

WCAP-08587-  
SUPP 2-E15A

EQUIPMENT QUALIFICATION  
TEST REPORT  
WCID OPTIMAC 100 RECORDERS  
(Post Accident Monitoring)  
(Environmental and Seismic Design  
Verification Testing)

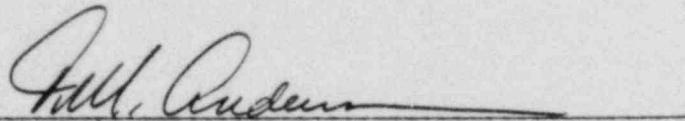
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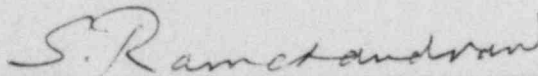
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TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
1.0	OBJECTIVE	1
2.0	EQUIPMENT TESTED	2
3.0	PERFORMANCE SPECIFICATIONS	3
4.0	DESCRIPTION OF TEST EQUIPMENT & FACILITY	4
5.0	TEST PROCEDURE	6
6.0	TEST DATA & ACCURACY	9
7.0	SUMMARY	12
APPENDIX A	LOT 1 & LOT 2 RECORDER SERIAL NUMBERS	30
APPENDIX B	TEST RESPONSE SPECTRA - LOT 1	33
APPENDIX C	TEST RESPONSE SPECTRA - LOT 2	54
APPENDIX D	WESTINGHOUSE CID SEISMIC RECORDER DRAWING	64

TABLES

	<u>Title</u>	<u>Page</u>
TABLE I	TEST UNITS	12
TABLE II	TEST EQUIPMENT	13
TABLE III	RECORDER ACCURACY DEVIATIONS FOLLOWING ENVIRONMENTAL TESTING	14
TABLE IV	RECORDER ACCURACY DEVIATIONS FOLLOWING SEISMIC TESTING	15
TABLE V	LOT #1 ENVIRONMENTAL CHAMBER CONDITIONS	16
TABLE VI	LOT #2 ENVIRONMENTAL CHAMBER CONDITIONS	17

FIGURES

	<u>Title</u>	<u>Page</u>
FIGURE 1	TEMPERATURE VERSUS HUMIDITY - ENCLOSED ENVIRONMENTS OUTSIDE CONTAINMENT	18
FIGURE 2	REQUIRED RESPONSE SPECTRUM (RRS) FOR SAFE SHUTDOWN EARTHQUAKE (SSE)	19
FIGURE 3	TEST SPECIMEN ORIENTATION	20
FIGURE 4	TEST FIXTURE IN TEST DIRECTION FOUR	21
FIGURE 5	TEST SETUP FOR ENVIRONMENTAL CYCLES	22
FIGURE 6	TEST SETUP FOR SEISMIC TESTING	23
FIGURE 7	REQUIRED ABNORMAL ENVIRONMENTAL TEST CONDITIONS	24
FIGURE 8	INPUT SIGNAL FLOW PATH	25
FIGURE 9	ACCELEROMETERS A1 (HORIZONTAL) AND A2 (VERTICAL) MOUNTED TO THE VIBRATION TABLE	26
FIGURE 10	ACCELEROMETERS A3 (HORIZONTAL), A4 (VERTICAL), AND A5 (SIDE-TO-SIDE) MOUNTED ON THE 2-PFN RECORDER 1LR-1063.	27
FIGURE 11	ACCELEROMETERS A6 (HORIZONTAL), A7 (SIDE-TO-SIDE), AND A8 (VERTICAL) MOUNTED ON THE 3-PEN RECORDER 1TR-4133.	28

FIGURES (Cont)

<u>Figure</u>	<u>Title</u>	<u>Page</u>
FIGURES B1 TO B20	TEST RESPONSE SPECTRA LOT NO. 1	34-53
FIGURES C1 TO C9	TEST RESPONSE SPECTRA LOT NO. 2	54-62
FIGURE D1	SEISMIC RECORDER OUTLINE	64

## 1.0 OBJECTIVE

The objective of this qualification program is to demonstrate that the Recorders meet or exceed their safety related performance requirements while subjected to the normal, simulated abnormal and seismic service conditions specified in Section 3. A qualification test was completed on eight recorders.

## 2.0 EQUIPMENT TESTED

2.1 A total of eight (8) Optimac 100 series recorders manufactured by Westinghouse Computer & Instrumentation Division (Westinghouse CID) were tested. These recorders were sampled from two (2) production lots. Of lot 1, three (3) two (2) pen units and three (3) three (3) pen units were tested. Of lot 2 one (1) two (2) pen unit and one (1) three (3) pen unit was tested.

2.2 [ ] b,c,e

2.3 A list of the model & serial numbers appear in Table I.

### 3.0 PERFORMANCE SPECIFICATIONS

The recorders were tested to verify their functional operability as defined below:

#### 3.1 Conditions

3.1.1 Twelve hours continuous operation at the extreme temperature and humidity conditions of Figure 1 (Condition 3 - Loss of Ventilation or non-Class 1E Air Conditioning).

3.1.2 Seismic response spectrum (Figure 2) of 28g's acceleration for all Safe Shutdown Earthquake (SSE) tests. One half SSE acceleration for all Operating Basis Earthquake (OBE) tests. The RRS along the control accelerometer axis is the  $\sqrt{2}$  higher over the entire frequency range than the RRS along the front to back, side to side direction of the equipment to account for the 45° orientation.

#### 3.2 Performance

Remain within an accuracy deviation of  $\pm 4.0\%$  of calibrated span during the environmental test and before and after the seismic test.



## 4.0 DESCRIPTION OF TEST EQUIPMENT & FACILITY

4.1 All environmental & seismic tests were performed in the testing laboratory at Westinghouse Advanced Energy Systems Division (AESD) in Large, Pa.

### 4.2 Test Equipment

A list of all test equipment used during testing appears in Table II.

### 4.3 Mounting

#### 4.3.1 Environmental

Test units were placed in an environmental chamber which provided the necessary conditions for the test.

#### 4.3.2 SEISMIC

Test units were mounted on a test fixture, using methods indicated by Westinghouse drawing [ ], a,c which was bolted to a 6 ft. by 6 ft. test table at a 45° angle to the horizontal table motion. The hydraulic piston driving the table was at a 35° angle to the horizontal plane of the table. This orientation produced equal motion in the three mutually perpendicular axes in the test units frame of reference. Figure 3 shows the test fixture orientation. Figure 4 shows a picture of the test table (position 4 shown).

### 4.4 Connections

Electrical setup requirements were identical for both the environmental and seismic tests. The power source was [ ]<sup>b,c,e</sup> VAC, [ ]<sup>b,c,e</sup> Hz, connected to the recorders using #12 AWG stranded

copper wire. The simulated signal input was provided from a [ ]b,c,e VDC source, connected to the recorders using #16 AWG shielded twisted pairs. Figure 5 shows the test setup for the environmental cycles, and Figure 6 shows the test setup for seismic testing.

## 5.0 TEST PROCEDURE

### 5.1 Environmental

#### 5.1.1 Burn-in

##### 5.1.1.1 Service Conditions

The recorders were operated at a chart speed of one (1) inch per hour for fifty (50) hours at ambient temperature. The power source was [ ]<sup>a,b,c</sup> vac, [ ]<sup>a,b,c</sup> and the signal source was [ ]<sup>a,b,c</sup> volts DC.

##### 5.1.1.2 Monitored Functions

Once every four hours, the signal voltage was stepped from zero to full span to zero in 20% of span increments. An eleven (11) point calibration check was performed after the burn-in.

#### 5.1.2 Operational Test

##### 5.1.2.1 Service Conditions

The recorders were operated at a chart speed of one (1) inch per hour during four (4) twelve (12)-hour cycles of varying temperature, humidity, power input voltage, and frequency. Figure 7 summarizes the required conditions. Once every four hours, the signal input was stepped from zero to full span to zero in 20% of span increments.

#### 5.1.2.2 Monitored Functions

At the end of each twelve (12)-hour cycle, an eleven (11) point calibration check for accuracy was performed. The chamber temperature and humidity were continuously monitored and recorded. The power supply voltage and frequency were recorded at 15 minute intervals.

### 5.2 Seismic

#### 5.2.1 Service Conditions

Before testing, the input was played into the system with a dummy weight attached to the vibration table. This ensured proper scaling before subjecting the test articles to simulations.

A resonant search on the complete test set-up was performed prior to any other testing. This was performed over the range of one (1) to fifty (50)Hz. and then fifty (50) to one (1) Hz. at a sweep rate of 1 octave per minute at 0.2g. The input for the simulations was supplied on 14 channel FM tape by Westinghouse Nuclear Technology Division (NTD). Each channel was attenuated by a 14-channel waveform summer, and this summation was twice integrated and fed to the hydraulic control system. A block diagram of this set-up is shown in figure 8. Five (5) Operating Basis Earthquakes (OBE) were then performed. Finally, one Safe Shutdown Earthquake (SSE) in four (4) different test fixture orientations ( $0^{\circ}$ ,  $90^{\circ}$ ,  $180^{\circ}$ ,  $270^{\circ}$ ) was performed.

No adjustment of the recorders was permitted during the OBE runs. Following each SSE run, the recorders were inspected for damage; repairs were permitted to the extent that they could be done without removing the recorders from the test fixture.

### 5.2.2 Monitored Functions

A total of eight (8) accelerometers were used for each test. A biaxial accelerometer set mounted on the surface of the test table sensed horizontal (in line with the piston) and vertical table motion. Five (5) triaxial accelerometer sets were located on the test units. Examples of mounting are shown in Figures 9, 10 and 11. Eleven point calibration checks were made before seismic testing and each SSE run.

## 6.0 TEST DATA & ACCURACY

A list of the maximum deviations for each test unit is given in Table III for each environmental run and Table IV for each seismic run. All numbers are expressed as plus or minus percent of calibrated span.

### 6.1 Lot 1

#### 6.1.1 Environmental

Table V indicates environmental chamber and input power conditions during each cycle of the test. These conditions were electronically controlled & manually recorded periodically. Conditions within the chamber were allowed to stabilize at normal ambient conditions between cycles.

#### 6.1.2 Seismic

Difficulties in achieving the RRS for the SSE in test direction 1 resulted in seven unsuccessful runs before the RRS was obtained.

b,c,e

b,c,e

] Lot 1 testing required additional seismic runs due to operator error or failure to obtain the RRS on earlier runs. Figures B2, B4, B5, B6, and B8 are acceptable OBE tests and figures B15, B16, B19 and B20 are acceptable SSE tests in the four directions described in Section 5.2.1.

## 6.2 Lot 2

### 6.2.1 Environmental

Table VI indicates environmental chamber and input power conditions during each cycle of the test. These conditions were electronically controlled and manually recorded periodically. Conditions within the chamber were allowed to stabilize at normal ambient conditions between cycles.

### 6.2.2 Seismic

The five OBE runs and the four SSE runs (one in each direction) are documented in Appendix C. Minor maintenance was needed, in reference to pens and paper rolls after the seismic test. These repairs were easily handled from the front of the recorders.



7.0 SUMMARY

7.1 Lot 1

[ ] b,c,e

The results of Lot 1 testing indicate that the errors [ ] b,c,e did not exceed the  $\pm 4.0\%$  deviation requirement.

[ ] b,c,e

7.2 Lot 2

All recorders remained functional throughout the environmental and seismic testing. Minor maintenance was needed, in reference to pens and paper rolls after the seismic test. These repairs were easily handled from the front of the recorder. All recorders remained well within the  $\pm 4.0\%$  deviation allowance. No structural failures or loosening of bolts was observed, [ ] b,c,e

[ ]

TABLE I

TEST UNITS

	<u>Tag Number</u>	<u>Type</u>	<u>Serial Number</u>
Lot 1	[		] a,c
Lot 2			

TABLE II

TEST EQUIPMENT

<u>Manufacturer &amp; Model</u>	<u>McBee No.</u>
B&F Model 1C1613 Conditioners (0-9)	4110
B&F Model 10-800 Amplifiers (0-9)	4190
B&F Model 1C1613 Conditioners (10-19)	4133
B&F Model 10-800 Amplifiers (10-19)	4109
B&F Model PS15-1500 Power Supply	4111
Data Precision 2480R DVM0683	
Gould Model 2800 Recorder (1)	1602
Gould Model 2800 Recorder (2)	1581
Tektronix 502 Oscilloscope	0480
Hewlett Packard 5323A Freq. Counter	0866
Spectral Dynamics SD105C Amplitude Servo-Monitor	1168
Spectral Dynamics SD104A-5 Sweep Oscillator	1306
MRAD Double Integrator	3408
Spectral Dynamics Corp. 13192 Transient Memory and 13231 Shock Spectrum Analyzer	2104
Esterline Angus 540 XY' Recorder	2349
Weston 1241 DVM	0350
Lufft HTAB-176 Hygrometer and Thermometer	1578
Honeywell Servoline 45 Temp/Humidity Recorder	0362

<u>Serial Number</u>	<u>Accelerometers</u>	<u>McBee No.</u>
2873		0108
2871		0110
3088		0884
4149		1711
1513		3757
4142		1706
1537		3696
1512	14	3452

TABLE III

RECORDER ACCURACY DEVIATIONS  
ENVIRONMENTAL TESTING

<u>Recorder</u>	<u>Lot#</u>	<u>Pen</u>	<u>Cycle</u> <u>1</u>	<u>Cycle</u> <u>2</u>	<u>Cycle</u> <u>3</u>	<u>Cycle</u> <u>4</u>	b,c,e
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TABLE IV

RECORDER ACCURACIES FOLLOWING  
SEISMIC TESTING

<u>Recorder</u>	<u>Lot#</u>	<u>Pen</u>	Test <u>Position 1</u>	Test <u>Position 2</u>	Test <u>Position 3</u>	Test <u>Position 4</u>

b,c,e

TABLE V

LOT #1 ENVIRONMENTAL CHAMBER CONDITIONS

Cycle	Time	Temp Deg. F	% Rel Humidity	Power		
				Voltage (A,C)	Freq. (Hz)	
1	8:30 AM	[				] b,c,e
	12:30 PM					
	4:30 PM					
	8:30 PM					
2	7:30 AM	[				] b,c,e
	11:30 AM					
	3:30 PM					
	7:30 PM					
3	8:00 AM	[				] b,c,e
	12:00 Noon					
	4:00 PM					
	8:00 PM					
4	7:45 AM	[				] b,c,e
	11:45 AM					
	3:45 PM					
	7:45 PM					

TABLE VI

LOT #2 ENVIRONMENTAL CHAMBER CONDITIONS

Cycle	Time	Temp Deg. F	% Rel Humidity	Power		
				Voltage (A,C)	Freq. (Hz)	
1	10:30 AM	[				] b,c,e
	2:30 PM					
	6:30 PM					
	10:30 PM					
2	9:30 AM					
	1:30 PM					
	5:30 PM					
	9:30 PM					
3	10:00 AM					
	2:00 PM					
	6:00 PM					
	10:00 PM					
4	10:00 AM					
	2:00 PM					
	6:00 PM					
	10:00 PM					

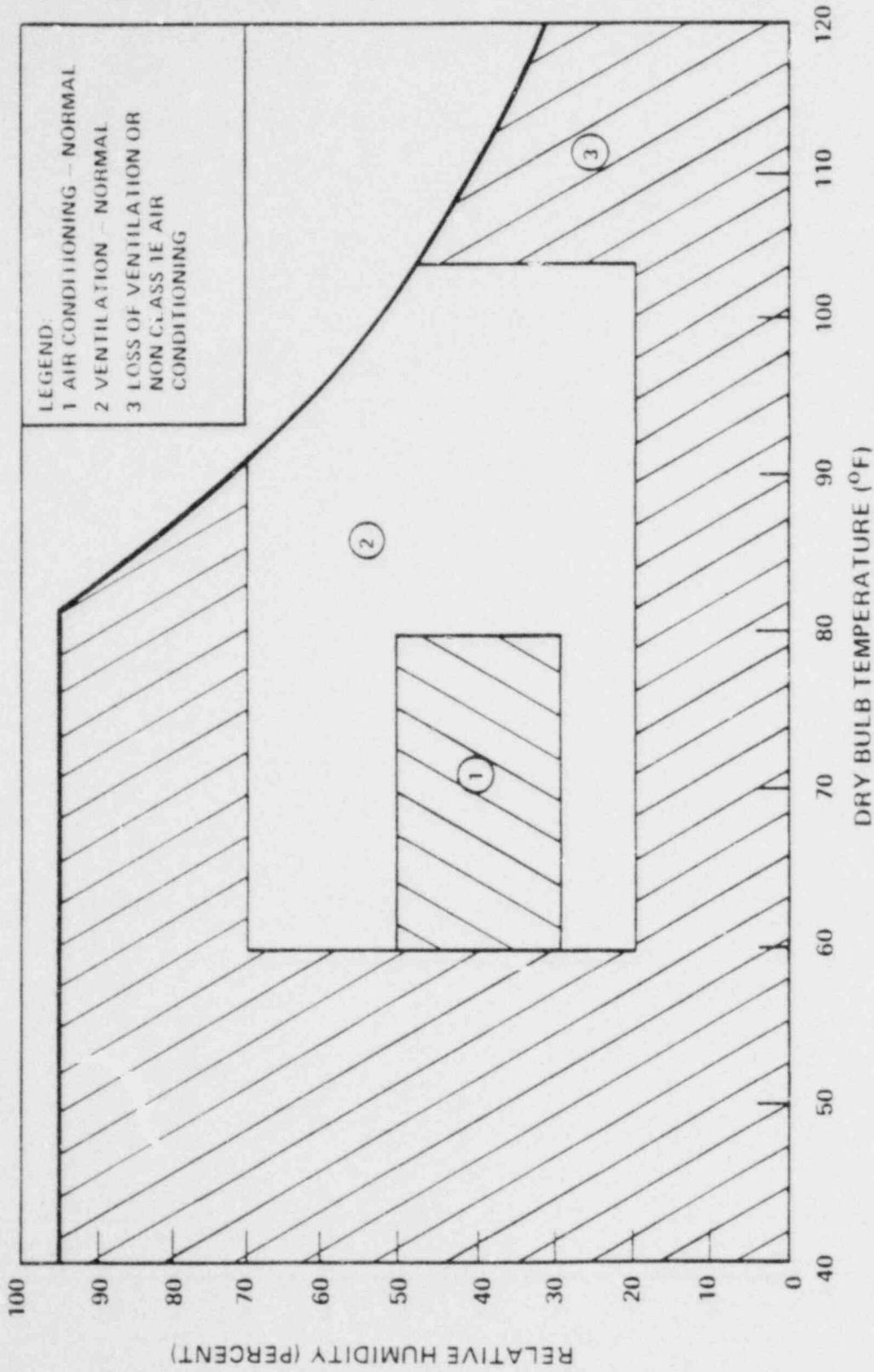


Figure 1 Temperature Versus Humidity - Enclosed Environments Outside Containment



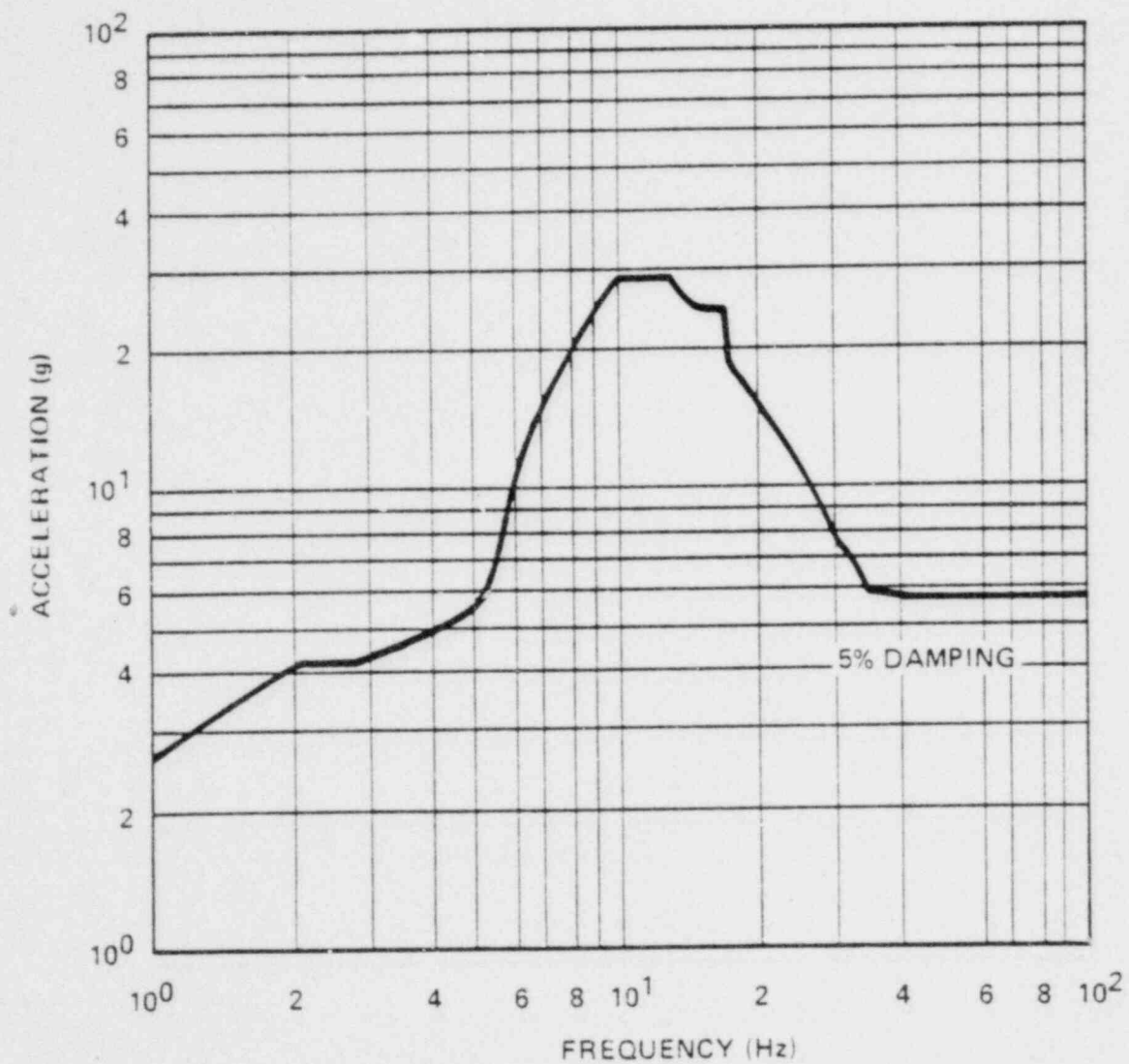


Figure 2 Required Response Spectrum (RRS) for Safe Shutdown Earthquake (SSE)  
(Note: OBE Required Response Spectrum = 0.5 SSE RRS)

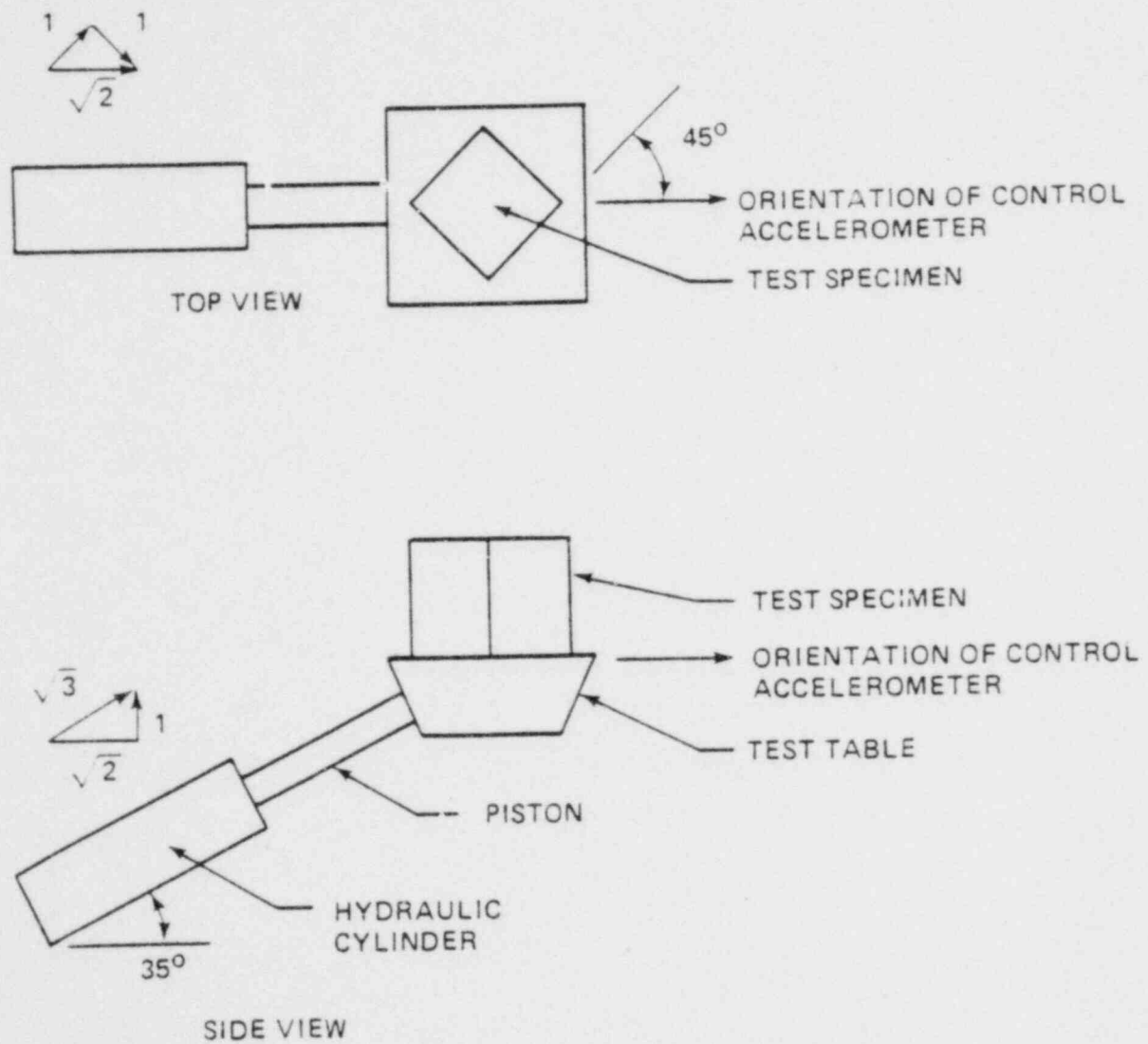


Figure 3 Test Specimen Orientation

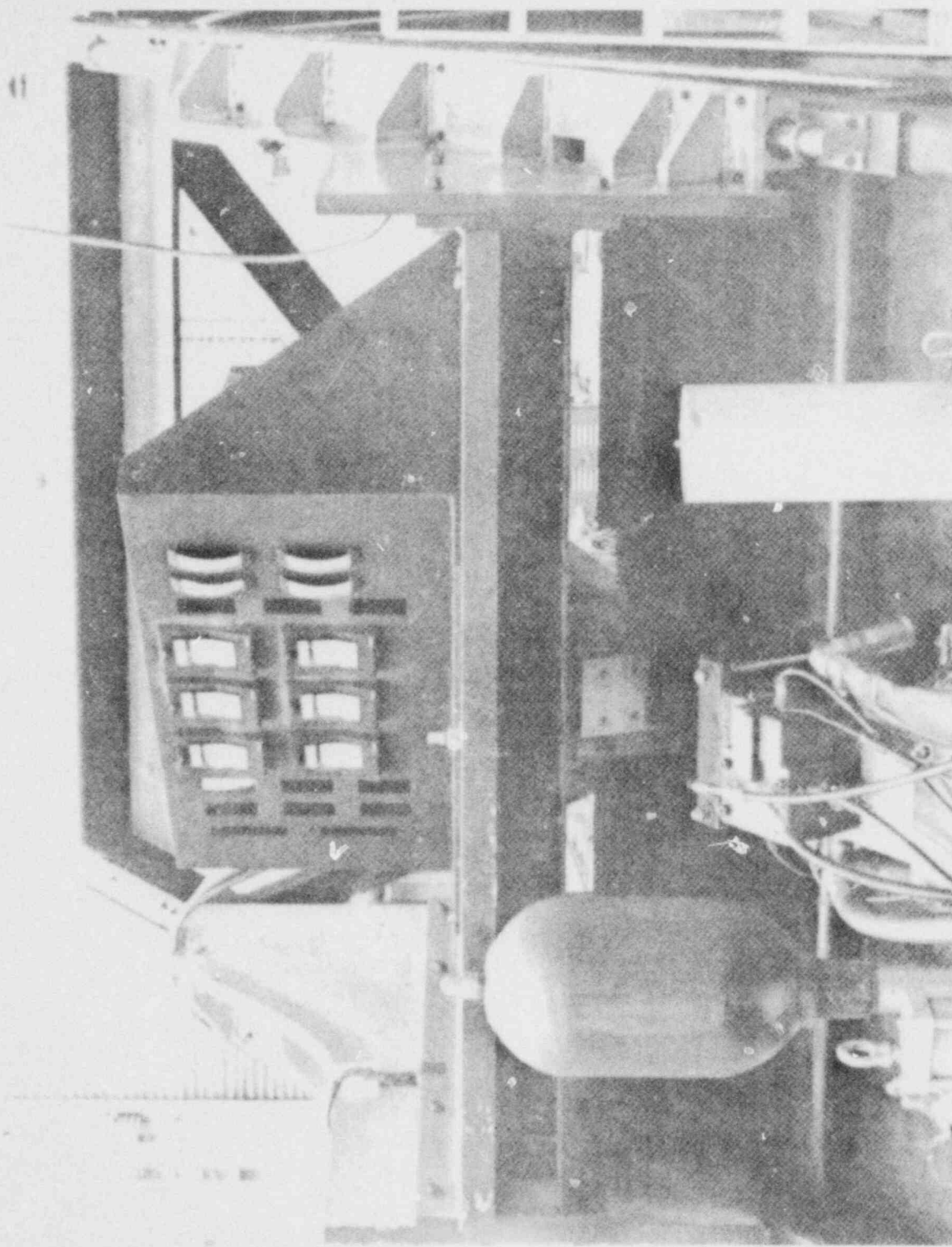


Figure 4 Test Fixture in Test Direction 4

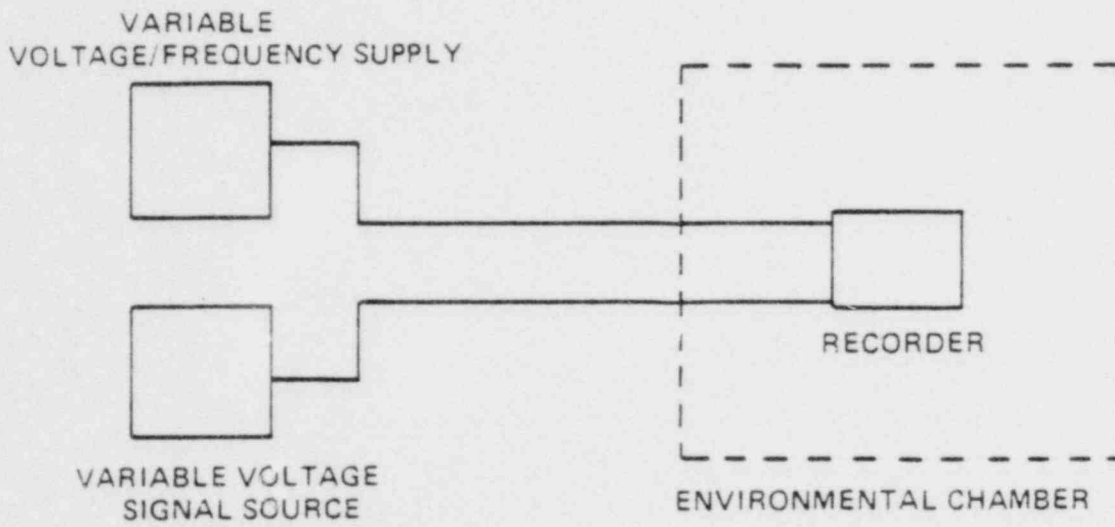


Figure 5 Test Setup for Environmental Cycles

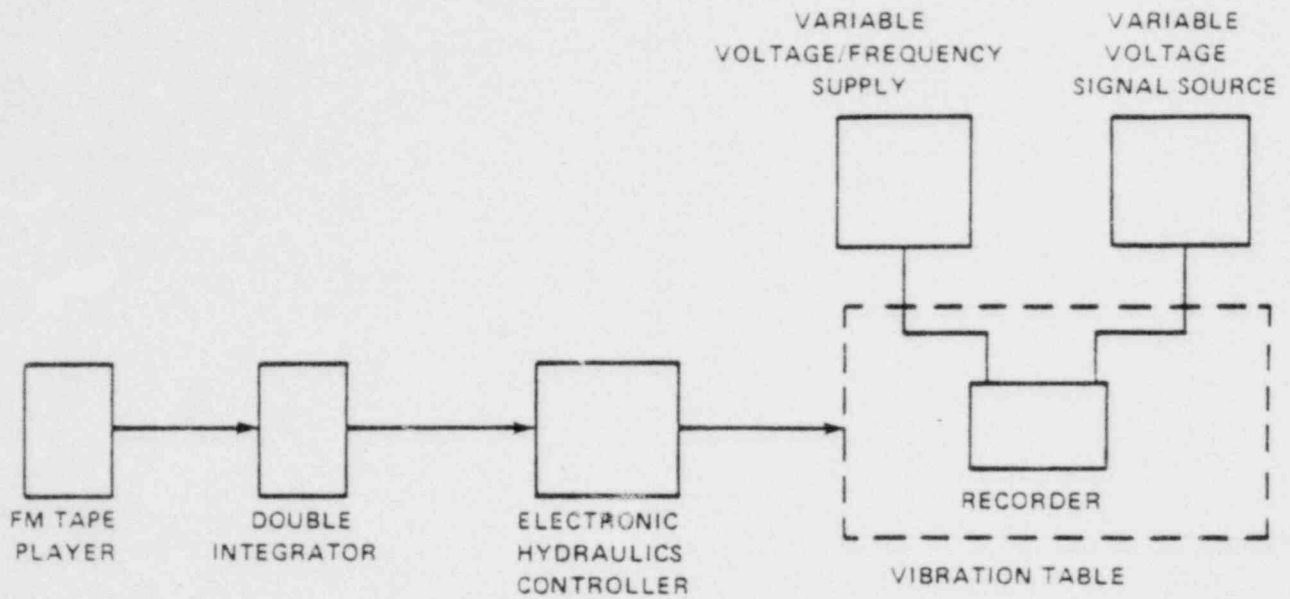


Figure 6 Test Setup for Seismic Testing

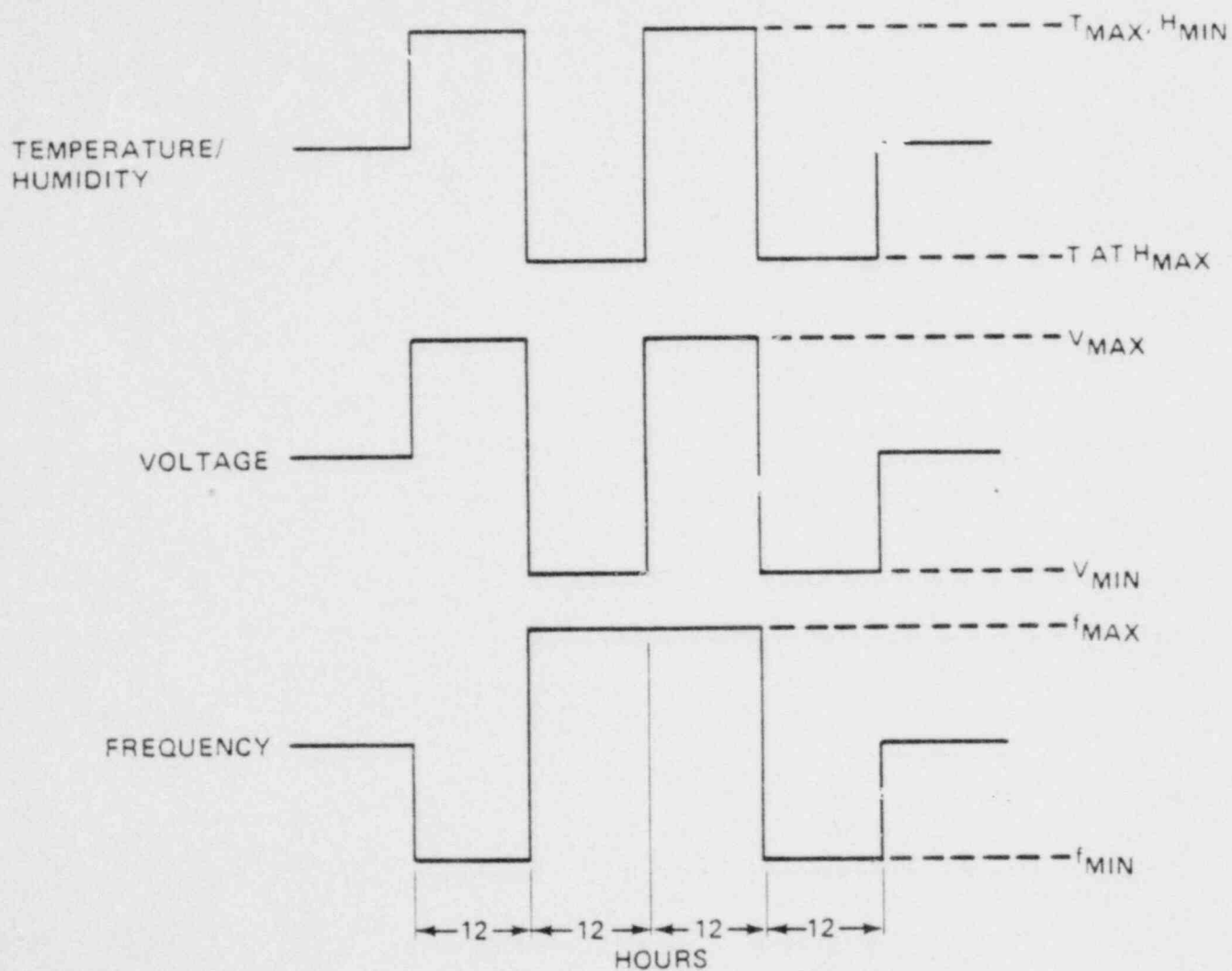


Figure 7 Required Abnormal Environment Test Conditions

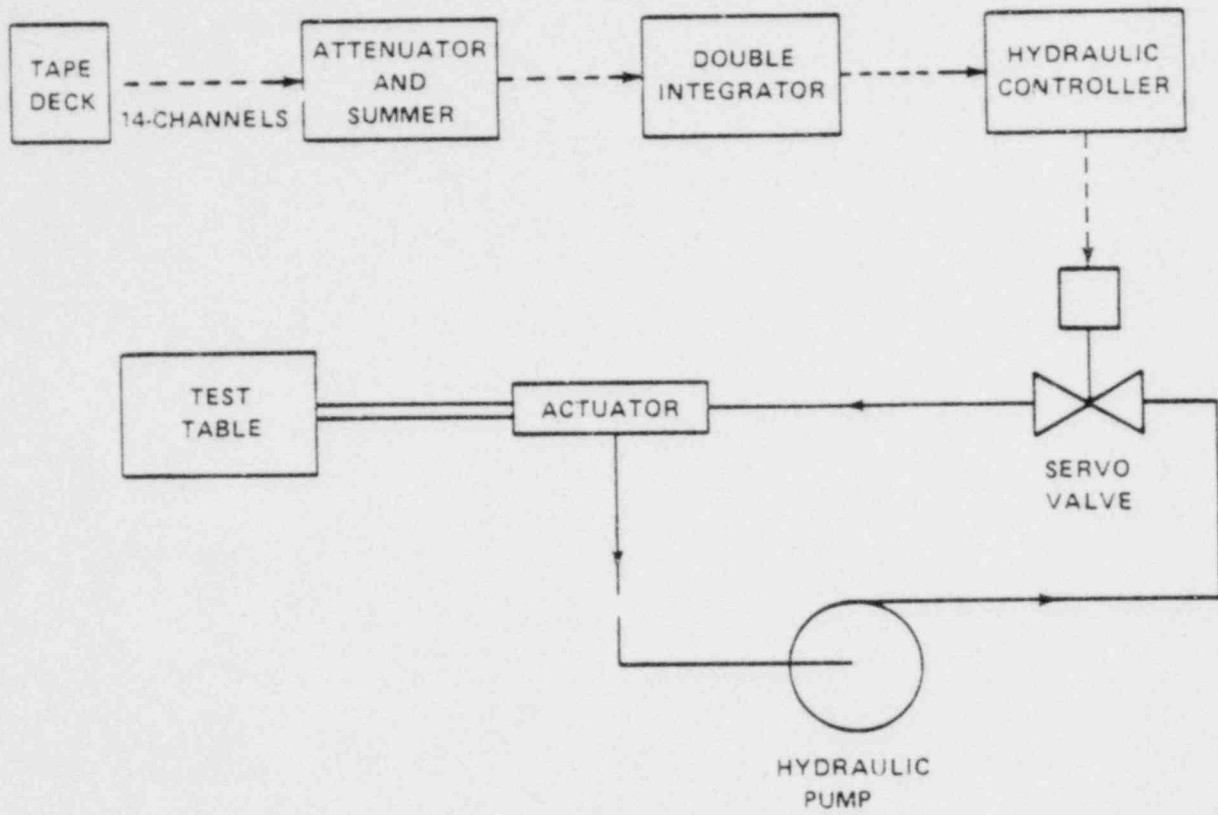


Figure 8 Input Signal Flow Path

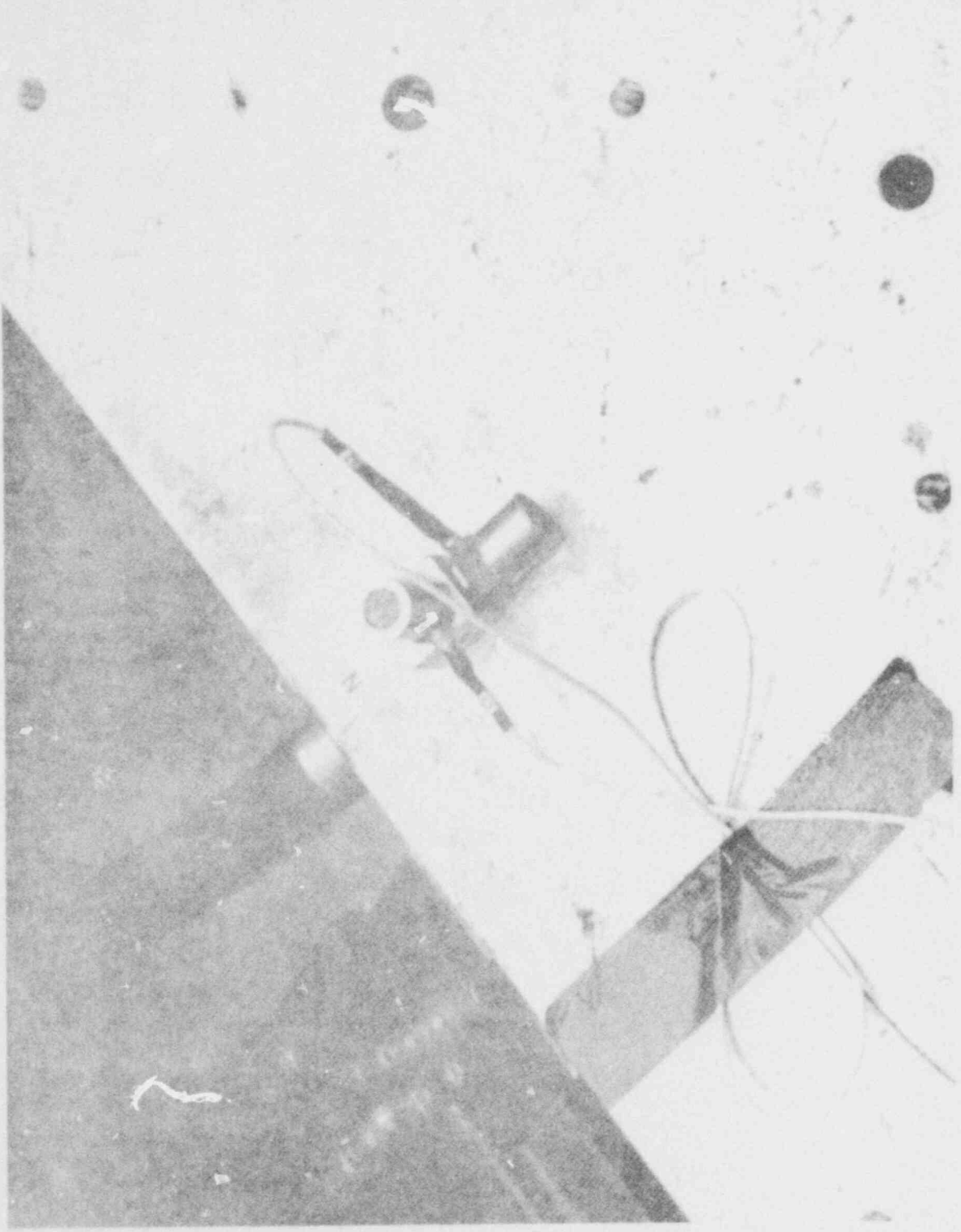


Figure 9 Accelerometers A1 (Horizontal) and A2 (Vertical) Mounted to the Vibration Table



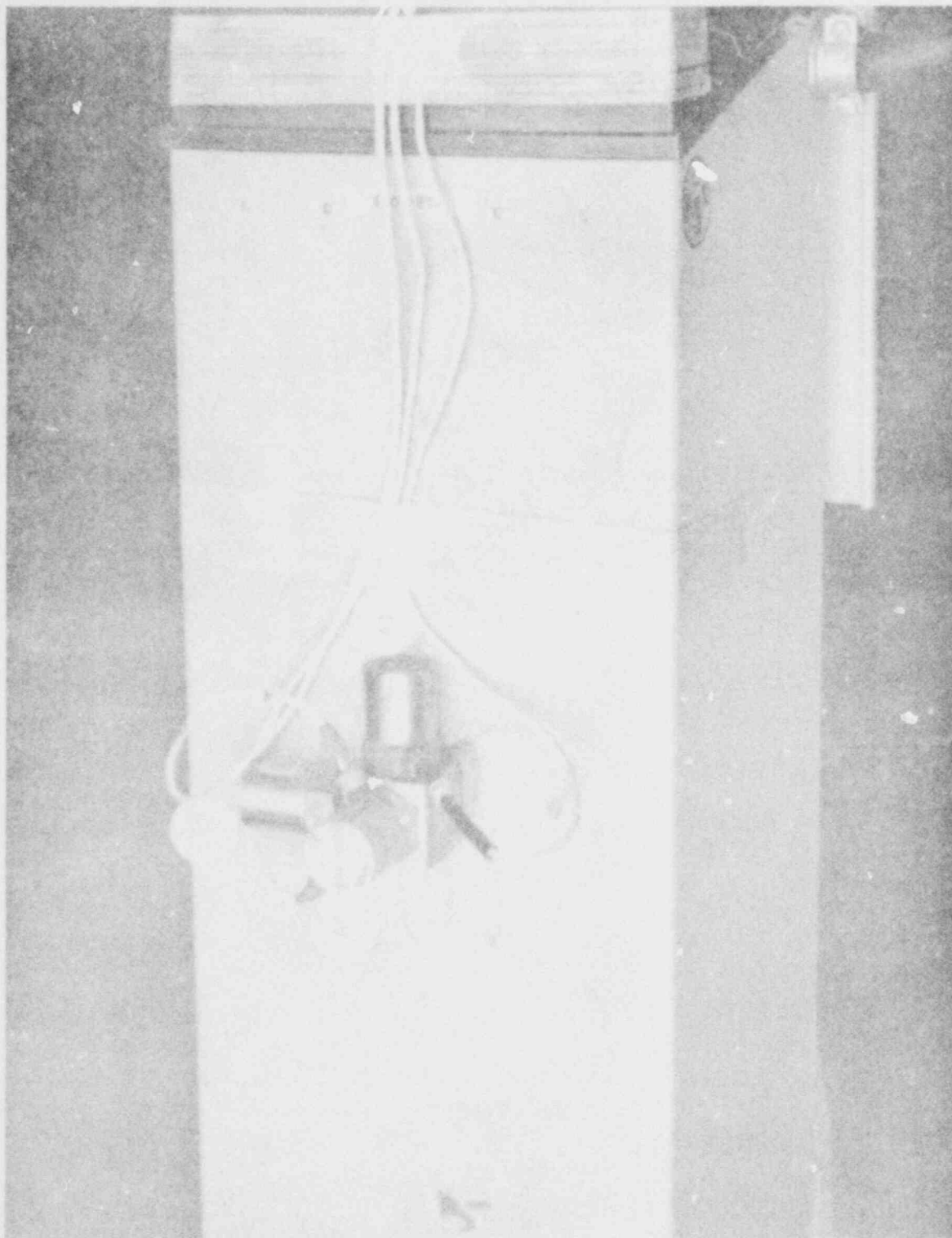


Figure 10 Accelerometers A3 (Horizontal), A4 (Vertical), and A5 (Side-to-Side) Mounted on the 2-Pen Recorder I LR-1063

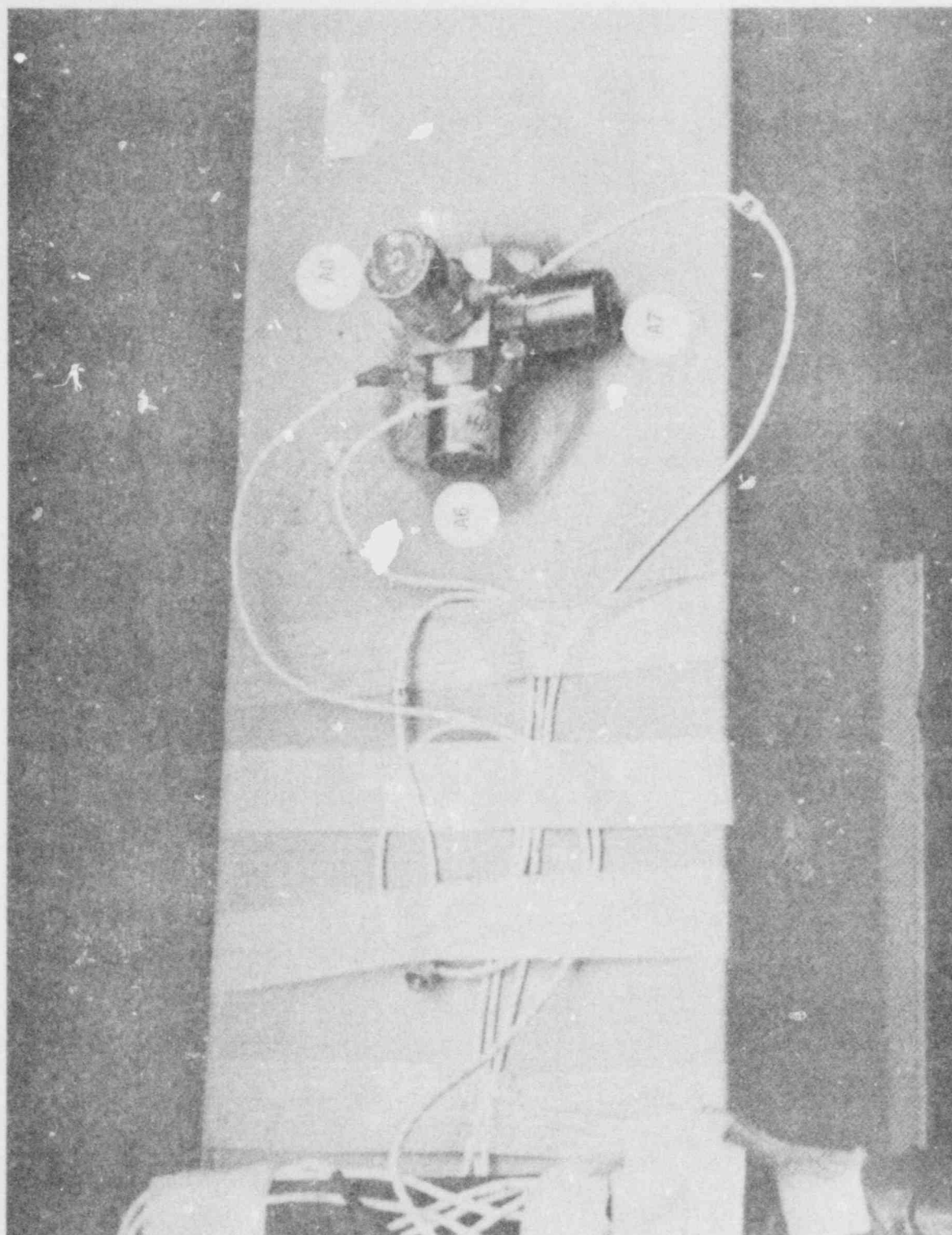


Figure 11 Accelerometers A6 (Horizontal), A7 (Side-to-Side), and A8 (Vertical) Mounted on the 3-Pen Recorder ITR-4133

APPENDIX A  
RECORDER SERIAL NUMBERS LOT 1 AND LOT 2

APPENDIX A

OPTIMAC RECORDER SERIAL NUMBERS

LOT #1

2 PEN RECORDERS

[ ] a,c

[ ] a,c

3 PEN RECORDERS

[ ] a,c

[ ] a,c

APPENDIX A (Cont)

OPTIMAC RECORDER SERIAL NUMBERS

LOT #2

2 PEN RECORDERS

[ ] a,c

[ ] a,c

3 PEN RECORDERS

[ ] a,c

[ ] a,c

APPENDIX B  
RESPONSE SPECTRA  
LOT #1

THIS PAGE REPLACES  
FIGURES B-1 TO B-20  
"TEST RESPONSE SPECTRA" WHICH  
ARE WESTINGHOUSE PROPRIETARY

APPENDIX C  
RESPONSE SPECTRA  
LOT #2



b,c,e

THIS PAGE REPLACES  
FIGURES C-1 TO C-9  
"RESPONSE SPECTRA"  
WHICH ARE  
WESTINGHOUSE PROPRIETARY

APPENDIX D

WESTINGHOUSE SEISMIC RECORDER DRAWING

a,c

Figure D1. Westinghouse Drawing [ ]<sup>a,c</sup>  
Seismic Recorder Outline