Metal Bellows Corporation

CHATSWORTH, CALIFORNIA

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FPU

CR 364

REPORT

HOSE ASSEMBLY

FLEXIBLE METAL - INSTRUMENTATION

PER ASME SECTION III, CLASSES 2 AND 3

SEISMIC CATEGORY I

20960 Knapp Street • Chatsworth, California 91311 • U.S.A. • Telephone (213) 341-4900 • Telex 651-483

METAL Bellows CORPORATION

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1.0 INTRODUCTION

The objective of the Design and Generic Test Program has been to develop, refine, and prove a superior hose design that would readily pass conservative worst case conditions considering the ASME Boiler and Pressure Vessel Code, Section III, Subsection NA, NC, ND, and MC, as well as the practical application conditions.

Considering the various potential applications for instrumentation and cooling water lines, a worst case 2500 psig 700°F condition was picked for generic test confirmation of the hose. One universal design and size was resolved to meet all of the initial size and operating cases beginning at 125 psi, 180°F to the 2500 psig 700°F case.

A Design objective of 40 year life was set, defined as 2000 hot, pressurization and shutdown cycles, with vibration, seismic, proof, and burst tests, with appropriate inspection and Mass Spectrometer level leakage tests. Specific tests considering Code K_s factors, etc., were:

Hot/Pressurization/Deflection/Depressurization/Cycling

4000 cycles at 750 ±50°F consisting of pressurization to 2500 psi, move to a 5.00 inch diagonal deflected position in the X, Y and Z axes, depressurization, return to installed position and repeat.

Operational Vibration

One million total cycles were performed, equally divided between each of 3 axes, pressurized in the 5.00 inch fully deflected position at 5 to 100 Hz, swept at one octave per minute per the required response spectra, which developed 3 to 51 g's depending on frequency.

Seismic

Tested per the required response spectrum, 1.5 to 16.5 g, which covers the majority of power plant locations in the United States. Biaxial tests were conducted (two axes simultaneously). The X-Z plane was tested for the three possible conditions; empty, filled with water, and finally filled with water and pressurized. The tests were then repeated for the Y-Z axis for a total of six tests of 45 seconds each. Note that the Z axis in which the most deflection occurs conservatively was tested twice.

Hydrostatic

After Mass Spectrometer leakage testing to insure that no leaks had developed, pressure was applied to specified proof conditions, 3750 psi for two minutes to verify integrity and lack of deformation. Burst pressure of 8750 psi was applied and held for two minutes to again verify structural integrity. Pressure was then increased for the actual failure test. Final failure was achieved on the second test after a test equipment failure at 11,200 psi. The final failure was not catastrophic. The braid-restrained hose simply leaked fluid when 11,200 psi was reached the second time.

Of six possible mounting configurations, the four shown on the installation drawing were evaluated for torsional load required to deflect (which relates directly to stress) and freedom to deflect under vibration and seismic conditions. The worst case, an unsupported "U" configuration was chosen for testing.

Material selection was based on the use of Inconel 625 for the hose and transition end tangents for the High Temperature High Pressure applications and those involving chlorides. Austenetic Stainless Steel is intended for low temperature and low pressure, non-chloride applications and for low stressed pressure boundry areas.

METAL Bellows CORPORATION

The central intent of the project was to produce a design appropriate for Nuclear use that is substantially superior to the design of normal aerospace quality hose. Five specific and interacting design concepts involving convolute end tangents and support components, were combined to assure uniform stress distribution and the ability to readily pass generic testing and assure safe general usage.

The reasons for success of the project are an N/NPT Stamp qualified supplier, intent on proper quality controls, the special design superior to aerospace hose, ASME quality material with proper processing and control of processing and proof of qualification based on a generic test that conservatively exceeds actual conditions.

METAL Bellows COMPANY

METAL BELLOWS CORPORATION
CHATSWORTH, CALIFORNIA

QTP 73989
QUALIFICATION TEST PROCEDURE

FOR

HOSE ASSEMBLY - FLEXIBLE METAL

PER ASME SECTION III, CLASS 2

JOB NO. 11337

E. A. Jachacz, Staff Engr.

R. H. Nystrom, Project Engr.

P. B. Campbell, Engr. Mgr.

W. E. Hughes, Q. A. Manager

No. of Pages 11

September 17, 1976

Rev. J March 10, 1977

INDEX OF REVISIONS

Date and Rev.	Pages Affected			Remarks	Revised by
	Revised	Added	Deleted		
10/13/76 A	Cover, 5, 6	i		Changes to Paragraphs 4.4, 4.5, 4.6, and added Paragraph 4.7.	EAJ
10-29-76 B	Cover, i, 3 5, 6, 7, 8 11	10		Changes to Para. 3.8, 4.4, 4.5, 4.6, Fig. 1, Fig. 2, Added figure 4, (Page 10) Page 11 was Page 10	EAJ
11-9-76 C	Cover, i, 5, 6, and 10			Change Paragraphs 4.4, 4.5, 4.6, and Figure 4	EAJ
12-1-76 D	Cover, i, 3, 5, 6, 8, 9			Change Paragraphs 3.8, 4.3, 4.5, 4.6, and Figures 3 and 4	EAJ
1-17-77 E	Cover, i, 9, 10			Revised Figures 3 and 4.	EAJ
1-25-77 F	Cover, i, 5, 6 & 10			Revised para. 4.5 and Fig 4.	EAJ
2-4-77 G	Cover, i, 3, 6, 9			Revised Paragraphs 3.8 and 4.6; added Paragraph 4.7. Revised fig. 3	EAJ
2-25-77 H	Cover, i, 6 9			Revised Para. 4.5, Fig. 3	EAJ
3-10-77 J	Cover, i, 4, 6, 9			Revised Para. 3.10, 4.7 and Figure 3.	EAJ

1.0 SCOPE

This document establishes the procedures Metal Bellows Corporation (MBC) shall follow to perform the qualification tests on the Hose Assembly - Flexible Metal per ASME Section III, Class 2, MBC P/N 73989, hereafter referred to herein as the "hose assembly".

2.0 APPLICABLE DOCUMENTS

2.1 American Society of Mechanical Engineers (ASME)

ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, Subsection NA, General Requirements.

ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, Subsection NC, Class 2 Components.

2.2 The Institute of Electrical and Electronics Engineers, Inc.

IEEE STD 344-1975 - IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

2.3 Military

MIL-P-27401, Class I, Pressurizing Agent, Gaseous Nitrogen

MIL-P- 27407, Pressurizing Agent, Gaseous Helium

MIL-C-45662, Calibration System Requirements

MIL-STD-810, Environmental Test Methods

2.4 Metal Bellows Corporation

CPS 3071, Leak Detecting Procedure

Drawing Number 73989, Hose Assembly - Flexible Metal per ASME Section III, Class 2

3.0 ADMINISTRATIVE DATA

3.1 Test Conditions

Unless otherwise specified, all measurements and tests shall be at "ambient" or "standard test" conditions as follows:

a) Temperature: 55 to 85°F

b) Pressure: 24 to 30 in Hg.

c) Relative Humidity: 20 to 80%

3.2 Test Tolerances

Unless otherwise specified, the test tolerances shall be as specified in MIL-STD-810

3.3 Calibration

Instrument calibration shall be in accordance with MIL-C-45662, and all gages for hydrostatic tests shall be in accordance with ASME Section III, NC 6000.

3.4 Test Facility

The testing shall be performed at MBC and/or an outside commercial laboratory approved by MBC.

3.5 Support and Participation

MBC shall be responsible for conducting all tests and provide total monitoring of all outside tests. Cognizant MBC design and quality assurance personnel shall be notified of intent to test and the time of test.

3.6 Quantity to be Tested

One test specimen, Part Number 73989, shall be subjected to all tests described in paragraph 4.0.

3.7 Reason for Test

The tests shall be conducted to verify that the design meets the specification requirements and successful completion of the tests shall qualify the configuration for use in Nuclear power plant generating stations.

3.8 Test Sequence

The test shall be conducted in the sequence shown below:

TEST SEQUENCE		
Test	DESCRIPTION	Applicable Paragraph
1	Inspection	4.1
2	Proof Pressure	4.2
3	Leakage	4.3
4	Thermo and Operating Cycle Test	4.4
5	Leakage	4.3
6	Operational Vibration Test	4.5
7	Leakage	4.3
8	Seismic	4.6
9	Leakage	4.3
10	Hydrostatic Pressure	4.7

3.9 Data Requirements, Reduction and Analysis Techniques

A All data required by the section 4.0 procedures shall be recorded on the applicable testing laboratory test data sheets.

B All data shall be witnessed by the test personnel and MBC witnessing personnel to the extent necessary to certify the test results.

C Test data sheets for each test shall include as a minimum pertinent parameters, i.e., part numbers, serial numbers, date, time, verification of environmental conditions, test parameters, all required input/output/computed data and initials/stamp of operator and witnessing personnel.

D Photographs as required to validate test setup.

E Copies of plots of frequency vs. acceleration for the input and response accelerometers during the survey and for the response accelerometers during the vibration to verify the input for vibration test.

F Justification for any deviation from the test procedure.

3.10 Description of Test Specimen

The hose assembly is a flexible metallic constructed configuration with a convoluted interior wall and a braided exterior. The hose is a nominal .44 inside diameter approximately 42.25 inches in length with 1/2 O.D. X .095 wall Tubestubs. The test sample shall include additional test sections on each end with standard "B" type nut assemblies, compatible for easy connections and for pressurizing.

4.0 TEST PROCEDURE

4.1 Inspection

Each hose assembly shall be examined for workmanship, material and process certifications, dimensional and interface requirements to MBC Drawing 73989. (Figure 3)
The inspection results shall be recorded on the Inspection Check List (ICL).

4.2 Proof Pressure

Hydrostatic proof pressure the hose with an internal pressure of 5330^{+25}_{-0} psig for a period of 10^{+1}_{-0} minutes. There shall be no evidence of permanent deformation or failure during the test or after release of the pressure.

4.3 Leakage

Install the hose assembly on the mass spectrometer such that the interior of the hose is exposed to the vacuum pressure of the mass spectrometer. Check the hose assembly for total leakage per CPS 3071, paragraph 3.2. The leakage shall not exceed 1×10^{-6} scc/sec of He.

4.4 Thermo and Operating Cycle

Install the hose assembly as shown in figure 4. The hose assembly shall then be placed in a chamber and the ambient temperature and fluid temperature shall be maintained at 700°F±50°F. The hose assembly shall be cycled 4000 times. A cycle is defined from installed position and pressurized at 2500 psig, hold for two (2) seconds minimum, move the movable end of the hose assembly to a equivalent position of +5.00 inches on a spherical radius in the X, Y, and Z axis, reduce the pressure in the hose assembly to 0 psig, and then return to the install position.

This exceeds the requirements of 2000 design cycles of ASME Boiler and Pressure Vessel Code, Section III, Class 2, 1974 Edition, through the summer of 1976 Addenda, and NC3641.4.

At the conclusion of the above test, the hose assembly shall meet the leakage requirements of paragraph 4.3.

4.5 Operational Vibration

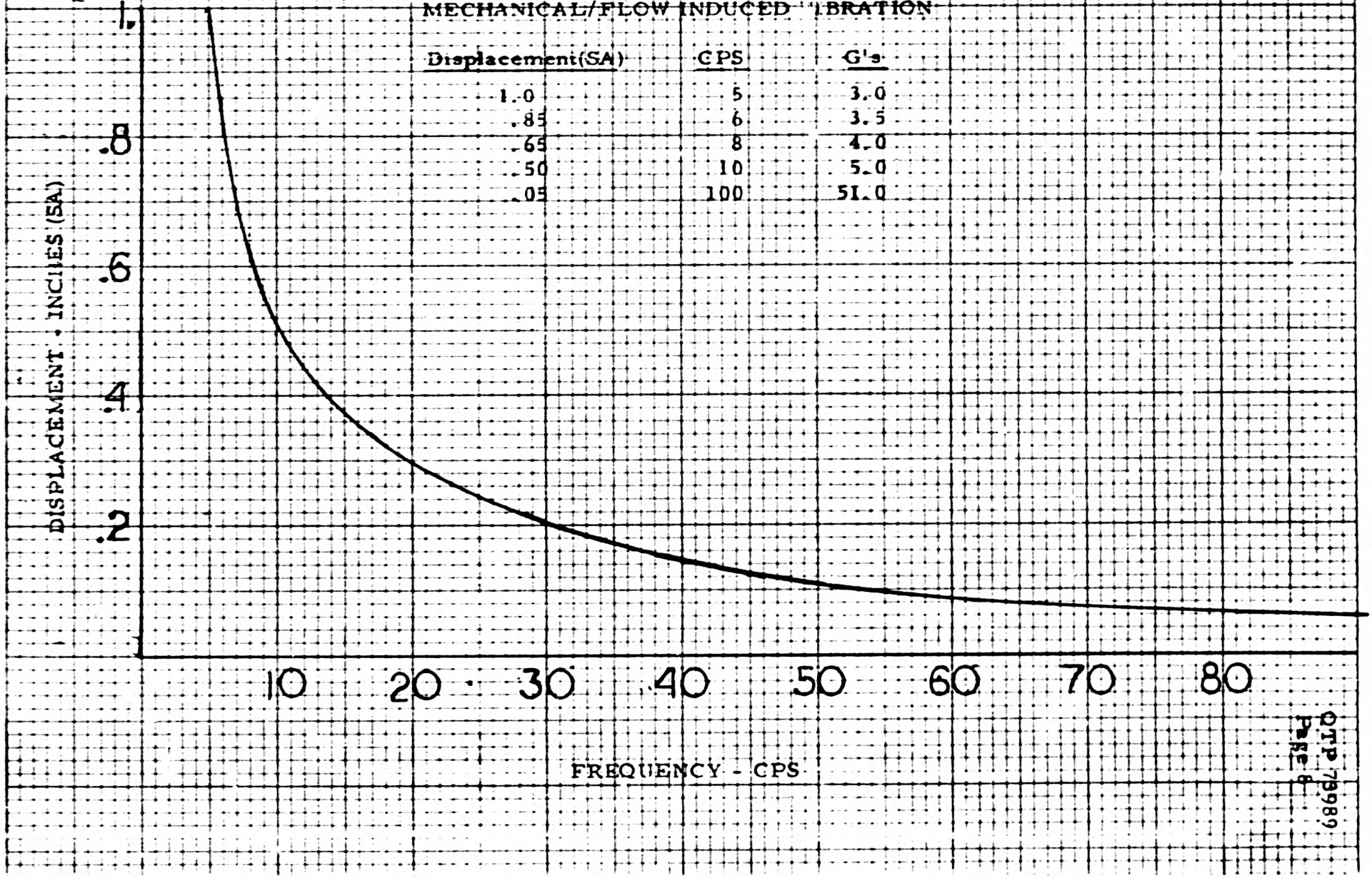
Install the hose assembly into a configuration as shown in Figure 4, with the fixed end of the hose assembly off the vibration table. The movable end shall be mounted on the test fixture on the vibration table to an equivalent position of -2.88 inches in the X axis, + 2.88 inches in the Y axis, and -2.88 inches in the Z axis, which shall be subjected to the vibration levels. The hose assembly shall be pressurized with water to 2,500 psig, and close off the pressure source. Sine sweep the hose assembly from 5 to 100 HZ at one (1) octave per minute for a total of 1/3 million (333,334) cycles in each axis for a total of one (1) million cycles.

Figure 2.

MBC P/N 73989

MECHANICAL/FLOW INDUCED VIBRATION

Displacement(SA)	CPS	G's
1.0	5	3.0
.85	6	3.5
.65	8	4.0
.50	10	5.0
.05	100	51.0



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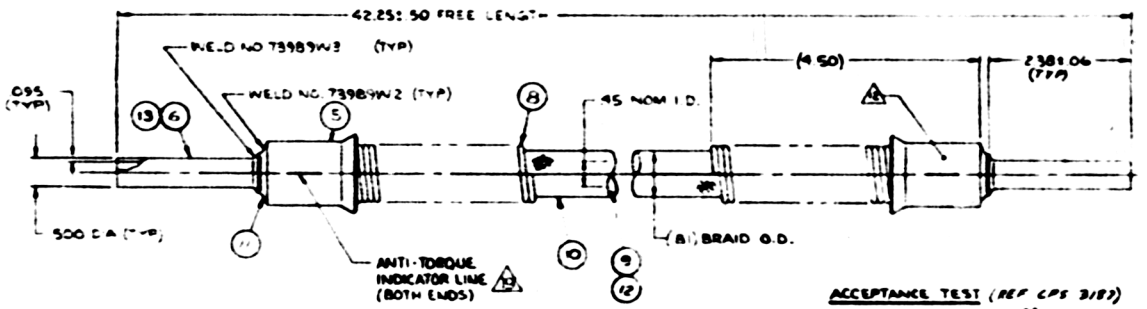
F	ENVELOPE RELEASE		
G	ADDED NOTE 19 (ECO 16751)		
H	REVISED PER ECO [illegible]		
J	ADDED PARTS LIST [illegible]		
K	REVISED PER ECO [illegible]		
L	REVISED PER ECO [illegible]		
M	REV. PER ECO 17199		
N	ECO 17292		

3. DESIGN CONDITIONS:
   DESIGN PRESSURE 2500 PSIG MAX
   DESIGN TEMPERATURE 100°F
   PROOF PRESSURE: 5330 PSIG
4. DELETED
5. LIQUID PENETRANT INSPECT WELDS AND APPROVE PER CPS 3118, CLASS C
6. POST HEAT TREATMENT NOT REQUIRED.
7. HOSE SHALL BE CAPABLE OF BEING BENT TO 3.0 INCH R RAD
8. MATERIAL TRACEABILITY TO BE MAINTAINED AT ALL TIMES IN ACCORDANCE WITH ASME SECTION III, PARA NA3766 USING THE PROCEDURE AS DEFINED IN MBC QC MANUAL BY SERIAL NO.
9. DELETED
10. DELETED
11. HOSE DESIGN & MANUFACTURE SHALL MEET THE REQUIREMENTS OF ASME SECTION II CLASS 2 OF 1974 EDITION.
12. AFTER ACCEPTANCE TESTING IDENTIFY AS SHOWN WITH THE FOLLOWING INFORMATION:
    (N PT 2) METAL BELLOWS CO
    2500 PSIG AT 100°F MAX
    P/N 16519/73989-XXX
    SERIAL NO. ———
    YEAR BUILT ———
    CODE CASE N-188-1 & N-192
13. DELETED
14. WITH ONE END FIXED, THE OTHER END SHALL BE CAPABLE OF BEING OFFSET 5 INCHES IN ANY DIRECTION FOR 2000 CYCLES.
15. WITH ONE END FIXED, THE OTHER END SHALL BE CAPABLE OF BEING OFFSET UP TO 1 INCH FOR INFINITE LIFE.
16. WITH ONE END FIXED, THE OTHER END SHALL BE CAPABLE OF AN INFINITE LIFE WITH A MAXIMUM OF 6gs IMPOSED VIBRATION.
17. WITH ONE END FIXED, THE OTHER END SHALL BE CAPABLE OF .1 INCH SEISMIC MOTION IN ANY DIRECTION, 100 CYCLES, 9 CPS
18. HOSE ASSEMBLY SHALL BE CAPABLE OF 1500 PSIG OPERATION AT 1000°F FOR A MAXIMUM OF 30 HOURS TOTAL
19. INDICATOR LINES TO PROVIDE A VISUAL INDICATION THAT EXCESSIVE TWIST HAS NOT BEEN IMPOSED ON HOSE AFTER INSTALLATION (SEE INSTRUCTION MANUAL IM73989)

△ WELD PER CPS 3049 WELDING PROCEDURE AS REQUIRED PER SFA 5.14 TYPE ER 70 S-3 (NOMINAL 2% Ni AWS CLASSIFICATION FOR NICKEL MOD-3)

△ SEE MBC REPORT CR-109 FOR INSTALLATION CONFIGURATIONS



ACCEPTANCE TEST *(REF CPS 3181)*

1. HYDROSTATIC PROOF TEST AT 5330 +50 -0 PSIG FOR 10 +5 -0 MINUTES. THERE SHALL BE NO PERMANENT DEFORMATION.
2. MASS SPECTROMETER LEAK TEST PER CPS 3071. LEAKAGE SHALL NOT EXCEED 1×10^{-6} SCC/SEC HELIUM AT ONE ATMOSPHERE △ PRESSURE.
3. LIQUID PENETRANT INSPECT WELDS (73989W2 & W3) PER NOTE 5 AFTER LEAK TESTING.

2	2				B76837	END TUBE		
1		1			C74591-01	INT		
2	2	2	2		C74991	ADAPTER		
1	1	1	1		C75752-7	BRAID		
	1		1		C74987	FMT		
2	2	2	2		C75736	SPACING		
AR	AR	AR	AR			FILLER WIRE		
		2	2		B74835	END TUBE		
2	2	2	2		B74833	FERRULE		
					D73989-201	HOSE ASSY		
					D73989-2	HOSE ASSY		
					D73989-101	HOSE ASSY		
					B74949	WIRE ASSY		

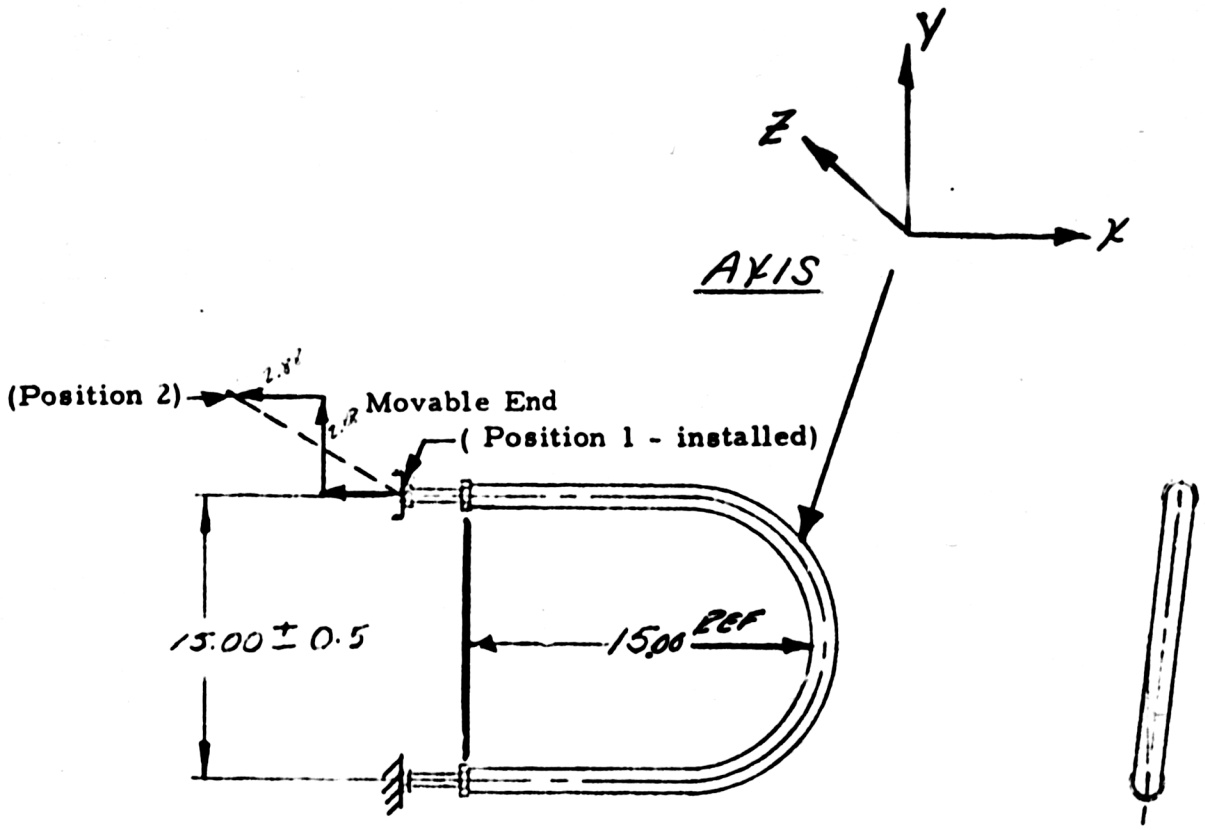
PARTS LIST

METAL BELLOWS CO AVICAFLEX

HOSE ASSEMBLY - FLEX METAL PER ASME SECTION III CLASS 2

(ENVELOPE)

D 16519 | 73989



NOTE: See Figure 3 for Installation Information.

INSTALLED POSITION OF HOSE

Total free length of Hose is approximately 45 inches.
Free length of hose less adapters, approximately 37 inches.
Movable end to move ± 2.88 inches motion in all planes. This meets the requirement of the movable end being capable of moving in a 5.0 inch spherical radius.

Moving from Position 1 to Position 2 may be in a straight line (-X, +Y, -Z)

Figure 4

METAL Bellows COMPANY

INSPECTION CHECK LIST

QTP 7398-
Page 11
REV: _____
DATE: _____

MBC Q.C. APPROVAL _____

PART No. 73989 Rev. _____ DESCRIPTION _____

JOB No. 11337 _____ Lot No. _____ Qty. _____

Item No.	Dimension or Req.	Tol.	Tool or Equipment Used	Results	Pcs. Acpt.	Pcs. Rej.	Remarks

Inspected _____ Date _____ Sheet _____ of _____

Customer MBC Customer Q.C. _____ Date _____

Form #QC-1

APPROVED ENGINEERING TEST LABORATORIES

Report No. 5410-7197
P.O. No. 78054
Date: 8 March 1977
39 Page Report

Test Report No. 5410-7197

Qualification Test Report

on

Hose Assembly - Flexible Metal
per ASME Section III, Class 2

Part Number 73989
Serial Number 007

TESTED FOR:

METAL BELLOWS CORPORATION
20977 Knapp Street
Chatsworth, California 91311

TESTED BY:

APPROVED ENGINEERING TEST LABORATORIES
9551 Canoga Avenue
Chatsworth, California 91311

OFFICIAL SEAL
THERESA J. HAMPTON
NOTARY PUBLIC - CALIFORNIA
LOS ANGELES COUNTY
My comm. expires APR 21, 1979

STATE OF CALIFORNIA
COUNTY OF LOS ANGELES } ss

WILLIAM TRAW, Facility Manager 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.

William R Traw

SUBSCRIBED and sworn to before me this 8 day of March, 19 77

Theresa J. Hampton
Notary Public in and for the County of Los Angeles, State of California.

SIGNATURES

Written By: Karl G. Schmidt Date: 3-8-77
PUBLICATIONS MANAGER, Karl G. Schmidt

Approved By: M.D. Connell Date: 3-9-77
PROJECT MANAGER, M. Connell

Approved By: R.B. Hauke for Date: 3-9-77
QUALITY CONTROL MANAGER, Ray B. Hauke, P.E.
Registered Professional Engineer, Calif.: QU 326

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this report is to present the test procedures used and the test results obtained during the performance of a test program. The test program was conducted to determine conformance of one Flexible Hose Assembly, Part Number 73989, Serial Number 007, to the Qualification Test requirements specified in Reference 2.1 in accordance with Reference 2.2.

2.0 REFERENCES

2.1 Metal Bellows Company Document Number QTP 73989, Revision G, dated 4 February 1977. Title: Qualification Test Procedure for Hose Assembly - Flexible Metal

2.2 Metal Bellows Corporation Purchase Order Number 78054.

3.0 SUMMARY

3.1 One Metal Hose Assembly, Part Number 73989, Serial Number 007, has been subjected to the Qualification Test described in this report. During the test program, no anomalies were noted.

3.2 All results are presented for evaluation.

4.0 TEST CONDITIONS AND TEST EQUIPMENT

4.1 Test Conditions

Unless otherwise specified in this report, all tests were performed at room ambient conditions consisting of a temperature of 70±20°F, a relative humidity of less than 95 percent and a barometric pressure of 29.92±2.0 inches of mercury absolute.

4.2 Test Equipment

The following test equipment was calibrated, as required, in accordance with MIL-C-45662A with traceability to the National Bureau of Standards. The NBS traceability records are maintained on file in the applicable AETL Quality Control office.

4.2 Test Equipment (Continued)

4.2.1 Thermo and Operational Cycle Test

AETL Number	E1105V
Instrument	Digital Thermometer
Manufacturer	John Fluke
Model Number	AC-DC2100A-01
Serial Number	13536
Calibration Period	One year (Cal. Due 12-30-76)
Range and Accuracy	-320 to +1400°F; ±0.1°F

AETL Number	E1108V
Instrument	Digital Thermometer
Manufacturer	John Fluke
Model Number	2100A
Serial Number	30037
Calibration Period	One year (Cal. Due 1-26-77)
Range and Accuracy	-320 to +1400°F; ±1.0°F

AETL Number	P247L
Instrument	Pressure Gauge
Manufacturer	Ashcroft
Model Number	1279D
Serial Number	None
Calibration Period	One month (Cal. Due 11-28-76)
Range and Accuracy	0 to 5,000 psig; ±0.5%

AETL Number	P745V
Instrument	Pressure Gauge
Manufacturer	Helicoid
Model Number	None
Serial Number	None
Calibration Period	Three months (Cal. Due 2-19-77)
Range and Accuracy	--

AETL Number	P1069V
Instrument	Pressure Gauge
Manufacturer	U. S. Gauge
Model Number	1818
Serial Number	None
Calibration Period	Six months (Cal. Due 4-20-77)
Range and Accuracy	0 to 5,000 psig; ±0.5%

4.2.2 Vibration Test

AETL Number	D501V
Instrument	Cathode Follower
Manufacturer	M. B. Electronics
Model Number	N504
Serial Number	834
Calibration Period	Six months (Cal. Due 3-3-77)
Range and Accuracy	5 Hz to 10 KHz (Amplifier), 3 Hz to 3 KHz (Integrate); ±1.0%

AETL Number	D546V
Instrument	Accelerometer
Manufacturer	Endevco Corp.
Model Number	2220C
Serial Number	RA67
Calibration Period	Six months (Cal. Due 1-28-77)
Range and Accuracy	2 Hz to 10 KHz, 0 to 1,000 g; ±5.0%

AETL Number	D561V
Instrument	Logarithmic Converter
Manufacturer	Moseley
Model Number	60D
Serial Number	838
Calibration Period	Six months (Cal. Due 5-18-77)
Range and Accuracy	0 to 60 db; ±0.5 db

AETL Number	D687V
Instrument	Charge Amplifier
Manufacturer	Endevco Corp.
Model Number	2720
Serial Number	AE15
Calibration Period	Six months (Cal. Due 5-13-77)
Range and Accuracy	1 to 100 mv, 1 to 1,000 g; ±2.0%

AETL Number	D732V
Instrument	Vibration Exciter
Manufacturer	M. B. Electronics
Model Number	C50
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	--

4.2.2 Vibration Test (Cont.)

AETL Number	D768V
Instrument	Charge Amplifier
Manufacturer	Unholtz Dickie
Model Number	8PMCVA
Serial Number	None
Calibration Period	Six months (Cal. Due 5-24-77)
Range and Accuracy	--

AETL Number	D923V
Instrument	X-Y Plotter
Manufacturer	Electronic Instruments
Model Number	320
Serial Number	None
Calibration Period	Six months (Cal. Due 7-17-77)
Range and Accuracy	0 to 50 vdc/inch; ±0.2%

AETL Number	D959V
Instrument	Power Amplifier
Manufacturer	M. B. Electronics
Model Number	T452
Serial Number	148
Calibration Period	Prior to use
Range and Accuracy	24 KW

AETL Number	E977V
Instrument	Electronic Counter
Manufacturer	Hewlett Packard
Model Number	None
Serial Number	5233L
Calibration Period	Six months (Cal. Due 2-3-77)
Range and Accuracy	--

AETL Number	None
Instrument	Servo Programmer
Manufacturer	Unholtz Dickie
Model Number	SPA-7
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	--

4.2.2 Vibration Test (Cont.)

AETL Number	None
Instrument	Sweep Sine Generator
Manufacturer	Unholtz Dickie
Model Number	OSC-1
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	None
Instrument	Accelerometer
Manufacturer	Endevco Corp.
Model Number	2246M4
Serial Number	HB96
Calibration Period	Six months (Cal. Due 7-3-77)
Range and Accuracy	--

4.2.3 Thermo and Operating Cycle Retest

AETL Number	E1105V
Instrument	Digital Thermometer
Manufacturer	John Fluke
Model Number	AC-DC2100A-01
Serial Number	13536
Calibration Period	One year (Cal. Due 1-4-78)
Range and Accuracy	-320 to +1400°F; ±0.1°F

AETL Number	E1108V
Instrument	Digital Thermometer
Manufacturer	John Fluke
Model Number	2100A
Serial Number	30037
Calibration Period	One year (Cal. Due 1-26-77)
Range and Accuracy	-320 to +1400°F; 21.0°F

AETL Number	G588V
Instrument	Sequence Cycler
Manufacturer	AETL
Model Number	CP1
Serial Number	None
Calibration Period	N/A
Range and Accuracy	--

4.2.3 Thermo and Operating Cycle Retest (Cont.)

AETL Number	P745V
Instrument	Pressure Gauge
Manufacturer	Helicoid
Model Number	None
Serial Number	None
Calibration Period	Three months (Cal. Due 3-18-77)
Range and Accuracy	--

AETL Number	P1084V
Instrument	Pressure Gauge
Manufacturer	Ashcroft
Model Number	1.66
Serial Number	None
Calibration Period	Three months (Cal. Due 3-14-77)
Range and Accuracy	0 to 3,000 psig; ±1.0%

4.2.4 Helium Leakage Test

AETL Number	V25L
Instrument	Mass Spectrometer
Manufacturer	CEC
Model Number	24-120B
Serial Number	9096
Calibration Period	Daily
Range and Accuracy	$5X10^{-11}$ scc/second/division (100,000 division)

AETL Number	V514V
Instrument	Vacuum Gauge
Manufacturer	Veeco
Model Number	GV-3SV
Serial Number	2424
Calibration Period	Three months (Cal. Due 2-11-77)
Range and Accuracy	1,000 to 1 microns of mercury; ±10%

AETL Number	V525V
Instrument	Helium Leak
Manufacturer	AVT Industries
Model Number	73168
Serial Number	1316
Calibration Period	One year (Cal. Due 12-13-77)
Range and Accuracy	$2.48X10^{-7}$ sccs; ±10%

4.2.4 Helium Leakage Test (Cont.)

AETL Number	P946V
Instrument	Compound Pressure-Vacuum Gauge
Manufacturer	Ashcroft
Model Number	1082AC
Serial Number	None
Calibration Period	Three months (Cal. Due 2-22-77)
Range and Accuracy	30 inches of mercury to 15 psig; ±0.25%

AETL Number	ENV659V
Instrument	Pressure Chamber
Manufacturer	KVI Test Labs
Model Number	None
Serial Number	None
Calibration Period	N/A
Range and Accuracy	--

4.2.5 Seismic Vibration Test

AETL Number	D800V
Instrument	Hydraulic Actuator
Manufacturer	Shore Western
Model Number	912-5.1-9-3-13
Serial Number	94054
Calibration Period	Prior to use
Range and Accuracy	10,000 pounds max.

AETL Number	D801V
Instrument	Servo Control Valve
Manufacturer	Moog
Model Number	72-103
Serial Number	911
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	D817V
Instrument	Linear Variable Differential Transformer
Manufacturer	Collins
Model Number	SS-20A
Serial Number	155111
Calibration Period	Prior to use
Range and Accuracy	0 to ±4 inches

4.2.5 Seismic Vibration Test (Cont.)

AETL Number	D818V
Instrument	Linear Variable Differential Transformer
Manufacturer	Collins
Model Number	LMT-719T31
Serial Number	Unknown
Calibration Period	Prior to use
Range and Accuracy	0 to ±5 inches; ±0.5%

AETL Number	D932V
Instrument	Servo Controller
Manufacturer	Shore Western
Model Number	SC1329C
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	0 to 10 inch stroke; ±5.0%

AETL Number	D965V
Instrument	Hydraulic Actuator
Manufacturer	Shore Western
Model Number	913-7.6-8-4-138
Serial Number	95063
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	D966V
Instrument	Servo Control Valve
Manufacturer	Moog
Model Number	72-103
Serial Number	951
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	D991V
Instrument	X-Y Display
Manufacturer	Spectral Dynamics
Model Number	13116
Serial Number	400
Calibration Period	Six months (Cal. Due 4-16-77)
Range and Accuracy	--

4.2.5 Seismic Vibration Test (Cont.)

AETL Number	D992V
Instrument	Shock Spectrum Analyzer
Manufacturer	Spectral Dynamics
Model Number	13231
Serial Number	21
Calibration Period	One year (Cal. Due 4-16-77)
Range and Accuracy	0 to 100 volts, 1 Hz to 10 KHz

AETL Number	D993V
Instrument	Transient Memory
Manufacturer	Spectral Dynamics
Model Number	13192
Serial Number	24
Calibration Period	One year (Cal. Due 4-16-77)
Range and Accuracy	--

AETL Number	D1007V
Instrument	Accelerometer
Manufacturer	Endevco Corp.
Model Number	2262-25
Serial Number	DY64
Calibration Period	One year (Cal. Due 3-16-77)
Range and Accuracy	0 to 750 Hz; ±1.0%

AETL Number	D1008V
Instrument	Standard Accelerometer
Manufacturer	Endevco Corp.
Model Number	2262-25
Serial Number	DY40
Calibration Period	One year (Cal. Due 3-16-77)
Range and Accuracy	1 to 25 g; ±1.0%

AETL Number	D1010V
Instrument	X-Y Plotter
Manufacturer	Spartan
Model Number	575
Serial Number	976142
Calibration Period	Six months (Cal. Due 2-17-77)
Range and Accuracy	1 mv/inch to 10 v/inch; ±0.025%

4.2.5 Seismic Vibration Test (Cont.)

AETL Number	D1023V
Instrument	Signal Synthesizer
Manufacturer	Byrd Enterprises
Model Number	Unknown
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	E503V
Instrument	Storage Oscilloscope
Manufacturer	Tektronix
Model Number	564
Serial Number	008387
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	E564V
Instrument	Time Base Plug In Unit
Manufacturer	Tektronix
Model Number	3B3
Serial Number	006688
Calibration Period	Six months (Cal. Due 7-5-77)
Range and Accuracy	0.1 µsecond/div. to 2.5 second/div.; ±3.0%

AETL Number	E593V
Instrument	Recording Oscillograph
Manufacturer	Midwestern Instruments
Model Number	M1603-F
Serial Number	1553
Calibration Period	Prior to use
Range and Accuracy	0.070 to 170 inches/second

AETL Number	E637V
Instrument	Dual Trace Plug In Unit
Manufacturer	Tektronix
Model Number	3A1
Serial Number	011750
Calibration Period	Six months (Cal. Due 7-5-77)
Range and Accuracy	10 mv/div. to 10 v/div.; ±3.0%

4.2.5 Seismic Vibration Test (Cont.)

AETL Number	E1058V
Instrument	Servo Controller
Manufacturer	Shore Western
Model Number	SC1125SP
Serial Number	None
Calibration Period	Prior to use
Range and Accuracy	0 to 10 inch strokes; ±5.0%

AETL Number	G587V
Instrument	Tape Recorder
Manufacturer	Precision Instruments
Model Number	214
Serial Number	112
Calibration Period	Prior to use
Range and Accuracy	3.25 or 7.5 inches/second; ±0.5 db

AETL Number	P700V
Instrument	Pressure Gauge
Manufacturer	Ashcroft
Model Number	Unknown
Serial Number	None
Calibration Period	Three months (Cal. Due 3-10-77)
Range and Accuracy	0 to 5,000 psig; ±1.0%

AETL Number	None
Instrument	Bridge Balance
Manufacturer	Calico
Model Number	X1-101
Serial Number	021
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	None
Instrument	Bridge Balance
Manufacturer	Calico
Model Number	X1-101
Serial Number	035
Calibration Period	Prior to use
Range and Accuracy	--

4.2.5 Seismic Vibration Test (Cont.)

AETL Number	None
Instrument	DC Amplifier
Manufacturer	CIC
Model Number	3101-D3P
Serial Number	CH7
Calibration Period	Prior to use
Range and Accuracy	--

AETL Number	None
Instrument	DC Amplifier
Manufacturer	CIC
Model Number	3101-D3P
Serial Number	CHH
Calibration Period	Prior to use
Range and Accuracy	--

4.2.6 Burst Test

AETL Number	P844V
Instrument	Pressure Gauge
Manufacturer	Helicoid
Model Number	4-1/2W-20,000-2
Serial Number	None
Calibration Period	Three months (Cal. Due 3-17-77)
Range and Accuracy	0 to 20,000 g; ±0.5%

AETL Number	N/A
Instrument	
Manufacturer	
Model Number	
Serial Number	
Calibration Period	
Range and Accuracy	

5.0 TEST PROCEDURES AND TEST RESULTS

5.1 Thermo and Operating Cycle Test

Reference 2.1, Paragraph 4.4

Date Performed: 18 January 1977

5.1.1 The specimen was installed in a test fixture as illustrated in Photograph 1. The specimen was placed in the test chamber. The chamber and fluid temperatures were increased to, and maintained at, 700±50°F. The specimen was pressurized to 2500 psig. Starting in the normally-installed position, the movable end of the hose assembly was then moved to an equivalent position of +5.0 inches on a spherical radius in the X, Y, and Z axes. The pressure was then reduced to zero psig and the hose assembly was returned to the normally-installed position. This constituted one cycle.

5.1.2 A total of 4000 cycles was performed. Visual examination following 4000 cycles of testing revealed no damage or other adverse effects.

5.2 Helium Leakage Test

Reference 2.1, Paragraph 4.3

Date Performed: 19 January 1977

5.2.1 The specimen was installed in a test chamber. The interior of the specimen was exposed to the vacuum pressure of the mass spectrometer. The outside of the hose assembly was flooded with helium gas. Total leakage measured was 2.64×10^{-7} sccs versus the maximum allowable of 1×10^{-6} sccs.

5.2.2 Visual examination following testing revealed no damage or other adverse effects.

5.3 Operational Vibration Test

Reference 2.1, Paragraph 4.5

Date Started: 21 January 1977
Date Completed: 31 January 1977

5.3.1 The specimen was installed in a test fixture and was mounted on the vibration exciter as illustrated in Photographs 2, 3, and 4. The specimen was pressurized to 2500 psig. The specimen was subjected to cycling over the frequency range of 5 to 100 to 5 Hz at a sweep rate of one octave per minute at an applied double amplitude of 1.0 inch up to a limiting value of 31 inches per second acceleration. Testing was performed in each of the three major orthogonal axes for totals of 333,388; 333,470; and 333,336 cycles for testing in the X, Z, and Y axes, respectively.

5.3.2 Visual examination following testing revealed no damage or other adverse effects.

5.4 Leakage Test

Reference 2.1, Paragraph 4.3

Date Performed: 1 Febr ary 1977

5.4.1 The specimen was installed in a test chamber. The interior of the specimen was connected to the vacuum of a mass spectrometer. The vacuum was maintained at 0.4 micron, maximum, as noted on the mass spectrometer.

5.4.2 The exterior of the specimen was flooded with helium gas. The leakage rate was measured and was 1.872X10-7 sccs versus the maximum allowable of 1.0X10-6 sccs.

5.5 Seismic Vibration Test

Reference 2.1, Paragraph 4.6

Date Performed: 8 February 1977

5.5.1 The specimen was rigidly mounted on a vibration test fixture as illustrated in Photographs 5 and 6. The specimen was subjected to test response spectrum (TRS) that exceeded the minimum of 2.0 percent critical damping curve of Figure 1 of Reference 2.1. The TRW was applied first along the Z and Y axis, biaxially, for a period of 45 seconds. During this period, the specimen was dry with no pressure applied. The specimen was then rotated 90 degrees to the Z and X axis and was subjected to the TRW for a period of 45 seconds with no pressure applied.

5.5.2 The testing described above was then repeated with the specimen filled with water and unpressurized.

5.5.3 The testing described in Paragraph 5.5.1 was then repeated with the specimen filled with water and pressurized to 2500 psig.

5.5.4 Visual examination following testing revealed no damage or other adverse effects. The X-Y plots prepared during the above testing are presented in Appendix 1. During Seismic Vibration Testing, the outputs of the control and response accelerometers were recorded on an oscillograph. The oscillograph records are being forwarded to the customer under separate cover.

6V265

5.6 Burst Test

Reference 2.1, Paragraph 4.7

Date Performed: 8 February 1977

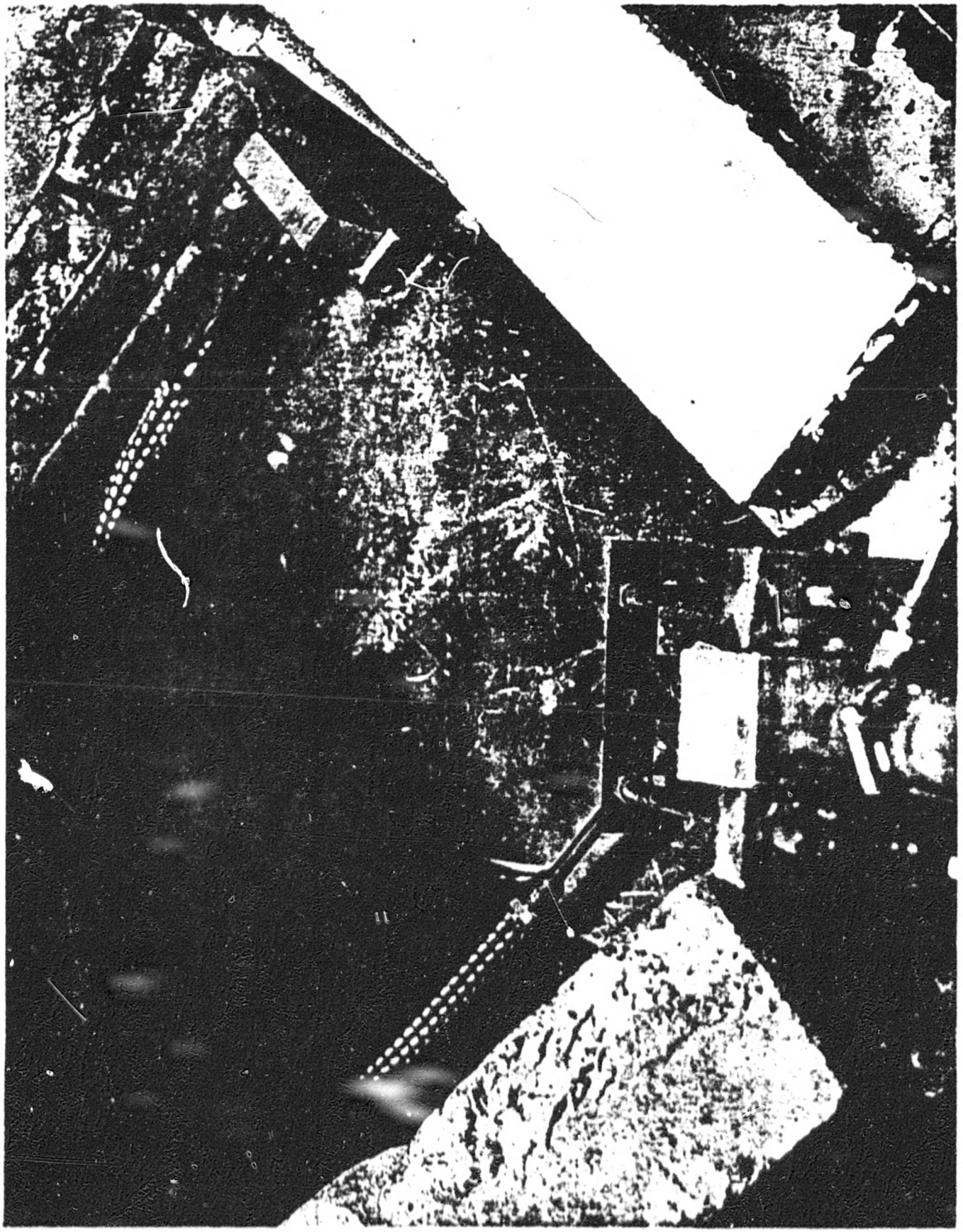
5.6.1 The specimen was installed in a hydrostatic pressure test system. The specimen was filled with deionized water and was bled of all air.

5.6.2 The specimen was then pressurized to 3750 psig and the pressure was maintained for a period of one minute. The pressure was then increased to 8750 psig and was maintained for an additional one-minute period.

5.6.3 An attempt was then made to increase the pressure until rupture of the specimen occurred. At a pressure of 11,200 psig, the test system line developed a leak. The pressure was reduced to zero psig. The line was repaired. The specimen was refilled with water and the burst test was continued. At an applied pressure of 11,200 psig, a leak was noted at the connection of the flexible hose and fitting. Burst testing was terminated at this point.

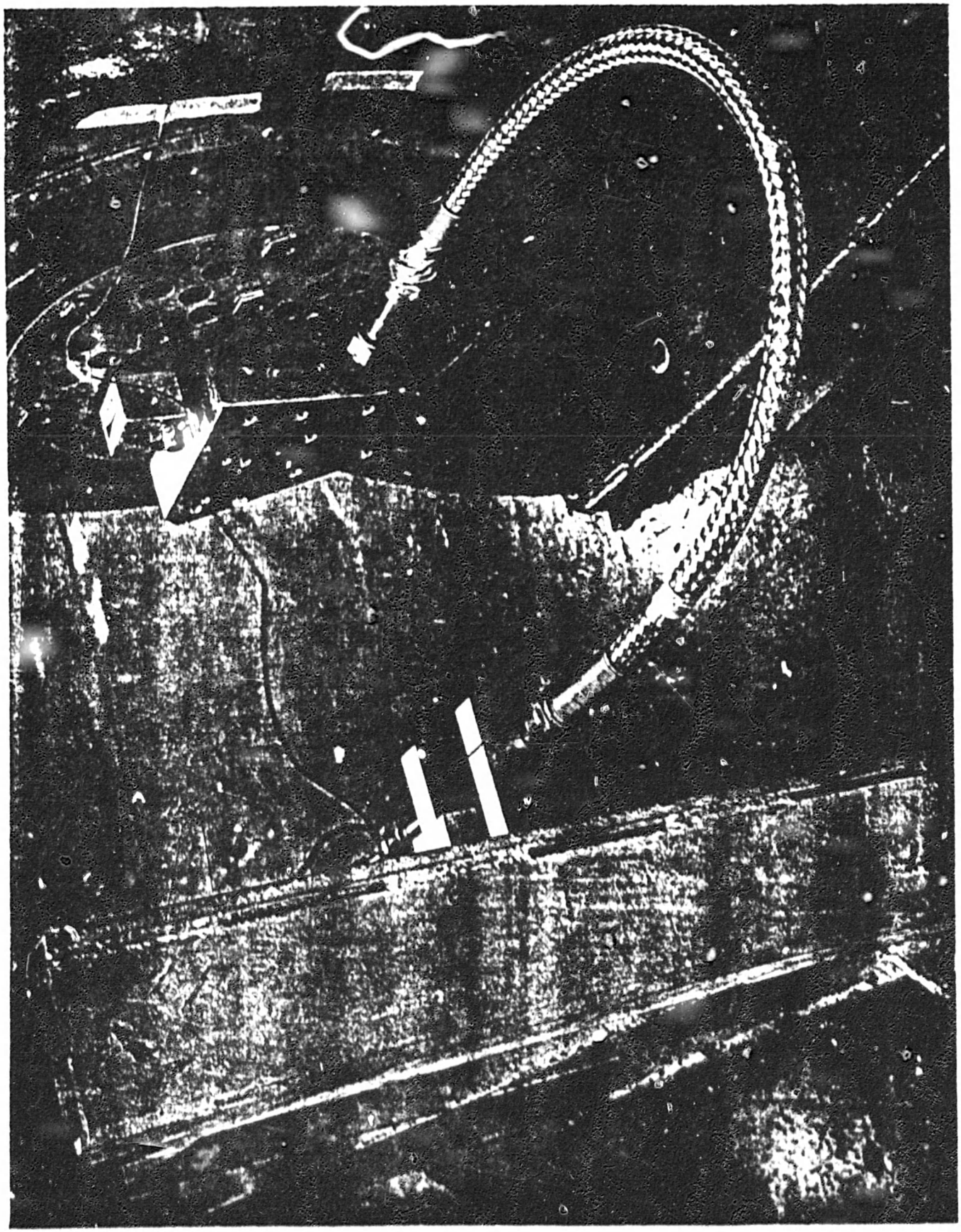
AETL

REPORT NO. 5410-7197
PHOTOGRAPH 1
TYPICAL THERMO AND CYCLING
TEST SETUP



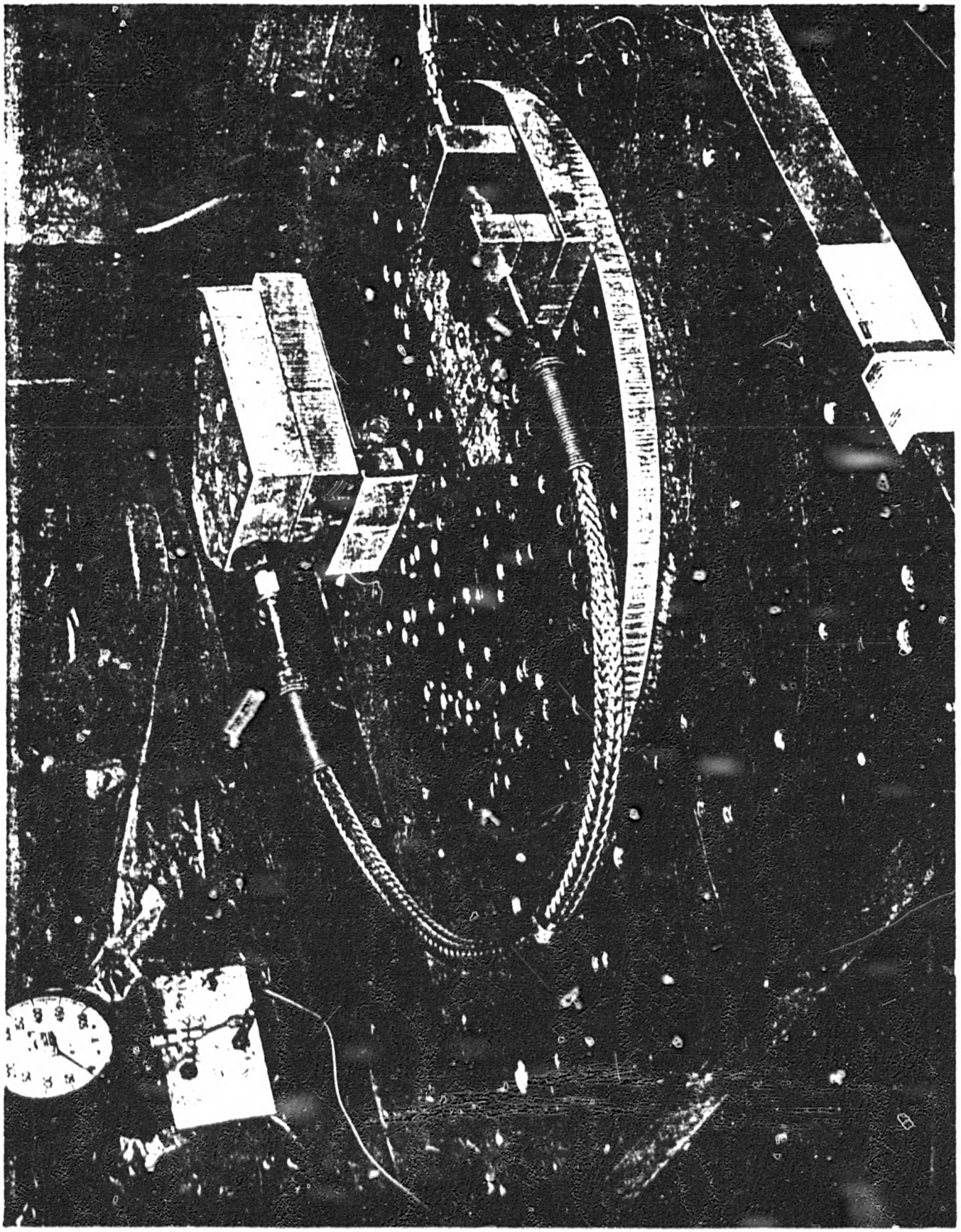
AETL

REPORT NO. 5410-7197
PHOTOGRAPH 4
OPERATING VIBRATION TEST
SETUP (Z AXIS)



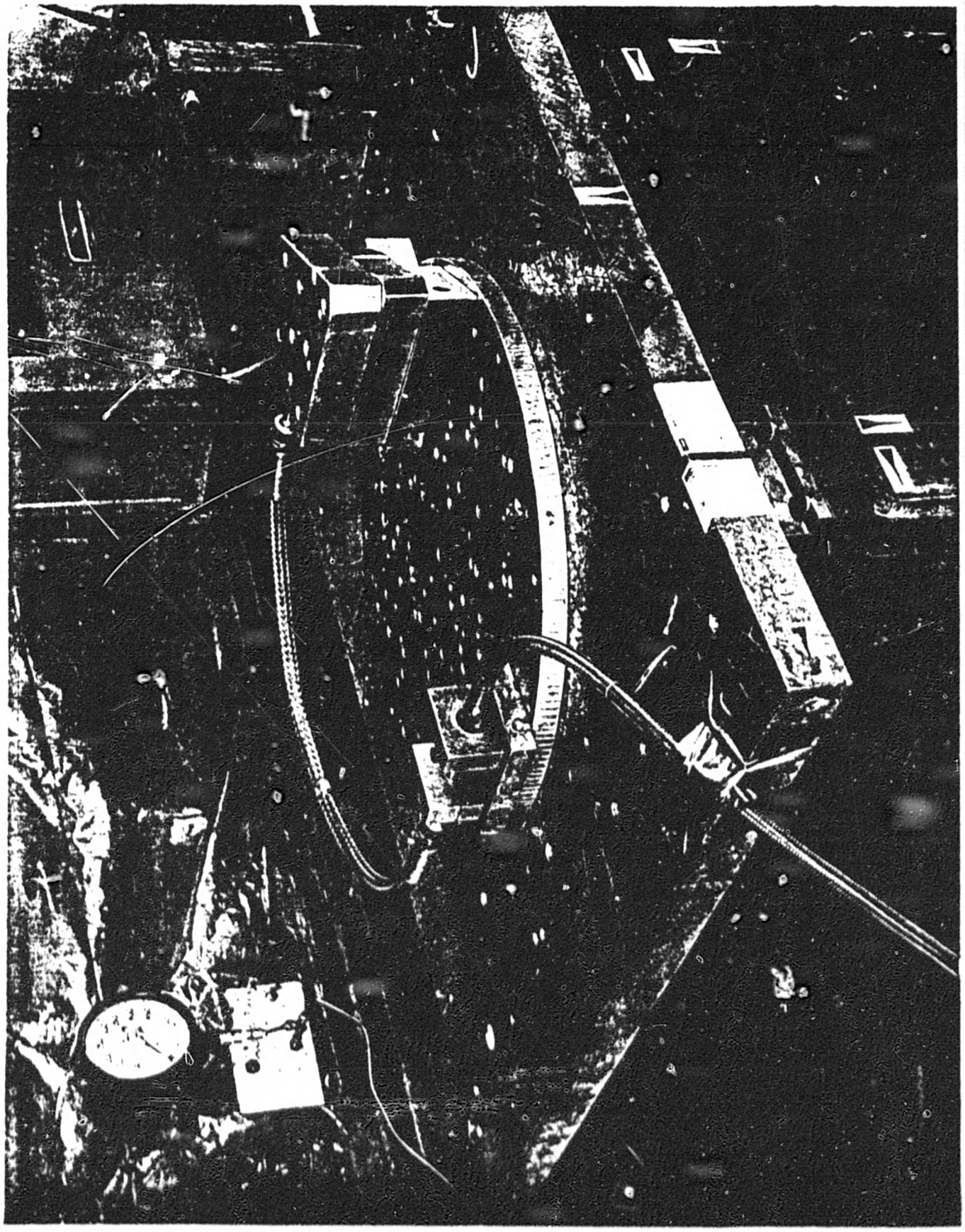
AETL

REPORT NO. 5410-7197
PHOTOGRAPH 5
SEISMIC VIBRATION TEST
SETUP (X AND Z AXIS)



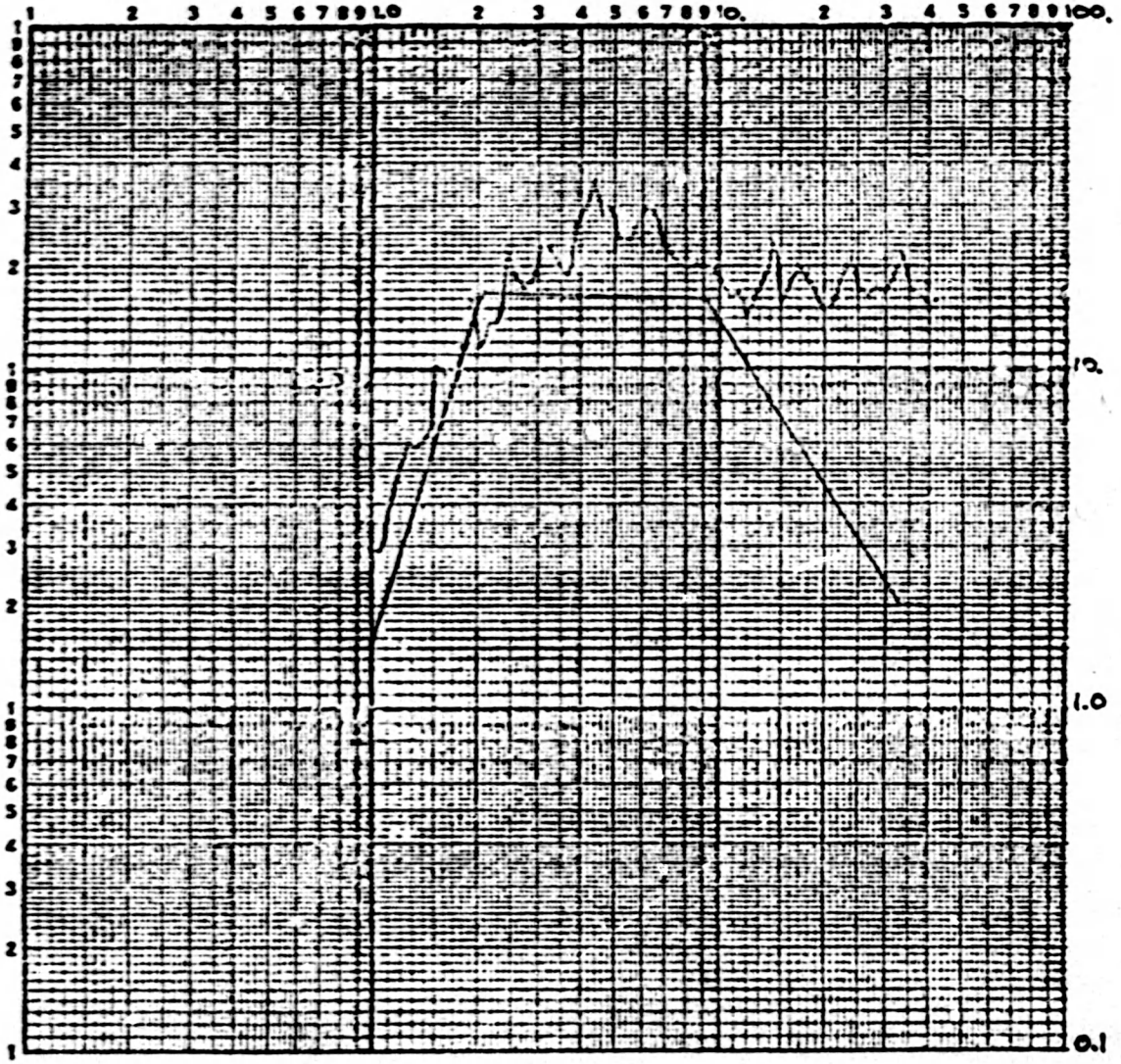
AETL

REPORT NO. 5410-7197
PHOTOGRAPH 6
SEISMIC VIBRATION TEST
SETUP (Y AND Z AXIS)



APPENDIX 1

X-Y Plots



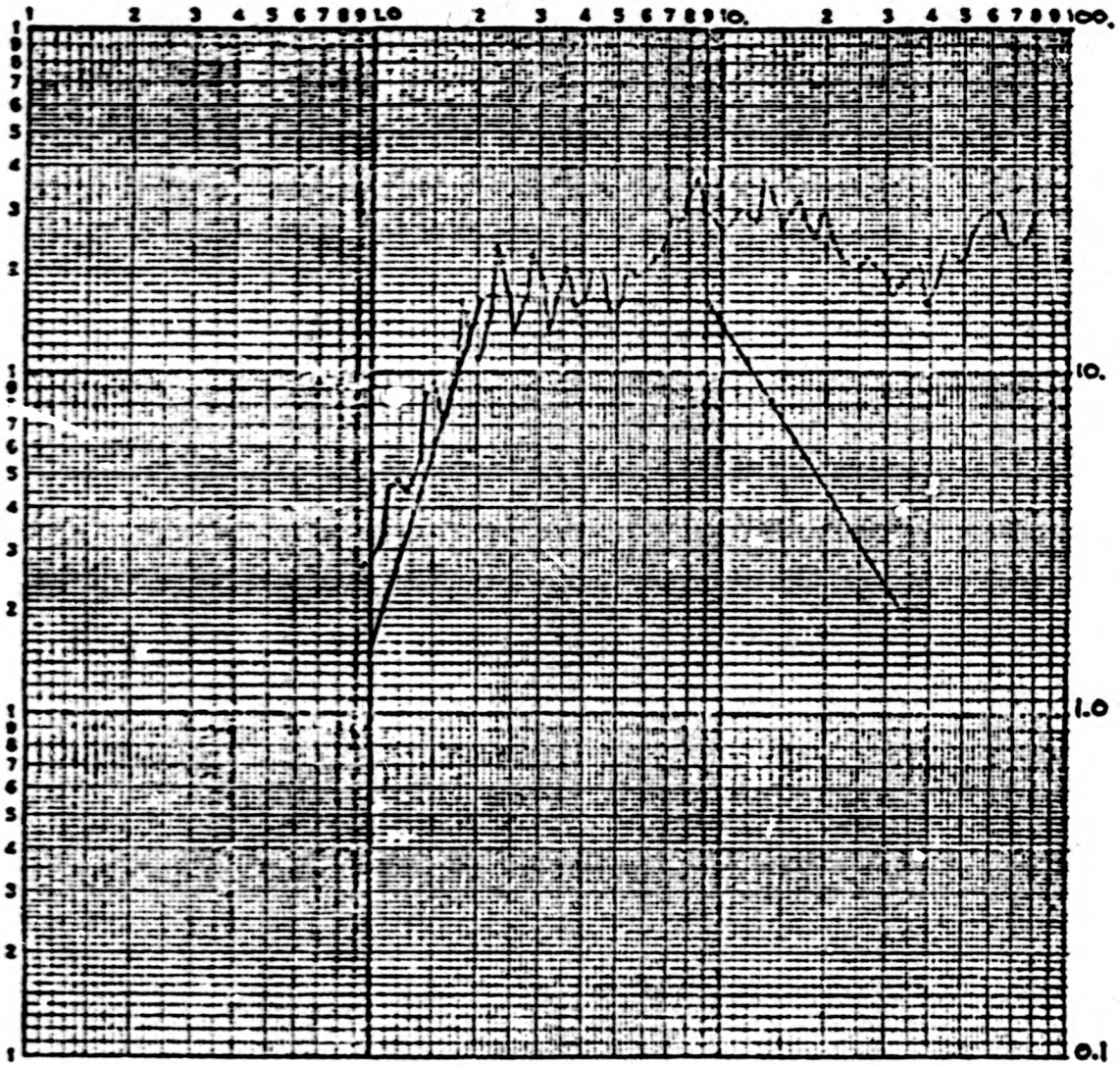
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAXI
POLARITY	+ MAXI
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY (FIX. ONLY
P/N:	73988
S/N:	007
AXIS:	HORIZONTAL
DATE:	2/8/77
TIME:	1008
OPERATOR:	J.M.

QTP 73989 FIGURE 1

Report No. 5410-1191
Date: 8 March 1977



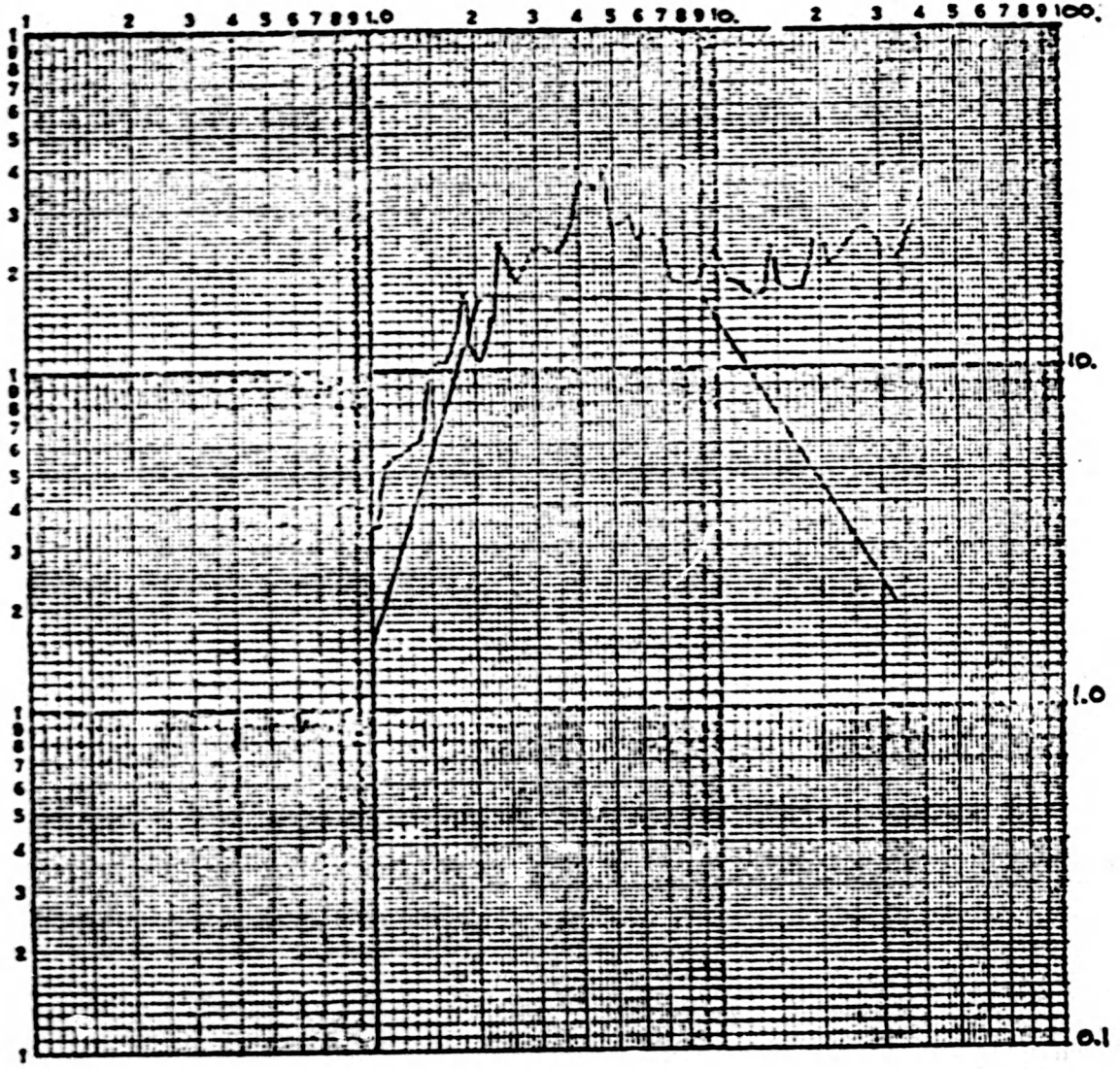
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAX
POLARITY	+ MAXI
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY (FIX. ONLY
P/N:	73988
S/N:	007
AXIS:	VERTICAL
DATE:	2/8/77
TIME:	1008
OPERATOR:	Jack.

QTP 73989 FIGURE 1

Report No. 5410-7197
Date: 8 March 1977



RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM: ACCEL. MAXI

POLARITY: +

DAMPING: 2.5%

ANALYSIS BANDWIDTH: 1/20 FILTERS OCTAVE

MJO NUMBER: 5410-6992

ITEM: HOSE ASSEMBLY DRY

P/N: 73988

S/N: 007

AXIS: HORIZ. Y

DATE: 2-8-77

TIME: 1105

OPERATOR: J.L.

QTP 73989 FIGURE 1

Report No. 5410-7197
Date: 8 March 1977

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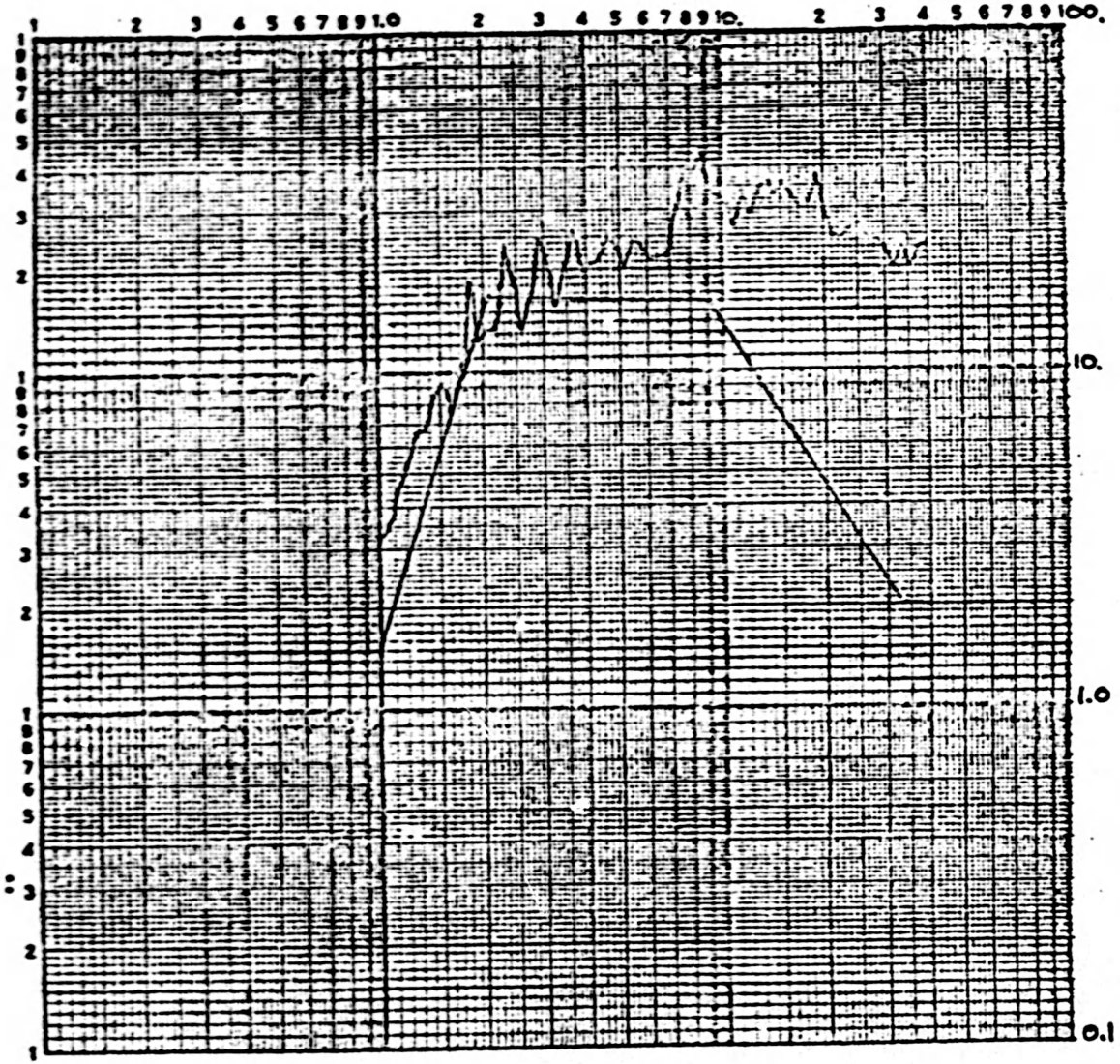


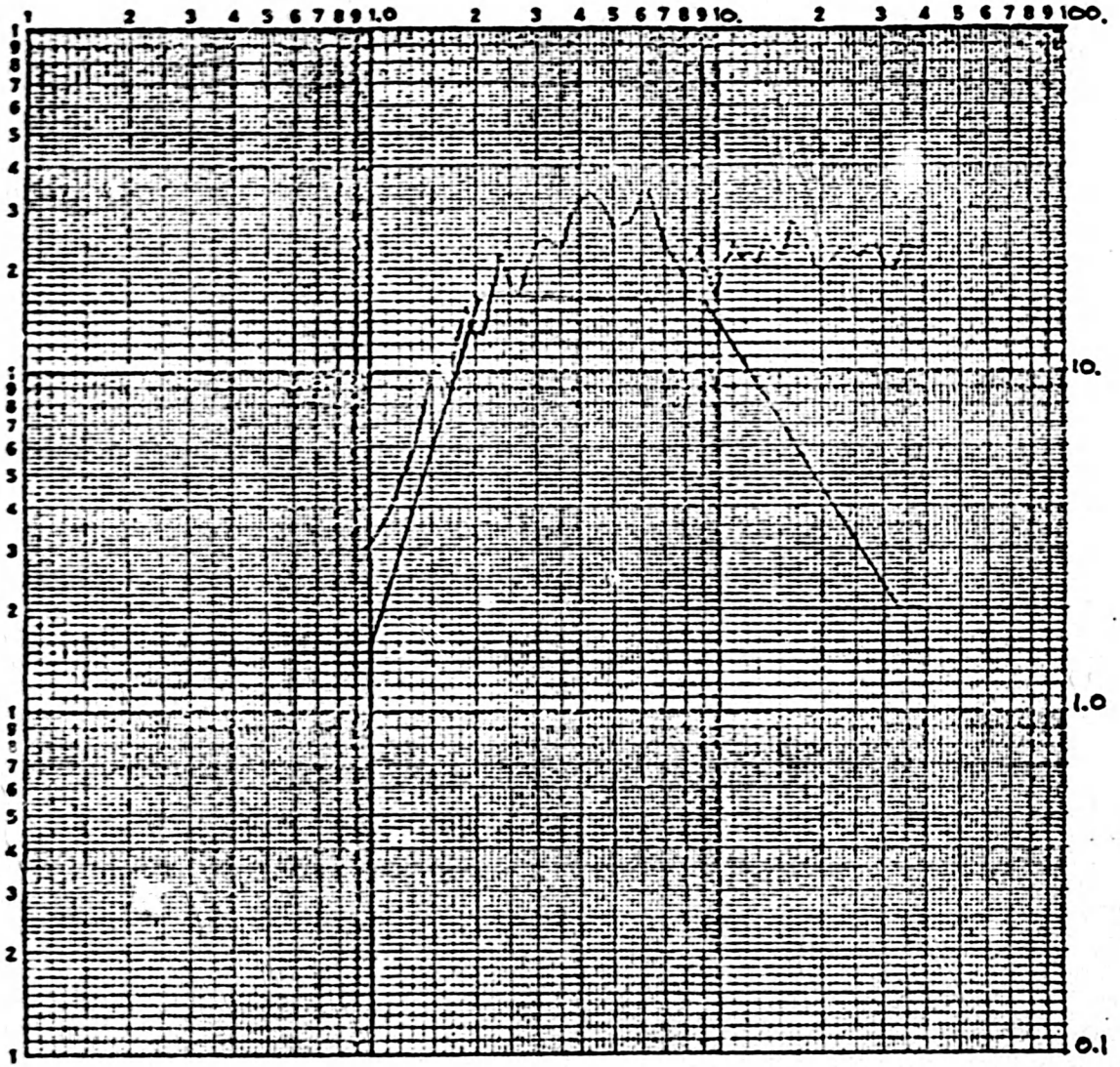
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAXI
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY DRY
P/N:	73988
S/N:	007
AXIS:	VERT. Z
DATE:	2-8-77
TIME:	1105
OPERATOR:	J.R.

QTP 73989 FIGURE 1

Date: 8 March 1977



RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM: ACCEL. MAXI

POLARITY: +

DAMPING: 2.5%

ANALYSIS BANDWIDTH: 120 FILTERS OCTAVE

MJO NUMBER: 5410-6992

ITEM: HOSE ASSEMBLY DRY

P/N: 73988

S/N: 007

AXIS: HORIZ. X

DATE: 2-8-77

TIME: 1125

OPERATOR: J.R.

QTP 73989 FIGURE 1

Date: 8 March 1977

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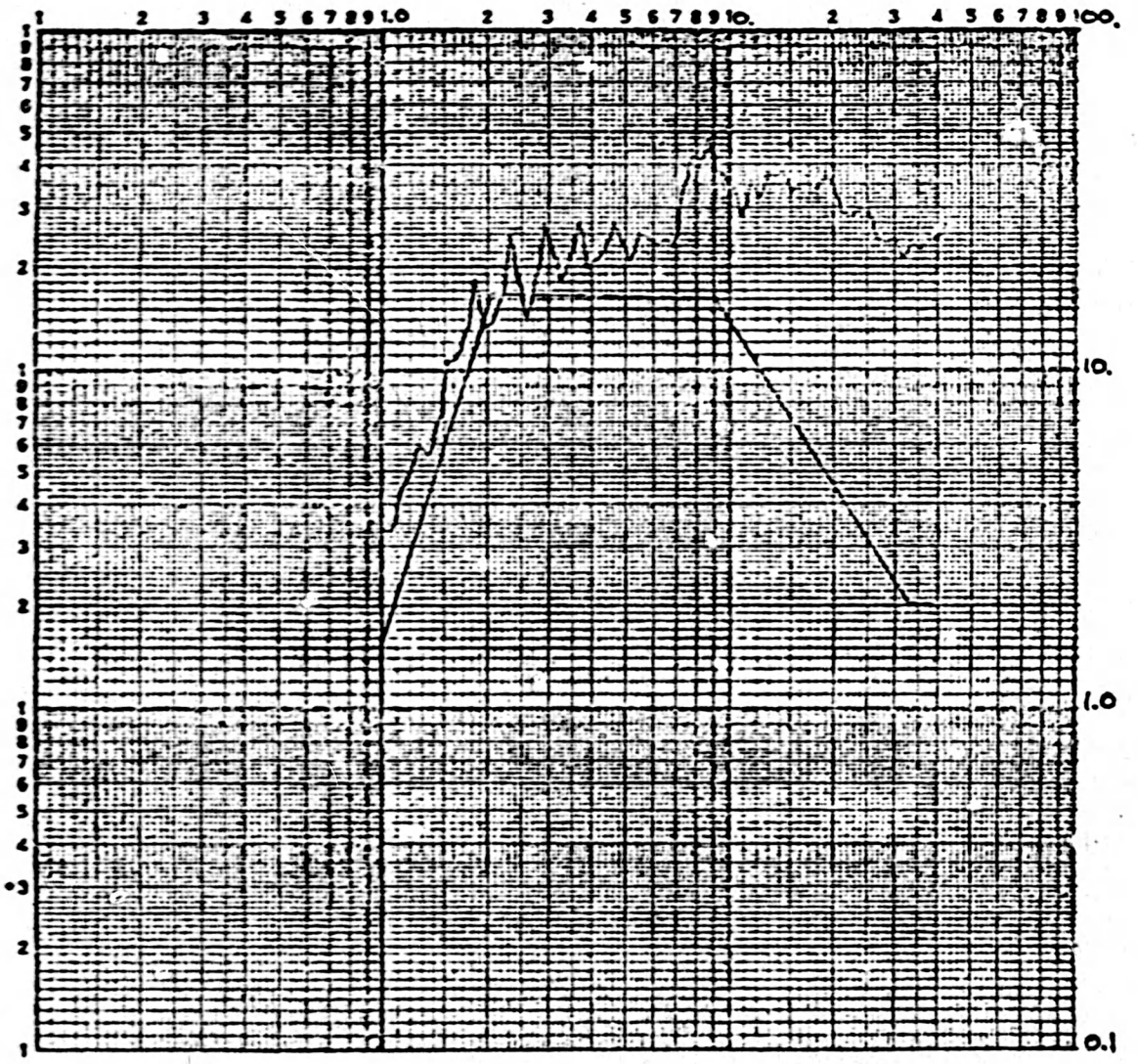


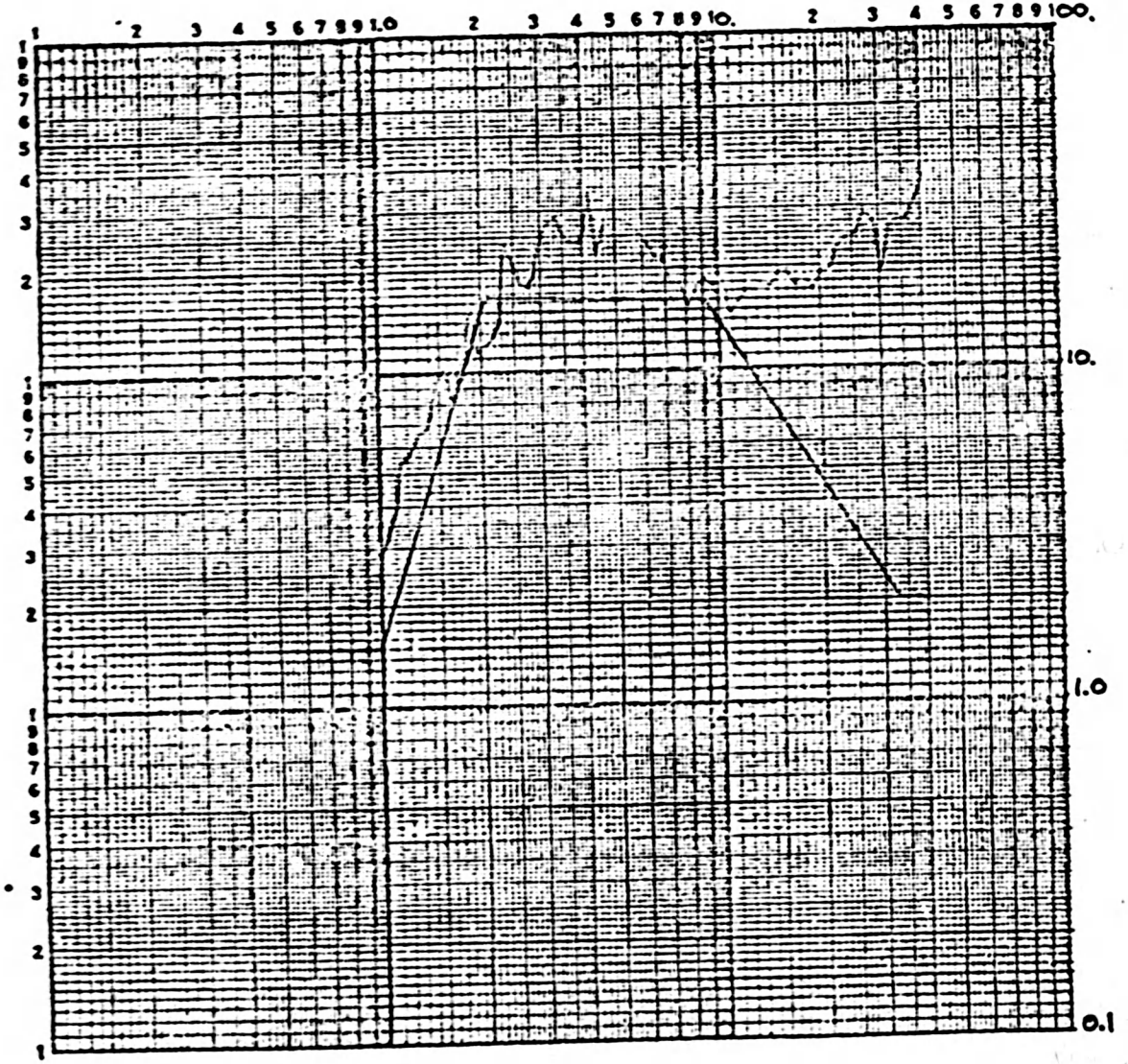
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAXI
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY DRY
P/N:	73988
S/N:	007
AXIS:	VERT. Z
DATE:	2-8-77
TIME:	1125
OPERATOR:	J.W.R.

QTP 73989 FIGURE 1

Report No. 5410-7191
Date: 8 March 1977



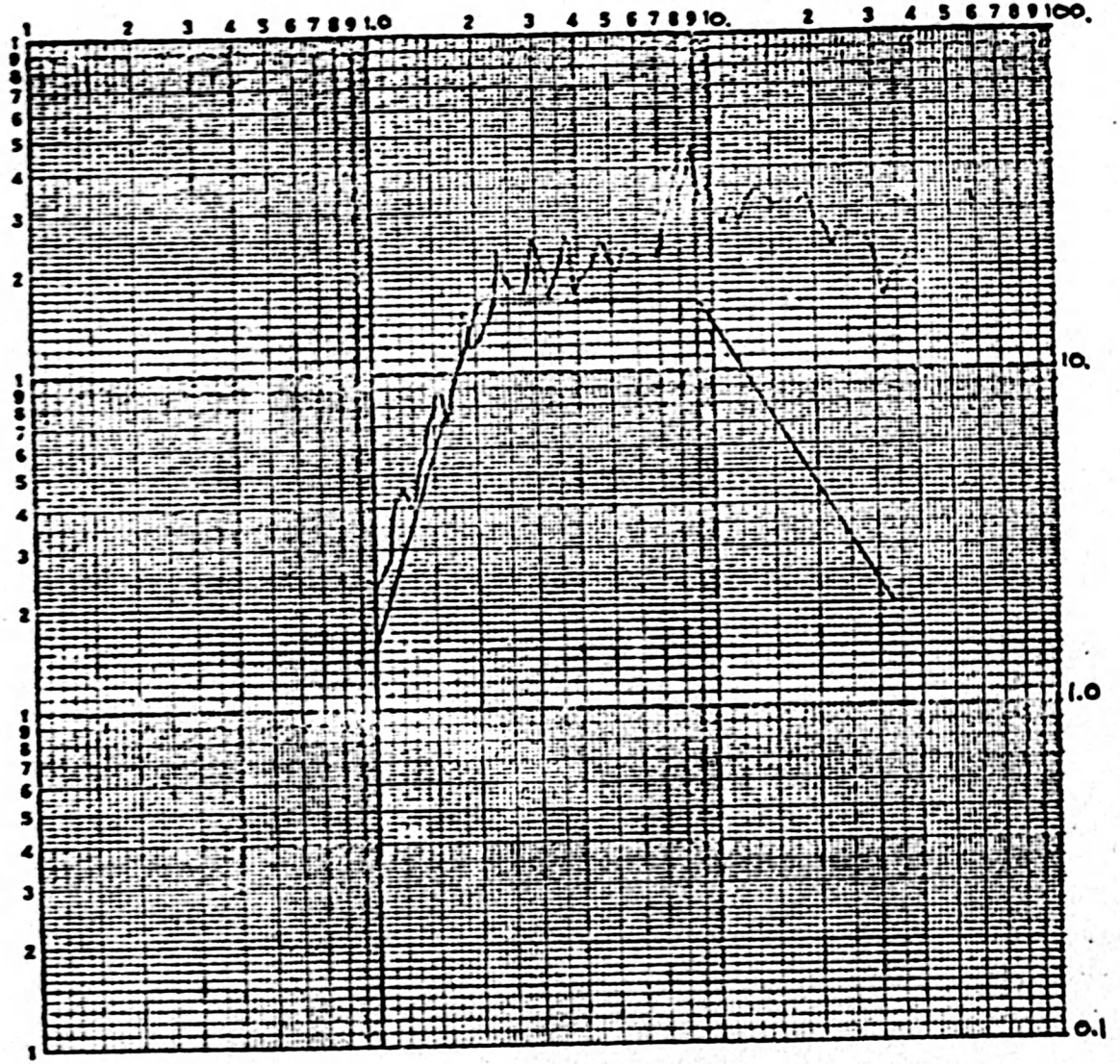
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL MAX1
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET NO PRESS.
P/N:	73988
S/N:	007
AXIS:	X AXIS
DATE:	2/8/77
TIME:	1134
OPERATOR:	L.J.M.

QTP 73989 FIGURE 1

Date: 8 March 1977



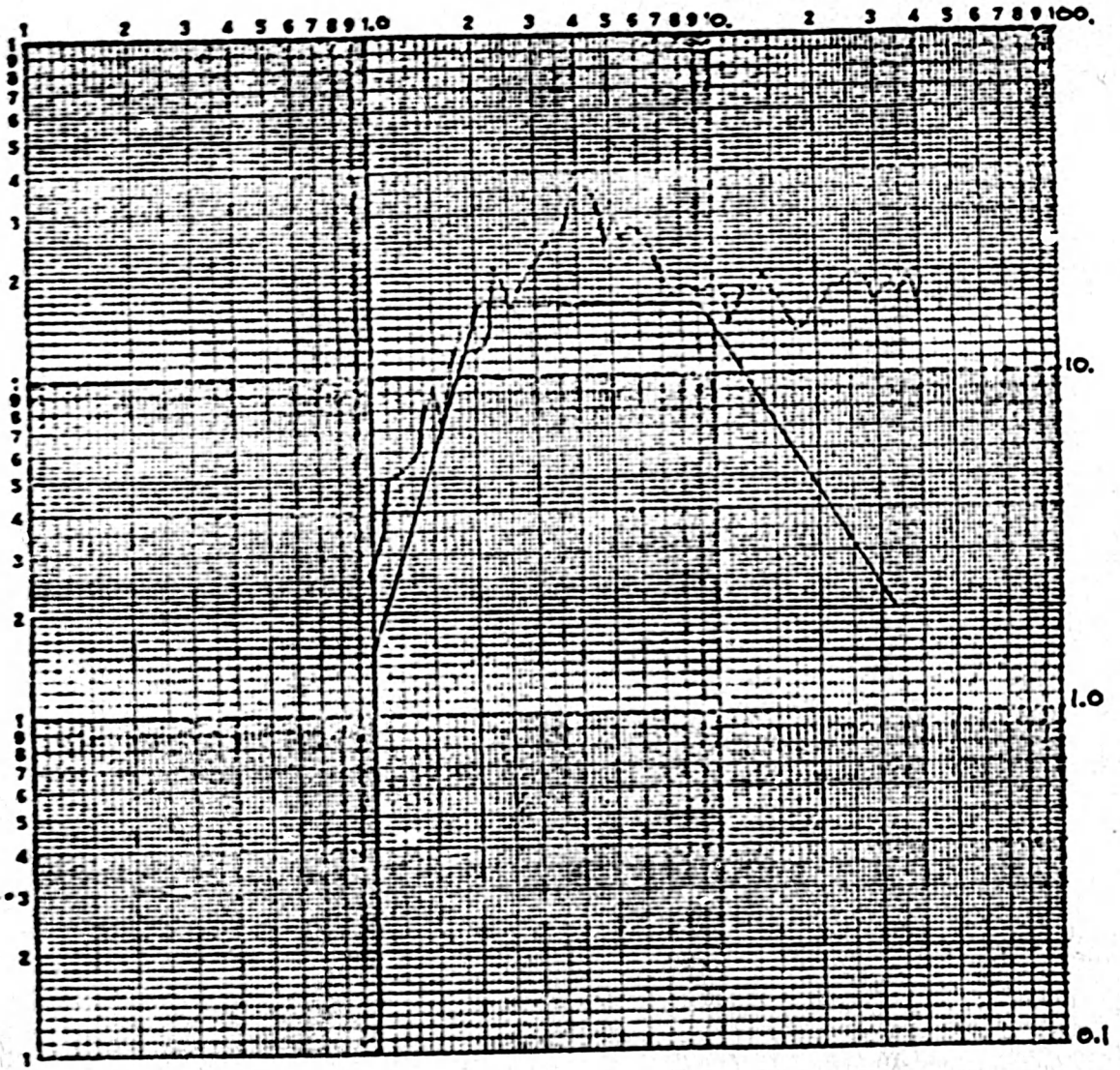
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL MAX1
POLARITY	+ ACCEL MAX1
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET NO PRESS
P/N:	73988
S/N:	007
AXIS:	Z AXIS
DATE:	2/8/77
TIME:	1134
OPERATOR:	R.J.M.

QTP 73989 FIGURE 1

Date: 8 March 1977



RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM: ACCEL MAXI

POLARITY +

DAMPING: 2.5%

ANALYSIS BANDWIDTH: 120 FILTERS OCTAVE

MJO NUMBER: 5410-6992

ITEM: HOSE ASSEMBLY WET 2500 PSI

P/N: 73988

S/N: 007

AXIS: X

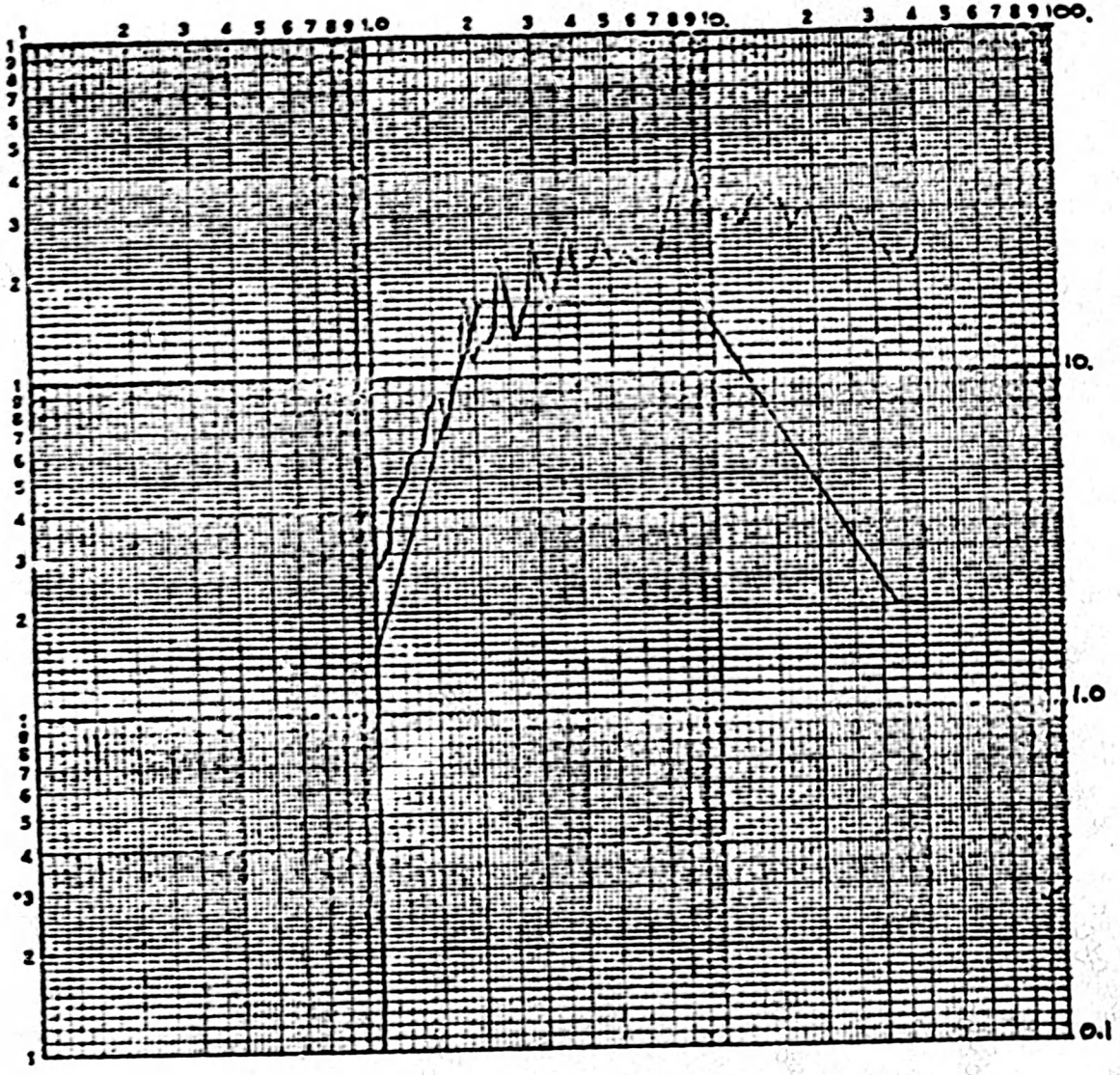
DATE: 2/8/77

TIME: ~~1340~~ 1140

OPERATOR: P.G.M.

QTP 73989 FIGURE 1

Report No. 5410-/19/
Date: 8 March 1977



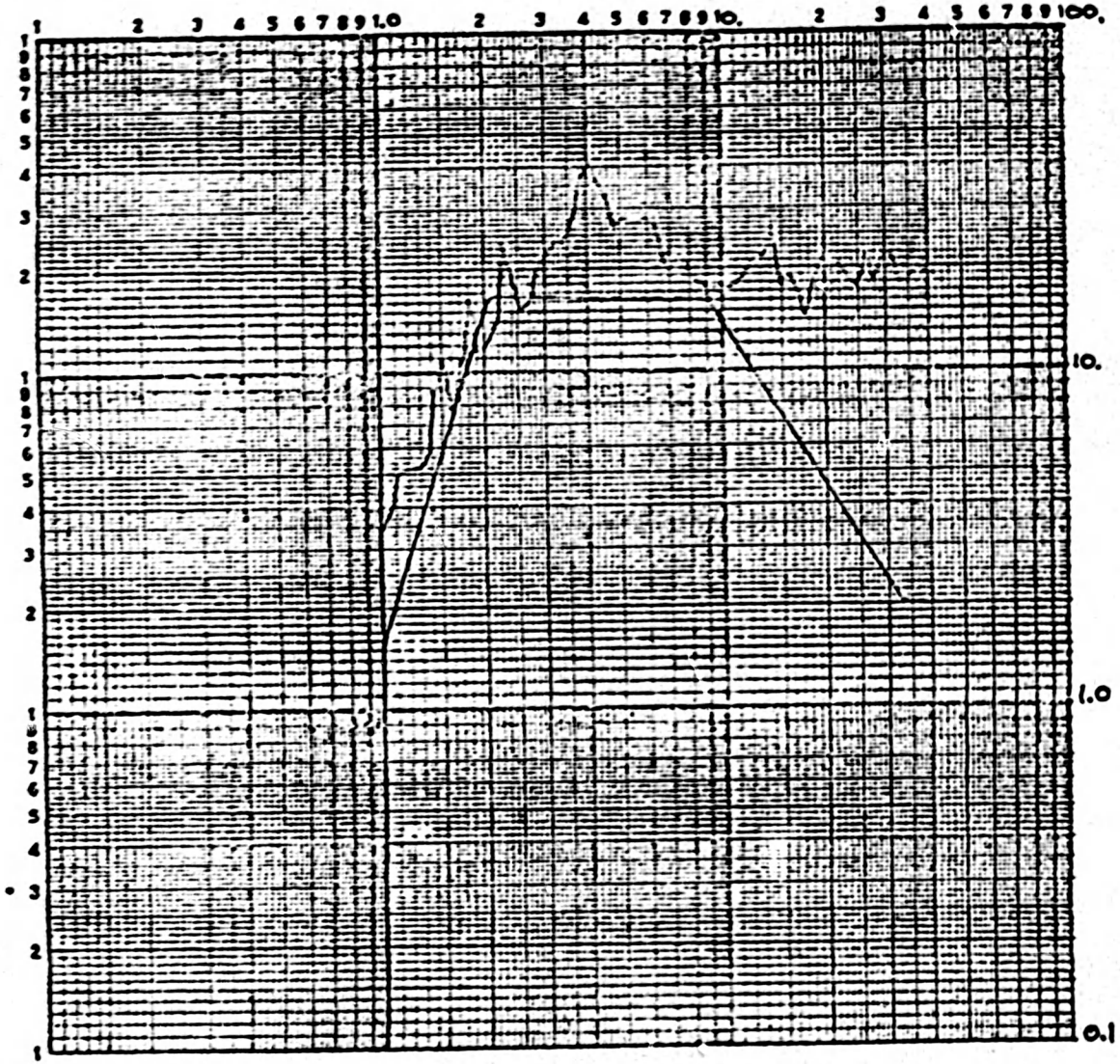
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL MAXI
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET 2500 PSI
P/N:	73988
S/N:	007
AXIS:	Z
DATE:	2/8/77
TIME:	~~1340~~ 1140
OPERATOR:	P.G.M

QTP 73989 FIGURE 1

Date: 8 March 1977



RESPONSE SPECTRA

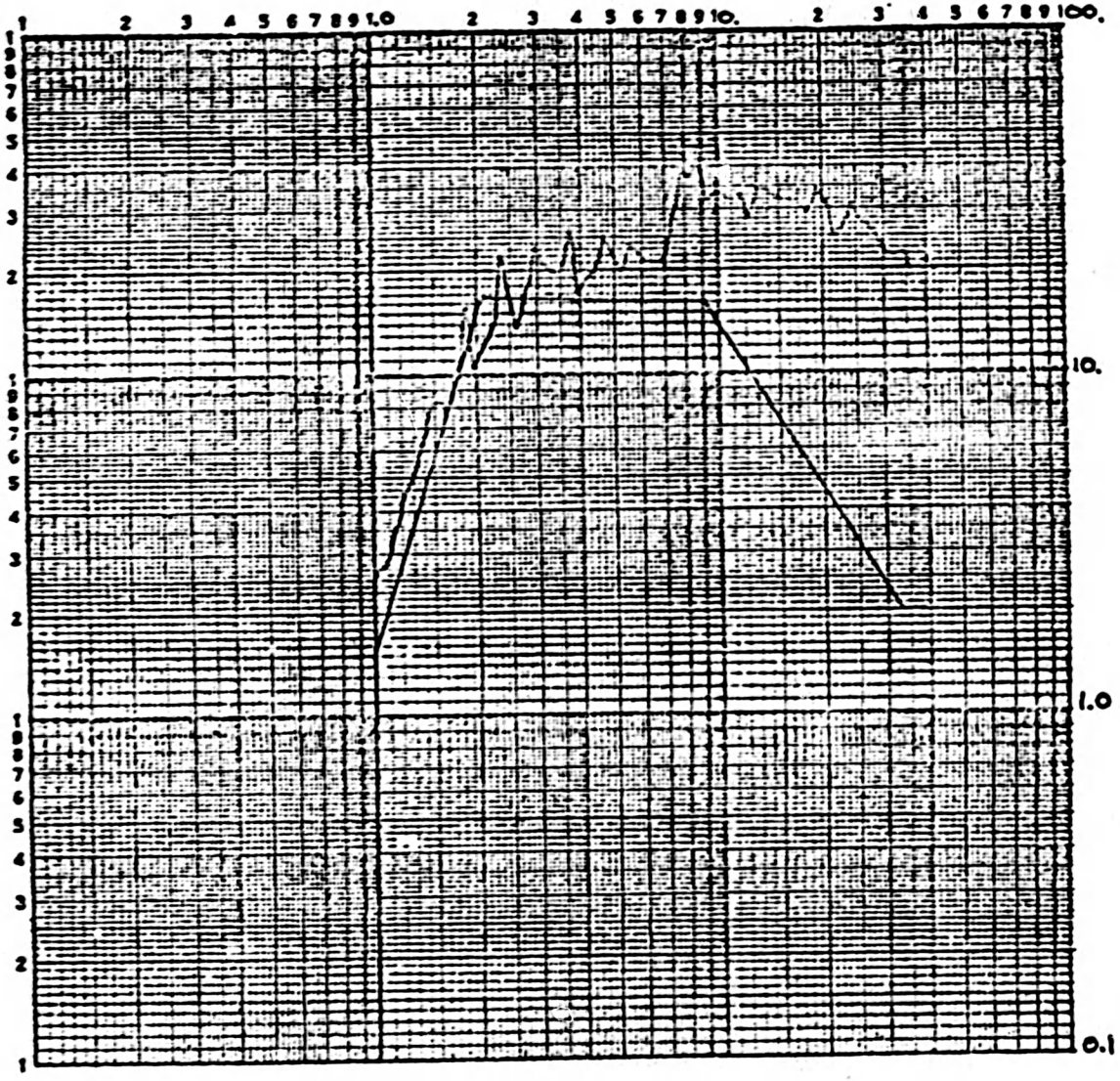
TRS EARTHQUAKE

SPECTRUM:	ACCEL MAX
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET NO PRESS
P/N:	73988
S/N:	007
AXIS:	Y
DATE:	2/8/77
TIME:	1158
OPERATOR:	jm

QTP 73989 FIGURE 1

HORIZ

Report no. 5410-191
Date: 8 March 1977



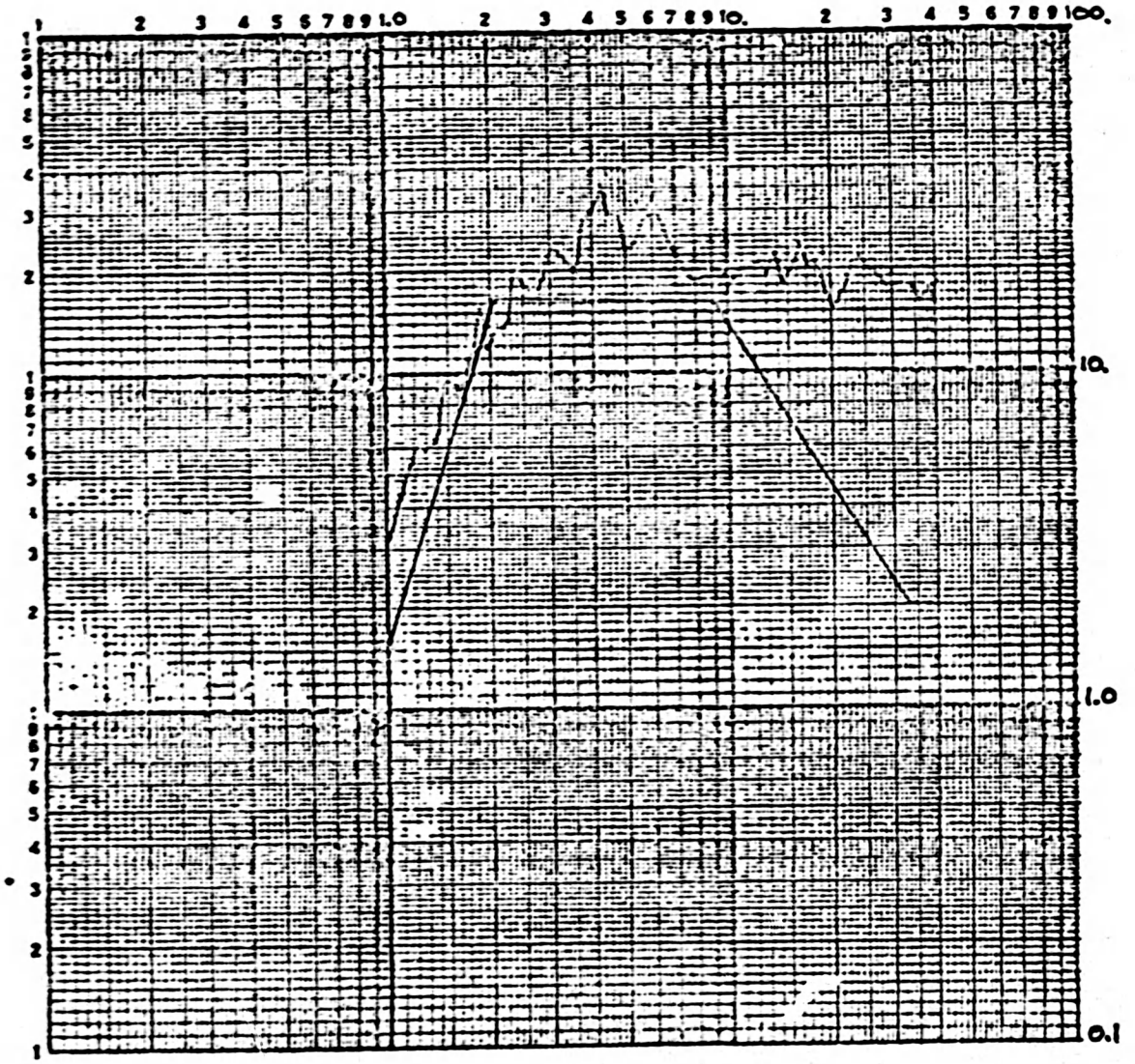
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAXI
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	1/20 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET NO PRESS
P/N:	73988
S/N:	007
AXIS:	Z
DATE:	2-8-77
TIME:	1158
OPERATOR:	P.J.M.

QTP 73989 FIGURE 1

Report No. 5410-7197
Date: 8 March 1977



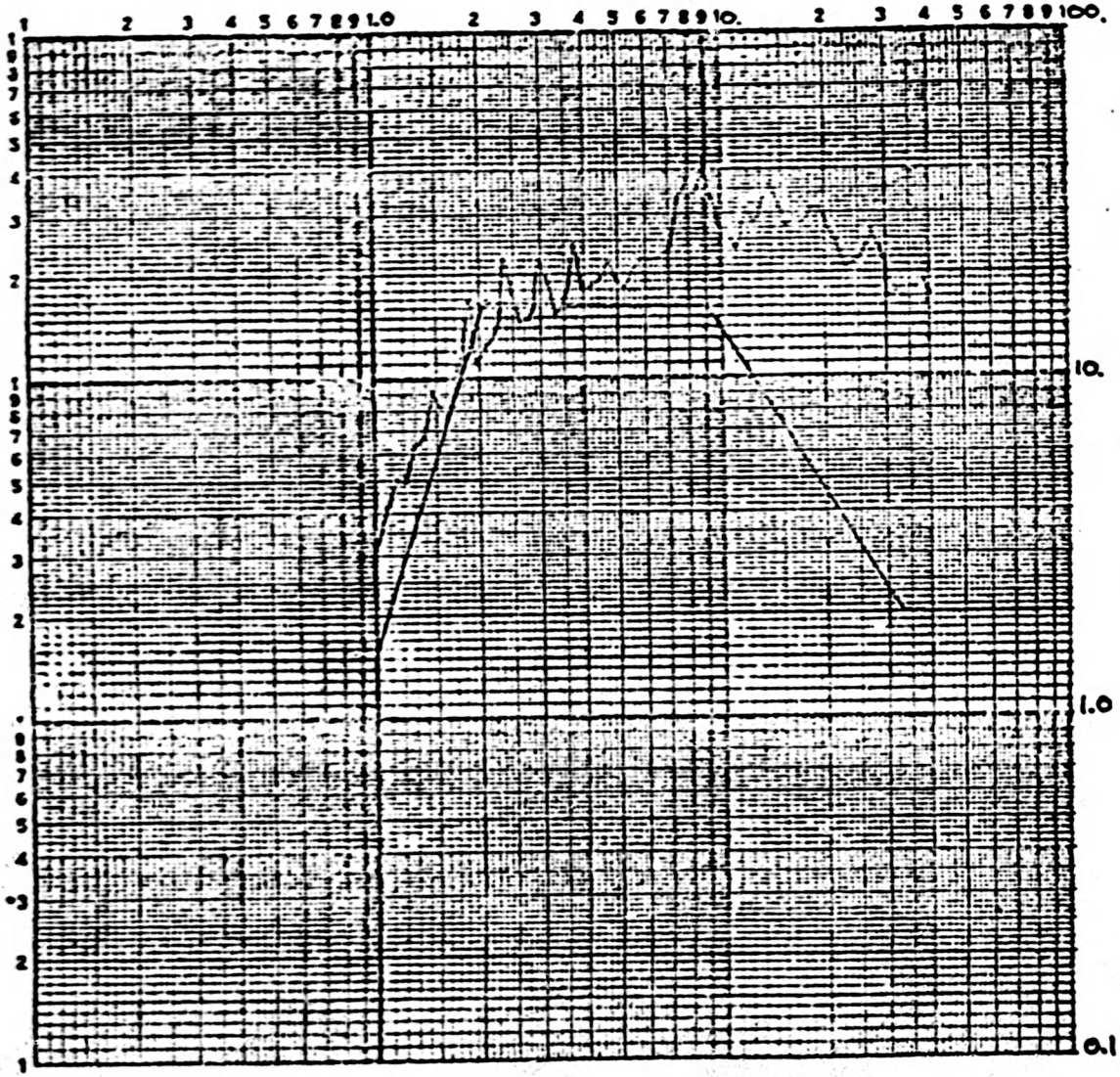
RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	+ACCEL. MAX
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	1/20 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET 2500 PSI
P/N:	73988
S/N:	007
AXIS:	Y AXIS
DATE:	2/8/77
TIME:	1202
OPERATOR:	P.J.M.

QTP 73989 FIGURE 1

Report No. 5410-7191
Date: 9 March 1977



RESPONSE SPECTRA

TRS EARTHQUAKE

SPECTRUM:	ACCEL. MAXI
POLARITY	+
DAMPING:	2.5%
ANALYSIS BANDWIDTH	120 FILTERS OCTAVE
MJO NUMBER	5410-6992
ITEM:	HOSE ASSEMBLY WET 2500 PSI
P/N:	73988
S/N:	007
AXIS:	Z
DATE:	2-8-77
TIME:	1202
OPERATOR:	Jwk.

QTP 73989 FIGURE 1

APPENDIX II

CR 431

SUPPLEMENTAL STRESS REPORT

METAL Bellows CORP.
CHATSWORTH, CALIFORNIA

ADDENDUM I
TO
CR 364

HOSE ASSEMBLY
FLEXIBLE METAL - INSTRUMENTATION
PER ASME SECTION III, CLASSES 2 AND 3
SEISMIC CATEGORY I

R. H. Nystrom, Project Engineer

W. D. Coodey, Chief Engineer

P. B. Campbell, Director of Engrg.

No. of Pages 5

February 24, 1978

1.0 This Addendum to Test Report CR 364 is to provide justification for MBC's use of P/N 73989 in the "U" configuration for qualification testing and to show that the tube ends meet the allowable stress requirements of the ASME B & PV Code, Section III, Para. NC 3650 (Piping System Analysis).

2.0 The major portion of the loads imposed on the hose end are caused by the friction between the braid and hose, which is caused by the squeezing effect of the braid because of end load. End load is a direct function of pressure.

With the hose in the various recommended installed positions, and pressurized to the maximum design pressure (2500 psig), the loads (force and moment) were measured to displace one end (opposite and fixed) of the hose through the various displacements. The loads were recorded at the maximum displacements.

The loads were non-linear, i.e., a minimum force was required to start the hose moving; then very little extra load was required to maintain the motion of the end until maximum deflection was reached. This deflection load would remain until the end was deflected slightly (.01 - .06 in) in the opposite direction. Also, the rate of change (different velocities) did not affect the load required. Note: With zero pressure, the forces required to displace the hose were so low, that they could not be measured with the equipment available in MBC's test laboratory.

To displace the moving end, a force was applied and at the same time a restoring moment was applied to maintain parallelism. The highest force to deflect the hose 5 inches was 18 lb. The highest moment applied was 9 ft-lbs. Most loads and moments were 6 - 10 lbs. and 5 - 7 ft-lbs. These moments were measured at the "B" nut coupling used for test purposes, which is the same point where the connecting socket weld would be located.

The selection of the "U" configuration for seismic testing was based on the following reasons:

1. It provided the floppiest configuration under seismic excitation; and because of the ease of deflection, it is MBC's contention that this was definitely a "worst case" test.

2. This configuration generated the highest moment loads on the hose as stated above.

3 REQUIREMENTS OF NC3650

3.1 CALCULATIONS REQUIRED

3.1.1 WEIGHTS

FLUID : $.1554(.59)^2(36)(.03611\ \frac{LB}{IN^3}) = .355$

HOSE : $[(.70-.45)360+.57(3)]\pi(.49)(.016)(.3) = .817$ } $= .0505\ LB/IN$

BRAID : $.215\ \frac{LB}{FT} \times 3FT = .645$

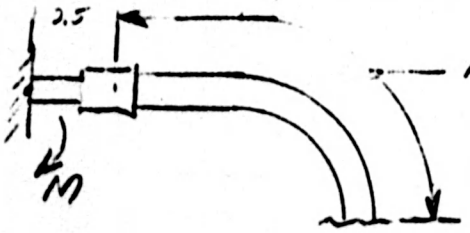
SPRING : $\pi(.89)(.093)^2(.7854)(45)(.3) = .274$

ADAPTER : $(.7^2-.47^2)(.72)(.7854)(.3) = .046$

TUBE : $(.5^2-.31^2)(2.2)(.7854)(.3) = .080$

FERRULE : $(.05)(1.5)(1.059)\pi(.3) = .075$

3.1.2 MOMENT (DEAD WEIGHT)



FOR CONSERVITISM, ASSUME HOSE IS STRAIGHT (½ LENGTH OF TOTAL WITH .5 SOCKET)

M_1 (HOSE) (SUPERPOSITION) $= \frac{w\ell^2}{2} = \frac{.0505[(20.75)^2-(2.5)^2]}{2} = 10.68$ IN-LB

M_2 (FERRULE) $= W\ell = (.075)(2.75) = .21$ "

M_3 (TUBE) $= \frac{W\ell}{2} = (.080)(.5)(2.5) = .10$ "

M_4 (ADAPTOR) $= W\ell = (.046)[2.5+(.5)(.7)] = .13$ "

M_5 (SPRING) $= W\ell = (.274)[2.5+(.5)(4.5)] = 1.30$

TOTAL MOMENT $= 12.42$ IN-LB

3.1.3 $S_A = f(1.25S_c' + .25S_h)$ (REF NC-3611.2 Eq (c))

$= 1[1.25(18.5)+.25(15.1)] = 27.1$ Ksi (@ 7000 CYCLES)

3.1.4 STUB END DESCRIPTION

.50 OD X .093 WALL PER SA 213 TP 304

3.1.5 MATERIAL PROPERTIES PER SECTION III TABLE I-7.2

MIN YIELD = 30 Ksi
MIN ULTIMATE = 75 Ksi
S_{ALLOW} = 15.9 Ksi @ 700°F DESIGN TEMP

3.1.5 FATIGUE ALLOWABLE PER SECTION III FIG I-9.2

S_{ALLOW} = 26 Ksi for 10^6 CYCLES
($E = 26.0 \times 10^6$)

3.2 SUSTAINED LOADS (REF NC-3652.1 EQ (3)

$$S_{SL} = \frac{PD_o}{4t_n} + \frac{.75\, i\, M_A}{Z} \leq 1.0 S_h$$

$$= \frac{2500(.5)}{4(.093)} + \frac{.75(2.1)\quad(12.4)}{\pi(.2035)^2(.093)} \leq 1.0(15.7\ \text{Ksi})$$

i = STRESS INTENSITY FOR FILLET WELD

M_A = DEAD WEIGHT

$Z = \pi r_m^2 t$ (REF NC3652.4(a))

= 3.36 Ksi + 1.62 Ksi = 4.98 Ksi ≤ 15.7 Ksi

ADEQUATE

4.5 Operational Vibration (continued)

. The sweep cycling shall be at the displacements and G levels of Figure 2.

The pressure source shall be monitored during the vibration test. There shall be no evidence of pressure loss. At the conclusion of the vibration test, the hose assembly shall meet the leakage requirement of Paragraph 4.3. Submerge the hose assembly in isopropyl alcohol for a minimum of two (2) minutes, and then oven dry at 275 ± 25°F for a minimum of one (1) hour prior to submittal of leakage test.

4.6 Seismic

Install the hose assembly into a configuration as shown in Figure 4, into a test fixture on the vibration table with one end offset to an equivalent position of -2.88 inches in the X axis, +2.88 inches in the Y axis, and -2.88 inches in the Z axis. Pressurize the interior of the hose assembly with water at 2500 psig, and close off the pressure source.

Subject the hose assembly to the Test Response Spectrum (TRS) that as a minimum exceeds the 2 percent critical damping curve of Figure 1, except that the acceleration response at 1 HZ shall be approximately 1.5 G's and following a straight line at 16.5 G's at 2.5 HZ. Develop the TRS by means of complex random motion Vertical-Horizontal (biaxial) then Vertical -90° Horizontal, complying with the requirements of IEEE Standard 344-1975. The two TRS levels shall be of 45 seconds duration each. The test shall be performed with the hose assembly with media at zero pressure, with water at zero pressure, and with water at 2500 psig.

At the conclusion of the seismic vibration test, the hose assembly shall meet the leakage test of Paragraph 4.3.

4.7 Hydrostatic Pressure

Hydrostatic proof pressure test to be conducted per Paragraph 4.2, except that the pressure shall be 3750 psig. After meeting the above requirements, increase pressure to the burst pressure requirement of 8750 psig. Hold for one (1) minute. Increase pressure to failure.

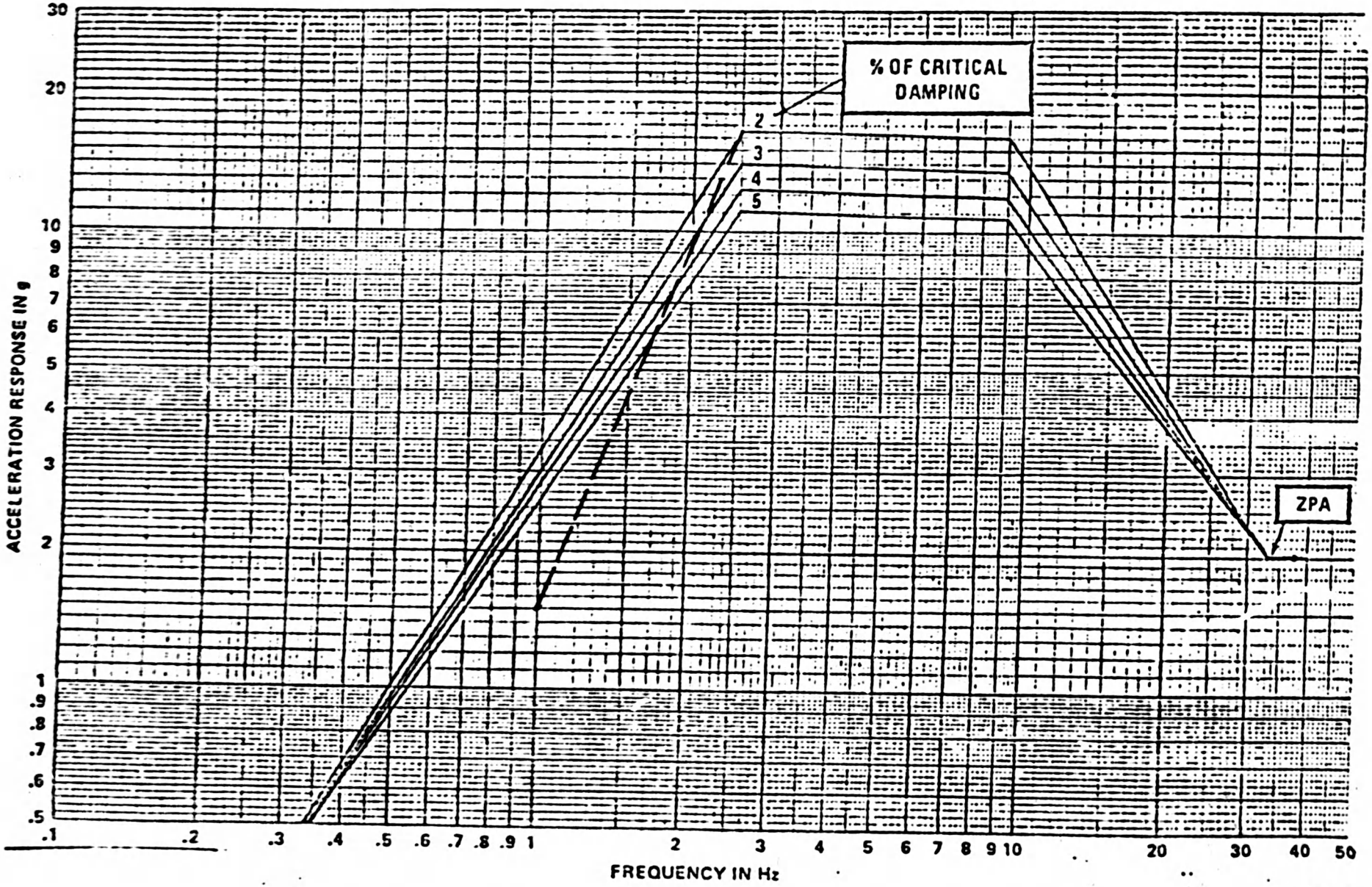
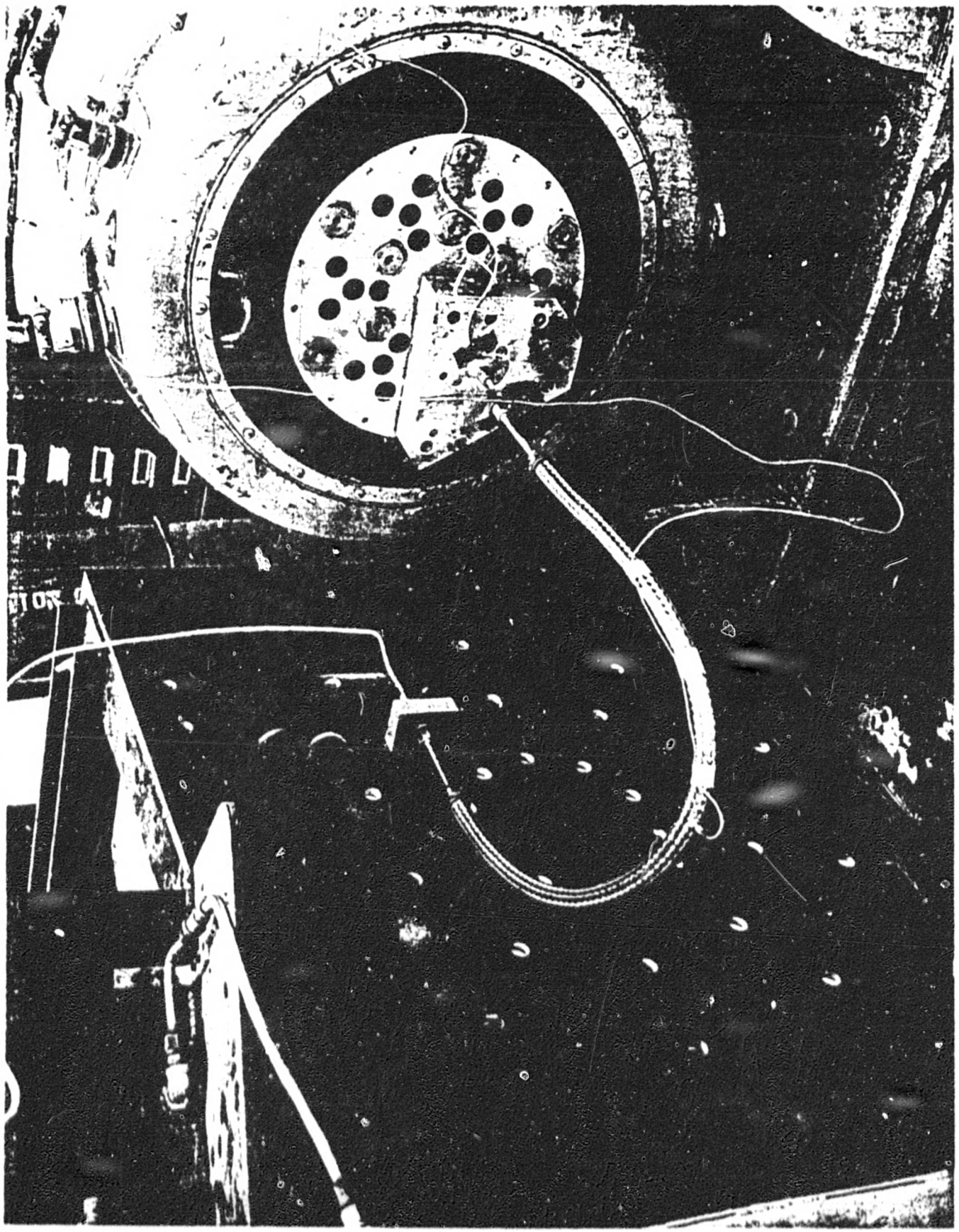


Fig. 1 Required Response Spectra (RRS) for Control Systems Purposes for the Majority of Nuclear Power Plant Locations in the Continental United States.

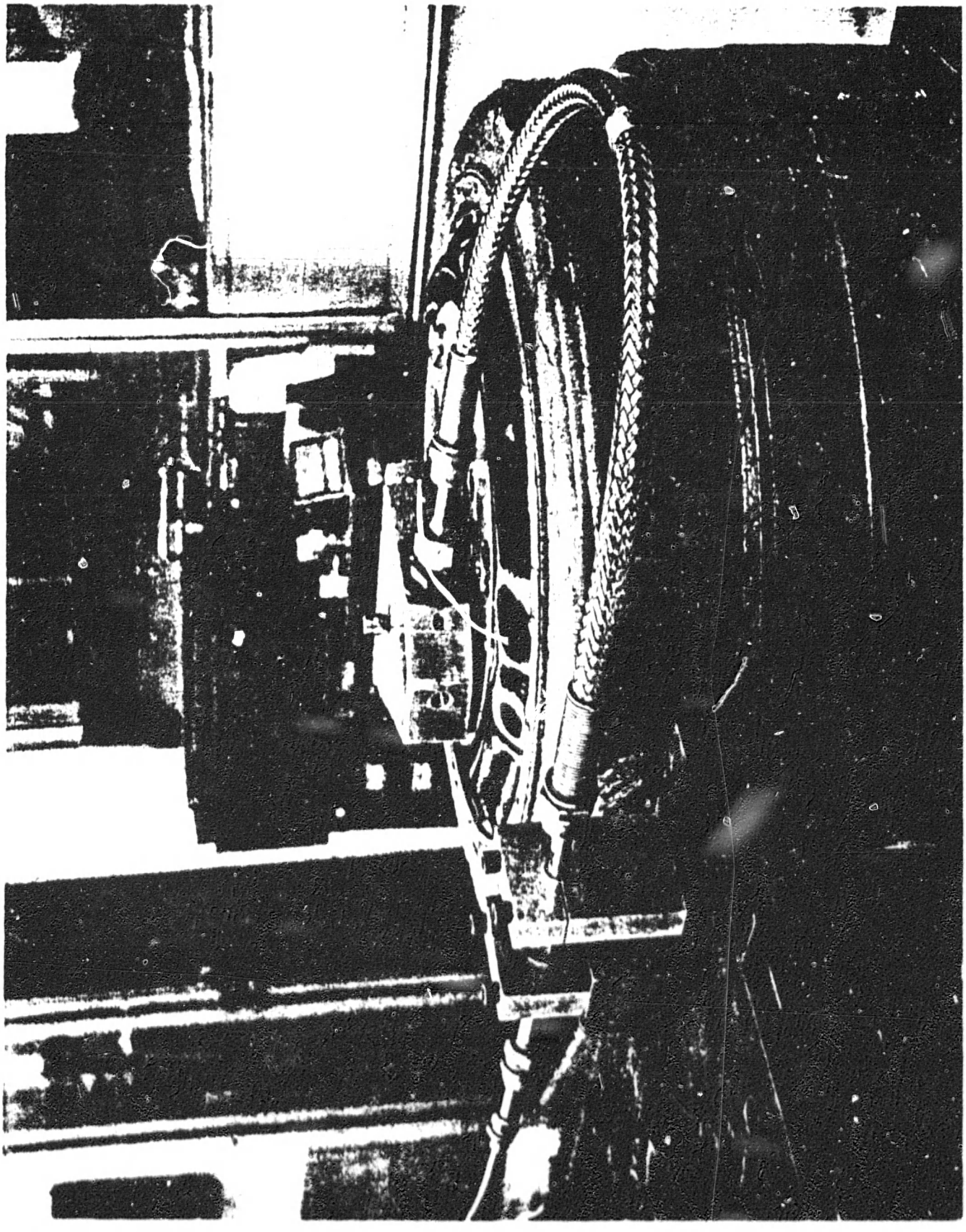
AETL

REPORT NO. 5410-7197
PHOTOGRAPH 2
OPERATING VIBRATION TEST
SETUP (X AXIS)



AETL

REPORT NO. 5410-7197
PHOTOGRAPH 3
OPERATING VIBRATION TEST
SETUP (Y AXIS)



3.3 OCCASIONAL LOADS (REF NC-3652.2, EQ(9))

$$S_{OL} = \frac{P D_o}{4 I} + .75 i \left(\frac{M_A + M_B}{Z} \right) \leq 1.2 S_h$$

M_B = 2g SEISMIC LOAD

$$= 3.36 \text{ Ksi} + .75(2.1)\left[\frac{(12.42) + 2(12.42)}{.0121} \right] \leq 1.2(15.9 \text{ Ksi})$$

$$= 3.36 \text{ Ksi} + 4.85 \text{ Ksi} \leq 19.08 \text{ Ksi}$$

$$8.21 \text{ Ksi} \leq 19.08 \text{ Ksi}$$

ADEQUATE

3.4 THERMAL EXPANSION (REF NC-3652.3, EQ(10))

$$S_E = \frac{i M_c}{Z} \leq S_A$$

M_c = MAX LOAD TO DEFLECT

$$= \frac{2.1 (108)}{.0121} \leq 27.1 \text{ Ksi}$$

$$= 18.7 \text{ Ksi} \leq 27.1 \text{ Ksi}$$

ADEQUATE

3.5 TOTAL LOAD EFFECTS (REF 11C3652.3 Eq (11))

$$S_{TE} = \frac{PD_o}{4t_n} + .75i\left(\frac{M_A}{Z}\right) + i\left(\frac{M_c}{Z}\right) \leq (S_h + S_n)$$

$$= 3.36\text{Ksi} + .75(2.1)\left[\frac{12.42}{.0121}\right] + (2.1)\left[\frac{108}{.0121}\right] \leq (15.9\text{Ksi} + 27.1\text{Ksi})$$

$$= 3.36\text{Ksi} + 1.62\text{Ksi} + 18.74\text{Ksi} = 23.72\text{Ksi} \leq 43\text{Ksi}$$

ADEQUATE

3.6 SHEAR STRESS (THIN RING)

$$S = \frac{2V}{A}$$

$$= \frac{2(18.68)}{.7854(.30^2 - .314^2)} = 0.3\text{ Ksi}$$

ADEQUATE