TWR-17245

SPACE SHUTTLE

Solid Rocket Motors
Morton Thiokol, Inc.

Field Joint Environmental Protection System Vibration/ Pressurization Qualification Final Test Report

9 March 1989

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Marshall Space Flight Center, Alabama 35812

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MORTON THIOKOL, INC.
Aerospace Group
Space Operations
P.O. Box 707, Brigham City, Utah 84302-0707 (801) 863-3511

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MORTON THIOKOL, INC.

Space Operations

Field Joint Environmental Protection System Vibration/Pressurization Qualification Final Test Report

Prepared by:

Test Planning and Reporting

Approved by:

Test Planning and Reporting Supervisor

Space Systems Engineering Manager

Systems Test and Support Manager

Space Engineering Design Manager

3/13/89

Project Engineer

Program Manager

Design Engineer

For Design Supervisor

3/9/89

Certification Planning

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System Safety

Reliability

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ABSTRACT

The field joint environmental protection system (herein referred to as the joint protection system (JPS)) vibration/pressurization qualification test consisted of flight-simulating environmental conditioning and dynamic environment testing of a JPS test article. The major purposes of the test were to certify that the flight-designed JPS will withstand the dynamic environmental conditions of flight, and to certify that the cartridge check valve (vent valve) will relieve pressure build-up under the JPS during the initial 120 sec (minimum) of flight.

The vibration test article performed satisfactorily and fulfilled all objectives listed in the test plan. The JPS remained intact, no visual anomalies were evident, and the bondlines showed no evidence of separation or degradation throughout the testing. All requirements for venting and pressure release were met. Also, button pull tests of the extruded cork insulation bondlines yielded acceptable results.

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ACRONYMS

CEI	contract end item
FJEPS	field joint environmental protection system
grms	gravity root mean square
JPS	joint protection system
LSC	linear-shaped charge
PSD	power spectral density
RSRM	redesigned solid rocket motor

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INTRODUCTION

This report documents the procedures used and results obtained from vibration testing the redesigned solid rocket motor (RSRM) field joint environmental protection system (FJEPS), hereafter referred to as the joint protection system (JPS), per CTP-0054, "Qualification Test Plan for the Field Joint Environmental Protection System Vibration/Pressurization Test." The JPS is installed to protect the RSRM field joints from the exterior environment. The test consisted of flight-simulating environmental conditioning and dynamic environment testing of a JPS test article. The major purposes of the test were to certify that the flight-designed JPS will withstand the dynamic environmental conditions of the redesigned solid rocket booster, and to certify that the cartridge check valve (vent valve) will relieve pressure build-up under the JPS during the initial 120 sec (minimum) of flight. Also, an evaluation of the extruded cork insulation bonding was performed after the vibration testing.

The test article was assembled and instrumented according to Morton Thiokol drawings 7U76358 (test article assembly) and 2U132025 (vibration fixture). The test article was built using sections of current JPS production components, except that the field joint used was a fixture designed to simulate the external contour of the RSRM field joint. Accelerometer and pressure data were acquired to verify the input and response vibration spectrums and the pressure buildup under the JPS during testing.

Testing was conducted at the Morton Thiokol Utah-based test facilities T-3, T-51, T-53, M-15, and M-53 and was completed on 8 Feb 1989.

1.1 BRIEF TEST ARTICLE DESCRIPTION

The test article configuration represented flight hardware, except for the joint simulator fixture (Figures 1 through 4). The test article assembly

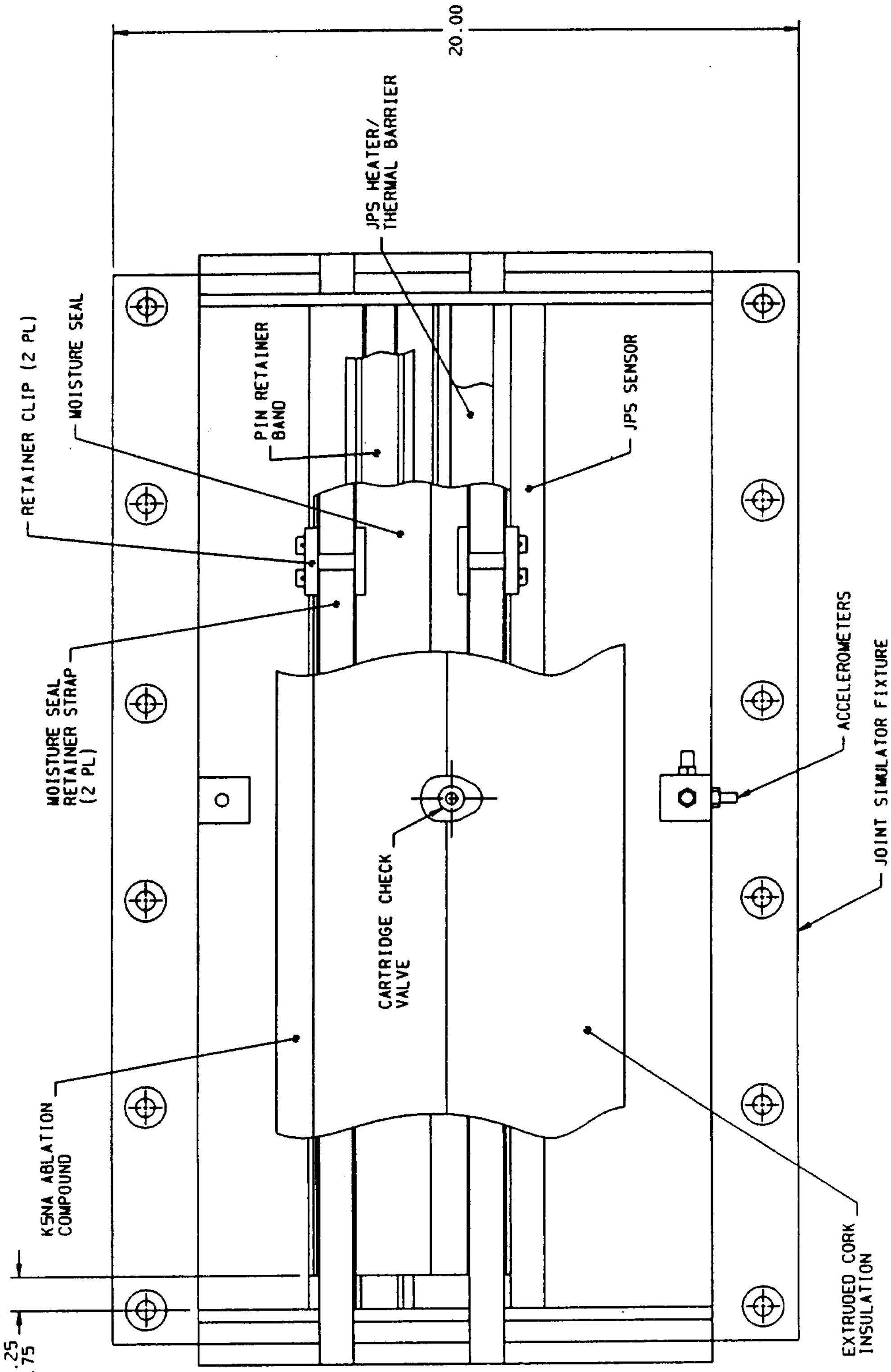

Figure 1. Top View, Field Joint Environmental JPS Vibration/Pressurization Test Article

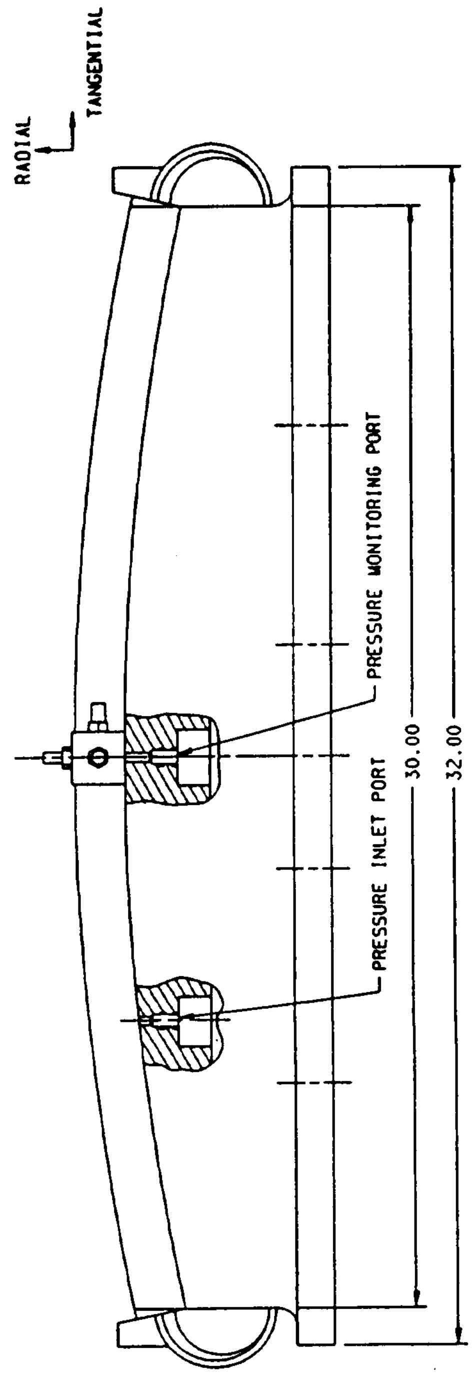

Figure 2. Front View, Field Joint Environmental JPS Vibration/Pressurization Test Article

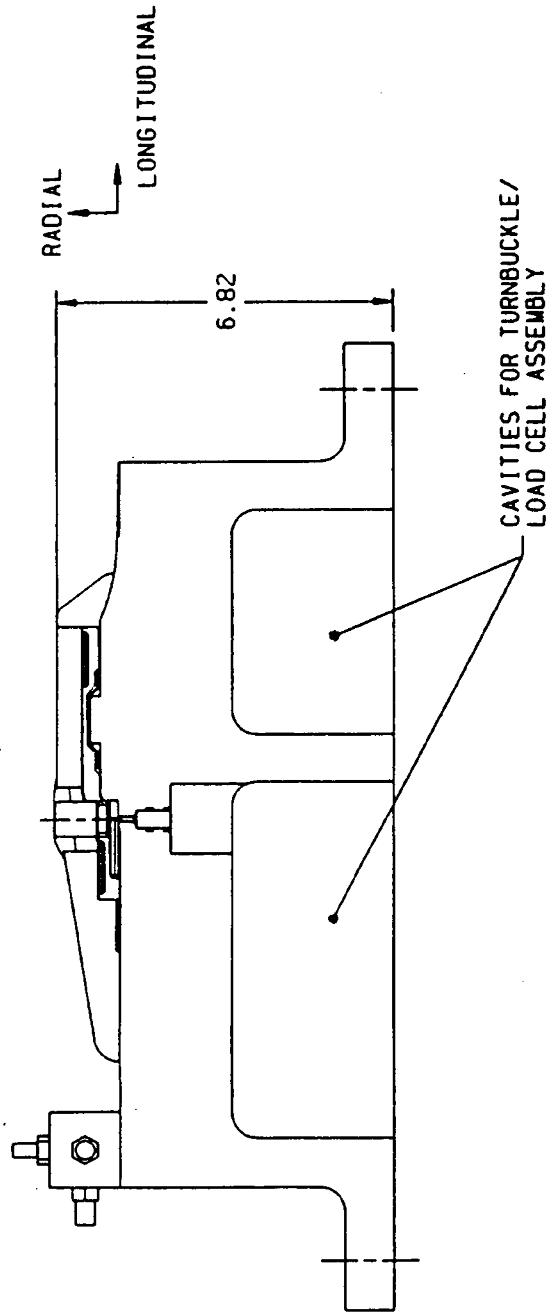

Figure 3. Side View, Field Joint Environmental JPS Vibration/Pressurization Test Article

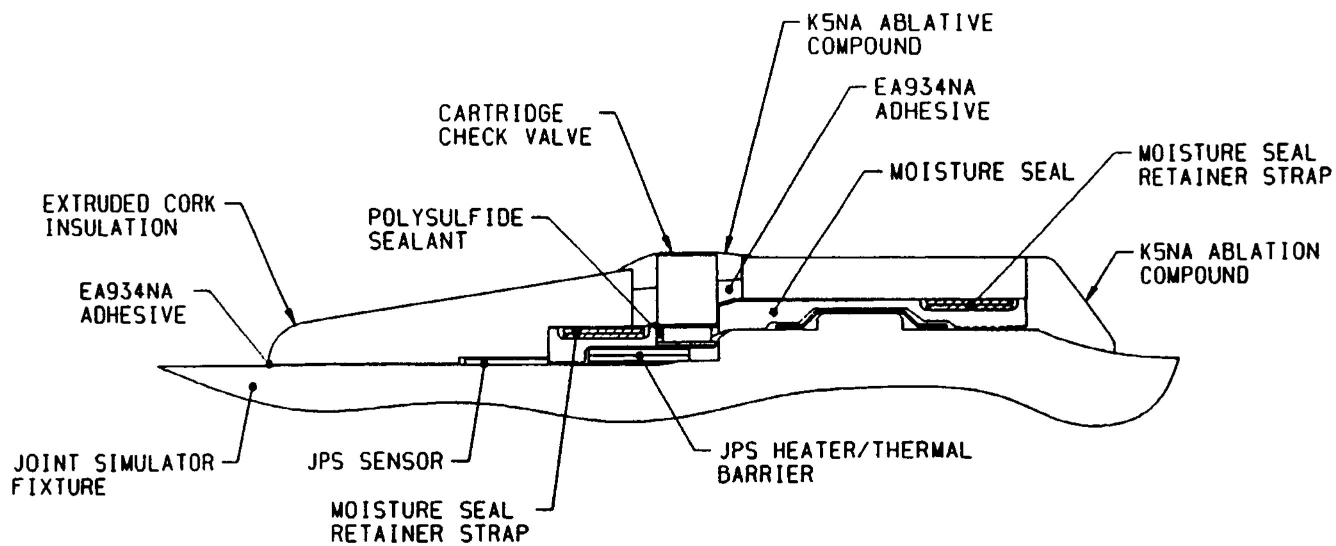

Figure 4. Side View, Closeup, Field Joint Environmental JPS Vibration/Pressurization Test Article

consisted of an aluminum joint simulator fixture and sections of pin retainer band, JPS heater, heater thermal barrier, moisture seal, moisture seal retainer straps, instrumented moisture seal retainer strap clips and links, JPS sensor, extruded cork insulation, and K5NA ablation compound. In addition, a cartridge check valve was installed into the center of the assembly.

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OBJECTIVES

The JPS vibration/pressurization test objectives were derived from the objectives in TWR-15723, Rev. C, "Redesign D&V Plan," to satisfy the requirements of contract end item (CEI) specification CPW1-3600. The objectives are listed with the CEI paragraph numbers as follows:

a. Certify that the JPS shall remain intact through simulated flight, post-separation, water impact and, as a goal, through recovery vibration and shock criteria. (3.2.1.11.d, 3.2.7.2.2.b)

b. Certify that the JPS structures and components are designed to demonstrate the life factor requirements. (3.3.6.5)

c. Certify that the JPS is designed to preclude the shedding of debris (Debris Prevention) from the elements during prelaunch and flight operations that would jeopardize the flightcrew and/or mission success. (3.2.6.5)

d. Certify that the vent valve will relieve the pressure buildup under the JPS during the initial 120 sec minimum of both flight random and vehicle dynamics vibration criteria in each axis. (3.2.1.11.d, 3.2.7.2.2.b)

e. Evaluate the JPS bondline performance when subjected to the prelaunch natural environments as listed:

  --Air temperature
  --Humidity
  --Rain
  --Salt air

f. Evaluate the JPS post-test structural integrity (adhesive bondlines) through button pull tests.

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APPLICABLE DOCUMENTS

Morton Thiokol Documents	Title
CPW1-3600	Prime Equipment Contract End Item (CEI) Detail Specifications
CTP-0054	Qualification Test Plan for the Field Joint Environmental Protection System Vibration/Pressurization Test
DPD 400	Data Procurement Document No. 400
SE-019-049-2H	Solid Rocket Booster Vibration, Acoustic and Shock Design and Test Criteria
STW5-2994	Paint, Polyethylene, Chlorosulfonated
STW5-3183	Ablation Compound, Cork Filled (K5NA)
STW4-3218	Epoxy Resin Adhesive, Nonasbestos, Structural Bonding (EA 934NA)
STW5-3225	Coatings, Epoxy-Polyamide
STW5-3226	Primer, Zinc-Rich, Epoxy-Polyamide
TWR-10163 (CD)	Safety Plan for Space Shuttle Solid Rocket Motor Project
TWR-15671	Quality Plan for the SRM Redesign Program
TWR-15723	Redesign D&V Plan
TWR-17230	Cork Extrusion Mechanical Characterization Final Test Report
TWR-19138	FJEPS Vibration/Pressurization Test Flash Report
GS&HM	Morton Thiokol/Wasatch Operations General Safety and Health Manual

Military Documents	Title
MIL-STD-810C	Environmental Test Methods
MIL-STD-810D	Environmental Test Methods and Engineering Guidelines
MIL-S-8802	Type I Cl B-2 Sealant (PR1422 Polysulfide)
MIL-STD-45662	Calibration System Requirements

Drawing No.	
2U132025	Vibration Fixture RSRM Field Joint
7U76358	Test Assembly, Vibration/Pressure

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RESULTS SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

4.1 RESULTS SUMMARY

This section contains an executive summary of the key results from the test data evaluation and post-test inspection. Additional information and details can be found in Section 7 of this report.

The vibration test article performed satisfactorily and fulfilled all of the objectives listed in CTP-0054. The JPS remained intact, no visual anomalies were evident, and the EA 934NA adhesive and K5NA ablation compound bondlines showed no evidence of separation or degradation throughout the testing. The cartridge check valve performed as expected. All requirements for venting and pressure release were met and the cartridge check valve remained securely bonded in place. Button pull tests of the bonds between the extruded cork insulation and the aluminum joint simulator fixture, moisture seal, and moisture seal retainer straps yielded satisfactory results.

Throughout the vibration environment tests there was no drop or change in the moisture seal retainer strap tension. During all of the flight random and vehicle dynamics pressurization tests there was no internal pressure drop.

For the water impact shock test, the impact-simulating pulse duration criterion was changed from 0.050 to 0.010 sec to accommodate the capabilities of the test equipment. Longitudinal axis shock No. 1 was run with a loose lead on the control accelerometer, and thus the article was over-tested to 70.23 g (test criteria peak level was 20 g). Tangential axis shock No. 1 was run to 19.77 g (test criteria peak level was 8 g). The cause of the tangential over-test is unknown. Since no visual damage was done to the test article in each over-test, both test runs were acceptable.

Based on the results of these tests, it can be concluded that the test was successful.

4.2 CONCLUSIONS

Overall, the results of this test were satisfactory. Test results indicate that when proper installation procedures are followed the JPS will remain intact throughout the flight environment. The JPS tested remained intact and did not come free from the joint simulator fixture. No evidence of debris was present and the cartridge check valve relieved the pressure built up under the JPS as needed. All of the bondlines were in excellent condition and post-test pull tests showed greater-than-anticipated bondline strengths.

4.2.1 Requirement Traceability

Listed following are the conclusions as they correspond to the objectives and CEI paragraphs. Additional information to support these conclusions can be found in Sections 7.2 and 7.3 of this report.

Objective	CEI Paragraph	Conclusions
Certify that the JPS shall remain intact through simulated flight, post-separation, water impact and, as a goal, through recovery vibration and shock criteria.	3.3.1.11d. The field joint protection system shall remain intact through flight and, as a goal, through recovery. 3.2.7.2.2b: Induced Environment Loads. The RSRM shall be designed to withstand postseparation-through-recovery loads as specified...	Certified. Throughout testing, all of the bondlines and components of the test article remained intact and did not degrade in any way.
Certify that the JPS structures and components are designed to demonstrate the life factor requirements.	3.3.6.5: Life Factors. The RSRM shall be designed to withstand fatigue and fracture mechanics requirements as specified...	Certified. The test article was subjected to accelerated environmental conditioning prior to successful completion of vibration and pressurization testing.

Objective	CEI Paragraph	Conclusions
Certify that the JPS is designed to preclude the shedding of debris (Debris Prevention) from the elements during prelaunch and flight operations that would jeopardize the flight crew and/or mission success.	3.2.6.5: <u>Debris Prevention</u>. The SRM shall be designed to preclude the shedding of debris from the elements during prelaunch and flight operations...	<u>Certified</u>. Throughout testing, all components of the test article remained intact and did not degrade in any way.
Certify that the vent valve will relieve the pressure buildup under the JPS during the initial 120 sec minimum of both flight random and vehicle dynamics vibration criteria in each axis.	3.3.1.11d. The field joint protection system shall remain intact through flight and, as a goal, through recovery. 3.2.7.2.2b: <u>Induced Environment Loads</u>. The RSRM shall be designed to withstand postseparation-through- recovery loads as specified...	<u>Certified</u>. The vent valve performed as designed and relieved the JPS internal pressure during the initial 120 sec minimum of each flight random and vehicle dynamics vibration test. Salt deposits were present on the vent valve from the environmental conditioning, but the deposits did not impact valve performance.
Evaluate the JPS bondline performance when subjected to the prelaunch natural environments as listed: --Air temperature --Humidity --Rain --Salt air	None	The test article was subjected to the specified simulated prelaunch environments and all bondlines remained intact and did not degrade in any way.
Evaluate the JPS post-test structural integrity (adhesive bondlines) through button pull tests.	None	Cork insulation pull tests yielded results as expected, and all breaking strength values were higher than expected.

4.3 RECOMMENDATIONS

Based on the results of this test, it is recommended that the use of the flight configuration JPS, as documented in this report, should be continued.

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INSTRUMENTATION

Vibration test instrumentation consisted of a triaxial accelerometer (A002-A004) mounted on the joint simulator fixture to measure response frequencies, and a single accelerometer (A001) mounted to the shaker table input plate to control input frequencies (Figure 1). In addition, a mass flowmeter controlled air flowing into the cavity under the JPS, and a pressure gage (P001) monitored the pressure buildup (Figure 2).

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PHOTOGRAPHY

Pretest and post-test photographs of the test article were taken. Figures 5 through 8 show the test setup and post-test condition of the test article.

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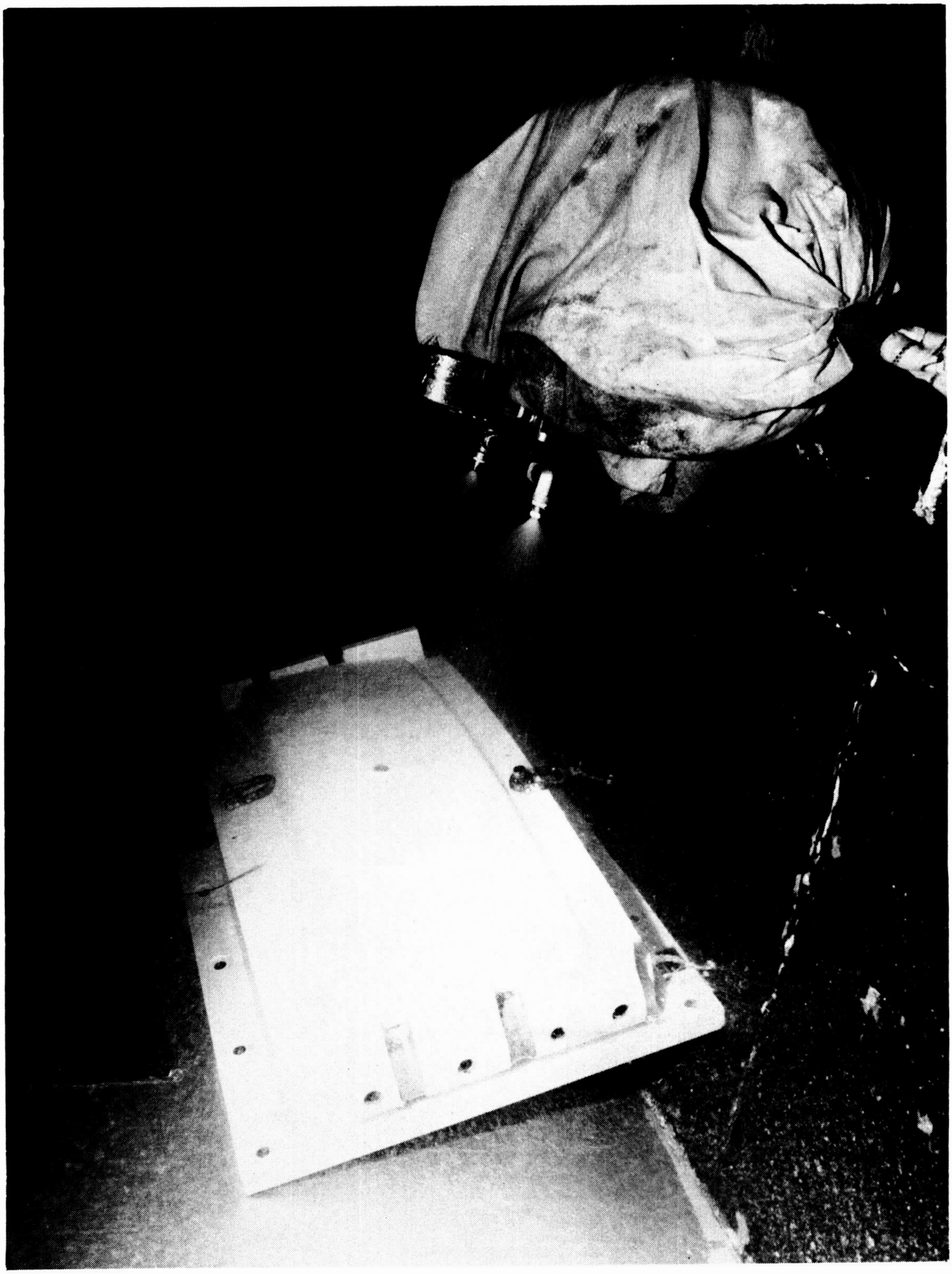

Figure 5. JPS Test Article Subject to Salt Spray Conditioning

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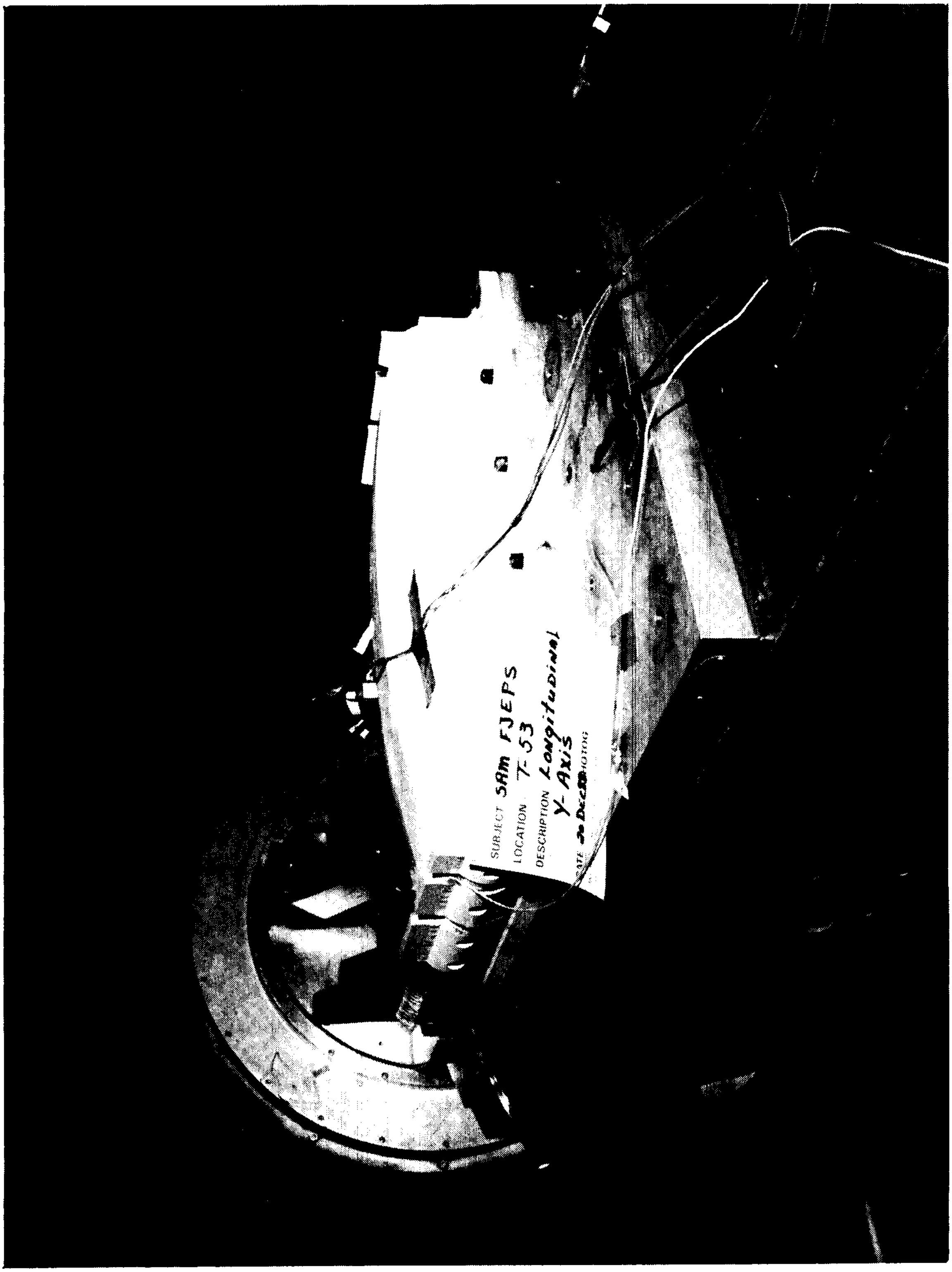

Figure 6. JPS Test Article Positioned for Longitudinal Vibration

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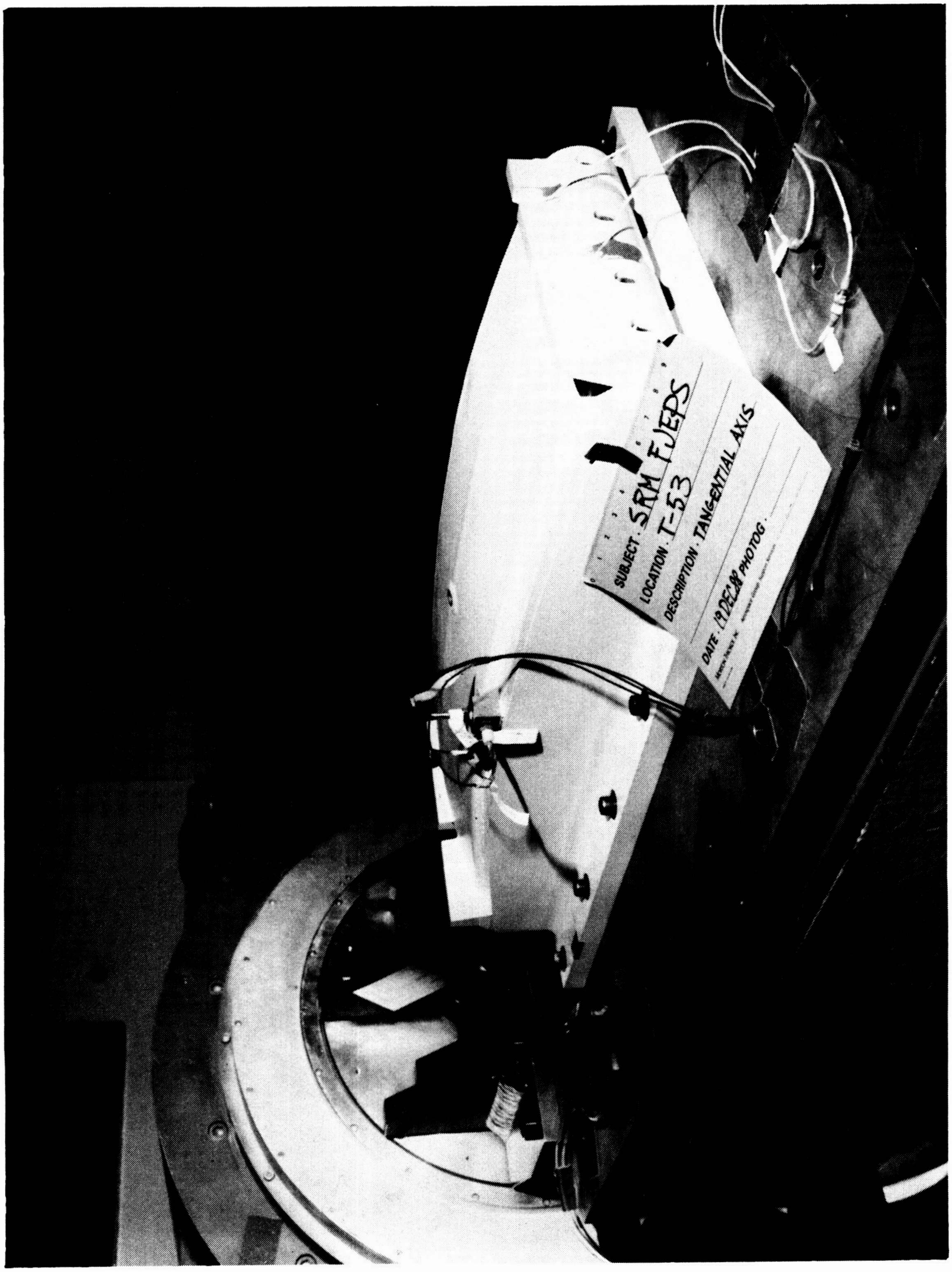

Figure 7. JPS Test Article Positioned for Tangential Vibration

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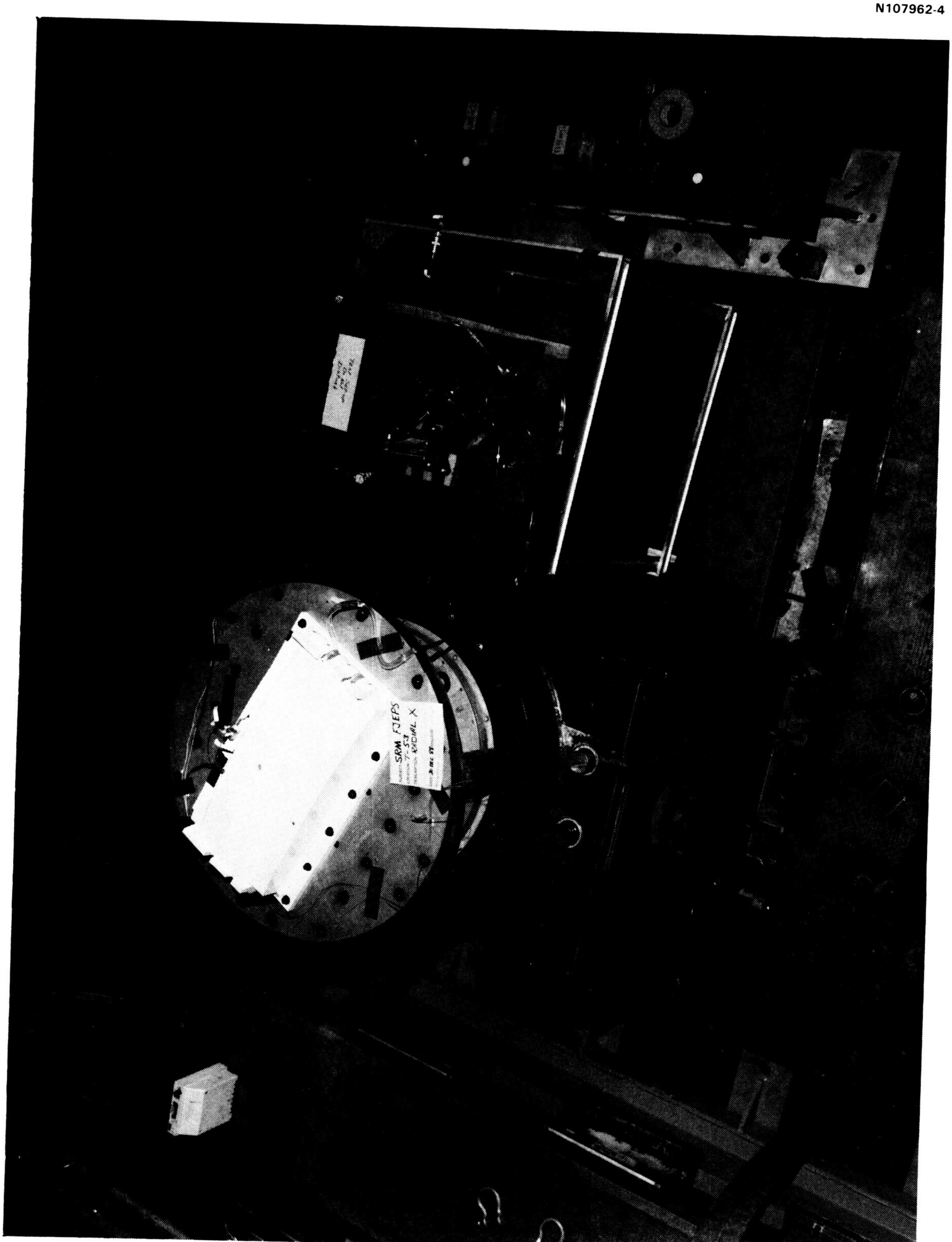

Figure 8. JPS Test Article Positioned for Radial Vibration

7
RESULTS AND DISCUSSION

Prior to the vibration/pressurization testing, the test article was assembled and subjected to accelerated environmental conditioning.

7.1 TEST ARTICLE DESCRIPTION

The test article configuration was designed to certify the JPS. Test article configuration represented flight hardware, except for the joint simulator fixture (Figures 1 through 4). The test article assembly consisted of an aluminum joint simulator fixture and sections of pin retainer band, JPS heater, heater thermal barrier, moisture seal, moisture seal retainer straps, instrumented moisture seal retainer strap clips and links, JPS sensor, extruded cork insulation, and K5NA ablation compound. In addition, a cartridge check valve was installed into the center of the assembly.

7.1.1 Joint Simulator Fixture

Drawing 2U132025 defined the joint simulator fixture configuration, which was designed to simulate the external profile of an assembled RSRM field joint and allow for the installation of the JPS. The fixture was machined from aluminum to be 32 in. long by 20 in. wide by 6.2 in. high. The 32-in. test article length was selected using the following criteria:

a. Similarity to the test article length used in the nozzle linear-shaped charge (LSC) and the systems tunnel qualification tests (approximately 30-to-40-in. length).

b. As close to the maximum length possible to achieve the 35.2-grms level required for reentry random vibration.

   (Analysis shows that vibration modes which cause element lifting, separation, debonding, etc., are relatively high in frequency and pure radial, tangential, or longitudinal modes. Although 32 in. is only about 15 percent of the JPS circumference, test article length for the lifting, separation, debonding, etc., modes is not a factor.)

A requirement of the JPS vibration fixture was to simulate and monitor pressure buildup under and venting through the cartridge check valve in the JPS. To accomplish this, two pressure ports were drilled into the joint simulator fixture: one to allow an airflow into the volume under the JPS, and one to monitor the pressure directly under the cartridge check valve in the JPS (Figure 2).

To ensure that tension in the moisture seal retainer straps could be monitored and verified to be within the 1,300-to-3,000-lb range during assembly, two cavities were machined into the joint simulator fixture to accommodate two turnbuckle/load cell assemblies to which the straps were attached and tightened (Figure 3).

Prior to installing the JPS, the fixture was grit blasted, vapor degreased, and spray painted with STW5-3226 zinc-rich primer and STW5-3225 top coat.

7.1.2 Vibration Test Article Assembly

Assembly and instrumentation of the JPS vibration fixture was conducted at the Morton Thiokol M-15 facility and was defined by drawing 7U76358. The assembly consisted of sections of the pin retainer band, JPS heater, heater thermal barrier, moisture seal, moisture seal retainer straps, instrumented moisture seal retainer strap clips and links, JPS sensor, extruded cork insulation, and K5NA ablation compound installed on the joint simulator fixture. In addition, a cartridge check valve was installed into the center of the JPS assembly.

To obtain an assembly which was capable of holding pressure, the moisture seal was trimmed 0.75 to 2.0 in. on either end and sealed in place using polysulfide sealant (MIL-S-8802). The cartridge check valve was then bonded to the moisture seal with polysulfide sealant (MIL-S-8802).

Once the seal was verified, the moisture seal retainer straps were installed and tightened to 2,990 ±10 lb tension. To monitor and record the tension in the straps, the straps were installed using two specially modified retainer strap clip and link assemblies (the modification to the strap clip and link assemblies consisted of instrumenting them to measure load) and two turnbuckle/load cell assemblies. The straps were allowed a 30-min period of relaxation and then retightened, after which the heater sensor was put in place.

Finally, EA 934NA adhesive was applied to both the joint simulator fixture and the extruded cork insulation. The cork was positioned in place and cured inside a vacuum bag for 8 hr. After cure, the adhesive surrounding the upper 0.25 in. of the cartridge check valve was removed and replaced with K5NA (Figure 4). K5NA was applied at the aft end of the cork, and all the cork and K5NA were painted with white polyethylene paint (STW5-2994). Assembled, the test article weighed 171.4 lb.

7.2 ACCELERATED ENVIRONMENTAL CONDITIONING

Prior to vibration testing, the test article was subjected to temperature, humidity, salt spray, and rain conditioning per CTP-0054 and MIL-STD-810D to simulate the prelaunch natural environment. This conditioning took place from 29 Nov to 12 Dec 1988.

7.2.1 High-Temperature, High-Humidity Conditioning

Initially, the test article was placed in the Morton Thiokol T-51 test facility and subjected to an environment of 120° +10-0°F and 90 +10-0 percent relative humidity for 48 hr minimum (Figure 9). Upon completion of this conditioning, the test article was placed in a 75° ±10°F environment for 24 hr minimum and allowed to return to ambient condition.

7.2.2 Salt Spray Conditioning

Following the high-temperature, high-humidity, and return-to-ambient conditioning cycle, the test article was placed in the Morton Thiokol T-3 test facility and subjected to a 95° ±10°F salt spray conditioning for 48 hr (Table 1 and Figure 5). Upon completion of this conditioning, the test article was placed in a 75° ±10°F environment for 48 hr and allowed to return to ambient conditions. Postconditioning inspection of the test article showed salt deposits accumulated in and around the vent valve.

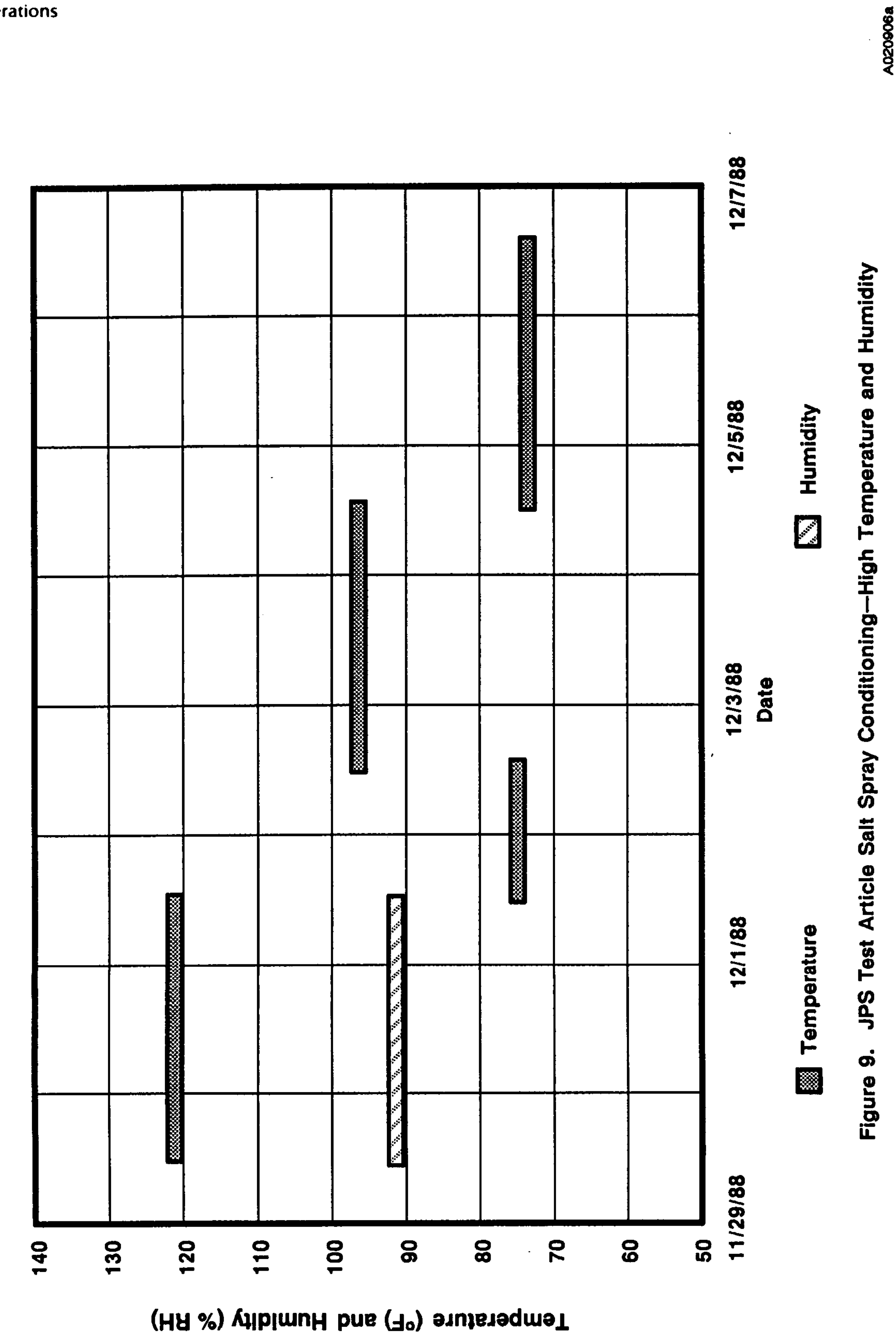

Figure 9. JPS Test Article Salt Spray Conditioning—High Temperature and Humidity

Table 1. JPS Test Article Salt Fog Conditioning Data

Required

pH	Specific Gravity	Temperature	Fallout
6.5 to 7.2	1.023 to 1.037	95 ±10°F	0.5 to 3.0 mL per hr of solution

Actual (Pretest)

Date	pH	Specific Gravity	Temperature	Fallout Receptacle No. 1	Fallout Receptacle No. 2
1 Dec 1988	6.9	1.028	96°F	25	70

Actual (Test)

Date	pH	Specific Gravity	Temperature	Fallout Receptacle No. 1	Fallout Receptacle No. 2
2 Dec 1988	6.5	1.026	95°F	25	70
3 Dec 1988	7.1	1.029	95°F	30	50
4 Dec 1988	6.5	1.025	95°F	50	50

7.2.3 Rain Conditioning

Simulated rain conditioning was conducted after completion of the salt spray conditioning. The test article was subjected to a water spray for a minimum of 1 hr. The conditioning was conducted at the Morton Thiokol T-3 test facility and met the following conditions:

Water pressure:	40 psig
Water temperature:	45°F
Chamber temperature:	73°F
Rain duration:	1 hr minimum
Rain droplet size:	2 to 4.5 mm diameter
Distance from nozzle:	19 ±1 in.

7.2.4 Low-Temperature Conditioning

Low-temperature conditioning was conducted after completing the rain conditioning. The test article was towel dried, immediately placed in the Morton Thiokol T-3 test facility, and subjected to a 20° +0-10°F environment for a minimum of 48 hr (Figure 10). Upon completion of this conditioning, the test article was placed in a 75° ±10°F environment for a minimum of 24 hr and allowed to return to ambient conditions. Postinspection of the test article showed salt deposits accumulated in the bottom of the vent valve.

7.3 TEST RESULTS AND DISCUSSION

The vibration/pressurization test was conducted in the Morton Thiokol T-53 shaker facility from 19 Dec 1988 to 6 Jan 1989. Two Ling A340 shakers were used to conduct the test. The longitudinal and tangential axes tests were conducted using a shaker which was configured horizontally and bolted to a shaker plate (Figures 6 and 7). The other shaker was configured vertically for the radial test (Figure 8). Test results (control and response accelerometer power spectral density (PSD) plots and time history plots) are included in Appendix A.

The test setup included an internal pressurization pretest of the test article per paragraph 8.1.2 of CTP-0054. All requirements for air flow (3.2 ±0.5 in.^{3}/sec for 160 sec) and pressure (1.0 +0.5-0 psig) were met. The cartridge check valve (vent valve) performed as designed and relieved the JPS

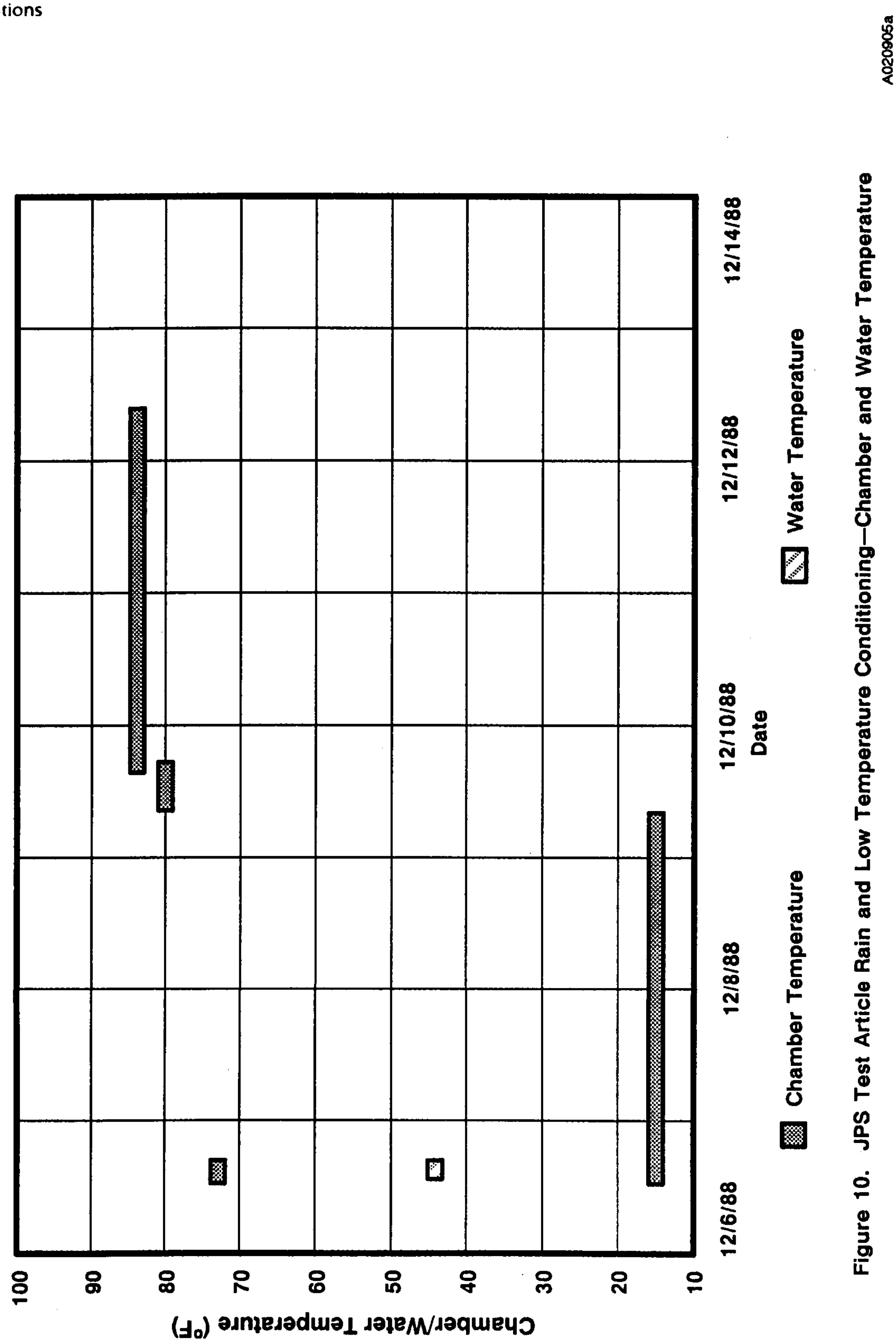

Figure 10. JPS Test Article Rain and Low Temperature Conditioning—Chamber and Water Temperature

internal pressure during the initial 120 sec (minimum) of each flight random and vehicle dynamics vibration test.

7.3.1 Flight Random Vibration/Pressurization Test

The equipment armature and head expander exhibited a natural resonance in the 1,000-to-2,000-Hz range. Two types of accelerometers were used: control accelerometers which measure motion of the shaker plate, and response accelerometers which measure motion on the test article. Control accelerometer PSD plots show that the test article was subject to motion within tolerances specified by CTP-0054 (Table II). Response accelerometer PSD plots, however, show the equipment resonance as a data spike which exceeds the tolerance criteria of CTP-0054. The resonance/spike was allowed per MIL-STD-810C (Method 514.2, para 4.5.2) and upon receipt of a redline copy of CTP-0054 and a memo from the vice president of Space Operations (Memo A400-FY89-139, included in Appendix B). (The test changes specified in Memo A400-FY89-139 have been incorporated into CTP-0054, Rev. C.) Control and response accelerometer PSD plots are included in Appendix A.

The test article was pressurized (1.0 +0.5-0 psig) during the initial 160 sec of the vibration test. Pressure gages indicated no internal pressure drop throughout this test. Instrumented moisture seal retainer strap clips and links were monitored with a portable data acquisition system to detect any change in strap tension. No change in strap tension was indicated throughout this test. Upon test completion, no visual anomalies on the test article were found. The test article met the requirements of CTP-0054.

7.3.2 Reentry Random Vibration Test

Radial axis test levels could only be met by using two control accelerometers and averaging the two outputs for a solid control. This setup was a result of equipment armature and head expander natural resonance in the 1,000-to-2,000-Hz range. As in the Flight Random Test, control motion was within test criteria, while response motion exhibited a data spike due to equipment resonance. The resonance/spike was allowed per MIL-STD-810C, and per the redline version of CTP-0054 and Memo A400-FY89-139, both included in Appendix B.

Instrumented moisture seal retainer strap clips and links were monitored, and no change in the strap tension was indicated. Upon test completion, no visual anomalies on the test article were found. The test article met the requirements of CTP-0054.

7.3.3 Vehicle Dynamics Vibration/Pressurization Test

The test article was pressurized (1.0 +0.5-0 psig) during the initial 160 sec of the vibration test. Pressure gages indicated no internal pressure drop throughout this test. Instrumented moisture seal retainer strap clips and links were monitored, and no change in the strap tension was indicated. Upon test completion, no visual anomalies on the test article were found. The test article met the requirements of CTP-0054.

7.3.4 Water Impact Shock Test

The test criteria required an impact-simulating, half-sine pulse duration of 0.050 sec. However, the computerized equipment could only give a duration of 0.010 sec. The pulse duration criterion was changed to 0.010 sec per the redline version of CTP-0054 and Memo A400-FY89-139, included in Appendix B. Time history data for the shock tests are included in Appendix A.

Longitudinal axis shock No. 1+ was run with a loose lead on the control accelerometer, and thus the article was over-tested (70.23 g at 100 Hz on the shock spectrum and test criteria peak level at 20 g). Discrepancy Report No. 168169 was written to cover the over-test, and is included in Appendix C. Since no visual damage was done to the test article, the over-test was acceptable. Shock No. 2+ was run to 31.14 g.

Tangential axis shock No. 1+ was run to 19.77 g. (Test criteria peak level was 8 g). The cause of the over-test is unknown. Discrepancy Report No. 168188 was written to cover the over-test, and is included in Appendix C. Since no visual damage was done to the test article, it met or exceeded the test requirements and was acceptable. Shock No. 2+ was run to 16.68 g, No. 1- to 13.49 g, and No. 2- to 13.43 g.

Radial axis shock testing was satisfactory. Shock No. 1- was run to 12.96 g, No. 2- to 12.98 g, No. 1+ to 13.44 g, and No. 2+ to 13.44 g.

7.3.5 Cork Button Pull Tests

Cork button pull testing was conducted on 8 Feb 1989 in the Morton Thiokol M-53 Development Lab (Table 2). Five specimens located on the extruded cork-to-joint fixture bond failed 100 percent in the cork and failed at higher stress than cork tensile dog bone tests (documented in TWR-17230, "Cork Extrusion Mechanical Characterization Final Test Report"). Two other pull test locations (moisture seal-to-cork extrusion bondline and Kevlar® strap and K5NA-to-cork extrusion bondline) also yielded acceptable results.

Table 2. Cork Button Pull Test Results

Specimen No.	Location	Max Load (lb)	Max Stress (psi)	Failure Mode
1	Cork-to-Case Bond	160	133	100% CCF
2		329	275	
3		312	261	
4		288	241	
5		279	233	
6	Moisture Seal-to-Cork Bond	54	45	10% CCF, 90% AFMS
7		97	81	25% CCF, 75% AFMS
8		89	75	
9		106	89	50% CCF, 50% AFMS
10		131	110	70% CCF, 30% AFMS
11	Kevlar® Strap/K5NA-to-Cork Bond	291	243	70% CCF, 30% AFKS
12		124	104	50% CCF, 50% AFKS
13		251	210	
14		218	182	80% CCF, 20% AFKS
15		194	162	

Date: 8 Feb 1989
Temperature: 75°F

Button Diameter: 1.2340 in.
Button Cross Section: 1.196 in.^{2}
Crosshead Speed: 0.5 in./min

CCF: Cohesive cork failure
AFMS: Adhesive failure to moisture seal
AFKS: Adhesive failure to Kevlar® strap/K5NA

A020996a

Appendix A

DATA FROM SRM FJEPS VIBRATION/PRESSURIZATION TEST

MORTON THIOKOL, INC.

Aerospace Group

Support Services

TEST REPORT

TITLE: Field Joint Environmental Protection System Vibration/Pressurization Test

PROJECT: HQ302-09-20 **DATE:** 25 January 1989

TEST DATE: 19 December 1988 - 6 January 1989 **REPORT NO.** TE-12775

PREPARED BY: Rick Baird

Rick Baird
Test Engineer

APPROVED BY: Bruce O. Tams

Bruce O. Tams, Manager
Test Engineering

DISTRIBUTION:

FORM TC 7155 (REV 10-87)

MORTON THIOKOL
WASATCH OPERATIONS

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MORTON THIOKOL, INC.
WASATCH OPERATIONS

1.0 SUMMARY

This report contains the results of the Vibration Testing conducted on the 7U76358 Field Joint Test Assembly. Testing met or exceeded the requirements contained in the CTP-0054 test plan. Testing was run per Shop Travelers 7A052 and 7A053.

2.0 TEST RESULTS

2.1 Test Configuration

The following test tools were used:

2U105664	Vibration Slip Plate
6021ST	Drive Bar
X-M19506-6	Head Expander
7U76358	Test Assembly

2.2 Test Set-Up

The test article was received at T-53 on 12 December 1988. Visual inspection showed rust and corrosion on all exposed metal (non-painted or non-plated). Test article was stored at T-53 til 19 December 1988 when test set-up could be scheduled.

Test set-up included an internal pressurization pre-test per paragraph 8.1.2 of CTP-0054. All requirements for air flow (3.2 +/- .5 in 3/sec for 160 sec) and pressure (1.0 + .5 -0 psig) were met.

Testing was conducted using the Ling A340 shakers. Longitudinal and radial axes were run on the slip plate. Radial axis was run on the vertical shaker.

2.3 Test Performance

2.3.1 Flight Random Vibration

Test was run per requirements listed in CTP-0054 table II Flight Random Vibration. Test article was pressurized during initial 160 seconds visually monitoring pressure gages. FM Tape #22957 contains flight random vibration levels and pressure levels. No visual ancmalies were noticed. Article met requirements of Test Plan.

2.3.2 Re-Entry Random

Test was run per requirements listed in CTP-0054 Table II Re-entry Random Vibration. FM Tape #22957 contains the longitudinal and tangential axes data. FM Tape #22959 contains the radial axis data. Article met requirements of test plan. Radial axis test levels could only be met by using two control accelerometers and averaging between their two outputs for a solid control. PSD plots show resonance between 1000-2000 Hz. This is due to armature and Head Expander set-up natural resonance.

2.3.3 Vehicle Dynamics

Test was run per requirement listed in CTP-0054 Table II Vehicle Dynamics Criteria. Test article was pressurized during initial 160 seconds of the vibration. No drop in pressure was seen by visually monitoring pressure gages. FM tape #22958 contains vehicle dynamics data. Article met requirements of test plan.

2.3.4 SRM Water Impact Shock

Test was run per requirements listed in CTP-0054 Table II under SRM Water Impact Shock Criteria.

Test criteria required a duration of .050 seconds. Computerized equipment can only give a duration of .010 seconds. Traveler was changed to .010 seconds upon receipt of a "red-lined" test plan and memo from J. D. Thirkill.

Longitudinal axis shock #1 was run with a loose lead on the control accelerometer and thus an overtest level of 70.23 G's wa seen. DR #168169 was written to cover this. Disposition was that data was acceptable.

Tangential axis shock was run to a 19,77G level. Cause was unknown. DR #168188 was written and dispositioned that data was acceptable.

2.3.5 Test Monitoring of Clip Gages

During the Flight Random, Re-entry and Vehicle Dynamics Vibration, Clip Gages were monitored by C/C 5618. This consisted of a PDAS set-up to monitor "clip-gages". The clip gages were installed on the straps during Field Joint Build-up. No loosening or change in the straps was noticed during testing.

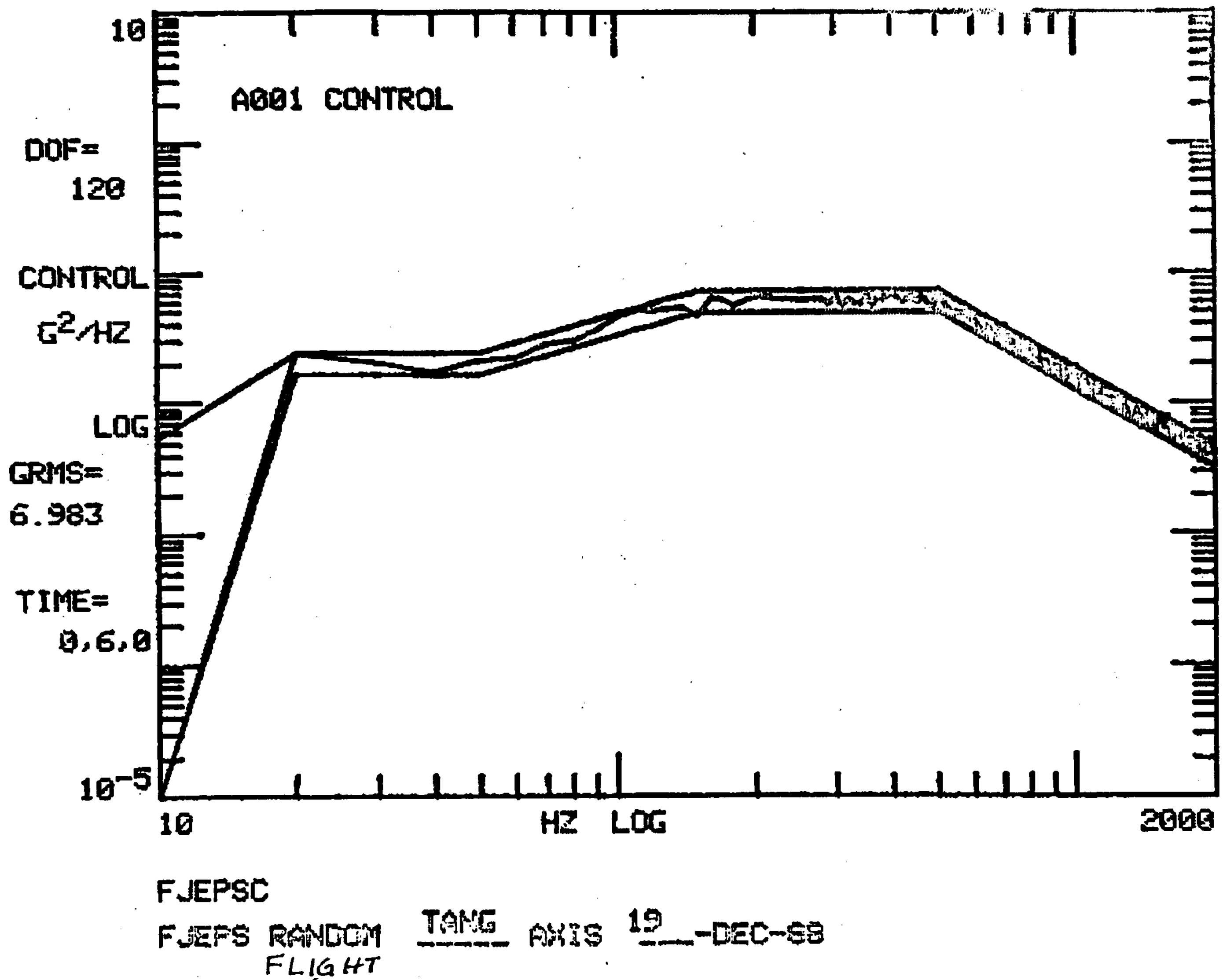
2.3.6 Post Test

Post test inspection showed no visual anomalies to the test article.

3.0 TEST DATA

A. Photographs

B. PSD Plots


10
A001 CONTROL
DOF=
120
CONTROL
G²/HZ
LOG
GRMS=
6.983
TIME=
0,6,0
10⁻⁵
10
HZ LOG
2000
FJEPSC
FJEFS RANDOM TANG AXIS 19__-DEC-88
FLIGHT

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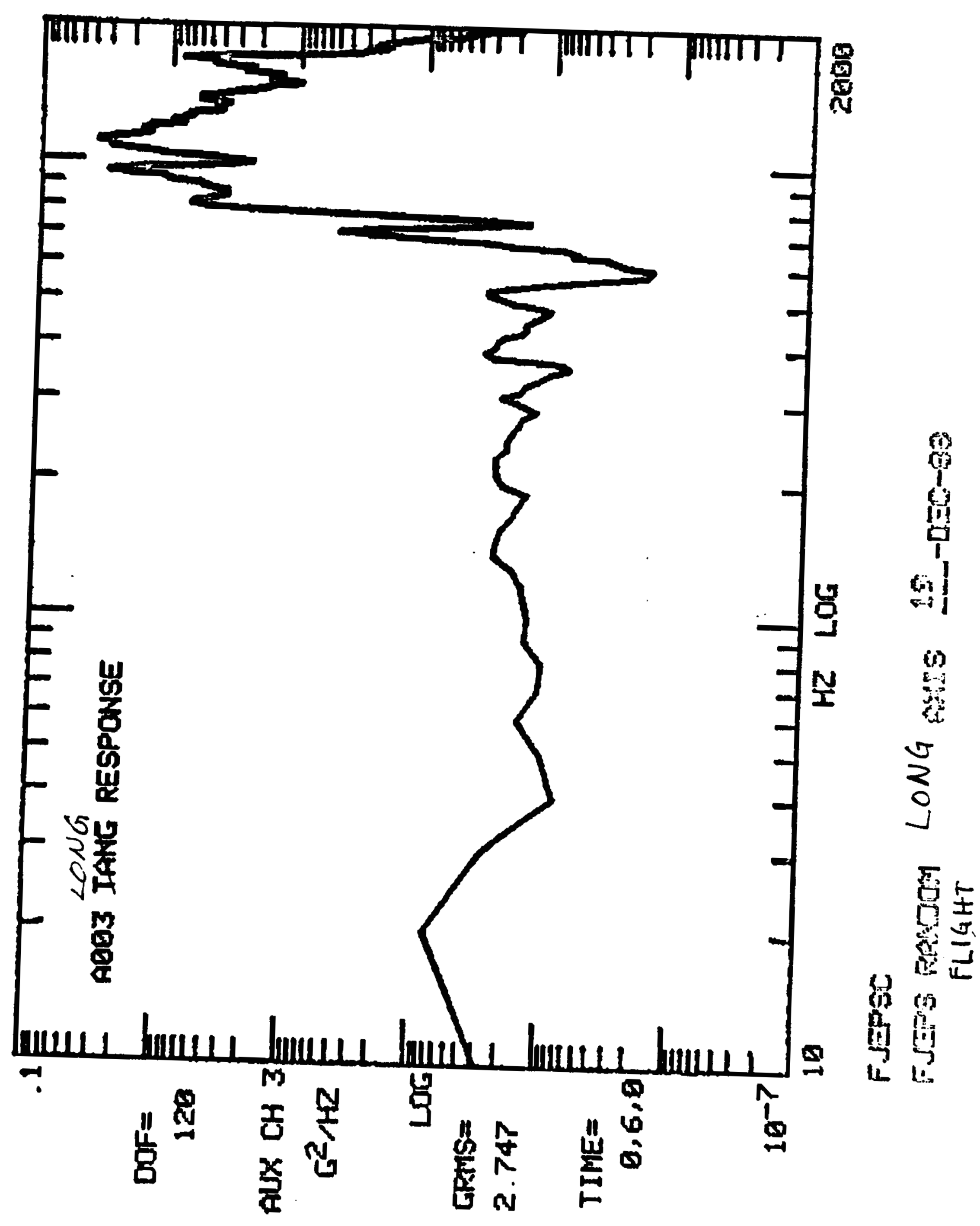
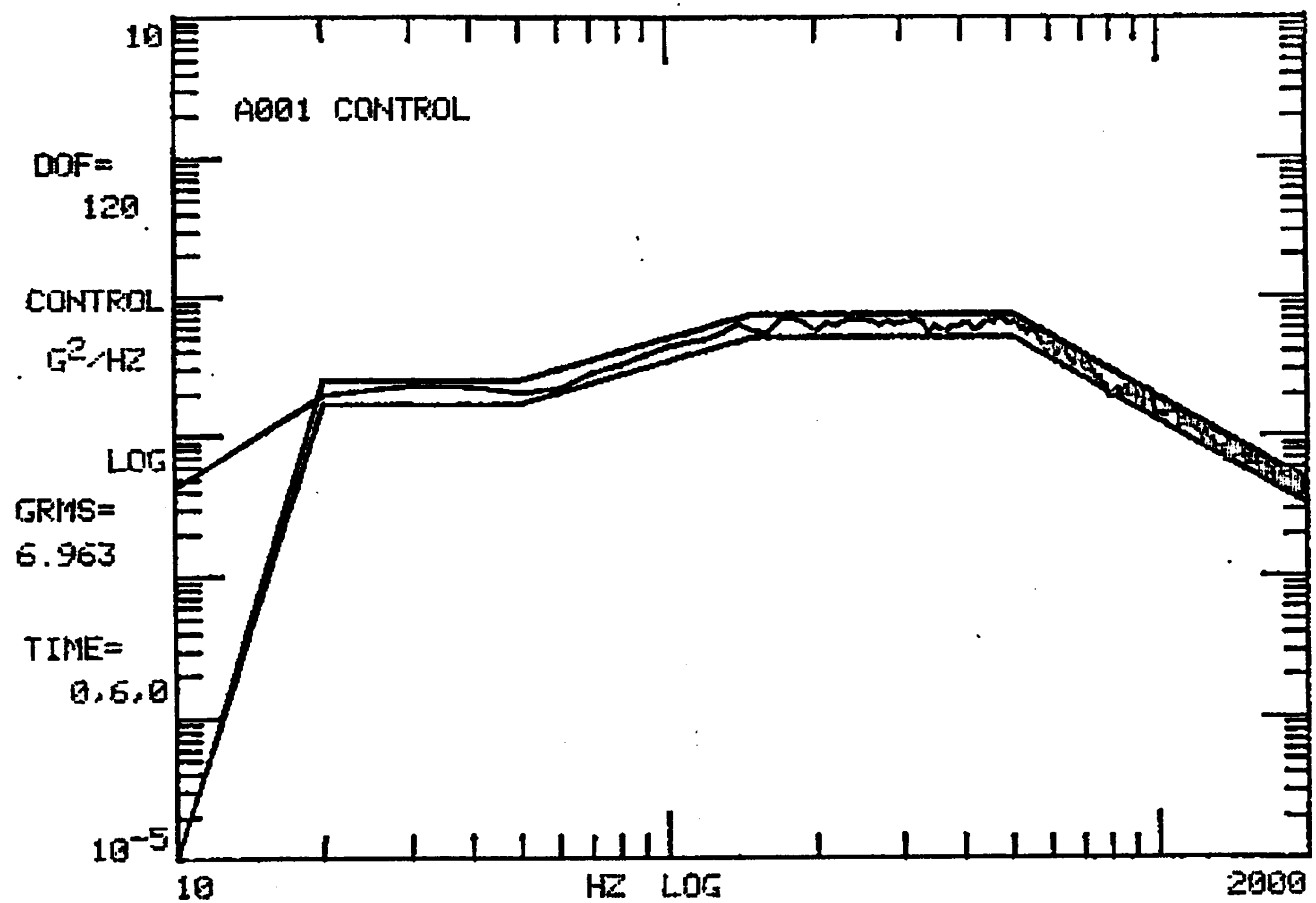
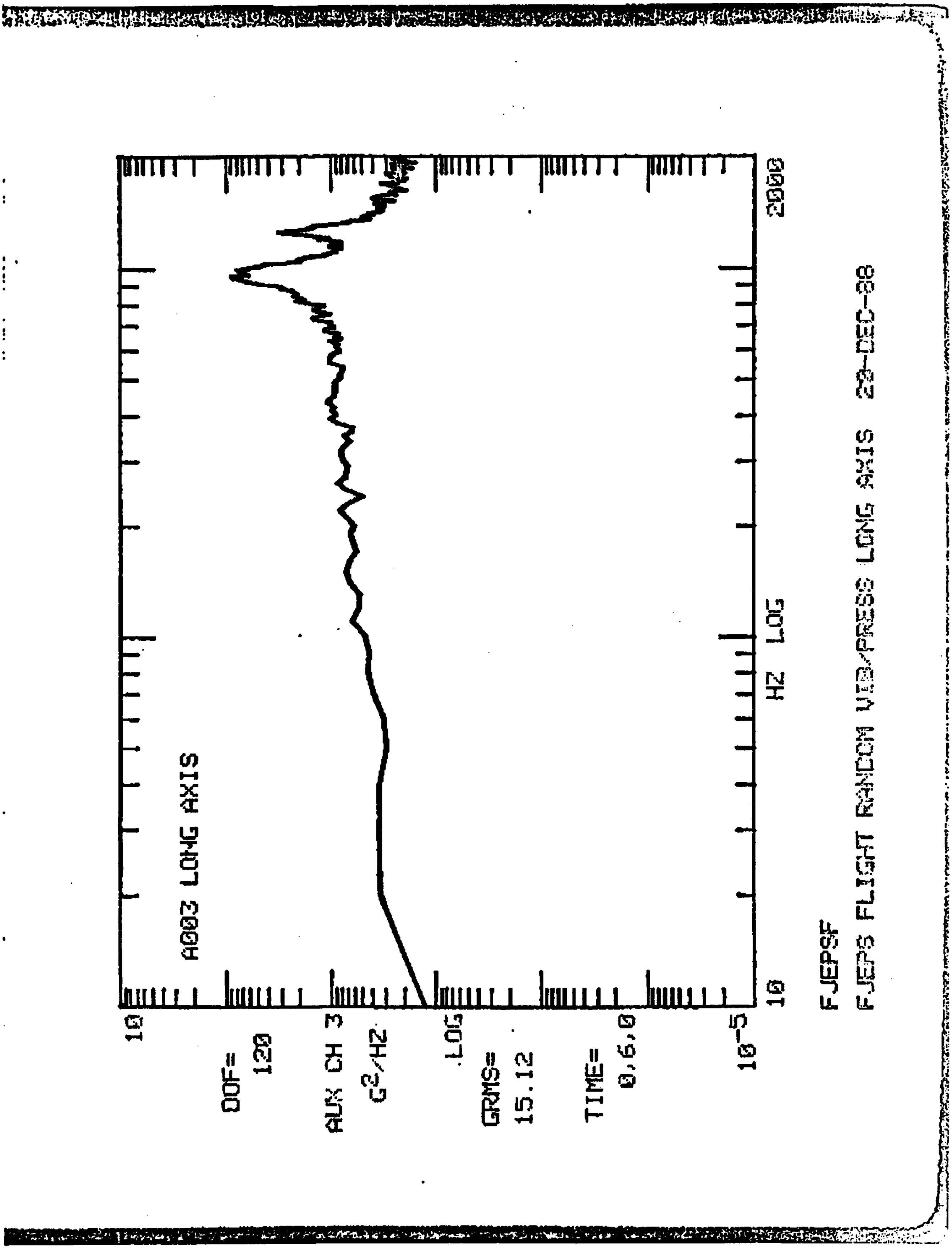
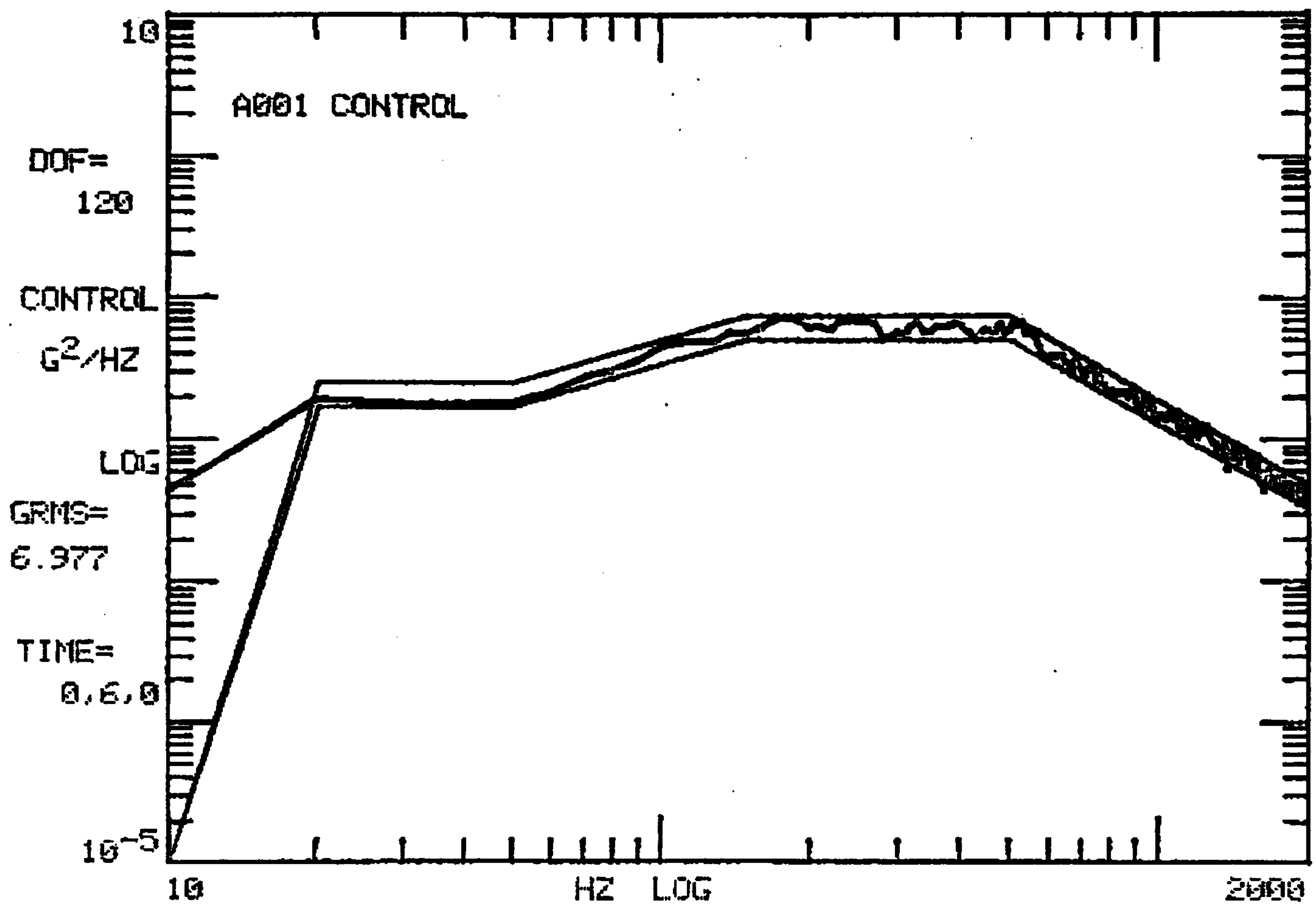




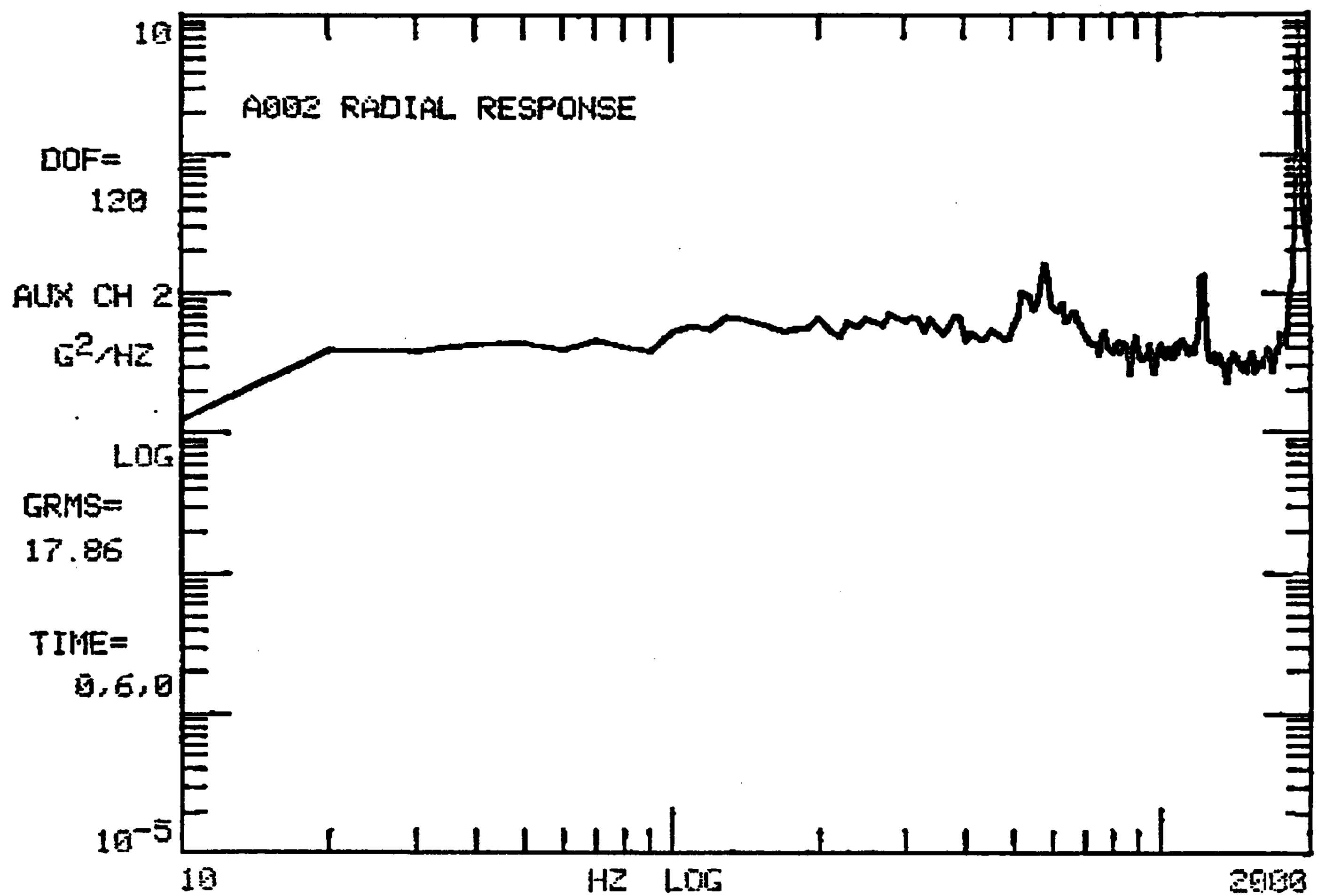
FJEPSF
FJEPS FLIGHT RANDOM VIB/PRESS LONG AXIS 20-DEC-88


A003 LONG AXIS
10
DOF=
120
AUX CH 3
G2/HZ
LOG
GRMS=
15.12
TIME=
0,6,0
10-5
10
HZ LOG
2000
FJEPSF
FJEPS FLIGHT RANDOM VIB/PRESS LONG AXIS 29-DEC-88



FJEPSG

FJEPS FLIGHT RANDOM VIB/PRESS RADIAL AXIS 20-DEC-88



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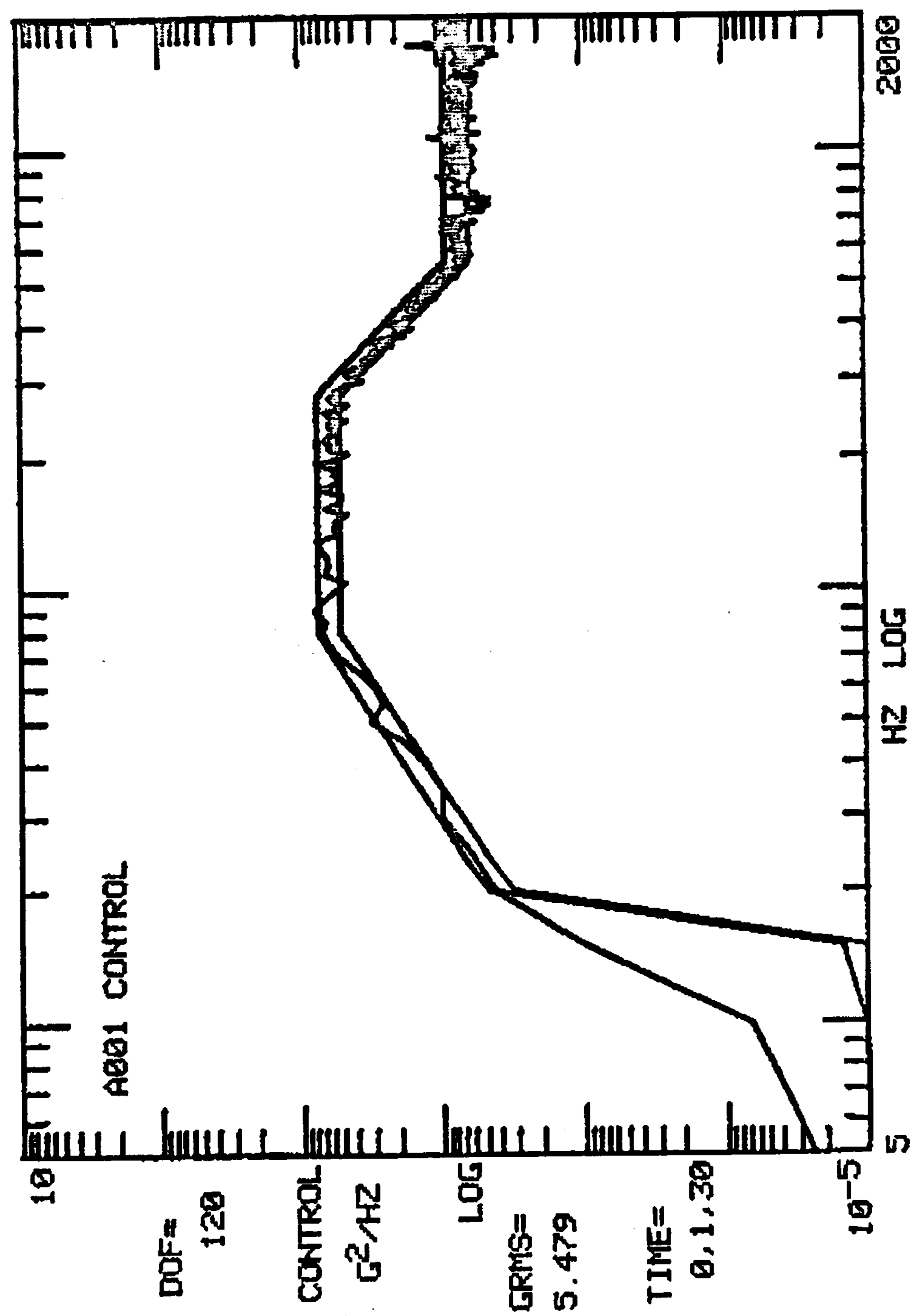
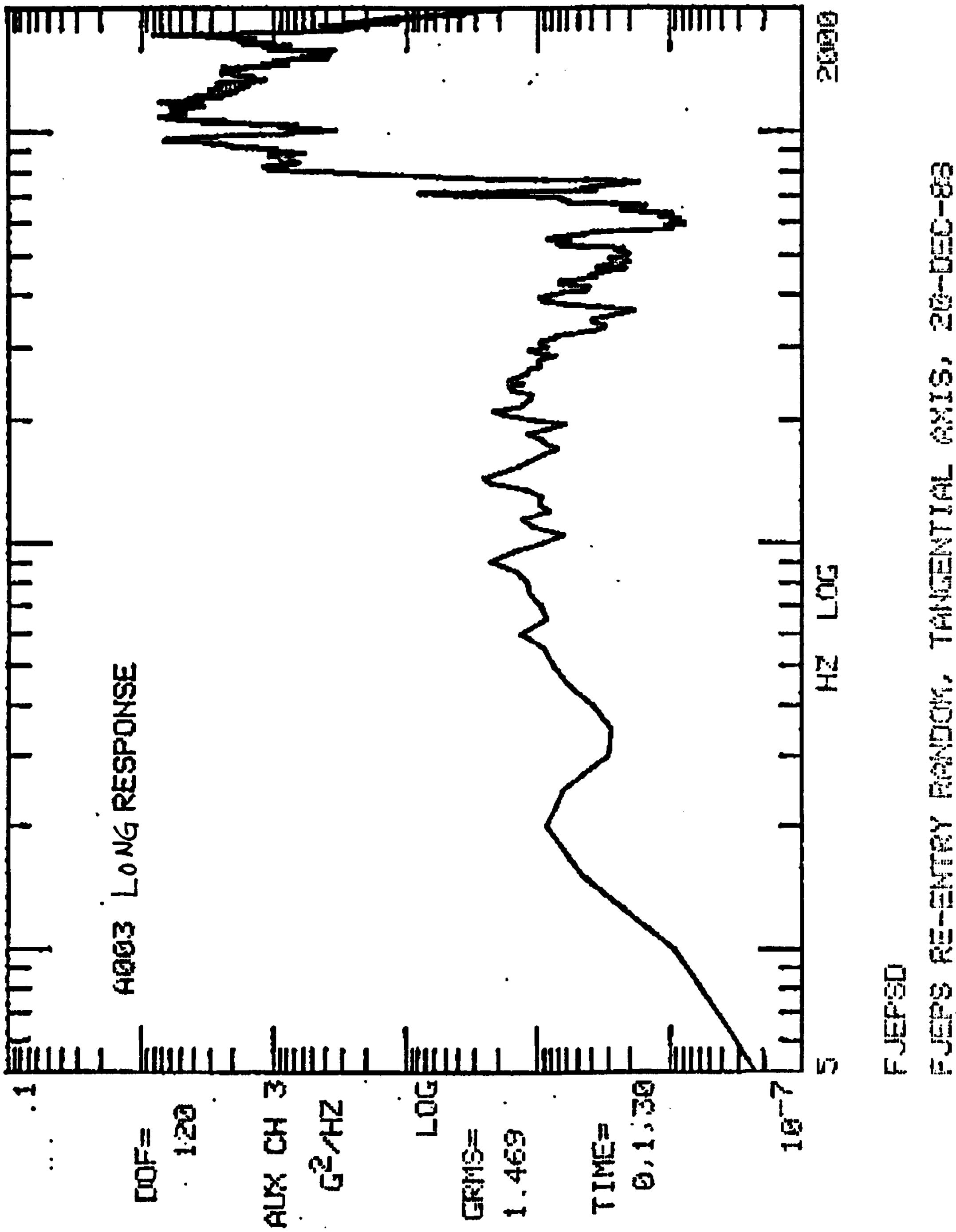
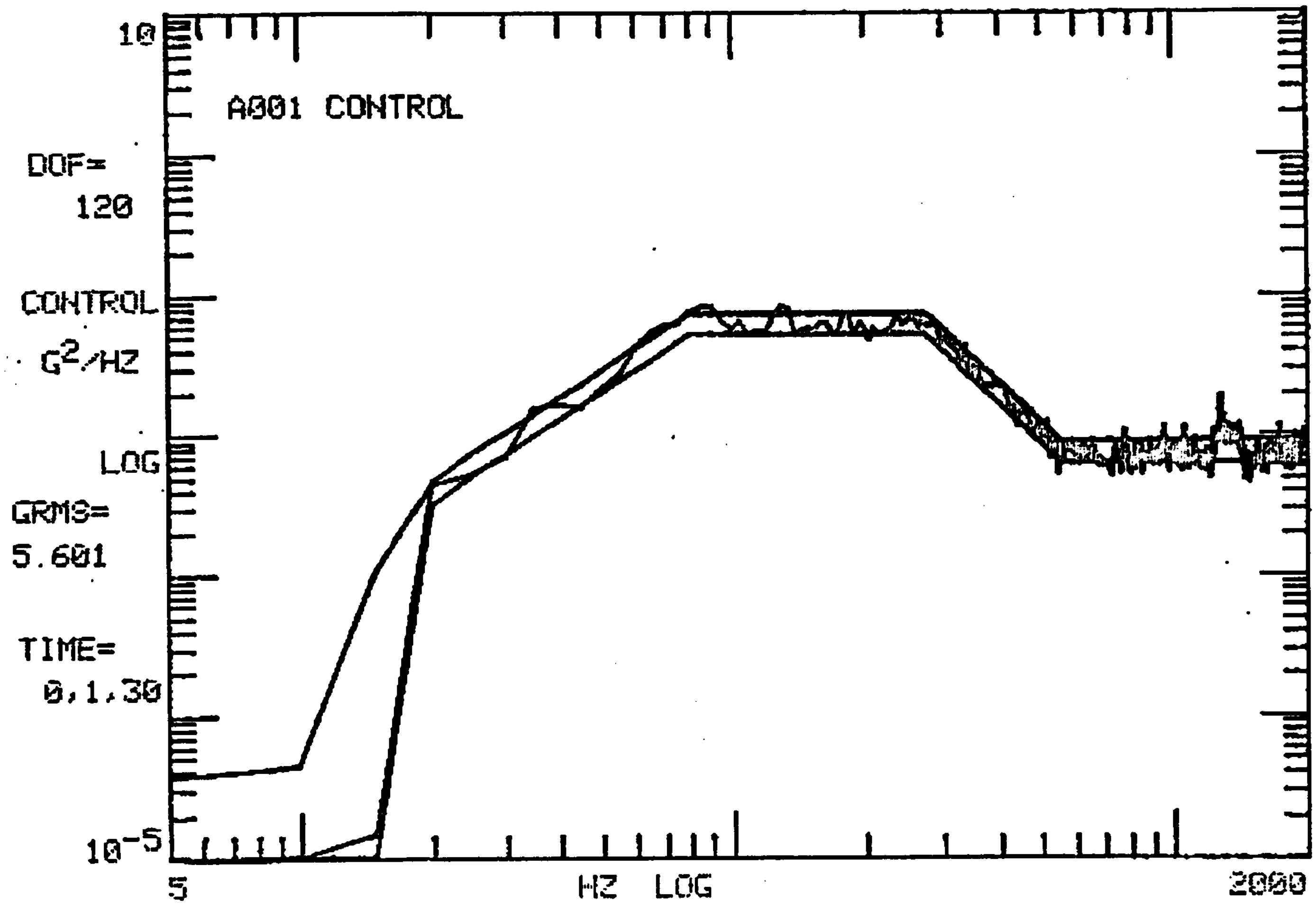
FJEPS FLIGHT RANDOM VIB/PRESS RADIAL AXIS 20-DEC-88



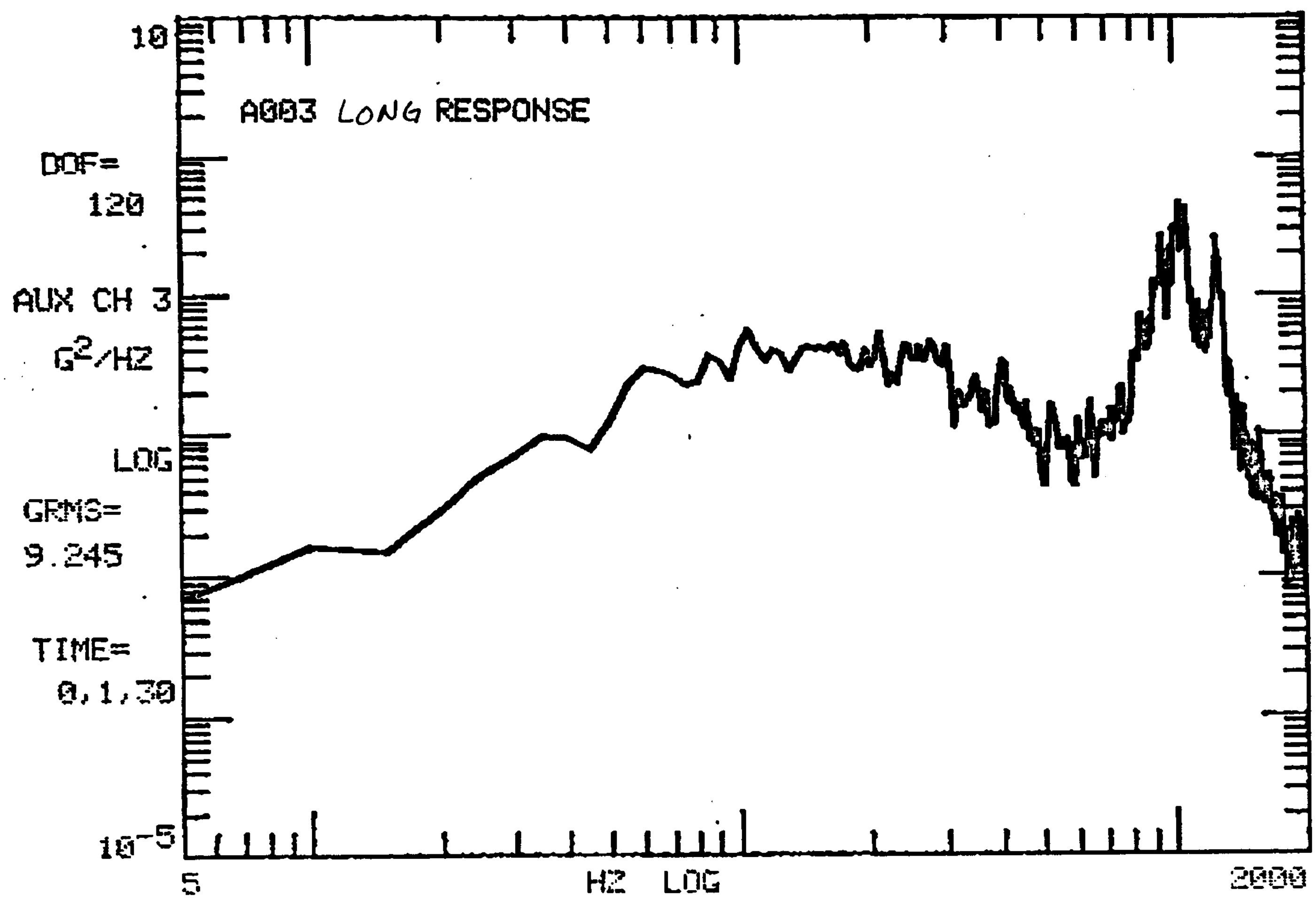
FJEPSD
FJEPS RE-ENTRY RANDOM, TANGENTIAL AXIS, 20-DEC-88


A003 LoNG RESPONSE
.1
DOF=
120
AUX CH 3
G2/HZ
LOG
GRMS=
1.469
TIME=
0.1.30
10-7
5
HZ LOG
2000
FJEPSD
FJEPS RE-ENTRY RANDOM, TANGENTIAL AXIS, 20-DEC-83



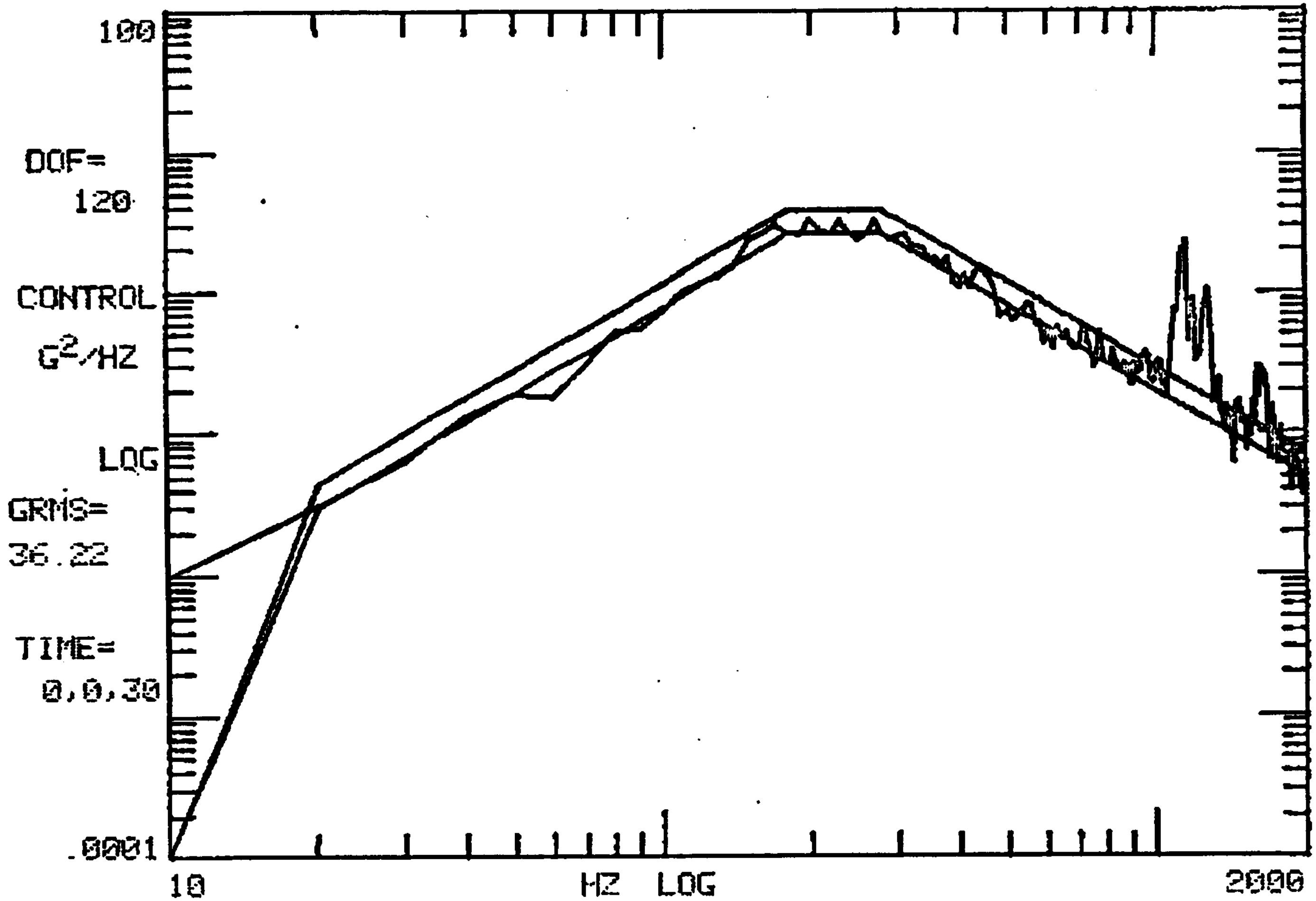
FJEPSE

FJEPS RE-ENTRY RANDOM, LONGITUDINAL AXIS 20-DEC-88



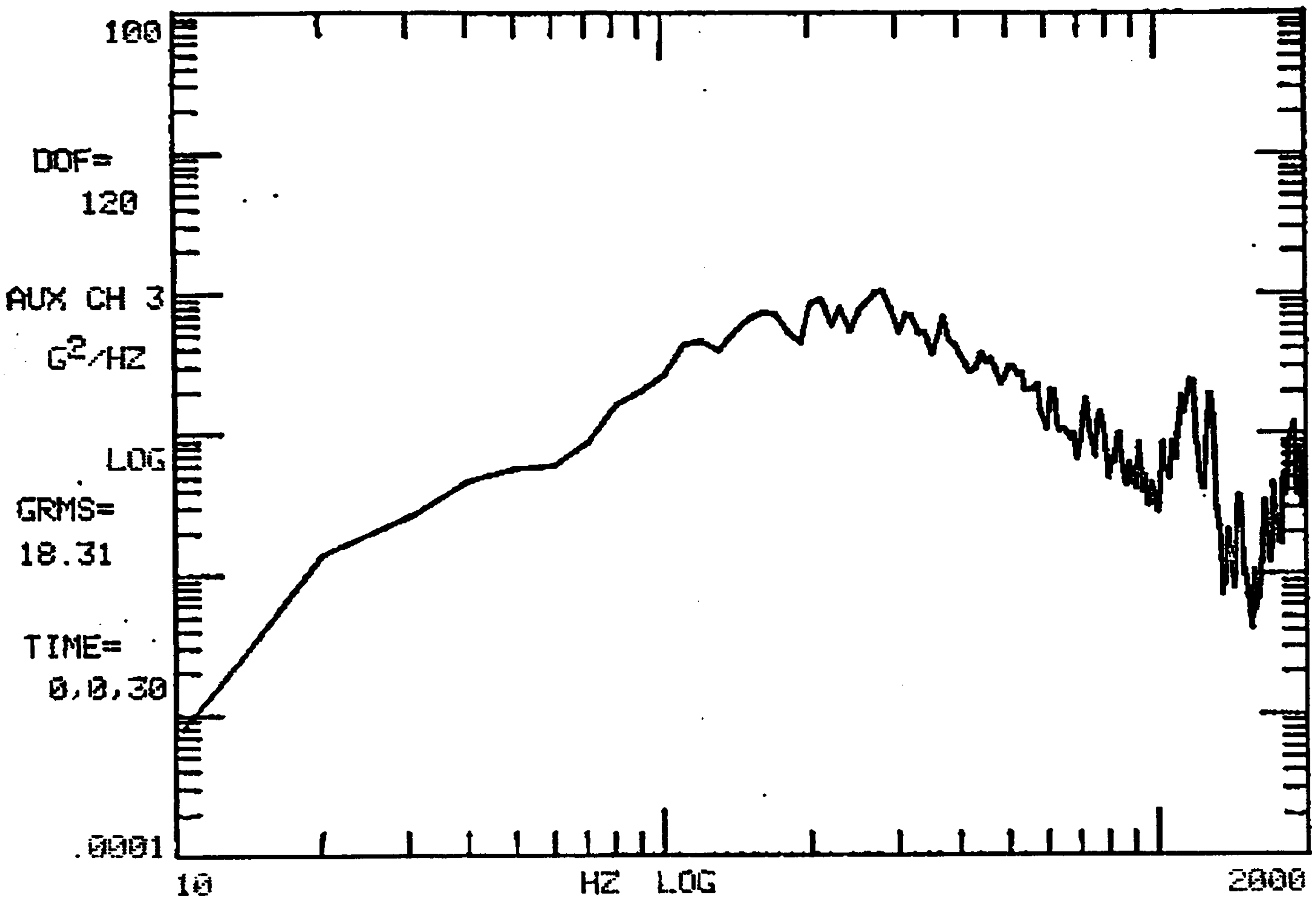
FJEPSE

FJEPS RE-ENTRY RANDOM, LONGITUDINAL AXIS 20-DEC-88



FJEPSJ

FJEPS RE-ENTRY RANDOM VIB., RADIAL AXIS, 22-DEC-88



FJEPSJ
FJEPS RE-ENTRY RANDOM VIB., RADIAL AXIS, 22-DEC-88

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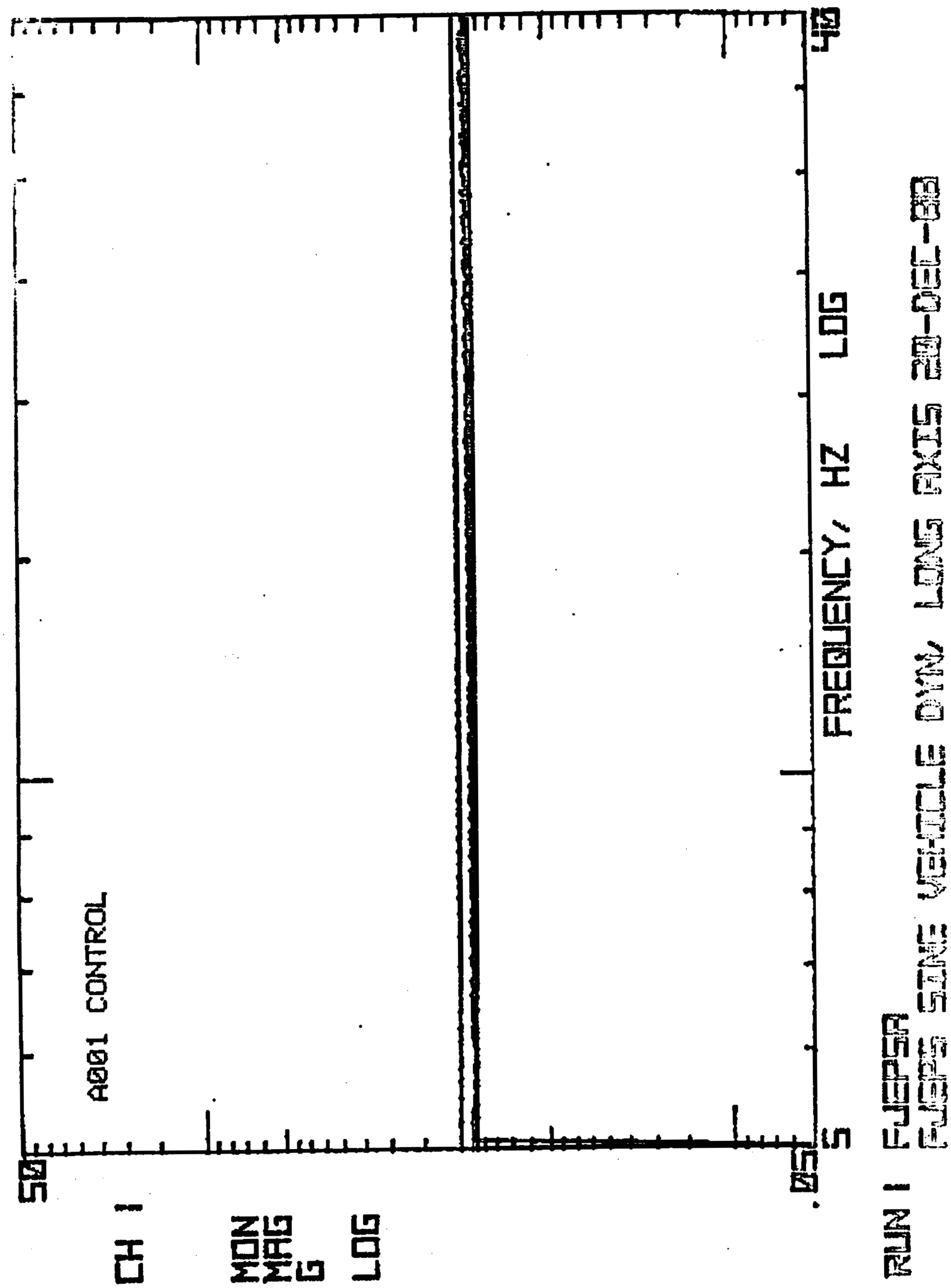

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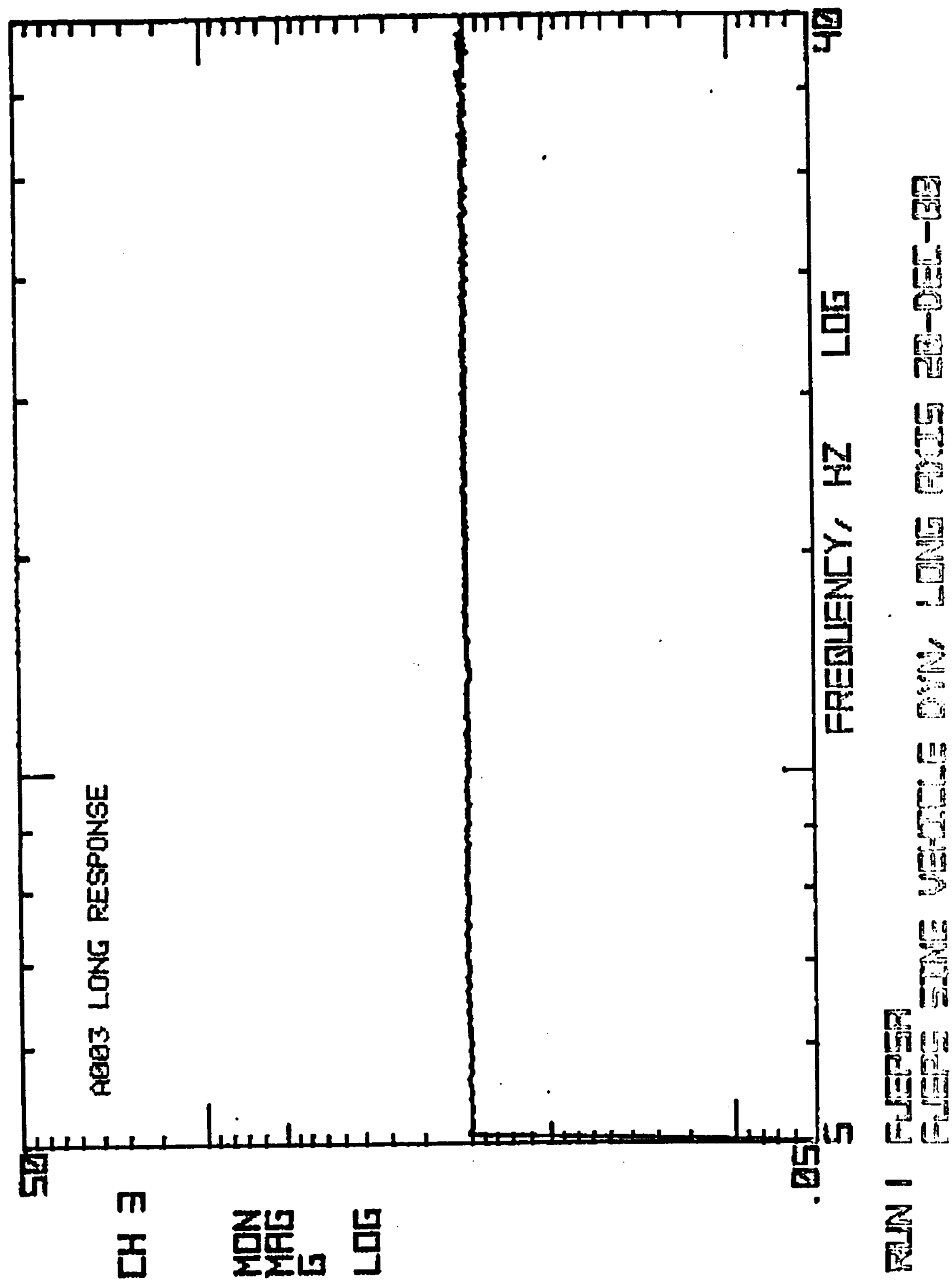

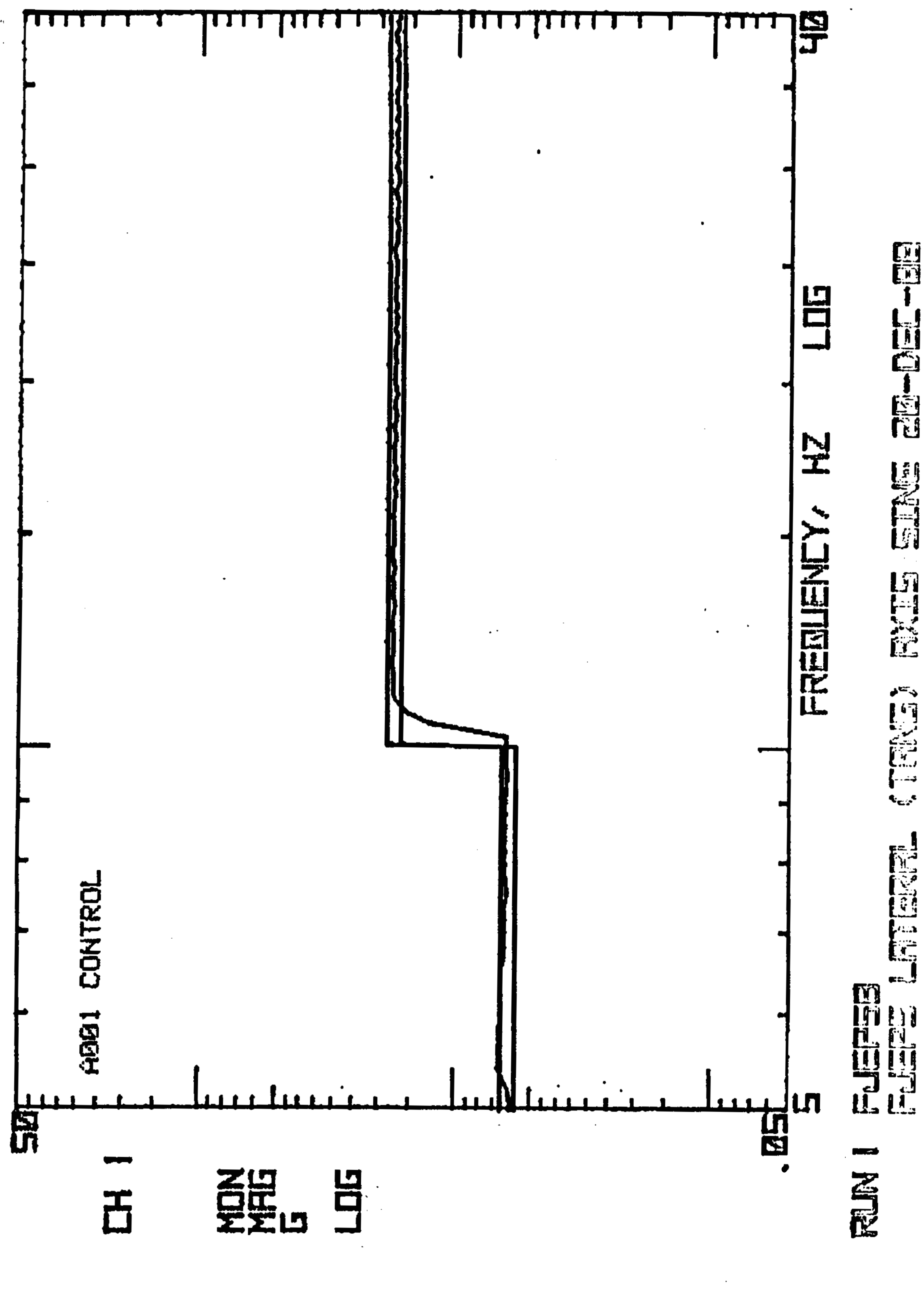
50
.05
5
40
A001 CONTROL
FREQUENCY, HZ LOG
CH 1
MON
MAG
G
LOG
RUN 1 FJEP53

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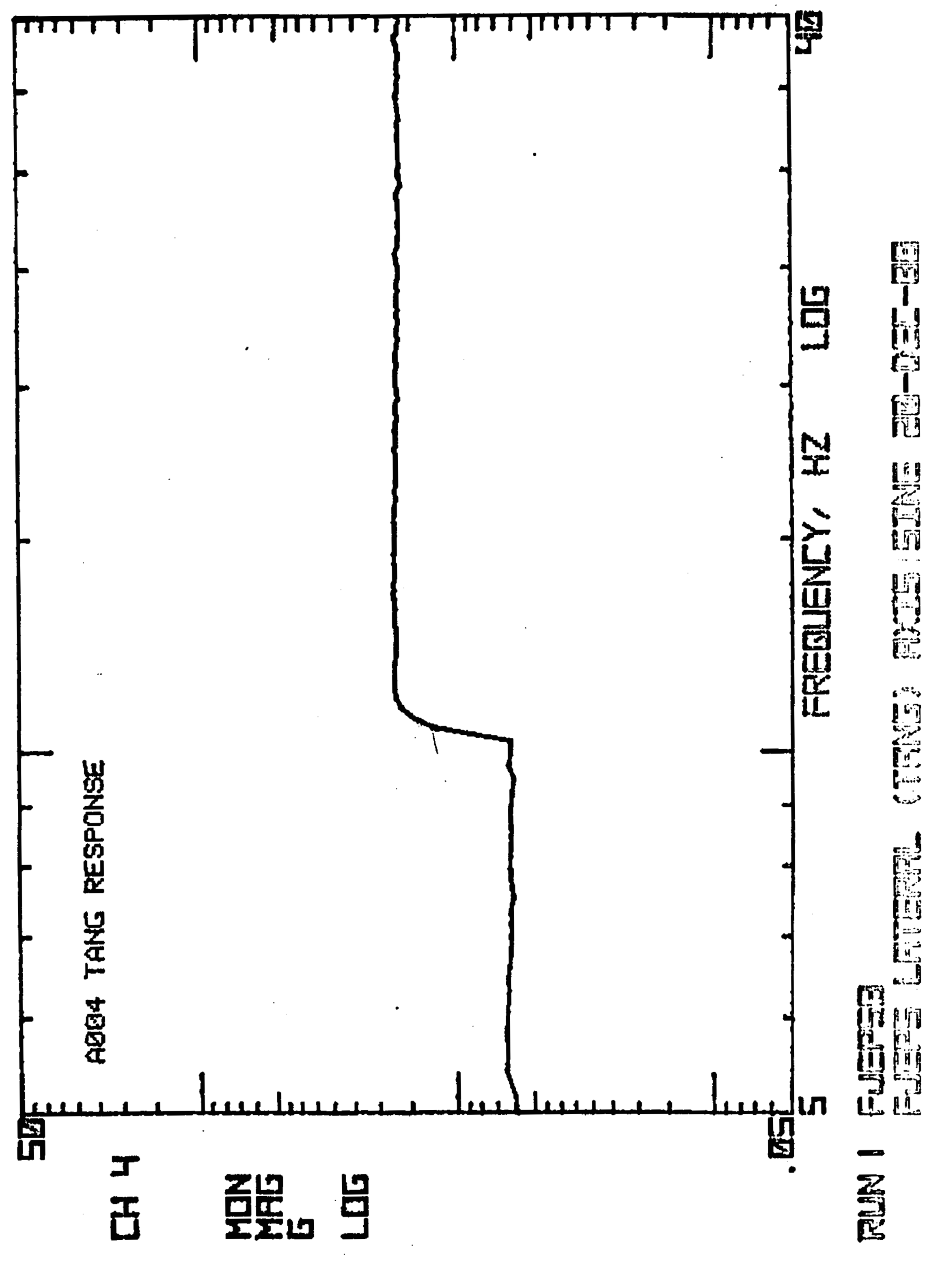
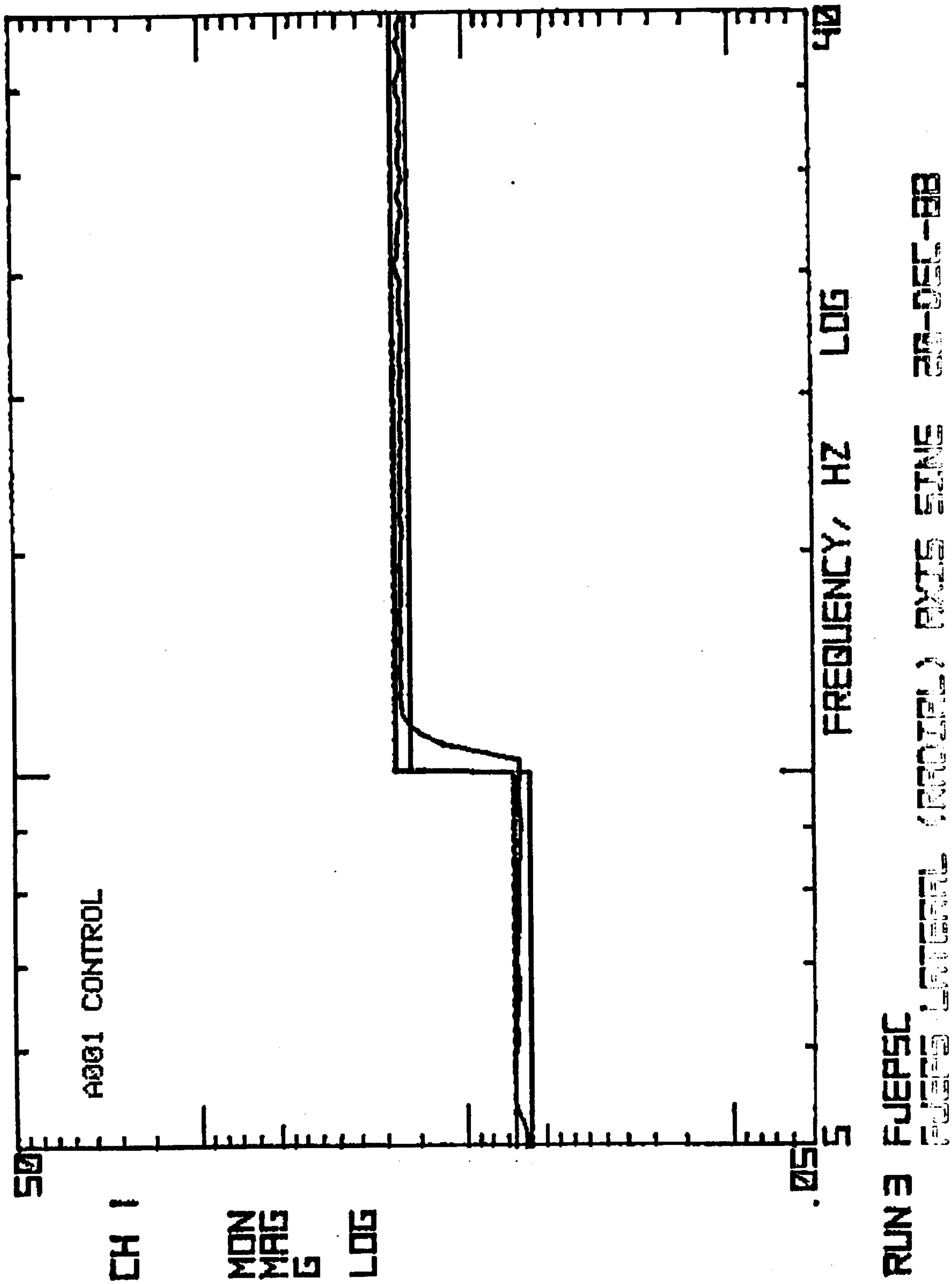
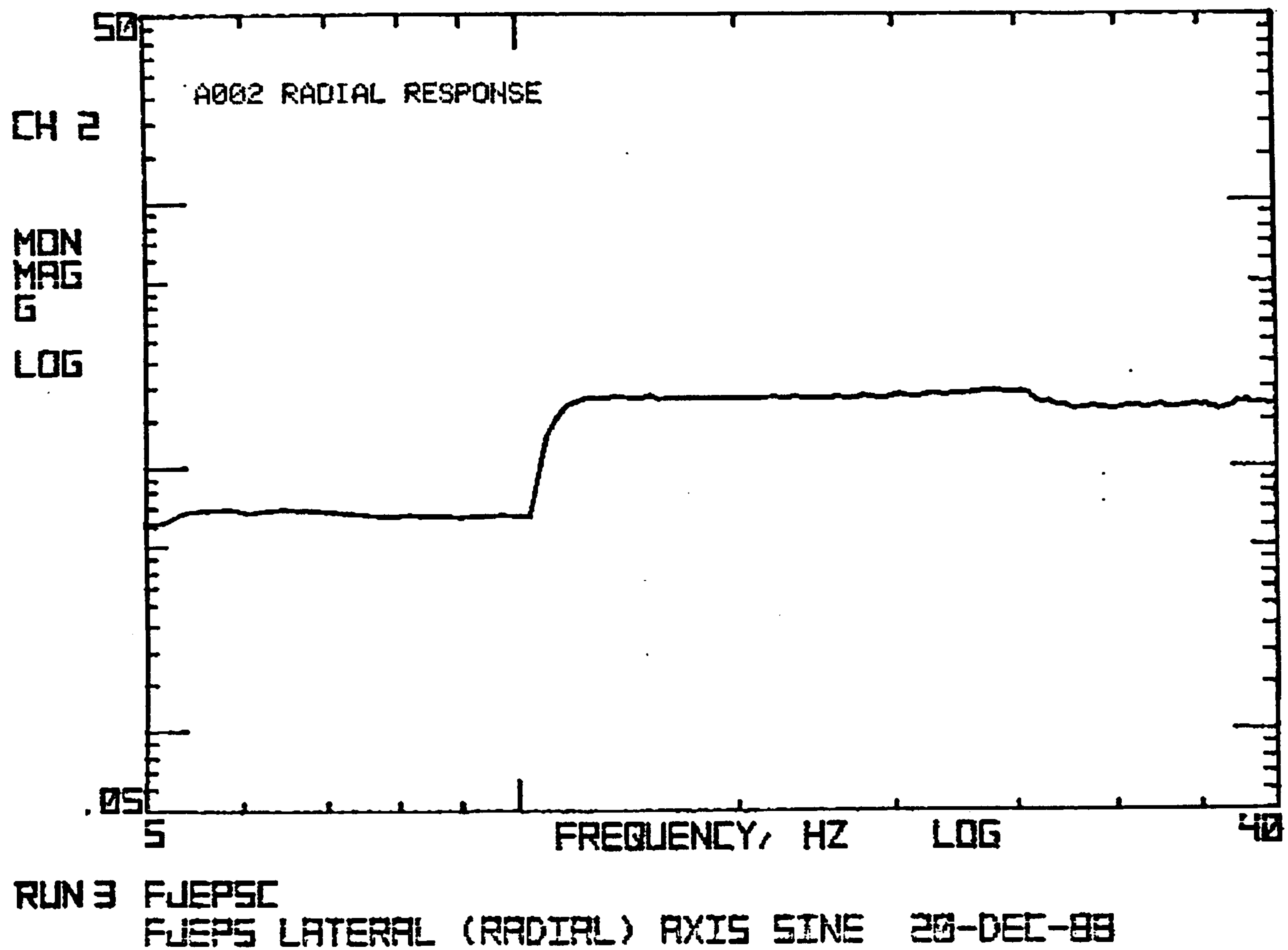
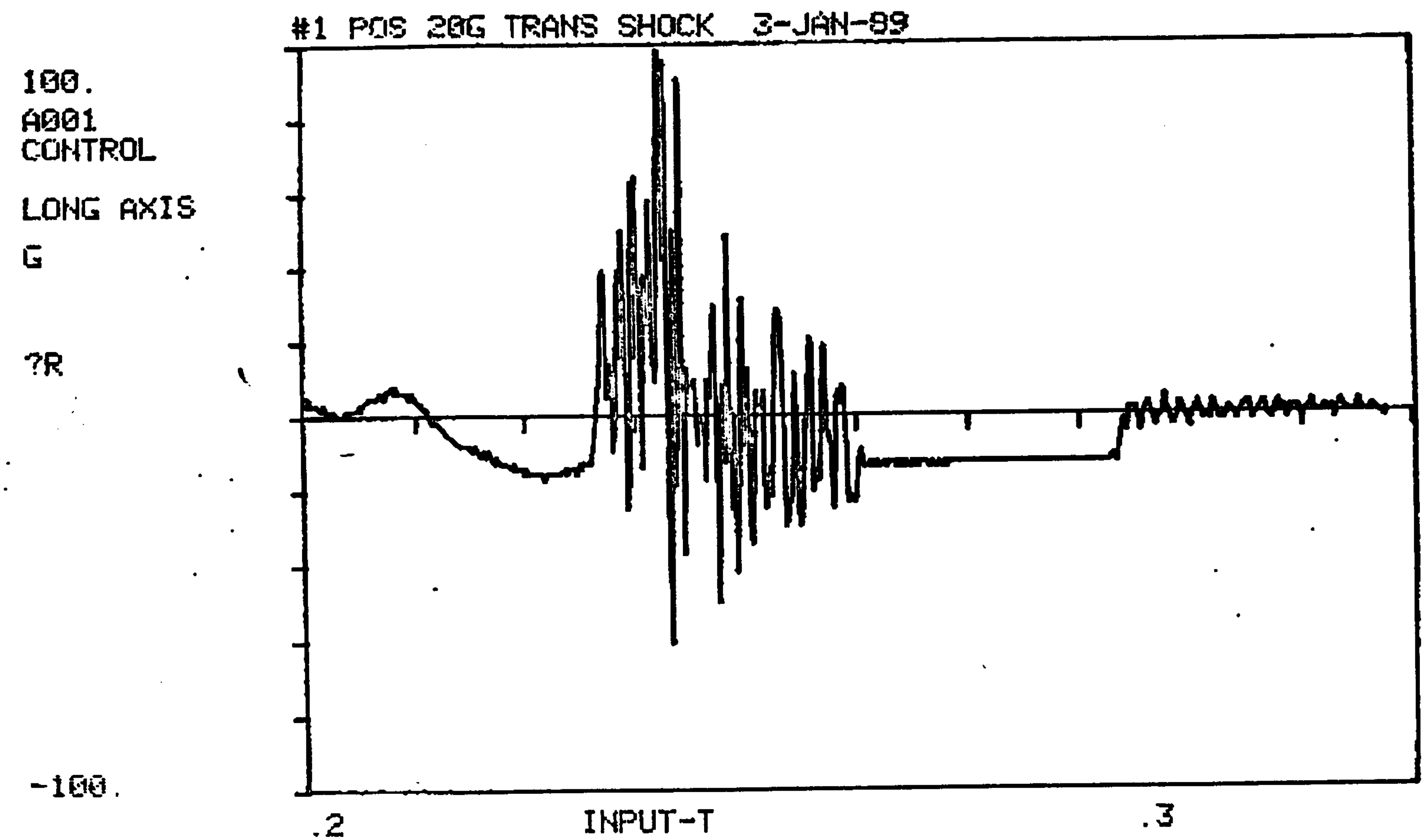


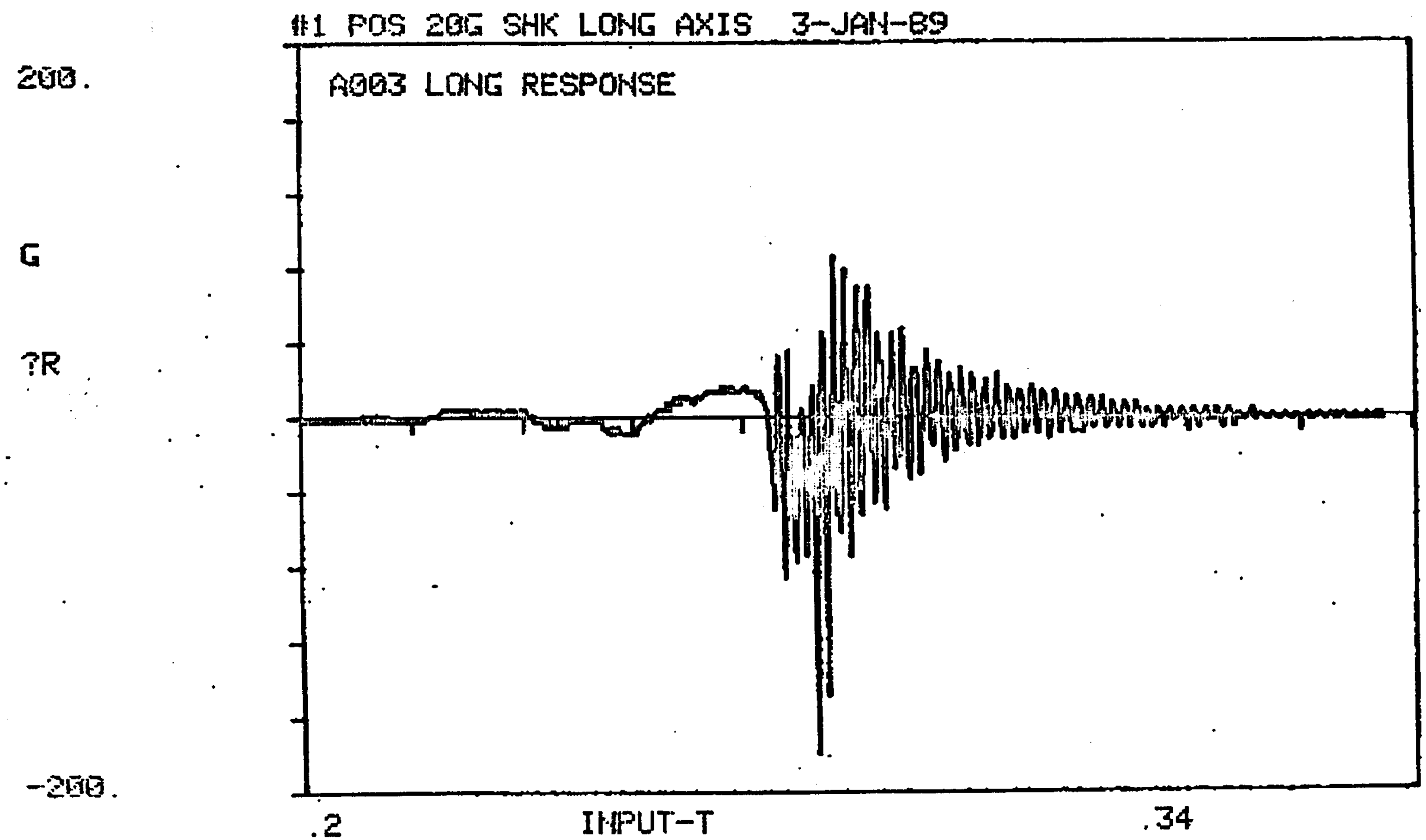

50
.05
5
40
FREQUENCY, HZ LOG
A001 CONTROL
CH 1
MON
MAG
G
LOG
RUN 3 FJEPSC


A002 RADIAL RESPONSE
CH 2
MON
MAG
G
LOG
50
.05
5
40
FREQUENCY, HZ LOG
RUN 3 FJEPSC
FJEPS LATERAL (RADIAL) AXIS SINE 20-DEC-88

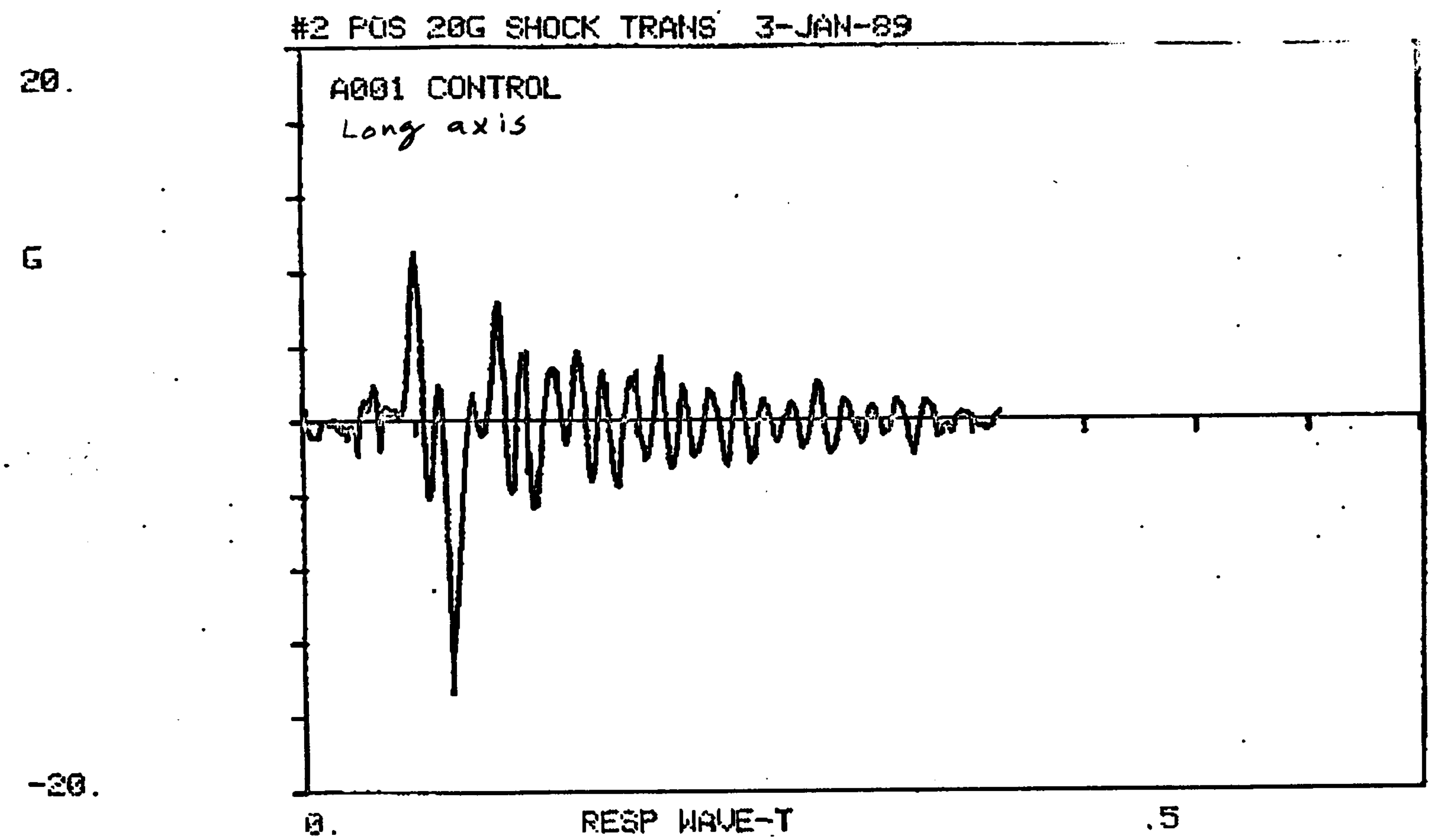

#1 POS 20G TRANS SHOCK 3-JAN-89
100.
A001
CONTROL
LONG AXIS
G
?R
-100.
.2
INPUT-T
.3

SHOCK SPECTRUM VALUES: SRM F.J.E.P.S. 3-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
1.	1.32	35.48	88.88
1.121	1.585	39.81	86.76
1.259	1.703	44.65	85.17
1.412	2.155	50.1	72.85
1.584	2.421	56.22	79.47
1.778	2.741	63.08	81.25
1.995	3.205	70.8	65.48
2.238	3.473	79.42	74.24
2.512	3.931	89.11	65.87
2.818	4.284	100.	70.23
3.162	4.84	112.1	39.8
3.547	5.381	125.8	49.62
3.98	6.043	141.2	62.26
4.467	6.912	158.4	62.7
5.011	7.847	177.8	79.57
5.623	8.968	199.5	90.56
6.309	10.03	223.9	94.42
7.078	11.11	251.1	74.61
7.941	12.81	281.8	68.61
8.912	15.68	316.3	78.74
10.	19.39	354.7	141.
11.21	23.48	398.1	111.9
12.58	28.39	446.7	172.8
14.12	32.63	501.2	218.4
15.84	35.61	562.5	253.4
17.78	41.25	630.9	290.5
19.95	45.26	708.1	419.6
22.38	47.04	794.1	281.2
25.11	60.	891.3	243.1
28.17	77.98	1000.	200.1
31.62	84.97		



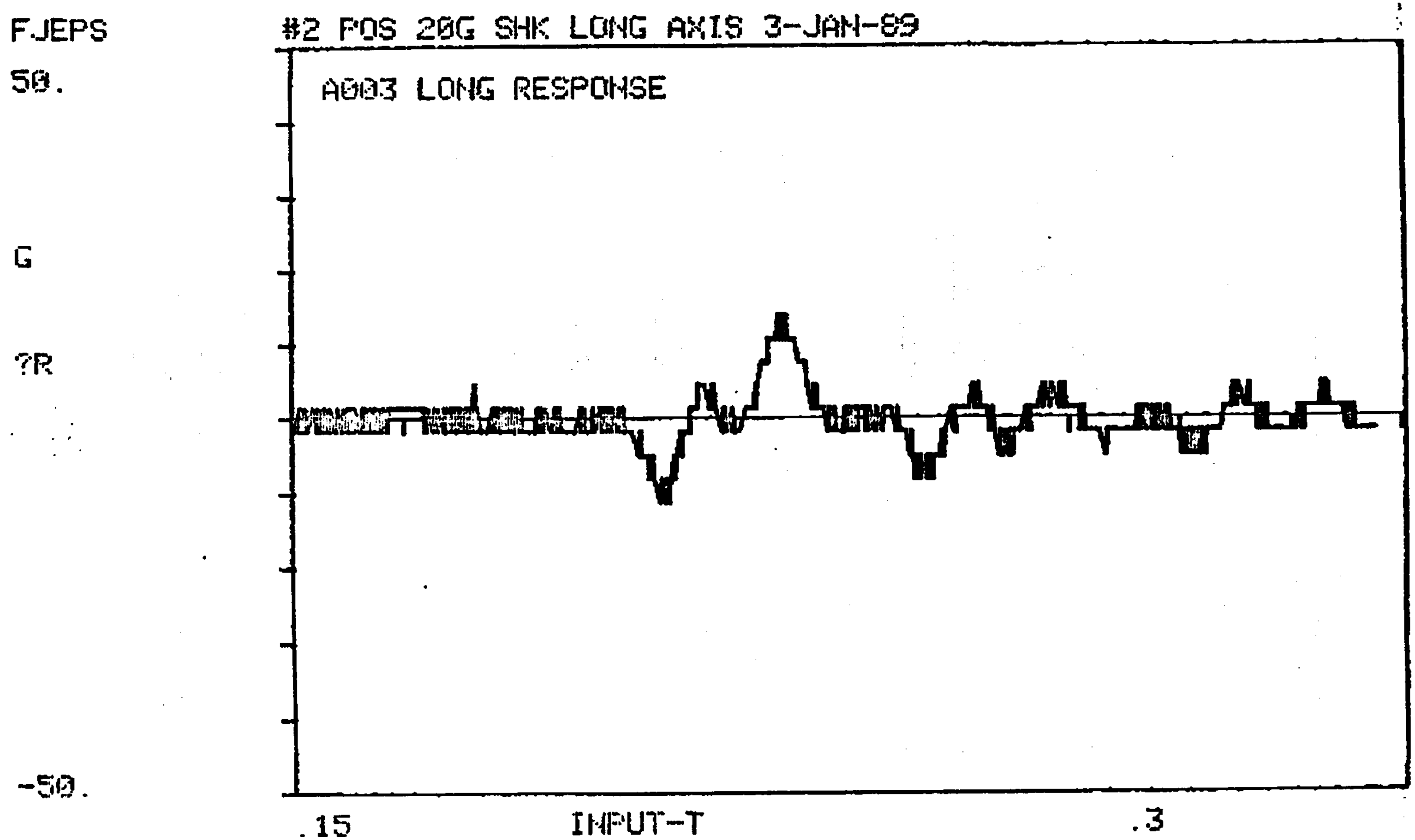
#1 POS 20G SHK LONG AXIS 3-JAN-89
A003 LONG RESPONSE
200.
G
?R
-200.
.2
INPUT-T
.34

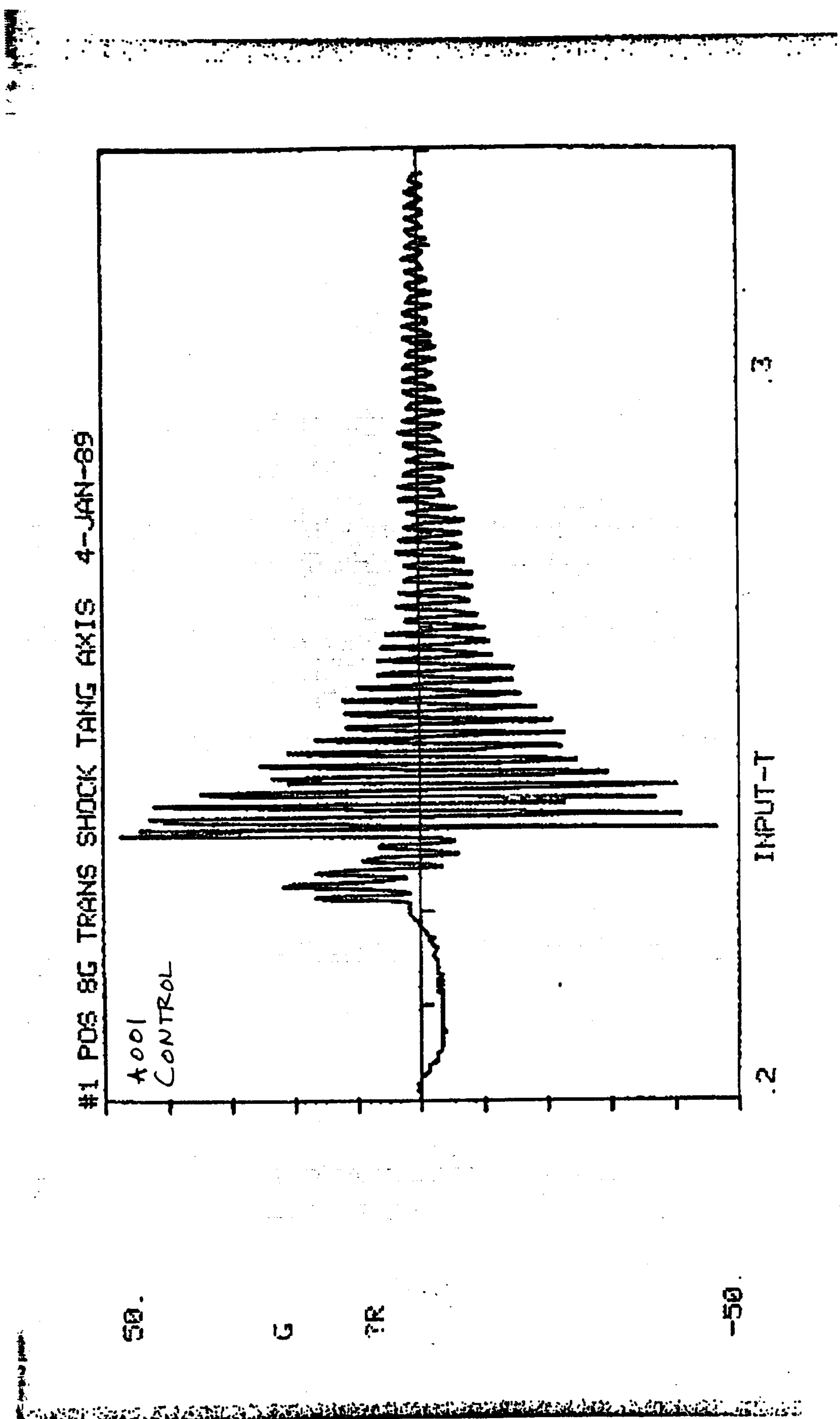


#2 POS 20G SHOCK TRANS 3-JAN-89
A001 CONTROL
Long axis
20.
G
-20.
0.
RESP WAVE-T
.5

SHOCK SPECTRUM VALUES: FJEPS 20G TRANS SHOCK 3-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
5.011	.6871	199.5	13.18
5.623	.874	223.9	13.23
6.309	1.11	251.1	13.05
7.078	1.406	281.8	13.11
7.941	1.767	316.3	13.41
8.912	2.32	354.7	12.72
10.	3.098	398.1	12.92
11.21	4.279	446.7	13.2
12.58	5.377	501.2	13.44
14.12	7.127	562.5	13.38
15.84	8.898	630.9	13.34
17.78	10.45	708.1	13.48
19.95	11.81	794.1	13.
22.38	13.51	891.3	13.01
25.11	15.18	1000.	13.28
28.17	17.37		
31.62	17.43		
35.48	16.98		
39.81	16.45		
44.65	14.85		
50.1	12.55		
56.22	13.74		
63.08	14.94		
70.8	21.38		
79.42	30.02		
89.11	32.38		
→ 100.	31.14		
112.1	24.28		
125.8	18.06		
141.2	13.95		
158.4	14.13		
177.8	13.18		


FJEPS
50.
G
?R
-50.
#2 POS 20G SHK LONG AXIS 3-JAN-89
A003 LONG RESPONSE
.15
INPUT-T
.3



#1 POS 8G TRANS SHOCK TANG AXIS 4-JAN-89
A001
CONTROL
50.
G
TR
-50.
.2
.3
INPUT-T

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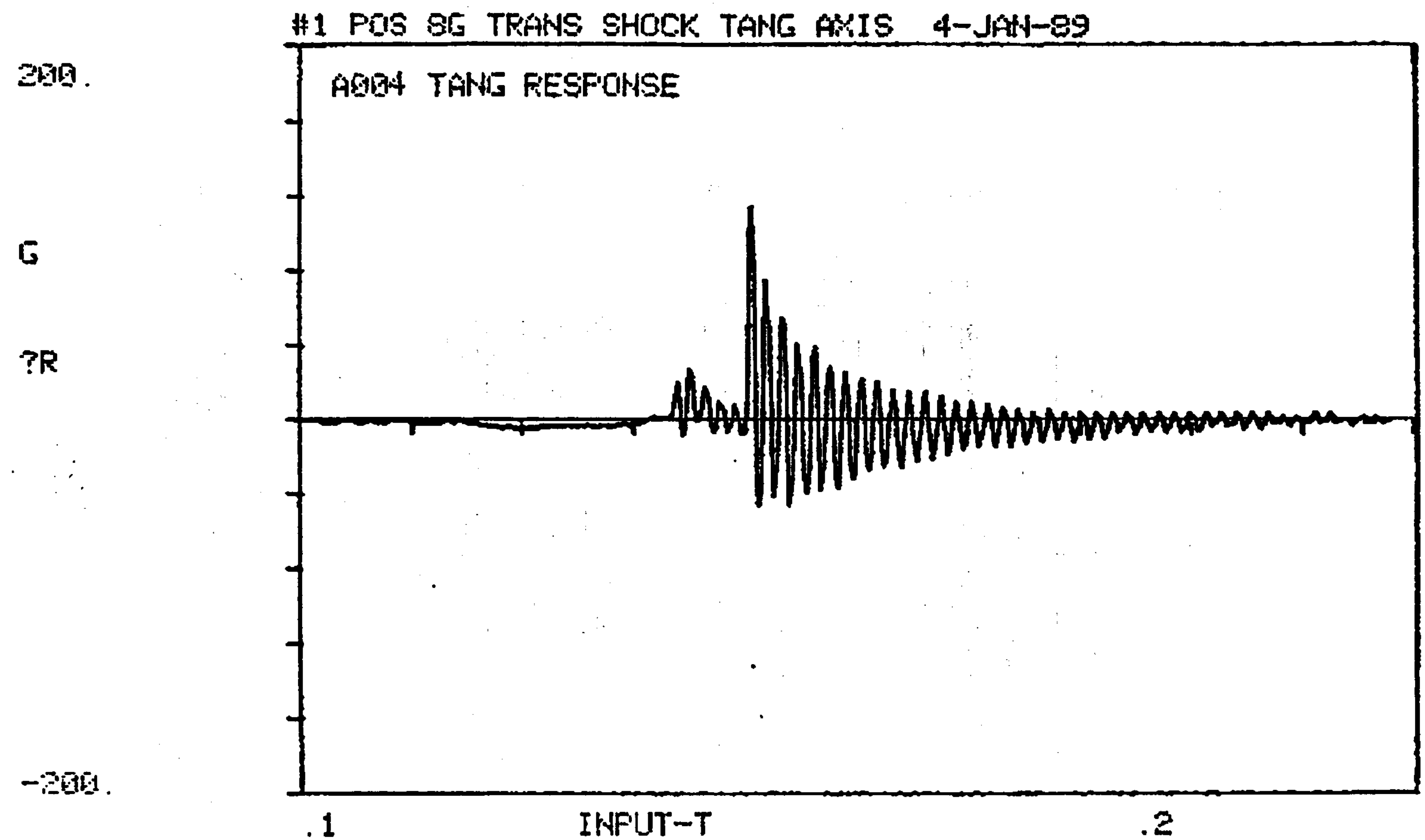
SHOCK SPECTRUM VALUES: FJEPS 8G SHOCK 4-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
1.	.09531	35.48	21.54
1.121	.1196	39.81	20.8
1.259	.1541	44.65	18.88
1.412	.1629	50.1	16.31
1.584	.1815	56.22	13.6
1.778	.2117	63.08	13.25
1.995	.2462	70.8	14.05
2.238	.2767	79.42	16.1
2.512	.3174	89.11	17.47
2.818	.3664	→ 100.	19.77
3.162	.4085	112.1	26.14
3.547	.4706	125.8	30.98
3.98	.5539	141.2	38.92
4.467	.6724	158.4	43.83
5.011	.8281	177.8	45.09
5.623	1.056	199.5	39.19
6.309	1.359	223.9	35.6
7.078	1.778	251.1	35.47
7.941	2.353	281.8	41.39
8.912	3.151	316.3	50.63
10.	4.166	354.7	54.92
11.21	5.42	398.1	59.53
12.58	6.944	446.7	64.2
14.12	8.75	501.2	70.17
15.84	10.79	562.5	106.6
17.78	13.01	630.9	[illegible]
19.95	15.23	708.1	255.1
22.38	17.42	794.1	143.7
25.11	19.53	891.3	117.8
28.17	21.22	1000.	98.86
31.62	21.17		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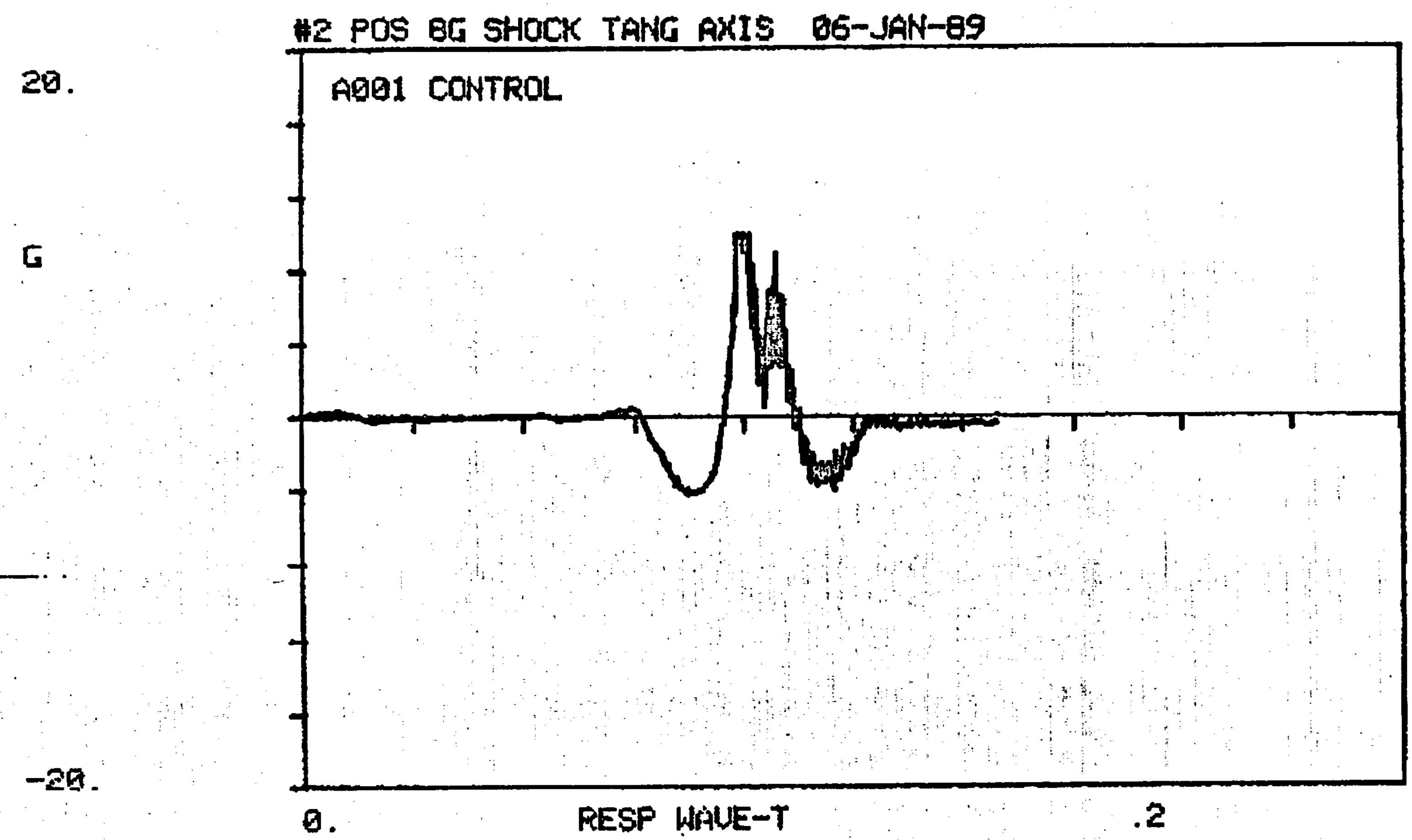
A004 TANG RESPONSE
200.
G
?R
-200.
.1
INPUT-T
.2


#2 POS 8G SHOCK TANG AXIS 06-JAN-89
A001 CONTROL
20.
G
-20.
0.
RESP WAVE-T
.2

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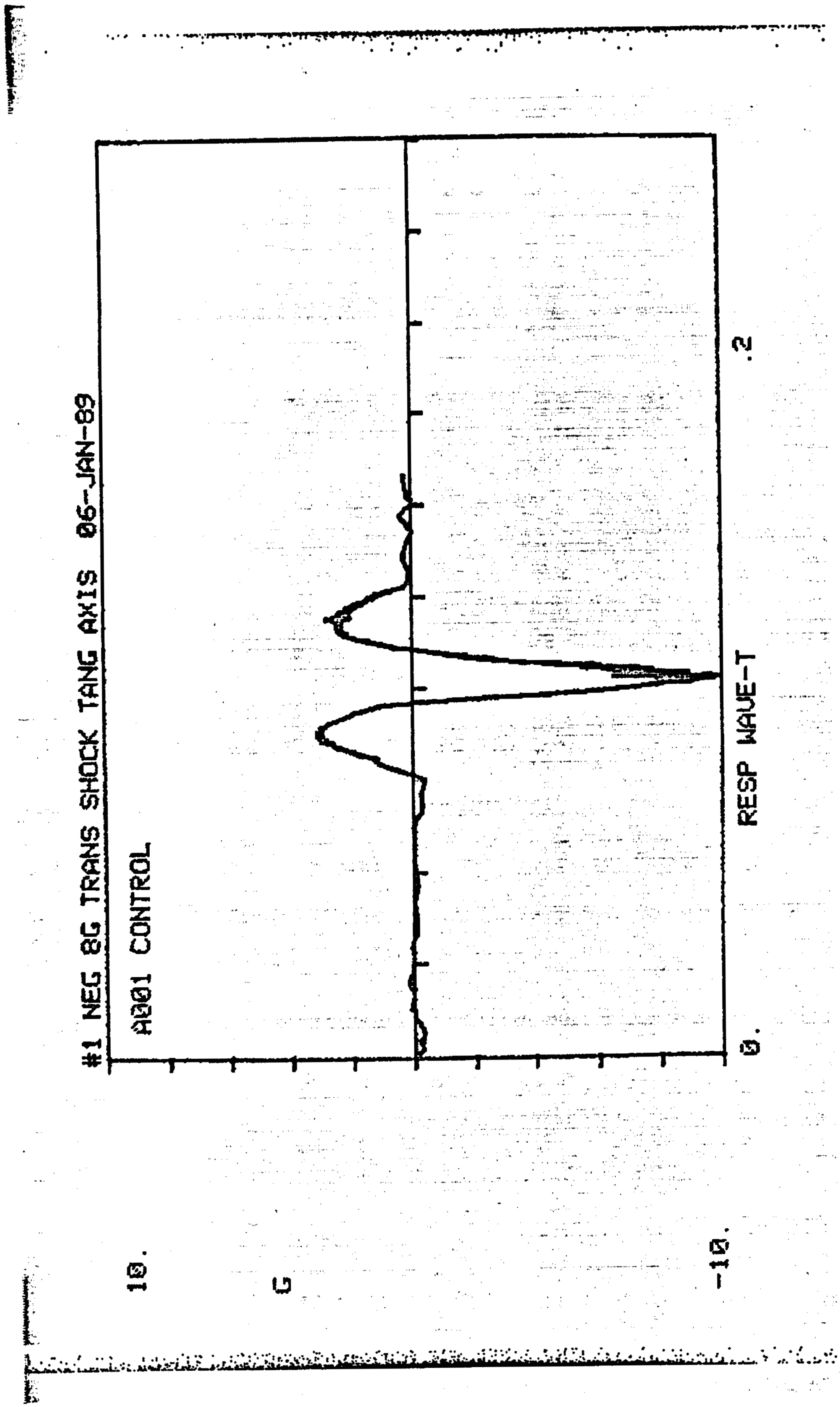
SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
12.58	2.616	501.2	13.44
14.12	3.433	562.5	13.34
15.84	4.445	630.9	12.87
17.78	5.749	708.1	12.48
19.95	7.468	794.1	12.83
22.38	9.517	891.3	13.06
25.11	11.85	1000.	13.
28.17	14.14	1122.	12.81
31.62	16.41	1259.	12.93
35.48	18.75	1412.	12.88
39.81	19.83	1584.	18.84
44.65	18.96	1778.	17.4
50.1	18.52	1994.	12.03
56.22	18.14	2238.	12.15
63.08	17.1	2511.	12.18
70.8	15.61		
79.42	15.95		
89.11	16.12		
100.	16.68		
112.1	15.92		
125.8	15.12		
141.2	15.19		
158.4	14.58		
177.8	13.69		
199.5	13.52		
223.9	13.15		
251.1	13.12		
281.8	13.27		
316.3	12.82		
354.7	12.63		
398.1	12.72		
446.7	13.1		


#1 NEG 8G TRANS SHOCK TANG AXIS 06-JAN-89
A001 CONTROL
10.
G
-10.
0.
.2
RESP WAVE-T

SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
12.58	2.293	501.2	9.176
14.12	2.988	562.5	8.852
15.84	3.872	630.9	9.062
17.78	4.987	708.1	9.024
19.95	6.467	794.1	8.953
22.38	8.19	891.3	8.942
25.11	10.25	1000.	9.032
28.17	12.35	1122.	9.07
31.62	14.58	1259.	9.114
35.48	16.86	1412.	9.115
39.81	18.13	1584.	9.191
44.65	18.16	1778.	9.04
50.1	17.46	1994.	9.848
56.22	15.84	2238.	10.31
63.08	14.94	2511.	11.17
70.8	13.75		
79.42	13.61		
89.11	13.77		
→ 100.	13.49		
112.1	12.8		
125.8	12.16		
141.2	12.08		
158.4	11.01		
177.8	9.92		
199.5	9.478		
223.9	8.914		
251.1	9.253		
281.8	9.747		
316.3	9.515		
354.7	9.194		
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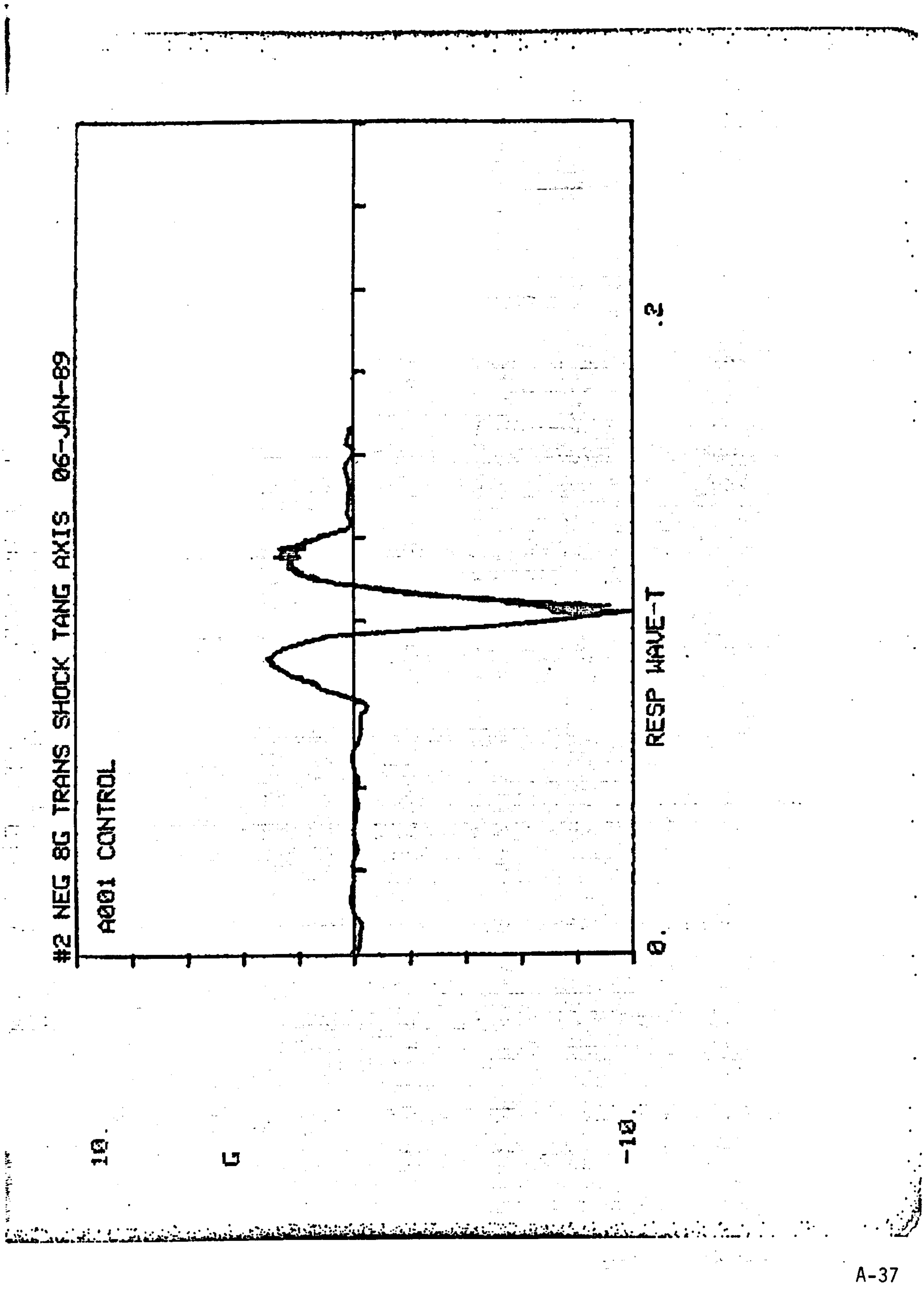
[illegible]	[illegible]		



#2 NEG 8G TRANS SHOCK TANG AXIS 06-JAN-89
A001 CONTROL
10.
G
-10.
0.
.2
RESP WAVE-T

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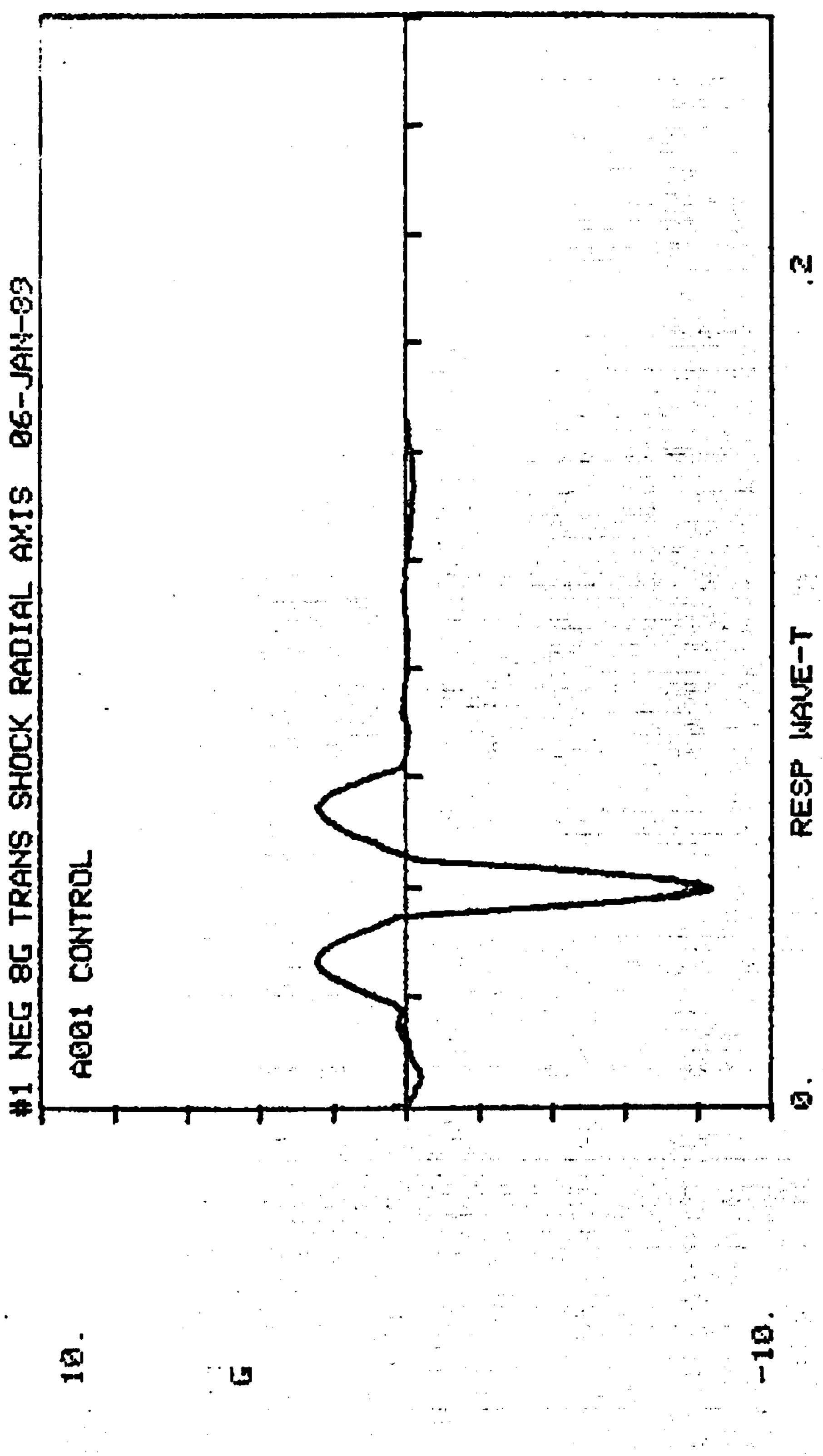
SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
12.58	2.287	501.2	9.028
14.12	2.989	562.5	8.713
15.84	3.885	630.9	8.91
17.78	5.004	708.1	8.93
19.95	6.466	794.1	8.881
22.38	8.172	891.3	8.85
25.11	10.24	1000.	8.916
28.17	12.34	1122.	8.985
31.62	14.56	1259.	9.003
35.48	16.83	1412.	9.054
39.81	18.12	1584.	9.073
44.65	18.12	1778.	9.069
50.1	17.42	1994.	9.557
56.22	15.71	2238.	10.6
63.08	14.89	2511.	11.15
70.8	13.72		
79.42	13.78		
89.11	13.8		
→ 100.	13.43		
112.1	12.1		
125.8	11.79		
141.2	11.79		
158.4	10.8		
177.8	9.849		
199.5	9.379		
223.9	8.781		
251.1	9.173		
281.8	9.594		
316.3	9.409		
354.7	9.047		
398.1	8.759		
446.7	9.062		



#1 NEG 8G TRANS SHOCK RADIAL AXIS 06-JAN-93
A001 CONTROL
10.
G
-10.
0.
.2
RESP WAVE-T

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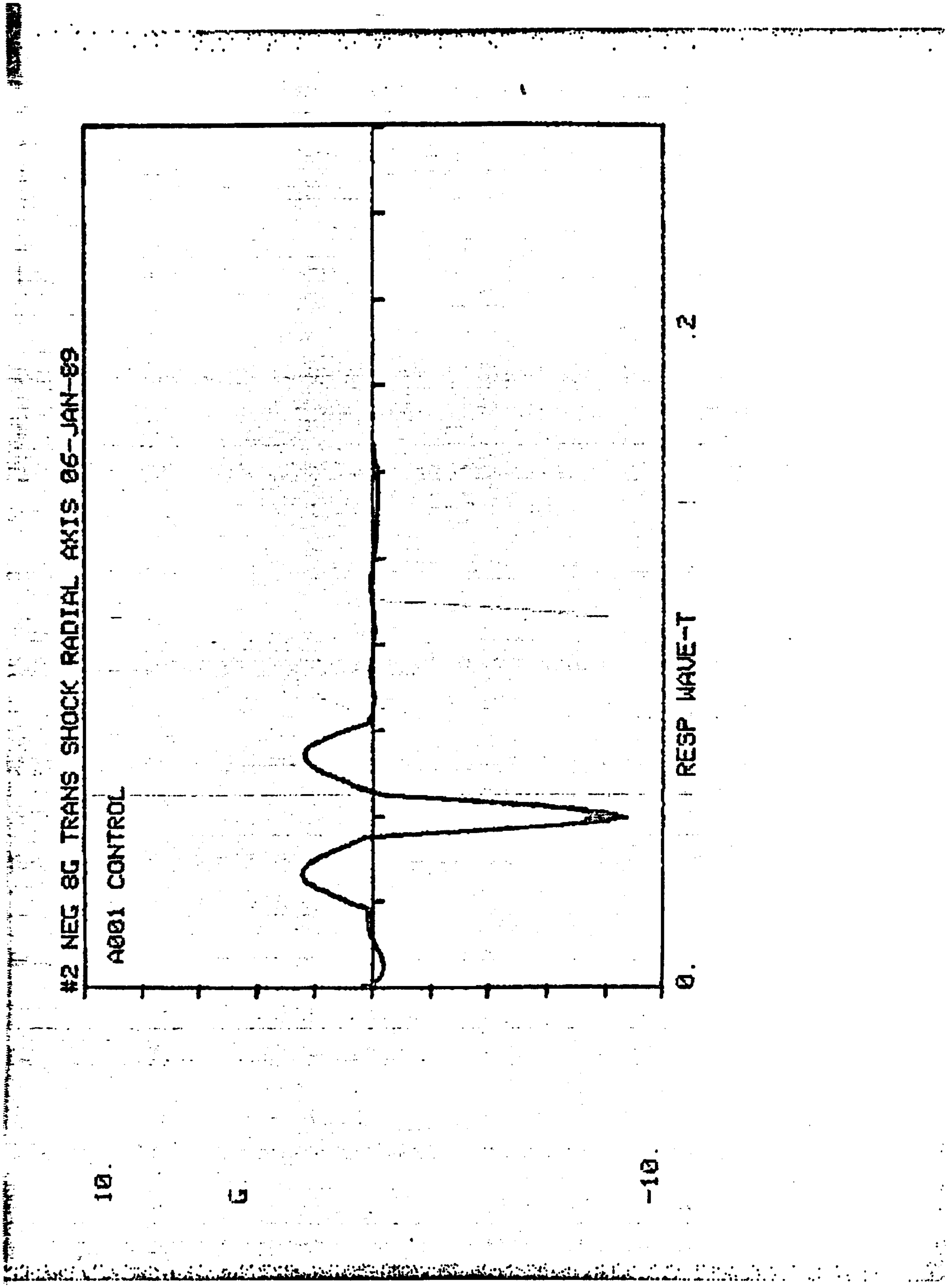
OF POOR QUALITY

SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G		
12.58	1.956	501.2	8.467
14.12	2.66	562.5	8.377
15.84	3.57	630.9	8.159
17.78	4.687	708.1	8.315
19.95	6.022	794.1	8.2
22.38	7.644	891.3	8.258
25.11	9.639	1000.	8.164
28.17	11.71	1122.	8.223
31.62	13.61	1259.	8.151
35.48	14.91	1412.	8.11
39.81	15.34	1584.	8.09
44.65	15.23	1778.	8.089
50.1	14.72	1994.	8.059
56.22	13.84	2238.	8.008
63.08	13.11	2511.	7.874
70.8	11.68		
79.42	12.48		
89.11	13.17		
→ 100.	12.96		
112.1	12.23		
125.8	11.57		
141.2	11.45		
158.4	10.77		
177.8	10.		
199.5	9.476		
223.9	8.588		
251.1	8.205		
281.8	8.776		
316.3	8.805		
354.7	8.713		
398.1	8.449		
446.7	8.247		



#2 NEG 8G TRANS SHOCK RADIAL AXIS 06-JAN-89
A001 CONTROL
10.
G
-10.
0.
.2
RESP WAVE-T

SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G
12.58	1.954
14.12	2.659
15.84	3.576
17.78	4.696
19.95	6.031
22.38	7.655
25.11	9.653
28.17	11.73
31.62	13.6
35.48	14.9
39.81	15.33
44.65	15.26
50.1	14.79
56.22	13.93
63.08	13.13
70.8	11.62
79.42	12.32
89.11	13.11
→ 100.	12.98
112.1	12.25
125.8	11.7
141.2	11.51
158.4	10.85
177.8	10.12
199.5	9.543
223.9	8.633
251.1	8.214
281.8	8.844
316.3	8.796
354.7	8.723
398.1	8.519
446.7	8.283
501.2	8.433
562.5	8.342
630.9	8.26
708.1	8.285
794.1	8.184
891.3	8.344
1000.	8.317
1122.	8.368
1259.	8.335
1412.	8.26
1584.	8.212
1778.	8.17
1994.	8.07
2238.	8.069
2511.	8.043

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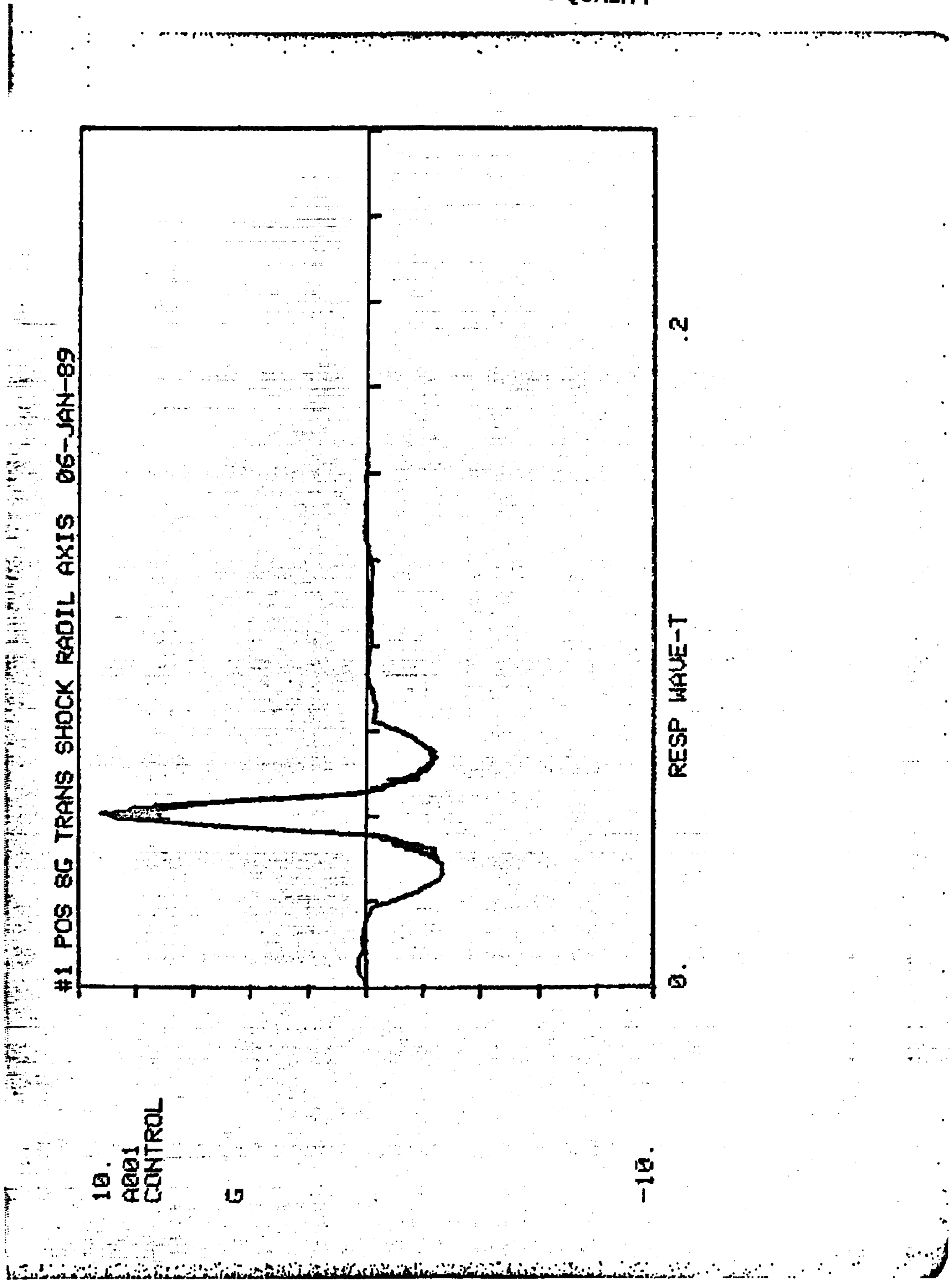

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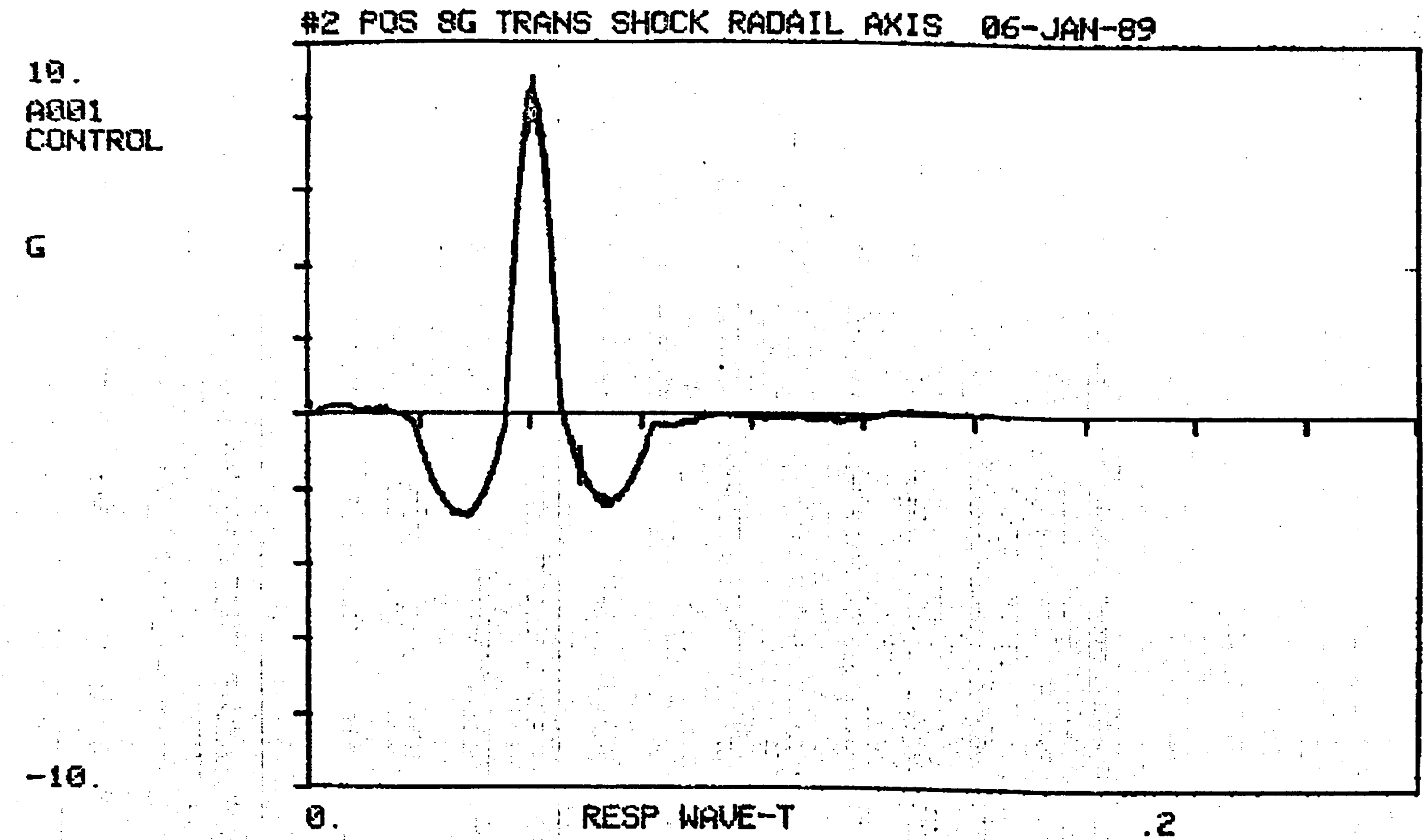
OF POOR QUALITY

SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G		
12.58	1.915	501.2	8.737
14.12	2.625	562.5	8.839
15.84	3.555	630.9	8.719
17.78	4.714	708.1	8.514
19.95	6.11	794.1	8.721
22.38	7.752	891.3	8.639
25.11	9.825	1000.	8.572
28.17	11.97	1122.	8.58
31.62	14.03	1259.	8.576
35.48	15.58	1412.	8.688
39.81	16.31	1584.	8.788
44.65	16.35	1778.	8.993
50.1	15.8	1994.	9.101
56.22	14.68	2238.	9.31
63.08	13.65	2511.	9.228
70.8	12.58		
79.42	13.39		
89.11	13.86		
100.	13.44		
112.1	12.54		
125.8	12.		
141.2	11.95		
158.4	11.33		
177.8	10.51		
199.5	9.958		
223.9	9.142		
251.1	8.56		
281.8	9.212		
316.3	9.229		
354.7	9.126		
398.1	8.829		
446.7	8.525		


#2 POS 8G TRANS SHOCK RADAIL AXIS 06-JAN-89
10.
A001
CONTROL
G
-10.
0.
RESP WAVE-T
.2

SHOCK SPECTRUM VALUES: FJEPS 8G TRANS SHOCK 06-JAN-89

FREQ-HZ	MAGN-G	FREQ-HZ	MAGN-G
12.58	1.925	501.2	8.855
14.12	2.625	562.5	8.774
15.84	3.562	630.9	8.534
17.78	4.728	708.1	8.705
19.95	6.123	794.1	8.598
22.38	7.792	891.3	8.634
25.11	9.868	1000.	8.554
28.17	11.99	1122.	8.737
31.62	14.07	1259.	8.582
35.48	15.63	1412.	8.569
39.81	16.35	1584.	8.59
44.65	16.42	1778.	8.488
50.1	15.85	1994.	8.59
56.22	14.71	2238.	8.593
63.08	13.65	2511.	8.618
70.8	12.55		
79.42	13.32		
89.11	13.85		
→ 100.	13.44		
112.1	12.52		
125.8	12.02		
141.2	11.97		
158.4	11.34		
177.8	10.54		
199.5	9.941		
223.9	9.091		
251.1	8.502		
281.8	9.174		
316.3	9.251		
354.7	9.106		
398.1	8.84		
446.7	8.578		

Appendix B

MEMO A400-FY89-139, "REDLINE TO CTP-0054, REV. C, 'QUALIFICATION TEST PLAN FOR FIELD JOINT ENVIRONMENTAL PROTECTION SYSTEM VIBRATION/PRESSURIZATION TEST'"

Note: The redline changes specified in this memo have been incorporated into CTP-0054, Rev. C. Revision C was accepted by NASA on 16 Feb 1989.

MORTON THIOKOL, INC.
Aerospace Group
Space Operations
John D. Thirkill

4 January 1989
A400-FY89-139

TO: Distribution

FROM: J. D. Thirkill

SUBJECT: Redline to CTP-0054, Rev. C, "Qualification Test Plan for Field Joint Environmental Protection System Vibration/Pressurization Test"

NASA has already approved the redline change. However, there is one area that was not marked up. Sheets 15 and 16 that are in question are attached.

These changes are required to finish the vibration test on the joint protection system hardware at T-53.

The Test Plan will be corrected for engineering traceability.

J. D. Thirkill

Attachments: a/s

TABLE II

FJEPS TEST CRITERIA

TEST	SPECTRUM & TOLERANCES	NOTES
FLIGHT RANDOM VIBRATION	20 - 50 Hz @ 0.020 g^2/Hz 50 - 150 Hz @ +3 dB/oct. 150 - 500 Hz @ 0.060 g^2/Hz 500 - 2000 Hz @ -6 dB/oct. 2000 Hz @ 0.0038 g^2/Hz Composite = 6.9 g_{rms} Duration = 360 seconds/axis Tolerances Composite Amplitude ± 10% PSD Amplitude +100%, -30% Frequency ± 5% Duration ± 10%, - 0%	For the initial 160 seconds of the vibration test, pressurize the test article as noted in the internal pressurization test (section 8.1.2 A-E).
REENTRY RANDOM VIBRATION (Radial Axis)	20 Hz @ 0.036 g^2/hz 20 - 180 Hz @ +6 dB/oct 180 - 280 Hz @ 3.13 g^2/hz 280 - 2000 Hz @ -6 dB/oct 2000 Hz @ 0.059 g^2/hz Composite = 35.2 g_{rms} Duration = 90 seconds/axis For test tolerances, see Flight Random Vibration (above).	None. 1000-2000 HZ SYSTEM RESONANCES IN THIS RANGE EXCEEDS PSD AMPLITUDE TOLERANCE.
(Tangential & Longitudinal Axis)	20 Hz @ 0.0039 g^2/hz 20 - 80 Hz @ +6 dB/oct 80 - 275 Hz @ 0.063 g^2/hz 275 - 560 Hz @ -9 dB/oct 560 - 2000 Hz @ 0.0075 g^2/hz Composite = 5.6 g_{rms} Duration = 90 seconds/axis For test tolerances, see Flight Random Vibration (above).	None.

TABLE II

FJEPS TEST CRITERIA (cont.)

TEST	SPECTRUM & TOLERANCES	NOTES
VEHICLE DYNAMICS CRITERIA (Longitudinal Axis) (Lateral Axis)	3.5 - 5 Hz @ 1.0 G's peak * 5 - 40 Hz @ 1.0 G's peak 2 - 5 Hz @ 1.7 G's peak * 5 - 10 Hz @ 0.6 G's peak 10 - 40 Hz @ 1.7 G's peak Sweep Rate = 3 Oct./Min. (1 Sweep from low to high frequency). <u>Tolerances</u> Peak Amplitude +20%, -10% Frequency ± 5% Duration +10%, -0%	For the initial 160 seconds of the vibration testing, pressurize the test article(s) as noted in the internal pressurization test (section 8.1.2 A-E). * Design Criteria Only.
SRB WATER IMPACT SHOCK CRITERIA (Longitudinal Axis) - - - - - - - - (Radial and Tangential Axis)	20 G's peak, 0.050 second, [.010] ½ - sine pulse. 2 shocks in flight direction. - - - - - - - - 8 G peak, 0.050 second, [.010] ½ - sine pulse. 2 shocks in each direction. - - - - - - - - <u>Tolerances (for both)</u> Amplitude: +40%, -20% Pulse Overshoot: +20% Duration: ± 10%	Long duration (0.1 - 0.15 sec) pulses are impossible to achieve on most electrodynamic shakers (0.070 - 0.080 sec. being about the limit). Since the majority of the test article response lies in the higher frequency range (compared to these lower frequency pulses) the pulse duration can be decreased to 0.050 sec. [.010] with negligible effect.

Appendix C

DISCREPANCY REPORTS NO. 168169 AND NO. 168188

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MORTON THIOKOL, INC.
Wasatch Operation.
P.O. Box 524, Brigham City, Utah 84302 (801) 863-3511

DISCREPANCY REPORT

TOTAL SHEETS: 1 (X)

Nº 168169

Field	Entry
1. PROGRAM	SPACE SHUTTLE
2. PROGRAM CODE	FE
3. TC NON CON MATL / CUST/GOVT FURN ITEM / VENDOR NON CON MATL / PROCESS DEPARTURE	[X] PROCESS DEPARTURE
4. PROJECT NO.	HQ302
5. PASS ORDER NO.	7A053000001
6. COMPONENT CODE	CMJ
7. ASSEMBLY PART NO.	7U76358-01
REV	N/C
8. ASSEMBLY SERIAL NO.	0000001
9. NAME OF ASSEMBLY	FJEPS VIB/PRESS
10. VENDOR NAME	N/A
11. VENDOR CODE	N/A
12. DISCREPANT PART NO.	7U76358-01
REV	N/C
13. DISCREPANT SERIAL NO.	0000001
14. NAME OF DISCREPANT PART	FJEPS VIB/ PRESS
15. RECEIVING REPORT NO.	N/A
16. PURCHASE ORDER/CONTRACT NO.	N/A
17. TOTAL DR ITEMS	01
18. TOTAL NO INSP	ONE
U/M	EA
19. TOTAL NO DISCREPANT	ONE
20. BLDG NO	T-53
21. MRB HOLD AREA	T-53?
22. OCD NO.	N/A
22A. IP ITEM NO	N/A
22B. MULT	N/A
22C. IP TYPE	P
22D. IP REV	N/A
22E. CAT	N/A
22F. CLIPS	N/A
22G. CPI NO	7A053
22H. REV	00
22I. OP NO.	150
22J. STEP NO	040
22K. REUSE	N/A
22L. REFURB	N/A
22M. DATA-ID	EA
23. ITEM NO.	01
24. QUANTITY	ONE
25. FREQ	N/A
26. ACCEPTED UNITS	N/A
27. REFERENCE DOCUMENT	CTP-0054 REV B PAGE 16 TABLE TWO

NON-CIL EIP 1/4/89

DESCRIPTION

28. SHOULD BE: IMPACT SHOCK CRITERIA, LONGITUDINAL AXIS, 20 G'S PEAK, 0.010 SEC.

CONDITION IS: CONTROL ACCELEROMETER LEAD WAS LOOSE, THUS GENERATING AN OVER SHOCK OF 70.23 G'S TOTAL

Field	Entry
29. INITIATOR	SCOTT WILSON
COST CENTER	8224
TIME	1500
DATE (MO DA YR)	01 03 89
30. SUPERVISOR APPROVAL	[signature]
TIME	0720
DATE (MO DA YR)	01 04 89
31. CUSTOMER ACKNOWLEDGEMENT	N/A
TIME	
DATE (MO DA YR)	
33. CAUSE CODE	N/A
34. RESP C/C	N/A
PRIORITY NO.	
BY	

CAUSE

32. CAR TO TEST ENGINEERING (ROBERT NIELSEN)

[illegible] Cause Code 01
[illegible] Cost Center 5632

CORRECTIVE ACTION

35. CAR

SDEDB DEF PARA | HC | DP
DR | FCI | MS
MOTOR NO. [illegible] | RETEST
CRITERIA

Field	Entry
36. CA DETERMINED BY	ROBERT NIELSEN
COST CENTER	5617
DATE	1/4/88
37. EFFECTIVITY SERIAL NO.	N/A
38. EFFECTIVITY DATE (MO DA YR)	N/A
39. CAR NO.	27465

DISPOSITION

Field	Entry
40. ITEM NO.	01
41. QUANTITY	1
42. DISP CODE	20
43. FINAL/MOST SEVERE DISPOSITION	ACCEPTABLE DEPARTURE

44. ACCEPTABLE DEPARTURE: NO VISUAL DAMAGE TO TEST ARTICLE. DATA FROM THIS TEST WILL BE ACCEPTED AS IS.

[signature]

C/W R. PALIGA 1-4-89

Field	Entry
45. CUST/GOVT WAIVER	YES [ ] NO [X]
46.	[X] PD [ ] PMR [ ] MRB
47. END CATEGORY	N/A
48. CLIFS AFFECTED	YES [ ] NO [X]
49. TC ENGR APPROVAL / DATE	[signature] 1-4-89
50. TC QA APPROVAL / DATE	[signature] 1-4-89
51. CUSTOMER APPROVAL / DATE	N/A
52. GOVT APPROVAL / DATE	N/A
53. DR RELEASED BY	[stamp: 31991 TMR WMB] 01 04 89
54. DISPOSITION COMPLETE	[stamp: T 31725 W] 01 06 89
55. SCHEDULE NEED DATE	

THIS APPROVAL DOES NOT CONSTITUTE A WAIVER BY THE GOVERNMENT OF ANY CLAIM FOR EQUITABLE PRICE ADJUSTMENT AS THE CONTRACTING OFFICER MAY DEEM APPROPRIATE BECAUSE OF SUCH WAIVER. THIS DISPOSITION DOES NOT ESTABLISH PRECEDENT FOR FUTURE DISPOSITIONS.

Nº 168169

FORM TC 1890 (REV 10 85)

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MORTON THIOKOL INC.
Wasatch Operations

DISCREPANCY REPORT

TOTAL SHEETS: 1 X

1. PROGRAM: SPACE SHUTTLE
2. PROGRAM CODE: FE
TC NON CON MATL / CUST/GOVT FURN ITEM / VENDOR NON CON MATL / PROCESS DEPARTURE [X]
№ 168188
4. PROJECT NO.: HQ302
5. PASS ORDER NO.: 7A053000001
6. COMPONENT CODE: CMJ
7. ASSEMBLY PART NO.: 7U76358-01 REV N/C
8. ASSEMBLY SERIAL NO.: 0000001
9. NAME OF ASSEMBLY: F JEPS VIB / PRESS
10. VENDOR NAME: N/A
11. VENDOR CODE: N/A
12. DISCREPANT PART NO.: 7U76358-01 REV N/C
13. DISCREPANT SERIAL NO.: 0000001
14. NAME OF DISCREPANT PART: F JEPS VIB / PRESS
15. RECEIVING REPORT NO.: N/A
16. PURCHASE ORDER/CONTRACT NO.: N/A

17 TOTAL DR ITEMS	18 TOTAL NO WSP	U/M	19 TOTAL NO DISCREPANT	20 BLDG NO	21 MRB HOLD AREA	22 OCD NO	22A IP ITEM NO	22B MULT	22C IP TYPE	22D IP REV	22E CAT	22F CLIFS	22G CPI NO	22H REV	22I OP NO	22J STEP NO	22K REUSE	22L RFFUPS	22M DATA ID
01	ONE	EA	ONE	T-53	T-53-T	N/A	N/A	NA	P	N/A	N/A	N/A	7A053	00	150	130	N/A	N/A	N/A

23. ITEM NO.: 01
24. QUANTITY: ONE
25. FREQ: NA
26. ACCEPTED UNITS: NA
27. REFERENCE DOCUMENT: CTP-0054 REV "B" PAGE 16 TABLE TWO
U/M: EA

DESCRIPTION

28. SHOULD BE: IMPACT SHOCK CRITERIA, TANGENTIAL AXIS 8G'S PEAK

CONDITION IS: OVER SHOCKED PART TO 19.77 G'S TOTAL.

NOTE: CAUSE UNKNOWN

29. INITIATOR: SCOTT WILSON COST CENTER: 8224 TIME: 1500 DATE: 01 04 89
30. SUPERVISOR APPROVAL: [signature] TIME: 1509 DATE: 01 04 89
31. CUSTOMER ACKNOWLEDGEMENT: N/A TIME: DATE:

CAUSE

32. CAR TO TEST ENGINEERING (Robert Nielson)

Preliminary Cause Code 04
Preliminary Cost Center 5632

33. CAUSE CODE: N/A
34. RESP C/C: N/A

SDEDB DEF PARA ____ HC ____ DC ____
DR ____ PCI ____ MB ____
MOTOR NO. ____ RETEST ____
CRITERIA ____

CORRECTIVE ACTION

35. CAR

NOTE: REF P.D.-168169

36. CA DETERMINED BY: MARK SWABSKY COST CENTER: 8830 DATE: 01 04 89
37. EFFECTIVITY SERIAL NO.: NA
38. EFFECTIVITY DATE: NA
39. CAR NO.: 21465

DISPOSITION

40. ITEM NO.: 01
41. QUANTITY: 1
42. DISP CODE: 20
43. FINAL/MOST SEVERE DISPOSITION: ACCEPTABLE DEPARTURE

44. ACCEPTABLE DEPARTURE. NO VISUAL DAMAGE TO TEST ARTICLE. OVERTEST MET AND EXCEEDED TEST REQUIREMENTS. DATA FROM THIS TEST WILL BE ACCEPTABLE. FACILITY CHECKOUT WILL BE PERFORMED TO VERIFY THE INTEGRITY OF THE SHOCK SYSTEM BEFORE TESTING IS CONTINUED.

R. Callsa 1-5-89 Robert Nielsen 1/5/89

45. CUST/GOVT WAIVER: YES / NO [X]
46. CLIFS AFFECTED: YES / NO [X]
47. END CATEGORY: N/A
48. [X] PD / PMR / MRB
49. TC ENGR APPROVAL: [signature] 1-5-89
50. TC QA APPROVAL: [signature] DATE: 1/5/89
51. CUSTOMER APPROVAL: N/A
52. GOVT APPROVAL: N/A
53. DR RELEASED BY: [stamp 31091 TMRB W] 01 05 89
54. DISPOSITION COMPLETE: [stamp 31725 W] 01 06 89

55. SCHEDULE NEED DATE:
PRIORITY NO. BY:

FORM TC 1890 (REV 10-85)

THIS APPROVAL DOES NOT CONSTITUTE A WAIVER BY THE GOVERNMENT OF ANY CLAIM FOR EQUITABLE PRICE ADJUSTMENT AS THE CONTRACTING OFFICER MAY DEEM APPROPRIATE BECAUSE OF SUCH WAIVER. THIS DISPOSITION DOES NOT ESTABLISH PRECEDENT FOR FUTURE DISPOSITIONS.

№ 168188

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