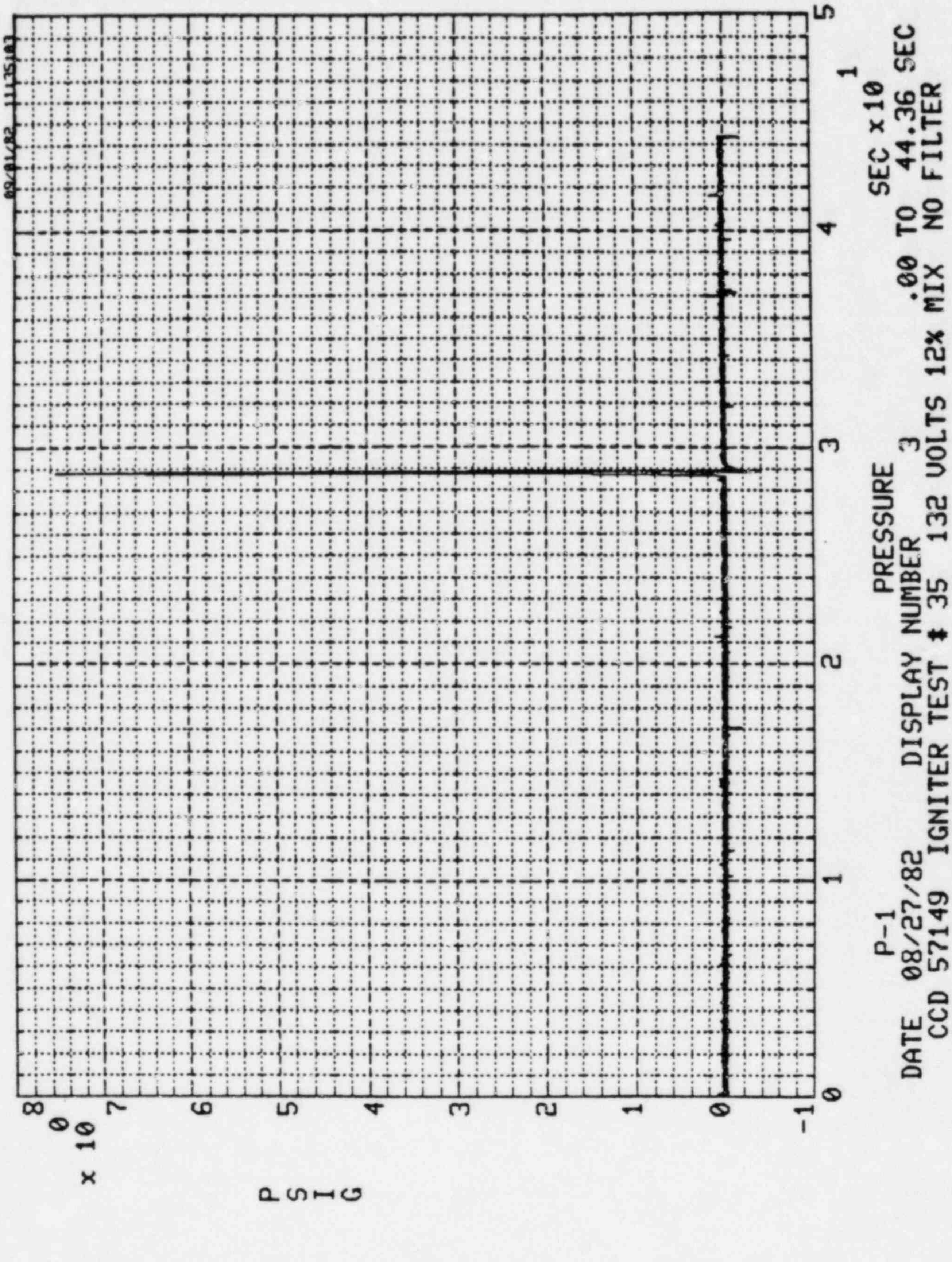


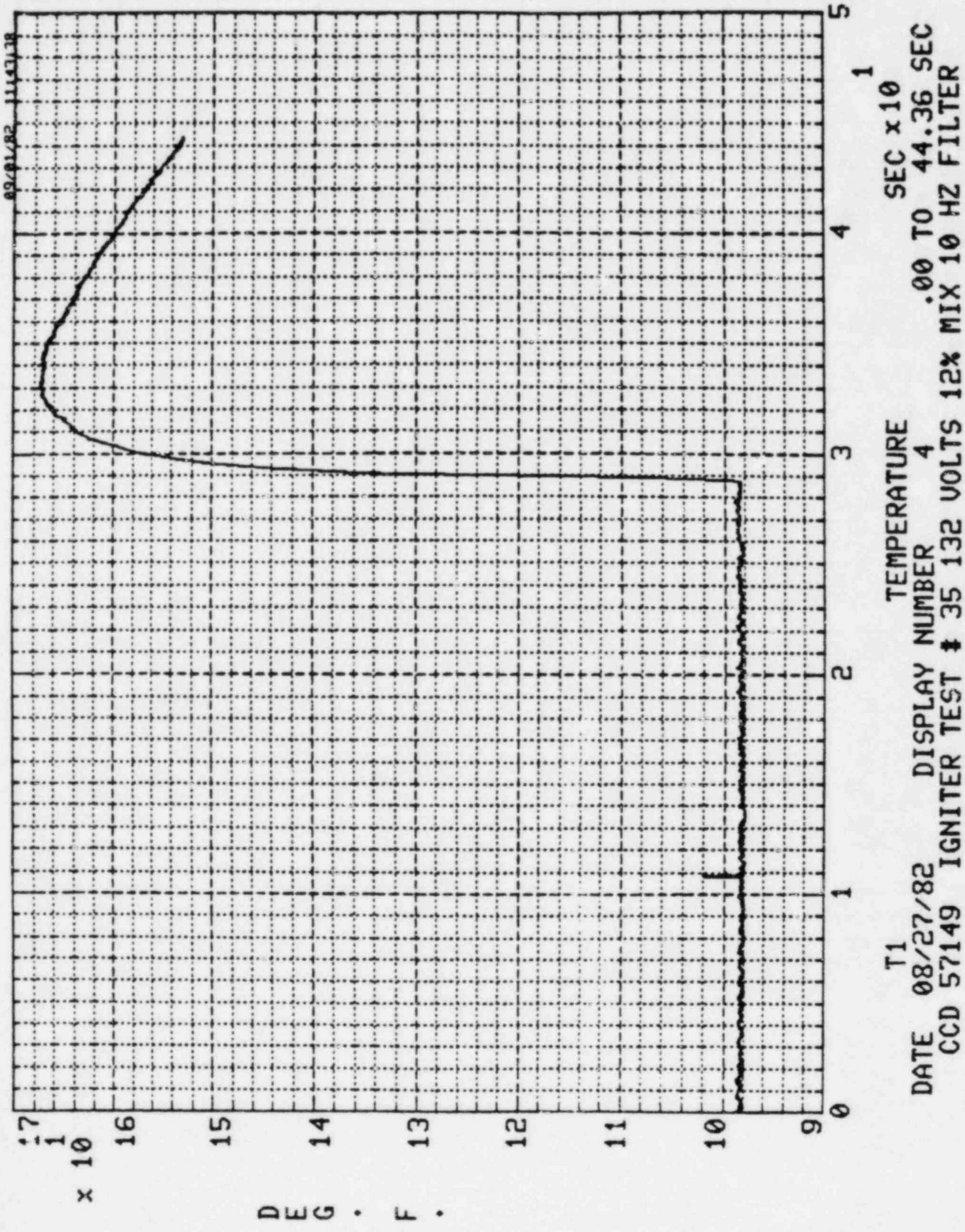
x 10^3
DEG. F.
1
0
-1
-2
-3
-4
-5
0
1
2
3
SEC x 10^1
T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 28.78 SEC
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX 10 HZ FILTER


T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6
CCD 57149 IGNITER TEST # 34 132 VOLTS 12% MIX 10 HZ FILTER
SEC x10^1
.00 TO 28.78 SEC
DEG. F.
x 10^2
2
1
0
-1
-2
-3
-4
-5
-6
0
1
2
3

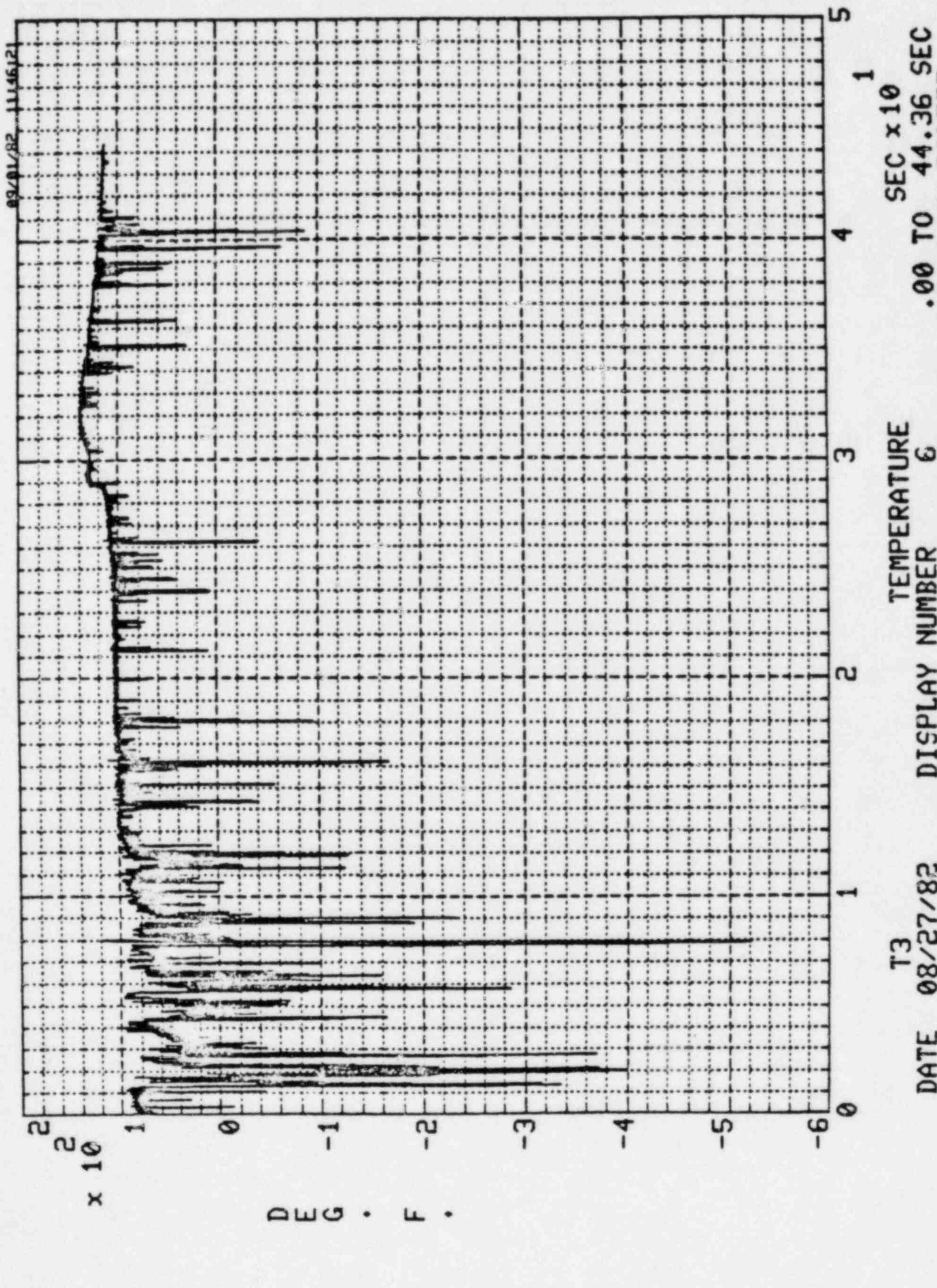

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 35 132 VOLTS 12% MIX
SEC x10 1
0.00 TO 44.36 SEC
NO FILTER
VOLTS
x 10 1
13
11
9
7
5
3
1
-1
0
1
2
3
4
5
09/01/82 11:32:22


CURRENT
DATE 08/27/32
CCD 57149 IGNITER TEST # 35 132 VOLTS 12% MIX
AC CURRENT
DISPLAY NUMBER 2
.00 TO 44.36 SEC
NO FILTER
SEC x10
1
AMPERES
x 10
0
2
1
0
-1
-2
0
1
2
3
4
5

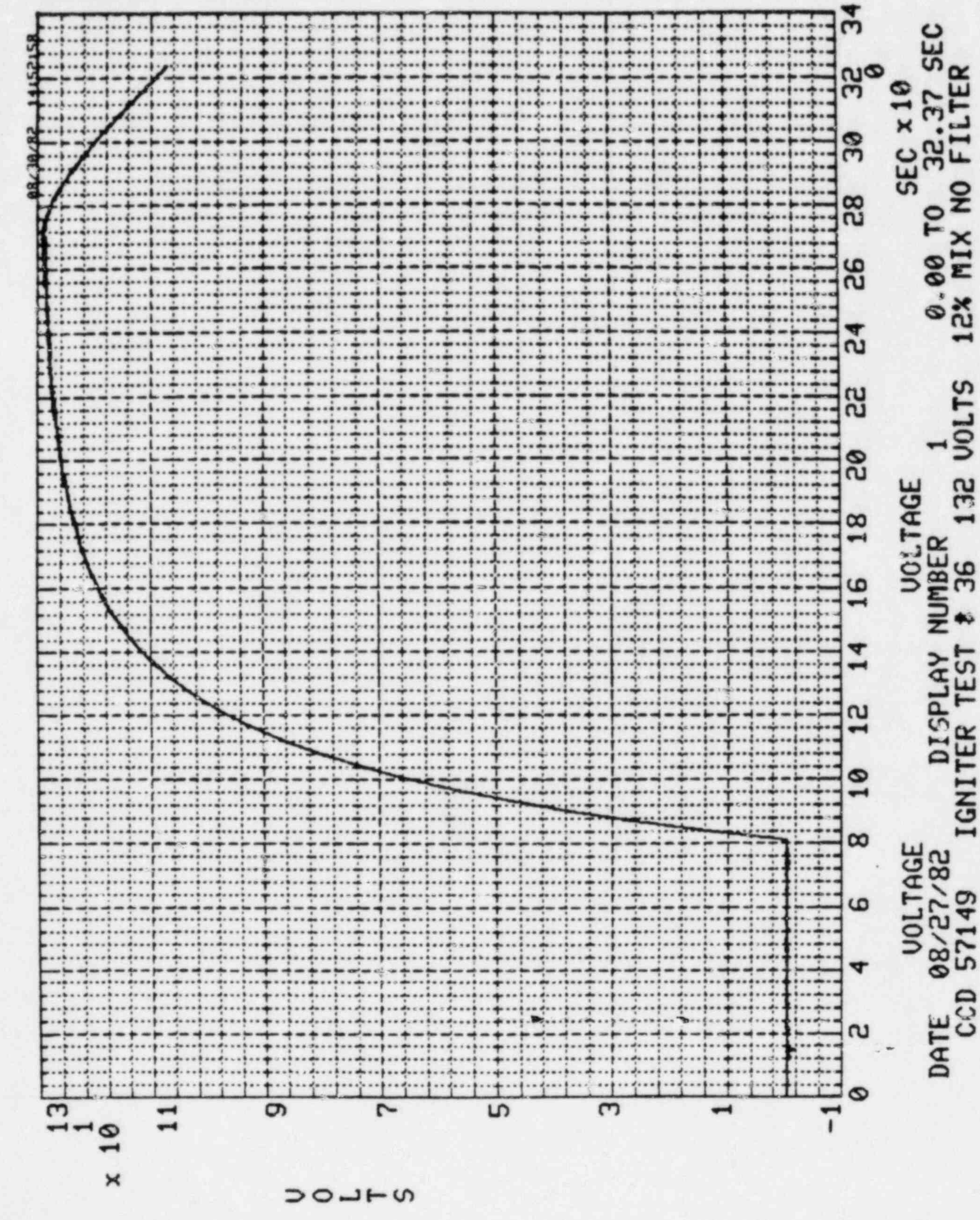

08/01/82 11:35:03
PSIG
x 10^0
8
7
6
5
4
3
2
1
0
-1
0
1
2
3
4
5
SEC x 10^1
PRESSURE
P-1
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 44.36 SEC
CCD 57149 IGNITER TEST # 35 132 VOLTS 12% MIX NO FILTER

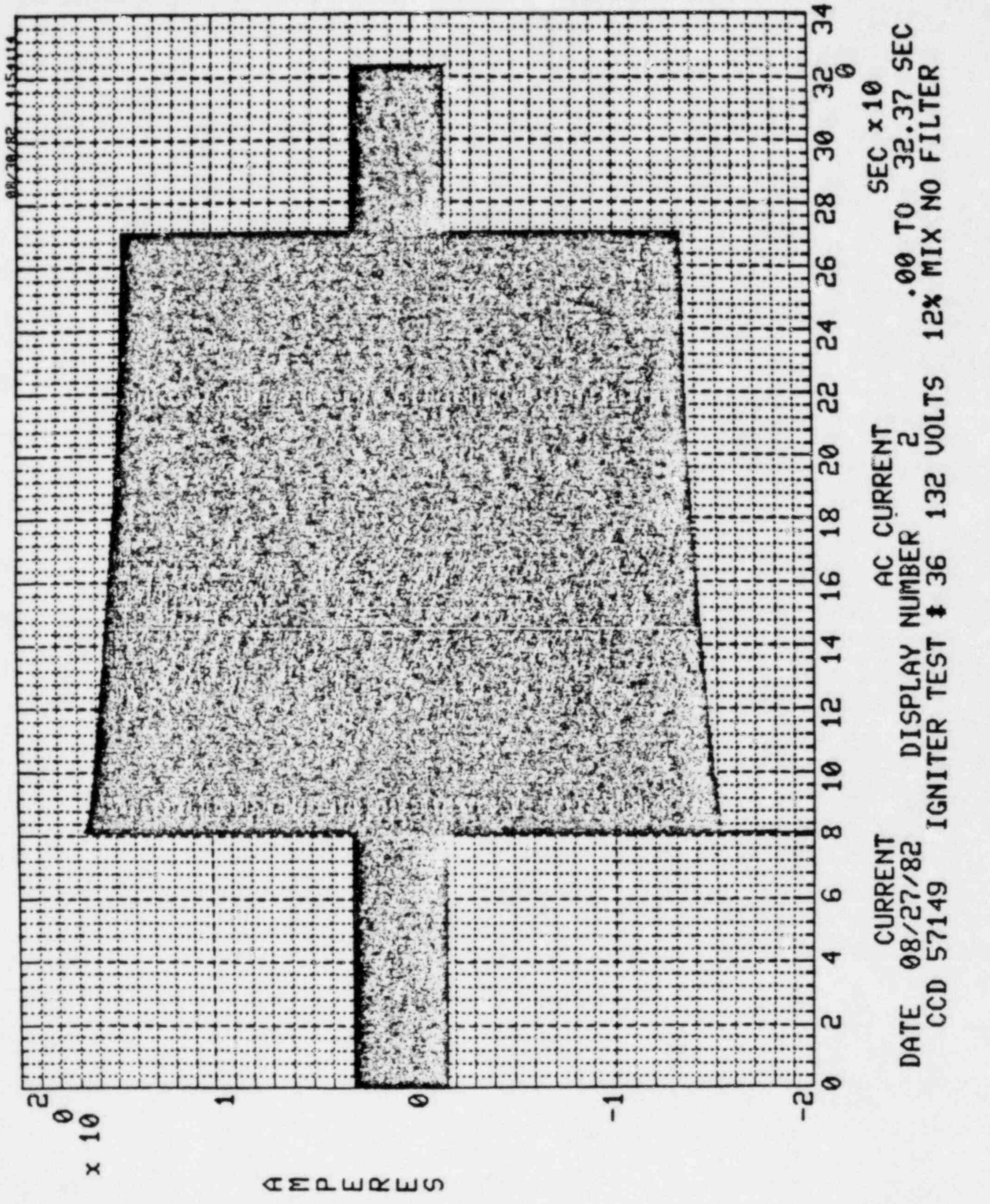

T1
DATE 08/27/82
CCD 57149 IGNITER TEST # 35 132 VOLTS 12% MIX 10 HZ FILTER
TEMPERATURE
DISPLAY NUMBER 4
.00 TO 44.36 SEC
SEC x 10
1
DEG. F.
x 10
1
17
16
15
14
13
12
11
10
9
0
1
2
3
4
5
09/01/82 11:47:38

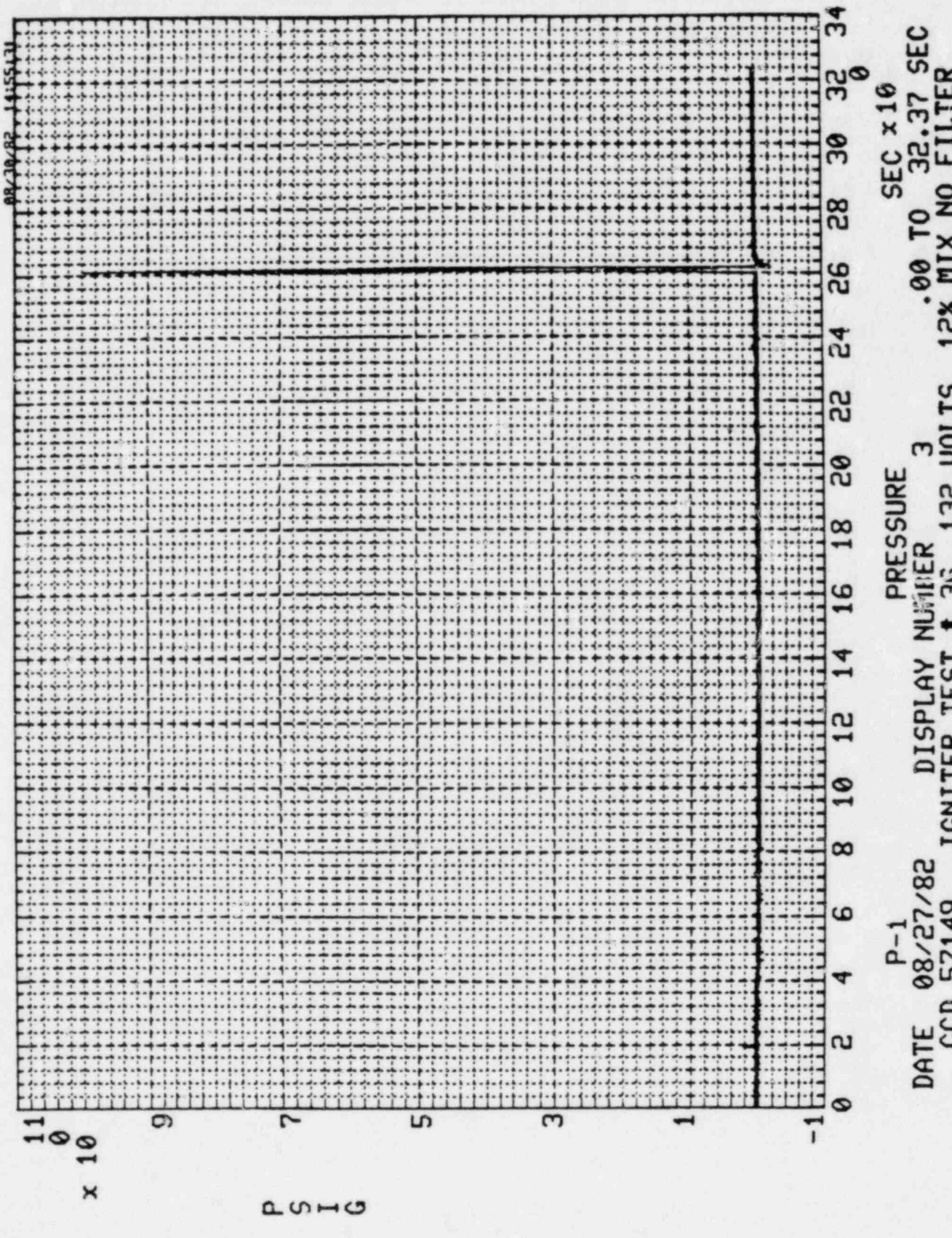
T2 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5 .00 TO 44.36 SEC
CCD 57149 IGNITER TEST # 35 132 VOLTS 12% MIX 10 HZ FILTER

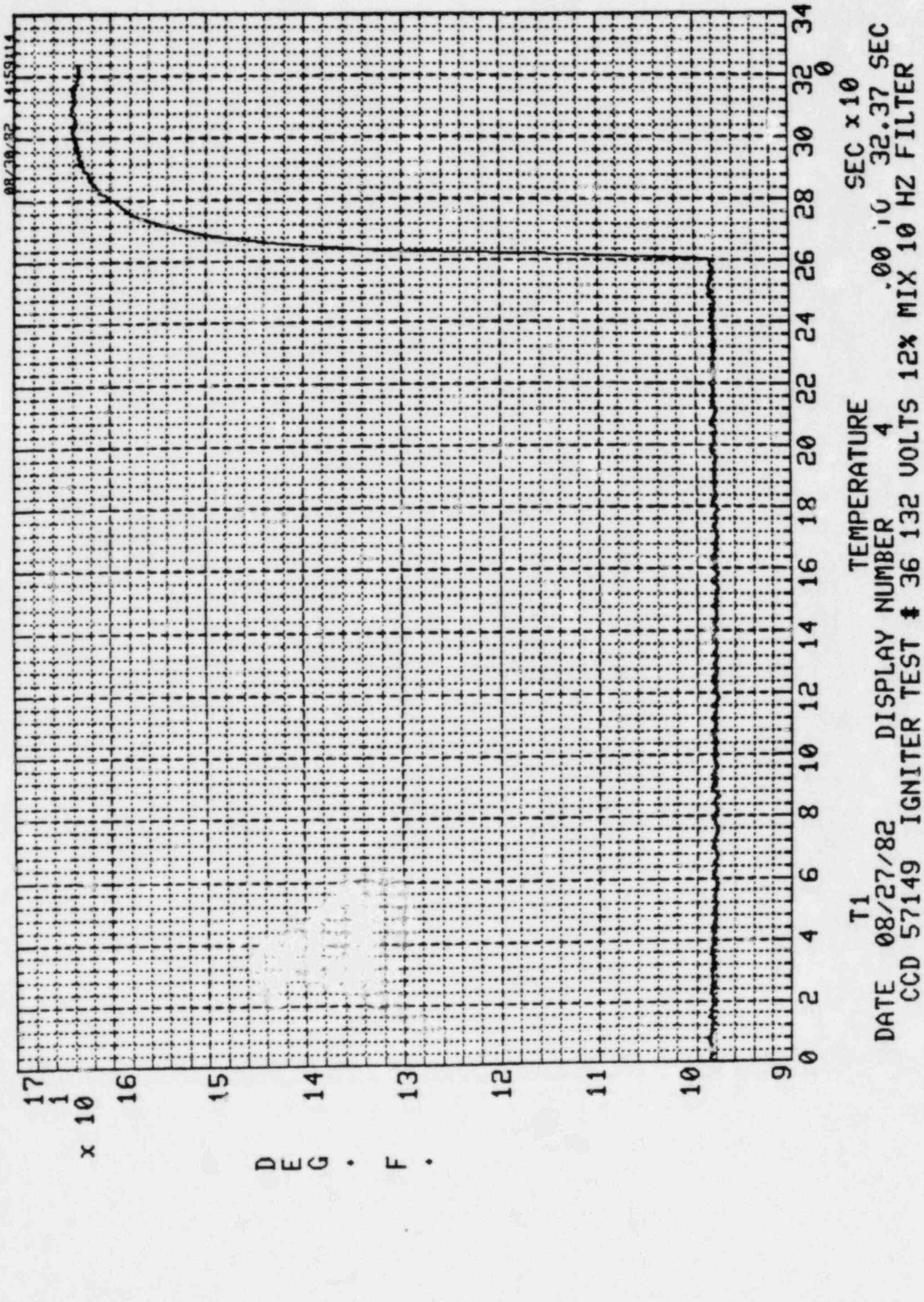


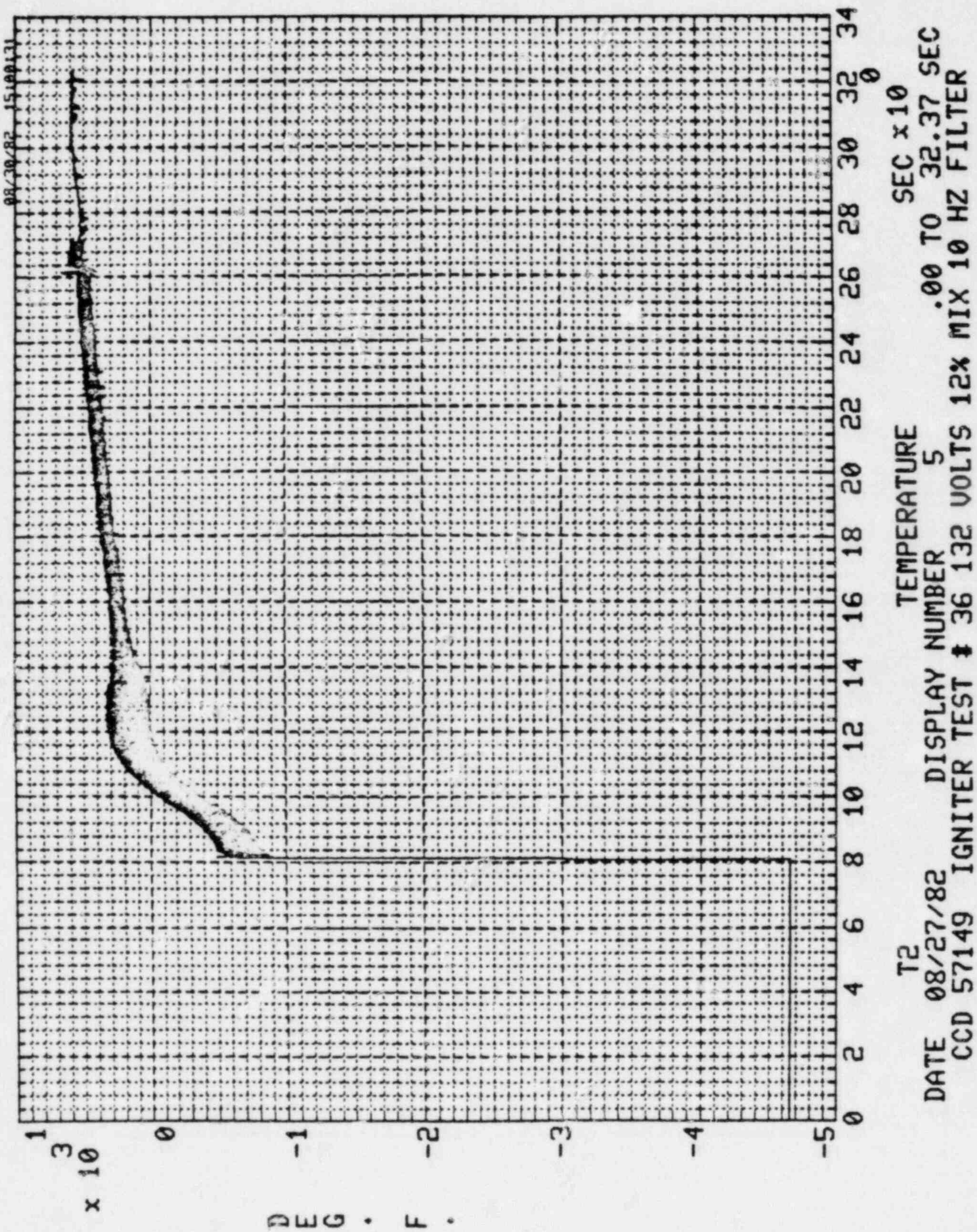
09/01/82 11:46:21
T3
DATE 08/27/82 DISPLAY NUMBER 6
TEMPERATURE
CCD 57149 IGNITER TEST # 35 132 VOLTS 12% MIX 10 HZ FILTER
SEC x10^1
.00 TO 44.36 SEC
0 1 2 3 4 5
DEG. F.
x 10^2
2 1 0 -1 -2 -3 -4 -5 -6

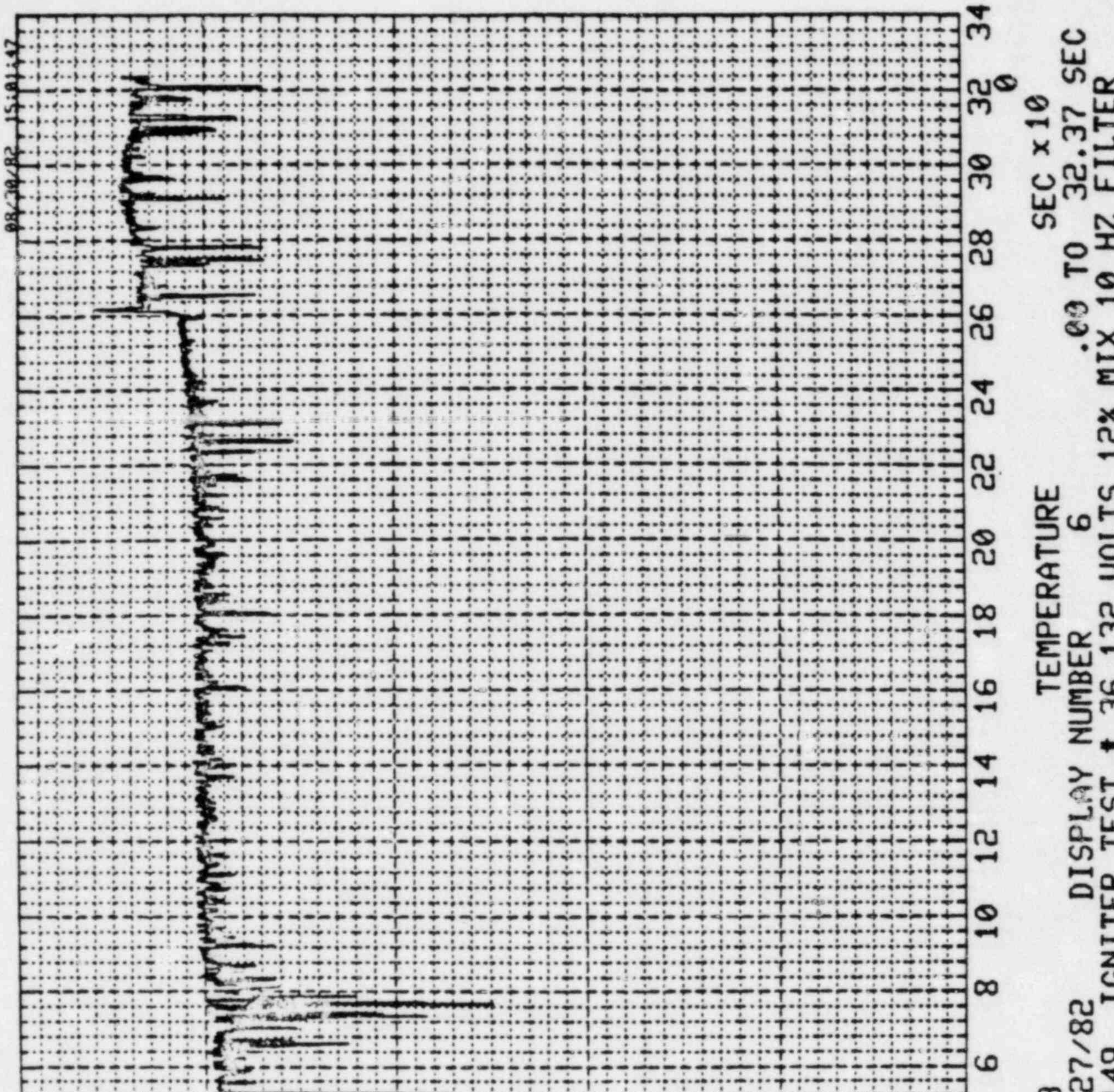

VOLTAGE
DATE 08/27/82
CCD 57149
VOLTAGE
DISPLAY NUMBER 1
IGNITER TEST # 36 132 VOLTS
SEC x10^0
0.00 TO 32.37 SEC
12% MIX NO FILTER
VOLTS
x 10^1
13
11
9
7
5
3
1
-1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34

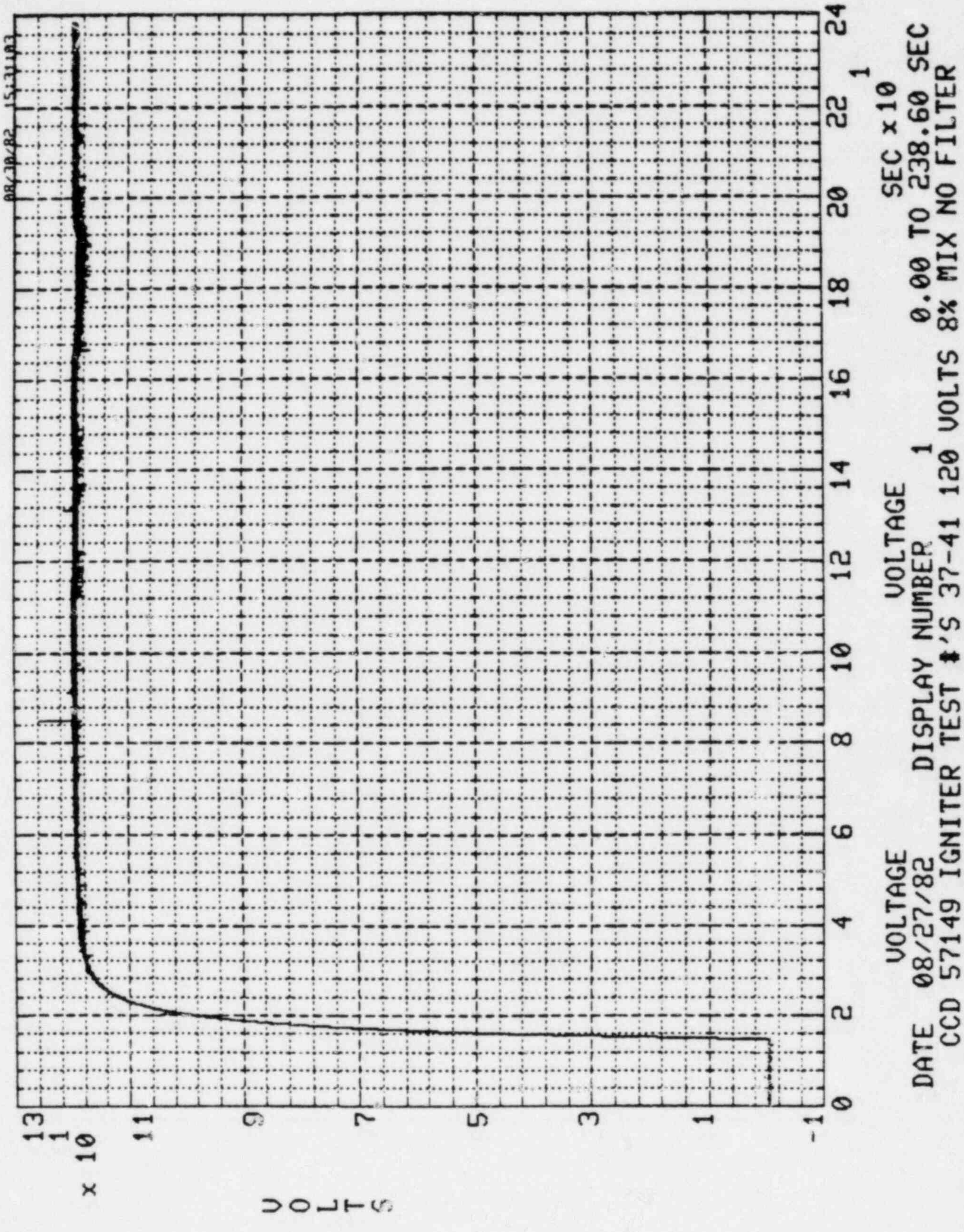

CURRENT
DATE 08/27/82
CCD 57149
AC CURRENT
DISPLAY NUMBER 2
IGNITER TEST # 36 132 VOLTS 12% MIX NO FILTER
SEC x10^0
.00 TO 32.37 SEC
AMPERES
x 10^0

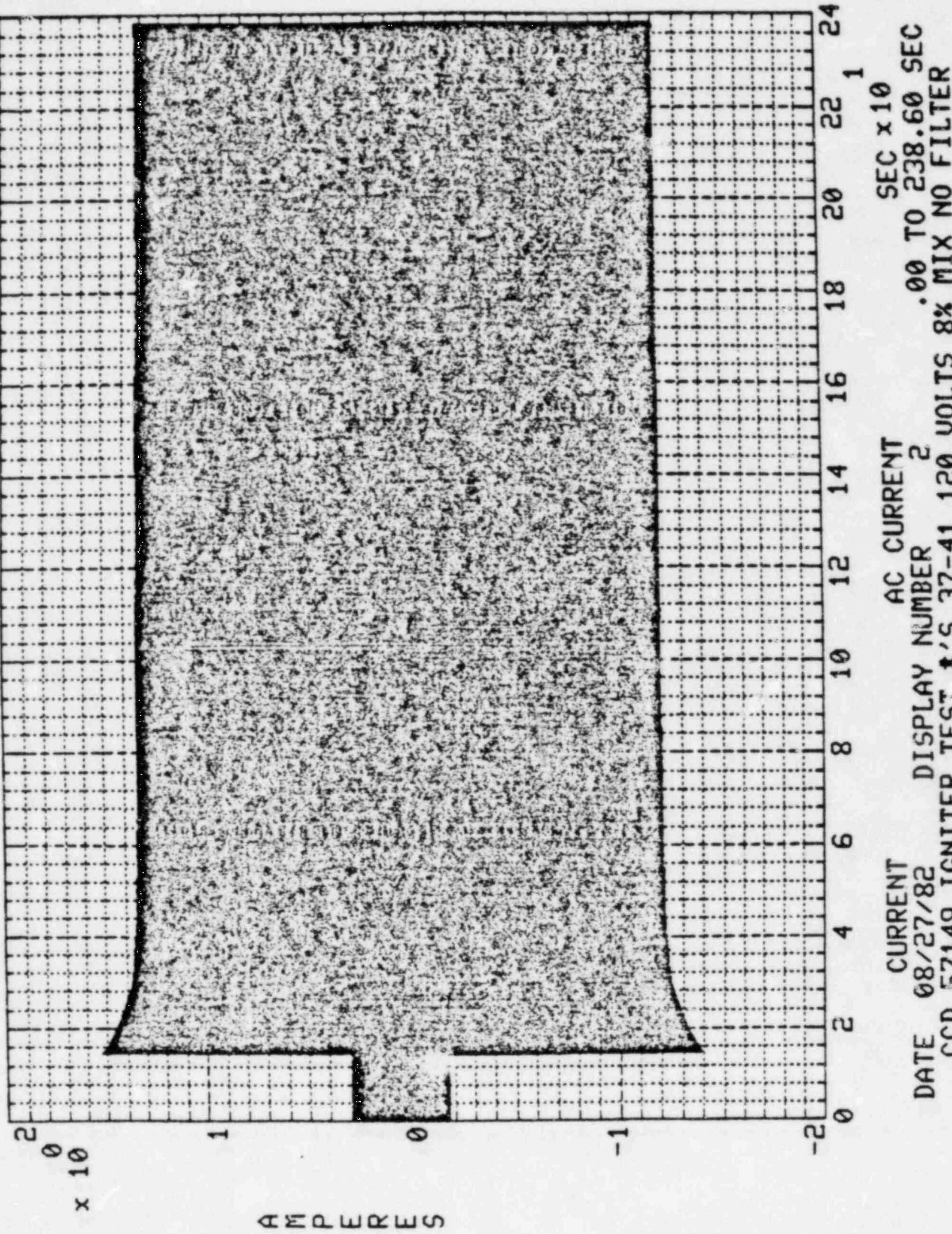

08/30/82 14:55:11
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3
CCD 57149 IGNITER TEST # 36 132 VOLTS 12% MIX NO FILTER
SEC x 10^0
.00 TO 32.37 SEC
PSIG
x 10^0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
-1 1 3 5 7 9 11

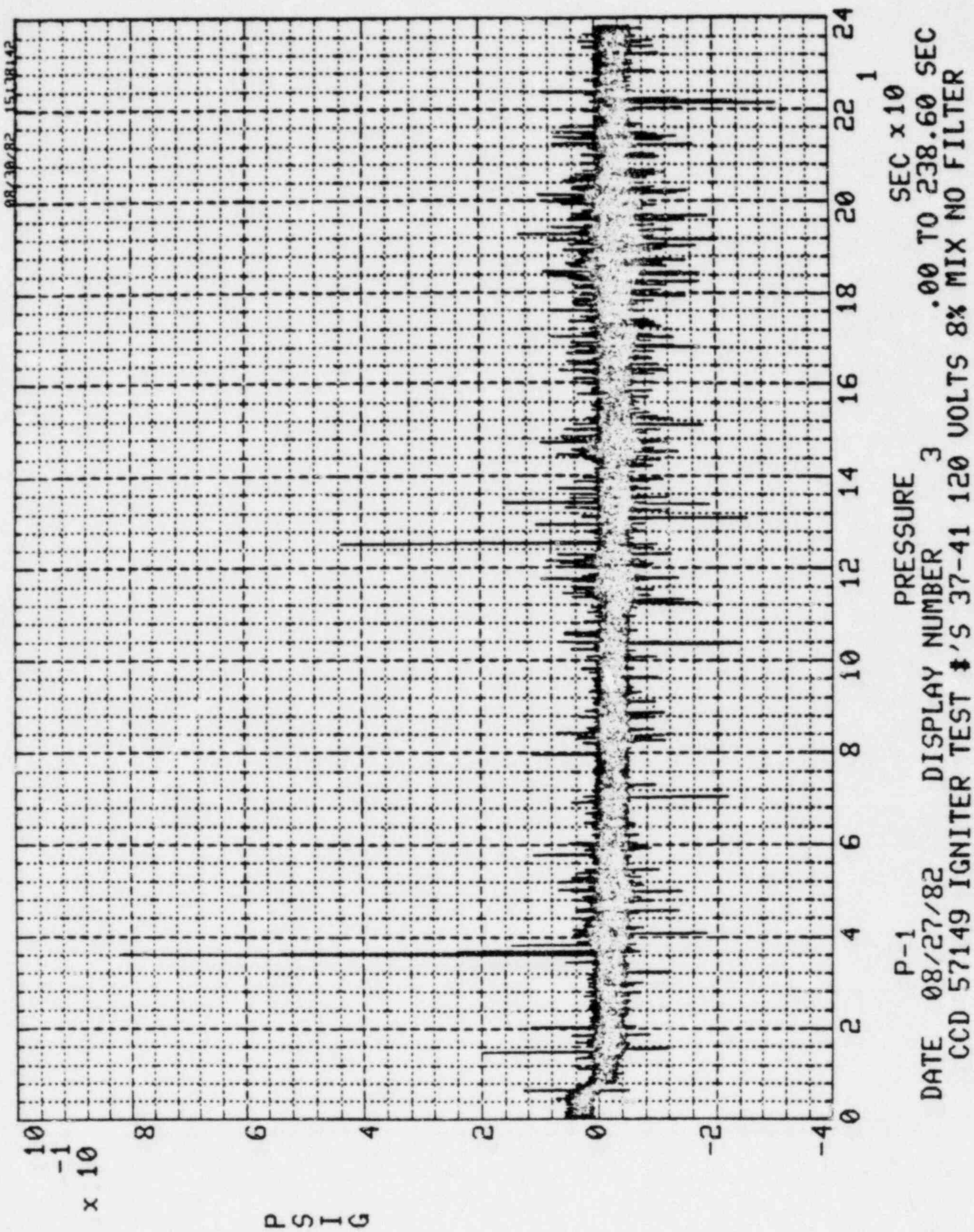

T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
CCD 57149 IGNITER TEST # 36 132 VOLTS 12% MIX 10 HZ FILTER
.00 TO 32.37 SEC
SEC x 10^0
DEG. F. x 10^1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
9 10 11 12 13 14 15 16 17

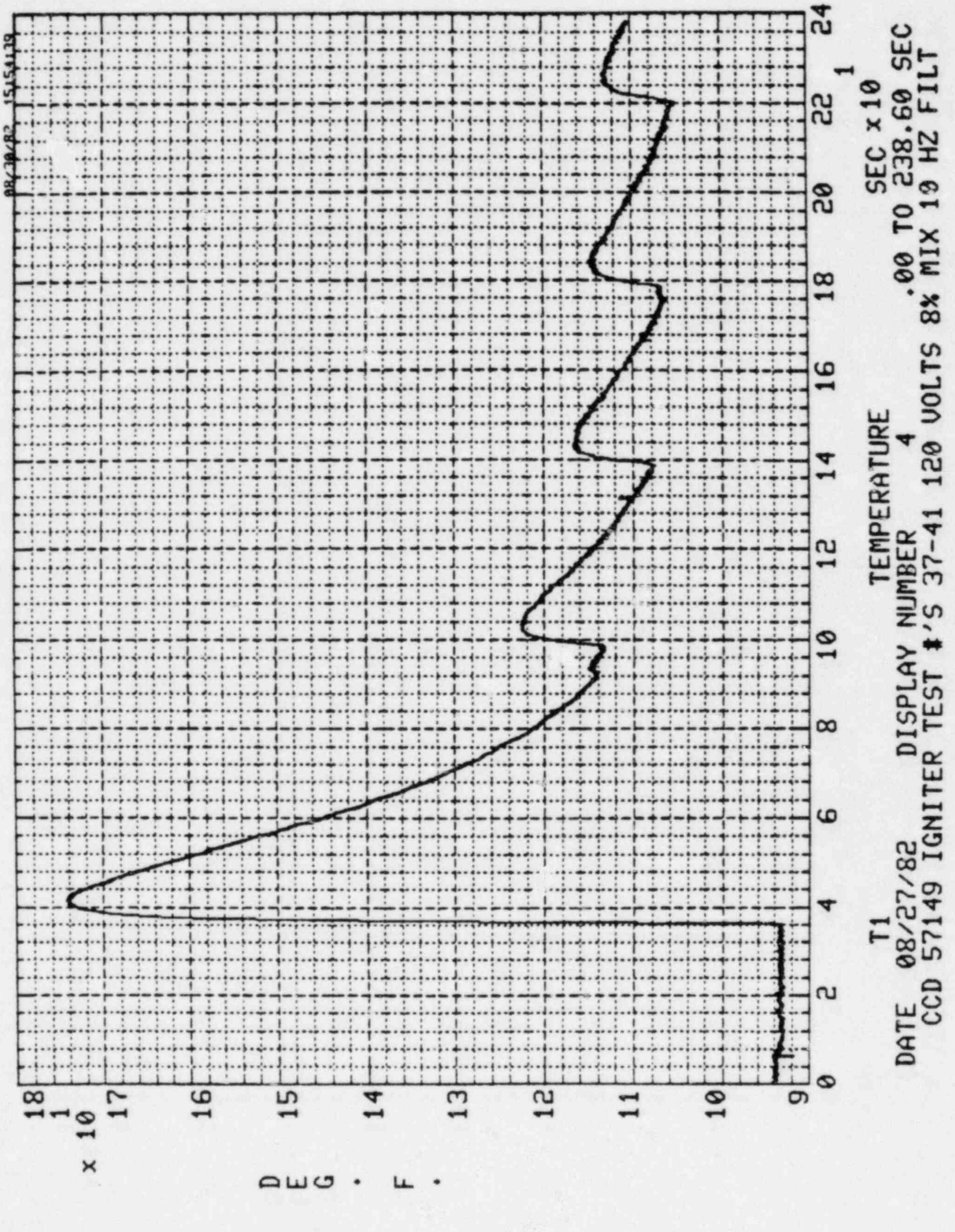

T2
DATE 08/27/82 DISPLAY NUMBER 5
TEMPERATURE
CCD 57149 IGNITER TEST # 36 132 VOLTS 12% MIX 10 HZ FILTER
SEC x10 0
.00 TO 32.37 SEC
DEG. F.
x 10 3
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
1 0 -1 -2 -3 -4 -5

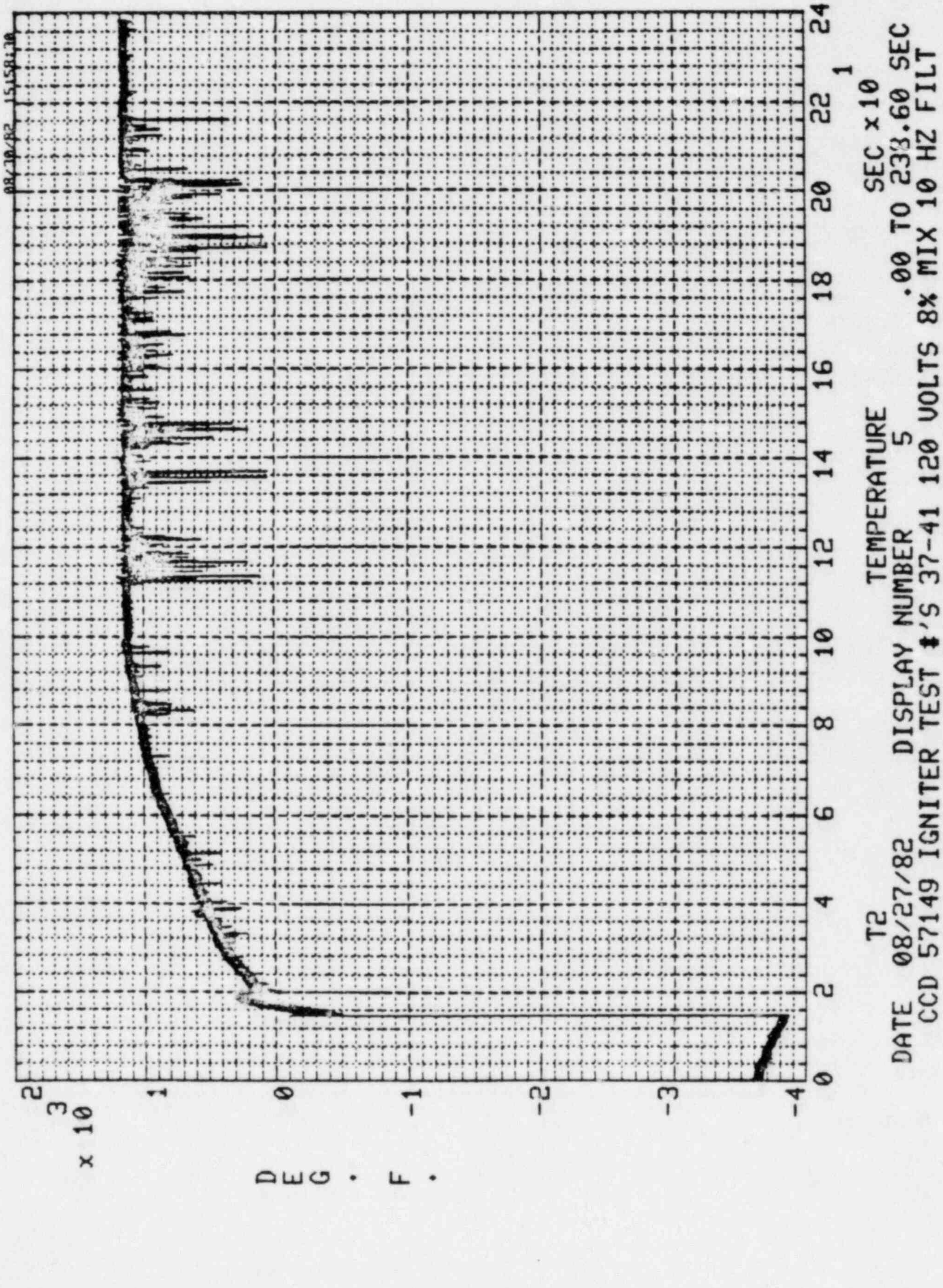

08/30/82 15:01:47
x 10^2
DEG. F.
2
1
0
-1
-2
-3
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
SEC x 10^0
T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 32.37 SEC
CCD 57149 IGNITER TEST # 36 132 VOLTS 12% MIX 10 HZ FILTER

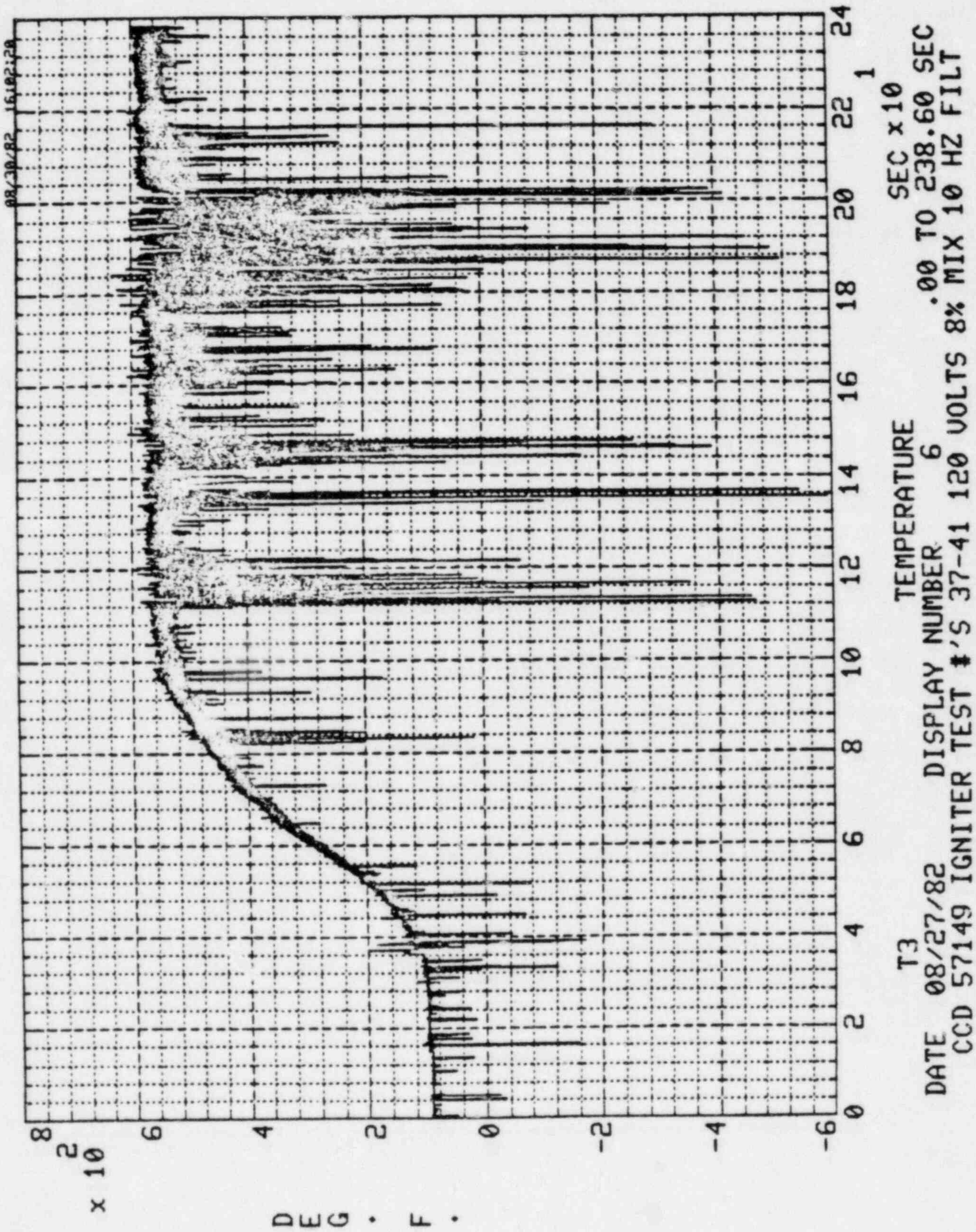

08/30/82 15:31:03
VOLTS x 10^1
13
11
9
7
5
3
1
-1
0
2
4
6
8
10
12
14
16
18
20
22
24
SEC x10^1
VOLTAGE
DATE 08/27/82
VOLTAGE
DISPLAY NUMBER 1
0.00 TO 238.60 SEC
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX NO FILTER

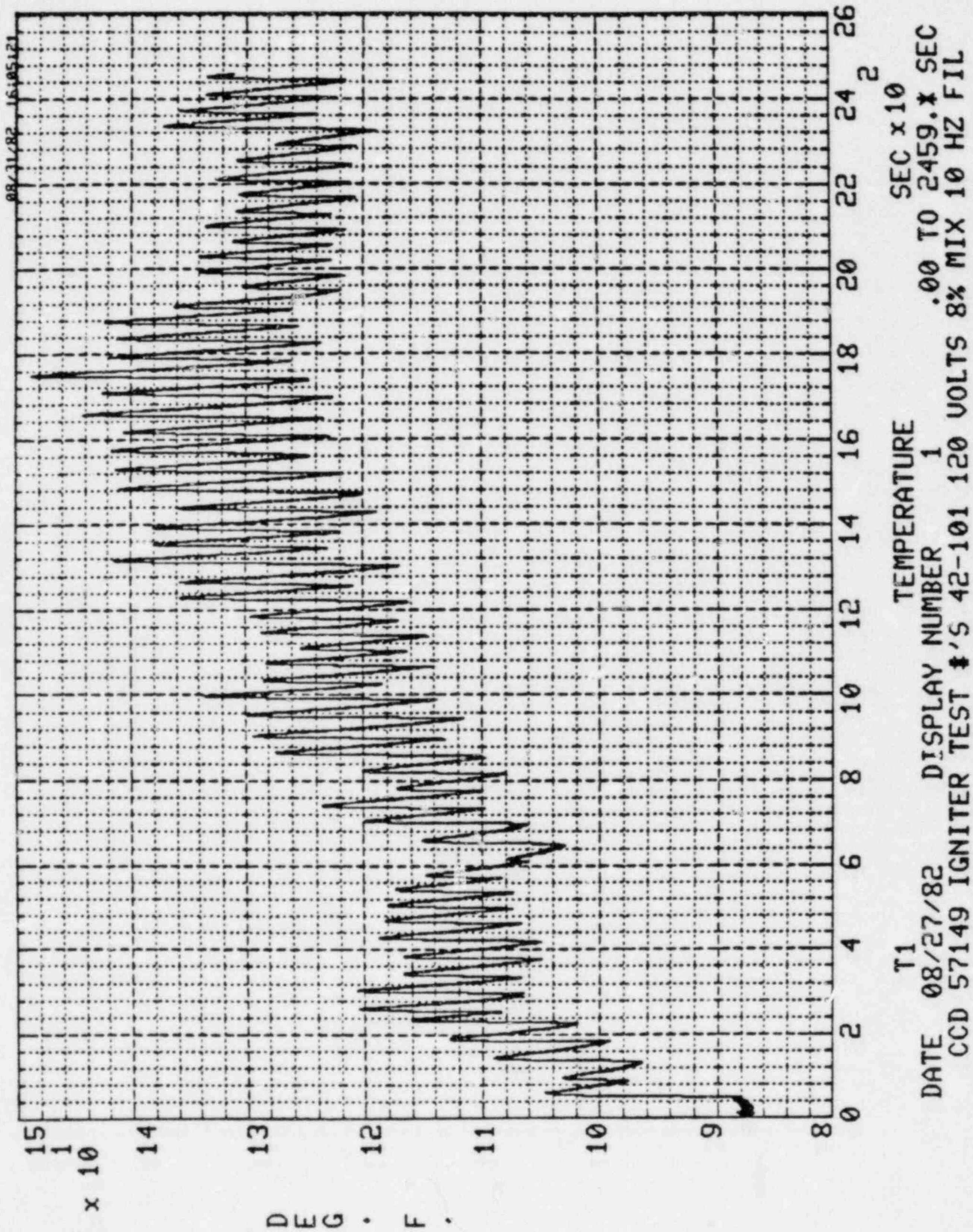

AMPERES
x 10^0
2
1
0
-1
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
SEC x10^1
CURRENT
AC CURRENT
DATE 08/27/82 DISPLAY NUMBER 2 .00 TO 238.60 SEC
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX NO FILTER

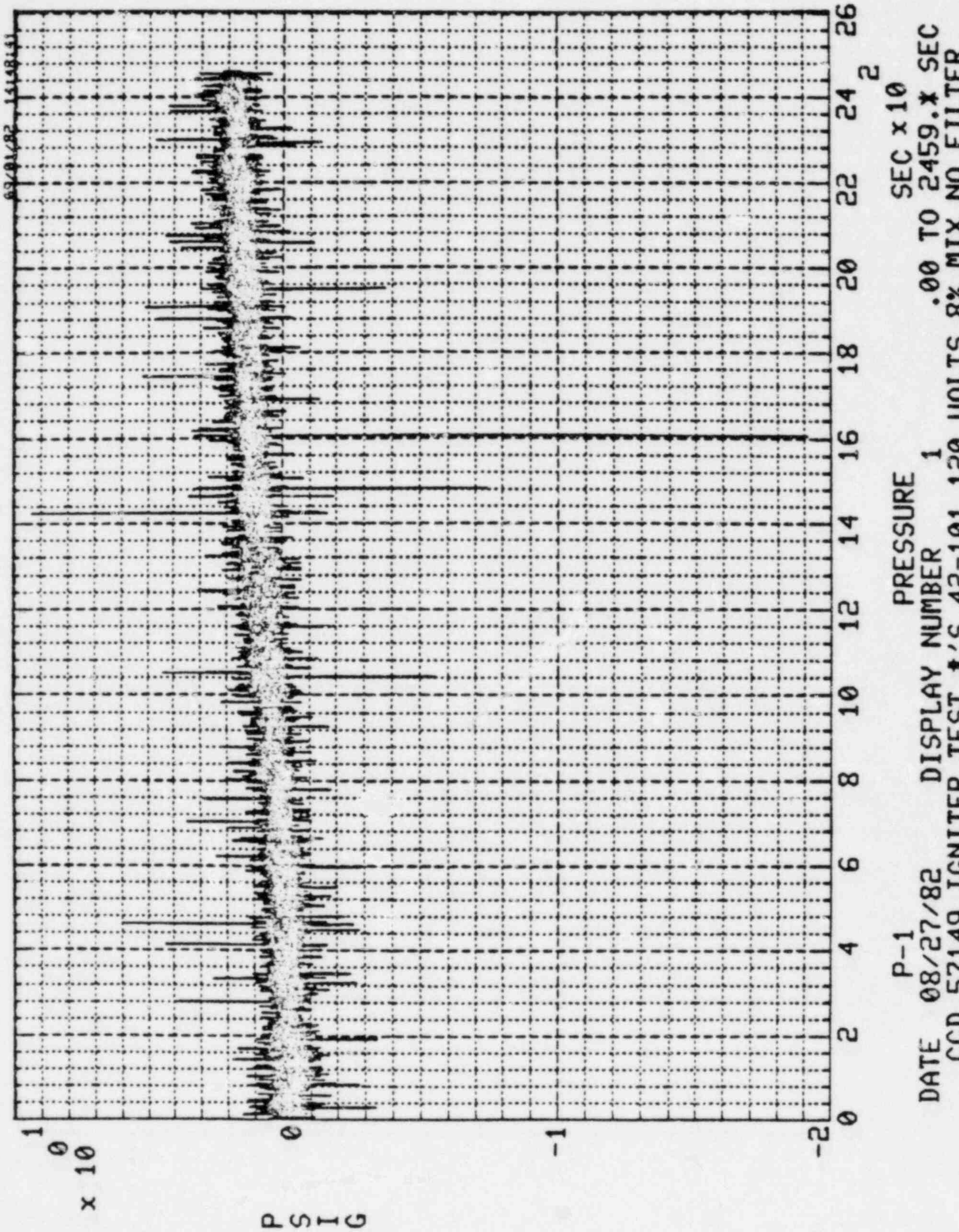

08/30/82 15:38:42
P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 3 .00 TO 238.60 SEC
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX NO FILTER
SEC x10^1
PSIG x 10^-1
0 2 4 6 8 10 12 14 16 18 20 22 24
10 8 6 4 2 0 -2 -4

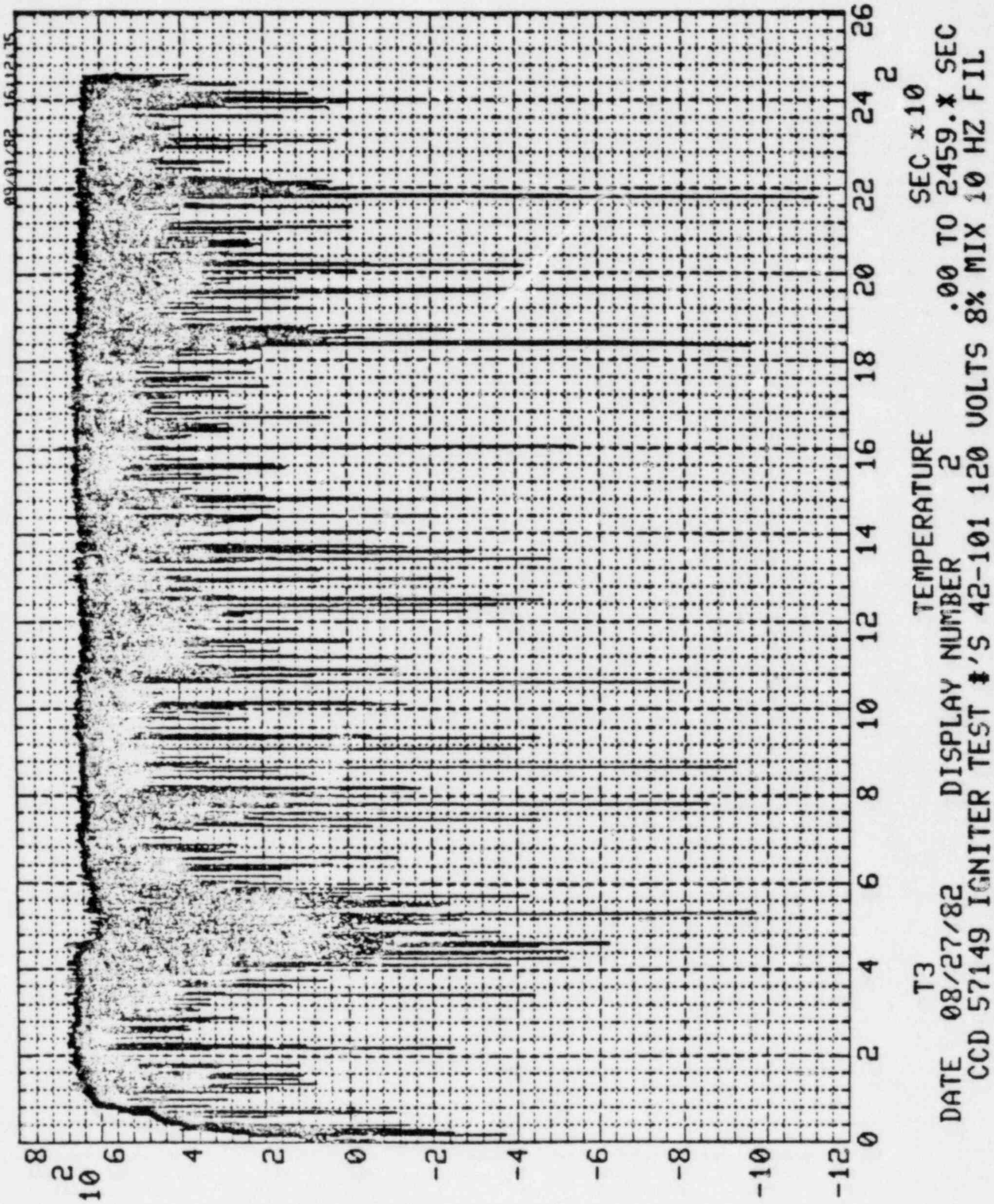

T1
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 4
SEC x 10^1
.00 TO 238.60 SEC
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX 10 HZ FILT
DEG. F.
x 10^1
0
2
4
6
8
10
12
14
16
18
20
22
24
9
10
11
12
13
14
15
16
17
18

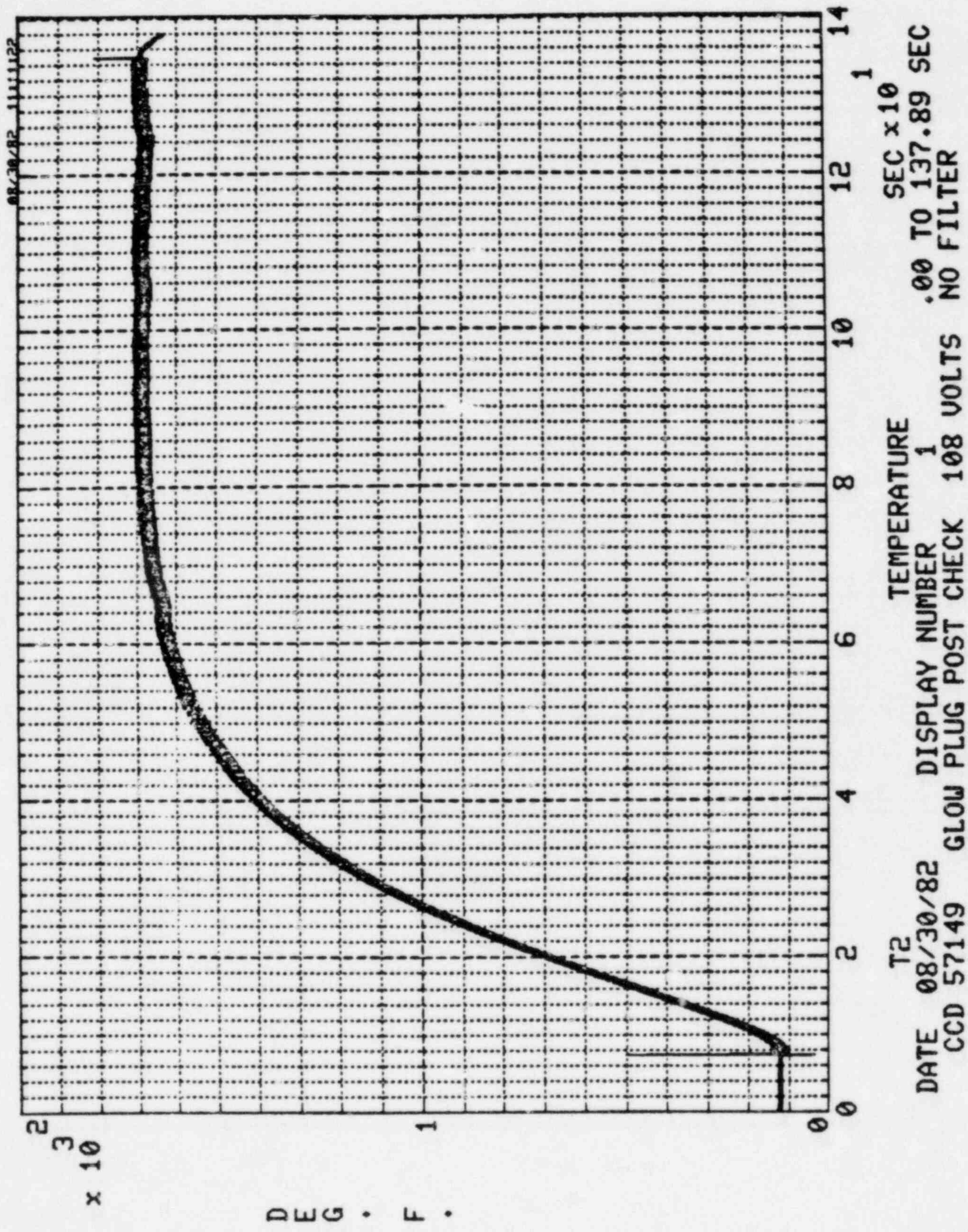

T2
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 5
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX 10 HZ FILT
SEC x 10 1
.00 TO 233.60 SEC
DEG. F.
x 10 3
2
1
0
-1
-2
-3
-4
0
2
4
6
8
10
12
14
16
18
20
22
24


08/30/82 16:02:28
DEG. F.
x 10 2
SEC x 10 1
T3
TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 6 .00 TO 238.60 SEC
CCD 57149 IGNITER TEST #'S 37-41 120 VOLTS 8% MIX 10 HZ FILT

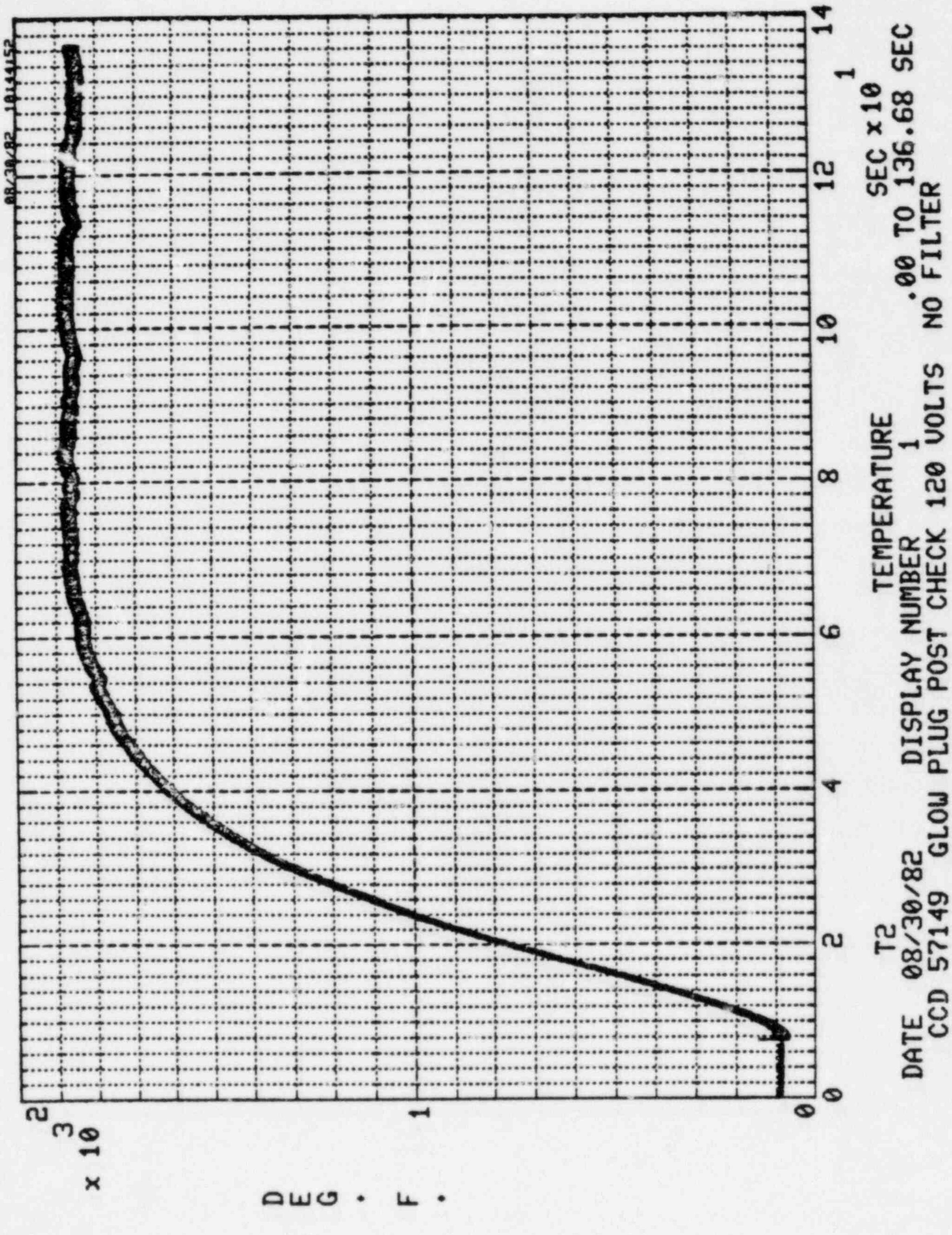

08/31/82 16:05:21
15
14
13
12
11
10
9
8
x 10 1
DEG. F.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
SEC x 10 2
T1 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST #'S 42-101 120 VOLTS 8% MIX 10 HZ FIL
.00 TO 2459.x SEC

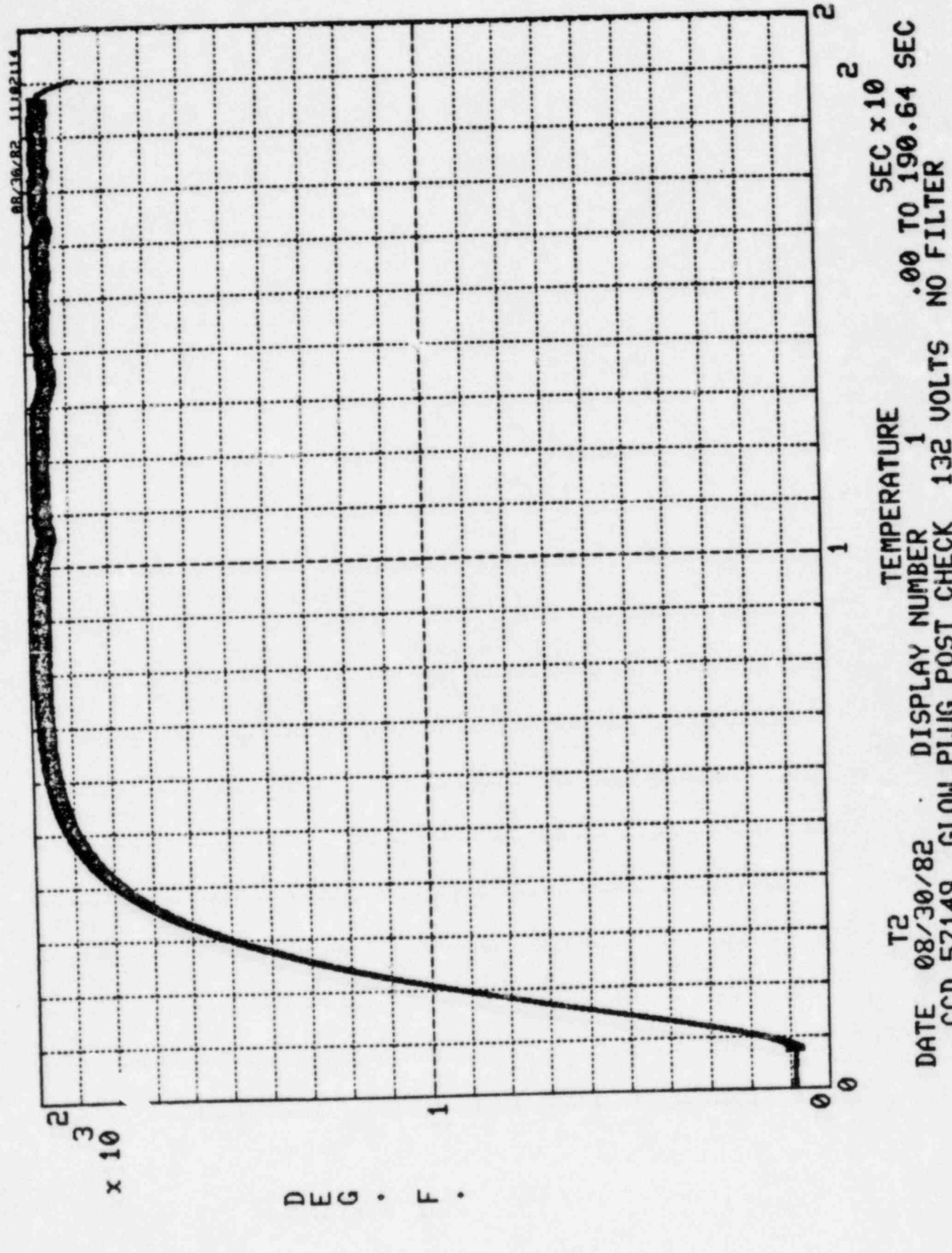

P-1 PRESSURE
DATE 08/27/82 DISPLAY NUMBER 1
CCD 57149 IGNITER TEST $'S 42-101 120 VOLTS 8% MIX NO FILTER
SEC x 10^2
.00 TO 2459.* SEC
PSIG
x 10^0
1
0
-1
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26


T3 TEMPERATURE
DATE 08/27/82 DISPLAY NUMBER 2
CCD 57149 IGNITER TEST #'S 42-101 120 VOLTS 8% MIX 10 HZ FIL
SEC x 10 2
.00 TO 2459.x SEC
DEG. F.
x 10 2



T2
DATE 08/30/82 DISPLAY NUMBER 1
CCD 57149 GLOW PLUG POST CHECK 108 VOLTS
TEMPERATURE
SEC x10 1
.00 TO 137.89 SEC
NO FILTER
DEG. F.
x 10 3
0
1
2
0
2
4
6
8
10
12
14


T2
TEMPERATURE
DATE 08/30/82 DISPLAY NUMBER 1
CCD 57149 GLOW PLUG POST CHECK 120 VOLTS
.00 TO 136.68 SEC
NO FILTER
SEC x10 1
DEG. F.
x 10 3
0
2
4
6
8
10
12
14
0
1
2


T2
TEMPERATURE
DATE 08/30/82
DISPLAY NUMBER 1
CCD 57149 GLOW PLUG POST CHECK 132 VOLTS
SEC x 10^2
.00 TO 190.64 SEC
NO FILTER
DEG. F.
x 10^3
0
1
2