WESTINGHOUSE CLASS 3

WCAP-8587
SUPP 2-E04A

EQUIPMENT QUALIFICATION
TEST REPORT
BARTON DIFFERENTIAL PRESSURE TRANSMITTERS-
QUALIFICATION GROUP B

(Seismic Design Verification Testing)

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TABLE OF CONTENTS

TABLES

FIGURES

FIGURES (Continued)

TITLE

1.0 OBJECTIVE

The objective of this qualification program is to demonstrate that of the Qualification Group B Differential Pressure Transmitters meet or exceed their safety-related performance requirements while subjected to the simulated seismic service conditions specified in Figure 1. A qualification test was completed on four Qualification Group B Differential Pressure Transmitters.

2.0 EQUIPMENT TESTED

2.1 A total of four (4) ITT Barton units were tested. These included two (2) level systems, a Model [ ]^{a,c} and a Model [ ]^{a,c}, and two (2) Model [ ]^{a,c} differential pressure transmitters. All test transmitters were purchased under purchase order number [ ].^{a,c}

2.2 The reference transmitter used was an ITT Barton Model Number [ ] .^{a,c}.

2.3 Test and reference transmitters are listed by model number, drawing number and revision, and serial number on Tables I & II respectively.

3.0 PERFORMANCE SPECIFICATIONS

The Group B Differential Pressure Transmitters were tested to verify their functional operability as defined below:

3.1 Environmental conditions for these tests require a seismic response spectrum (Figure 1) of 7 g's acceleration for safe shutdown earthquake (SSE) tests. One half SSE acceleration was used in 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^{0} orientation.

3.2 Performance requirements for ITT Barton transmitter units Model Number $[\quad]^{a,c}$ differential pressure transmitters are that the test units should not deviate more than ±10% of calibrated span from its initial value during the seismic test. In addition, the test units should return to within its original specified reference accuracy of ±0.5% after the seismic event.

4.0 DESCRIPTION OF TEST EQUIPMENT & FACILITY

4.1 Seismic testing was performed in the testing laboratory at Westinghouse Advanced Energy Systems Division (AESD) in Large, PA.

Test inputs for the OBE and SSE tests were provided from FM tape. A control accelerometer oriented in the horizontal plane of the test table along the axis of the piston was used to determine the success of each test run. The output of this accelerometer was analyzed by a Spectral Dynamics Model 13192 shock spectrum analyzer. Three different inputs labeled A, B and C (Appendix B) were used to obtain the broad band response spectrum shown in Figure 1.

4.2 Test equipment

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

4.3 Mounting

All four test units were mounted on a test fixture. The test fixture was bolted to a 6 ft. test table at a 45^{o} angle to the horizontal table motion. The hydraulic piston driving the table was at a 35^{o} angle to the horizontal plane of the table. This orientation of the test fixture and driving piston produced equal motion in the three mutually perpendicular axes in the test units' frame of reference. Figure 2 shows the test fixture orientation. Figure 5 show test fixture and test units prepared for seismic test. (Test Units BI-1 and BI-2 shown on this figure are not included in this report.)

The test transmitters were attached to the test fixture by four (4) 5/16 inch bolts at 240 in-lbs. torque. The pressure sensors for test transmitters BG-1 & BG-2 were bolted to the stand using (4) 1/2" bolts torqued to 240 in-lbs. Pressure lines and flexible conduit were rigidly supported to the test stand.

5239A

Reference transmitters were mounted in a rack adjacent to the test table.

4.4 Connections

4.4.1 Pressure Supply

Pressure tubing to the test units was 3/8" O.D., 0.049" wall stainless steel tubing. Conax fittings were used for all connections. Flexible hydraulic hose connected the test units to the pressure supply located off the table. The reference transmitter sensed the same pressure as the test transmitters.

All pressure lines were filled with water prior to the start of testing. Pressure was supplied from a bottled nitrogen supply.

A schematic of the pressure supply is shown in Figure 3.

4.4.2 Electrical Connections

The pigtail leads from the test transmitters were brought through a flexible conduit to a terminal strip on the test stand. From this point, wires were run to the power supply and data acquisition equipment. Power was supplied from Westinghouse ISD 7300 series NLP cards that were provided by Westinghouse NTD. A schematic of the electrical set-up is shown in Figure 4.

5.0 TEST PROCEDURE

5.1 Service Conditions

Once all electrical and mechanical connections were made, the system was pressurized so that each test unit was at approximately mid-scale with a 2000 psig static pressure. A resonant search in the range of 1-50 Hz was performed on the complete test set up at 0.2g. The search ran up and down the range at a rate of 1 octave per minute. Five (5) operating basis earthquakes (OBE) using input B of the test tape were then performed. Finally, one safe shutdown earthquake for each input, (A, B and C) in four different test fixture orientations (0^{o}, 90^{o}, 180^{o}, 270^{o}) was performed.

5.2 Monitored Functions

5.2.1 Acceleration

A total of eight (8) accelerometers were used. A biaxial accelerometer set mounted on the surface of the test table sensed horizontal (in line with the piston) and vertical table motion. Two triaxial accelerometer sets were located (one each) on the test fixture cross beam on which the test units were mounted and on top of Test Unit BF-2.

The output of the accelerometer sensing horizontal table motion was fed into a shock spectrum analyzer. The result of the analysis, plotted on acceleration versus frequency coordinates, was used to determine the success of each test run. All accelerometer outputs were recorded on strip chart and FM tape. A block diagram of the accelerometer data acquisition equipment is shown in Figure 6.

5.2.2 Transmitter Outputs

The outputs of all the transmitters were monitored continuously across a 120 ohm resistor. These signals were conditioned and fed to strip chart recorders where the full range of the signal was approximately ±10% of the normal output of each transmitter. A digital voltmeter capable of reading the output of each transmitter was used for obtaining the pre-test and post-test static readings.

5.2.3 Input Signals

The test inputs were supplied on 14-channel FM tape by Westinghouse NTD. The signals from the tape were sent through a 14-channel attenuator/ summer. A displacement signal was then obtained by twice integrating the summed tape signal. This displacement signal provided the input to the hydraulic controller which resulted in table motion corresponding to the desired acceleration levels. A block diagram of this set-up is shown in Figure 7.

6.0 TEST DATA & ACCURACY

A list of the maximum deviations of each test and reference unit is given in Table IV for each seismic run. The values were derived from the peak deviation of the transmitter output from the steady state value at the start of the test. All numbers are expressed as plus or minus percent of calibrated span. All transmitters remained well within the required ± 10% accuracy. Due to this, no attempt was made to subtract the deviations noted by the reference transmitters during the test.

Table V lists the change in post-run steady state transmitter output compared to the pre-run steady state output. These values were derived from the output readings taken before and after each test run. All numbers are expressed in percent of test transmitter calibrated span. The change in the output of the reference transmitter has been subtracted from the values in Table V so that these figures represent the change in each test transmitter with respect to its reference transmitter.

The test data of Table IV and V demonstrates that the equipment under test meets the accuracies specified in Section 3.2. In addition, no structural failures or loosening of bolts was observed.

7.0 SUMMARY

The Differential Pressure Transmitters (Qualification Group B) were tested under simulated OBE and SSE conditions (see Appendix B for spectra) to demonstrate their capability to perform their safety- related function under these conditions. The test results (Tables IV and V) show the equipment remained within the specified accuracy when subjected to the seismic conditions of Appendix B. The generic required response spectrum (Figure 1) contains significant margin with respect to any single plant application referencing this program.

TABLE I

TEST TRANSMITTERS

a,c

DESIGNATION	MODEL NUMBER	SERIAL NUMBER	DRAWING#/REV #	CALIBRATED SPAN
BF-1				
BF-2				
BG-1				
BG-2				

TABLE II

REFERENCE TRANSMITTER

Designation	Manufacturer	Model No.	Serial No.	Calibrated Span	Output
AS-1	ITT Barton	[			] a,c

5239A

TABLE III

TEST EQUIPMENT

Device	Manufacturer	Model No.	Serial No.
Accelerometers	Kulite	GAD-813-50	1512
			1438
			2870
			1544
			2245
			2817
			2873
			2226
			2244
			2872
			2821
Signal Conditioner	B&F Instruments	1C1613	4106
			4110
			0260
Amplifier	B&F Instruments	10-800	0532
			4189
			0560
Recorder	Brush	Mark 200	2246
			1722
			0105
			1718
FM Tape Recorder	Honeywell	101	
FM Tape Recorder (Playback)	Consolidated Electrodynamics	VR-2800	
Double Integrator	M-Rad	--	3408

TABLE III (Continued)

TEST EQUIPMENT

Device	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Spectral Dynamics	13231 & 13192	2104
X-Y Plotter	Electro Instrs.	500	1409
Pressure Gage	Heise	C	4507
Digital Volt Meter	Weston	1241	0548

TABLE IV

MAXIMUM TRANSMITTER OUTPUT DEVIATIONS DURING SEISMIC RUNS

	BF-1	BF-2	BG-1	BG-2	AS-1
Position 1*					b,c,e
Run 2					
Run 3					
Run 4					
Run 5					
Run 6					
Run 7					
Run 8					
Run 11					
Position 2					
Run 1					
Run 2					
Run 3					
Position 3					
Run 1					
Run 2					
Run 3					
Position 4					
Run 1					
Run 2					
Run 3					

*Omitted runs did not achieve required response spectra (see Appendix B.)

NOTE: All numbers are in percent of calibrated span.

TABLE V

CHANGE IN STATIC OUTPUT READINGS

	BF-1	BF-2	BG-1	BG-2
Position 1*				
Run 2				
Run 3				
Run 4				
Run 5				
Run 6				
Run 7				
Run 8				
Run 11				
Position 2				
Run 1				
Run 2				
Run 3				
Position 3				
Run 1				
Run 2				
Run 3				
Position 4				
Run 1				
Run 2				
Run 3				

b,c,e

*Omitted runs did not achieve the required response spectra (see Appendix B).

NOTE: All numbers are in percent of calibrated span.

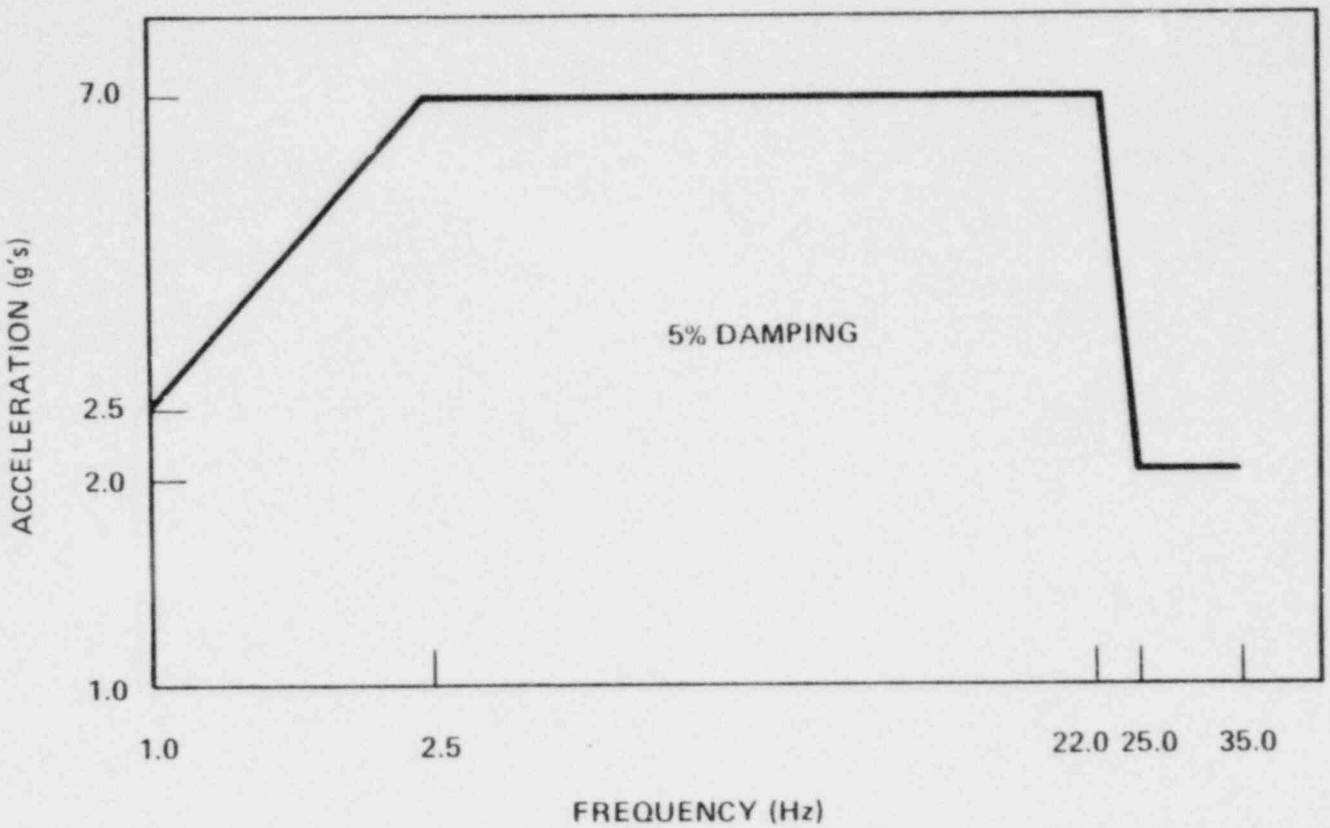

Figure 1 Required Response Spectrum for Safe Shutdown Earthquake (SSE) Transmitter Seismic Qualification (Note: Operating Basis Earthquake (OBE) Required Response Spectrum = 0.5 SSE)

16642-13

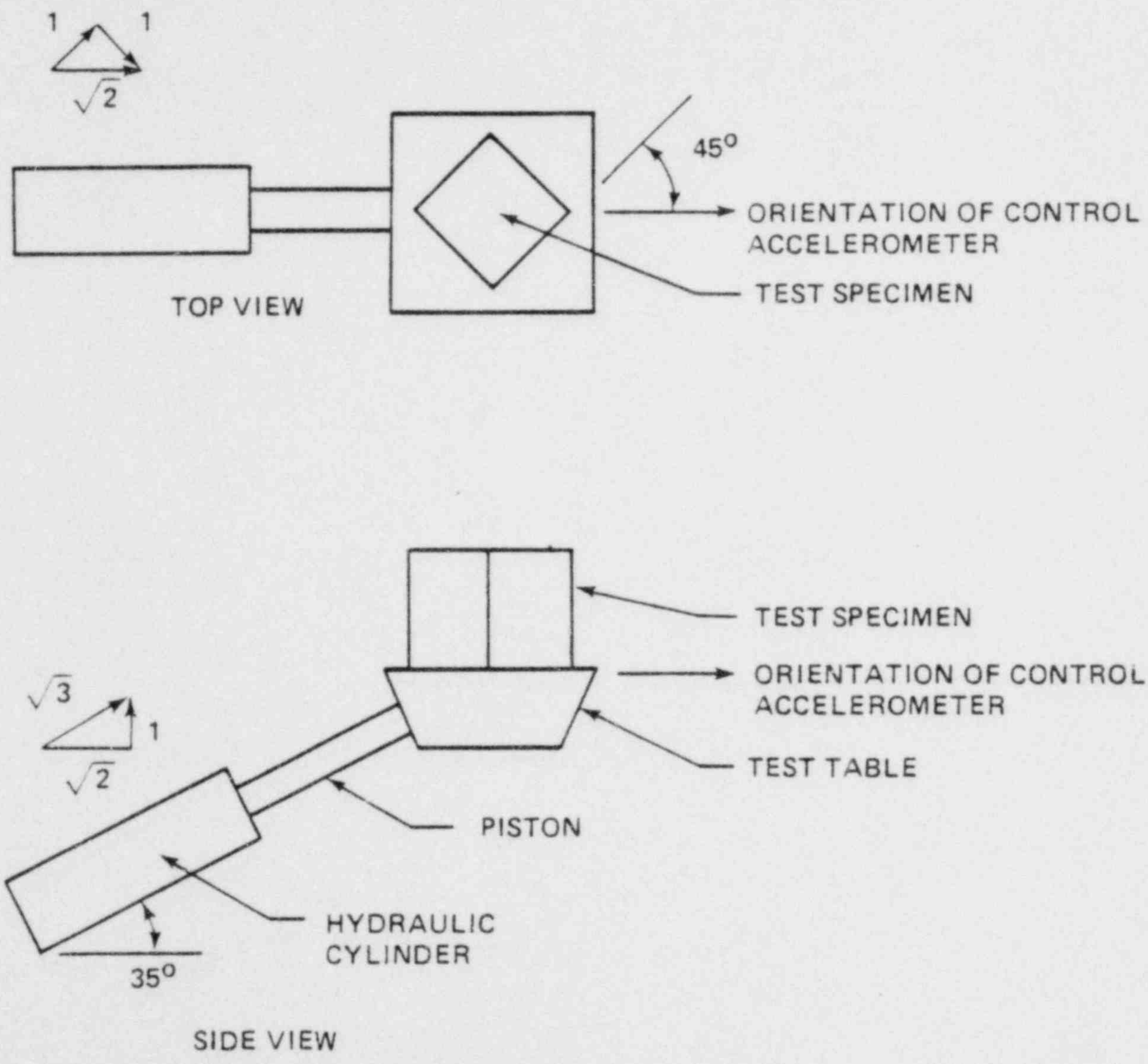

Figure 2 Test Specimen Orientation

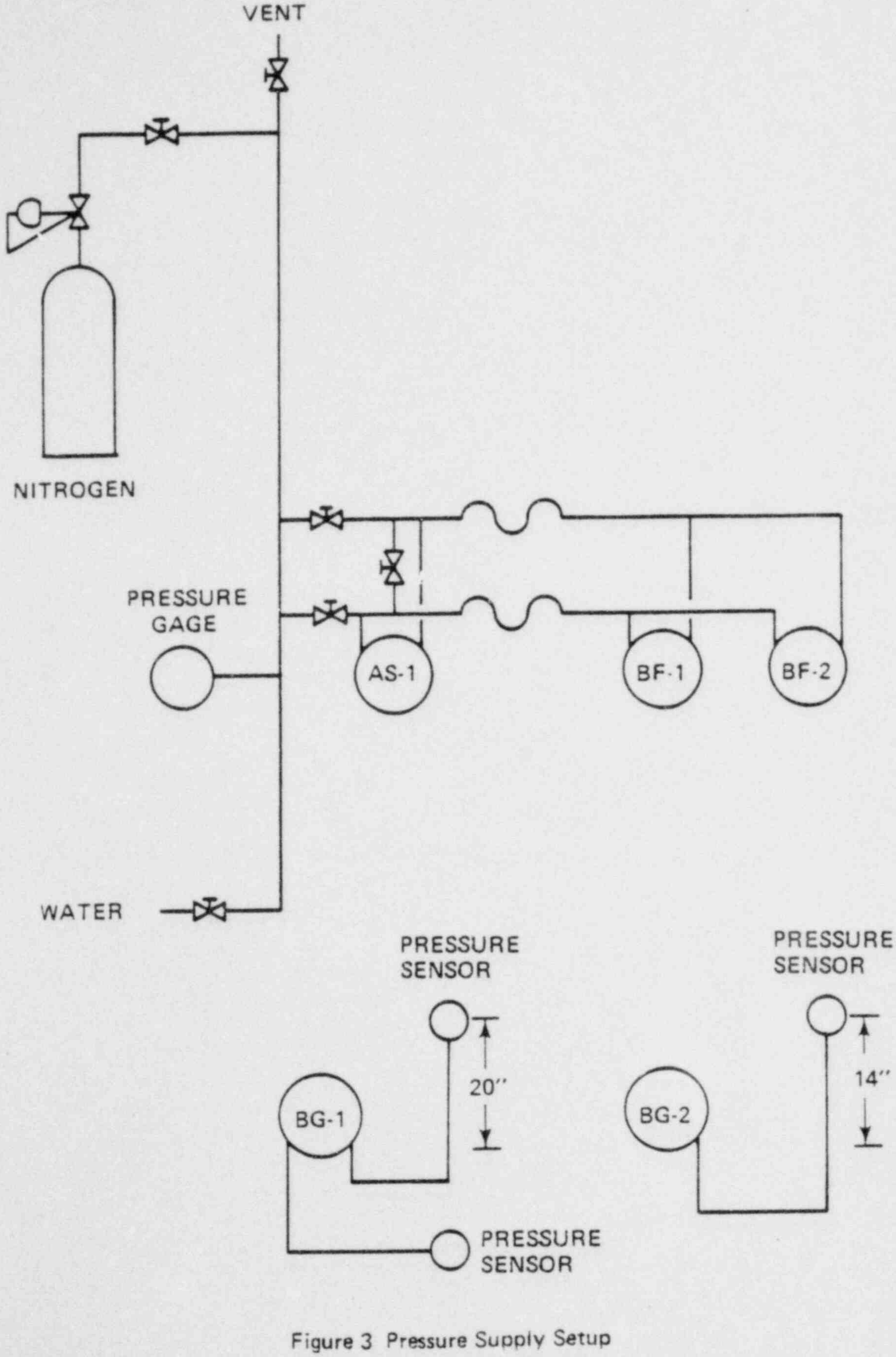

Figure 3 Pressure Supply Setup

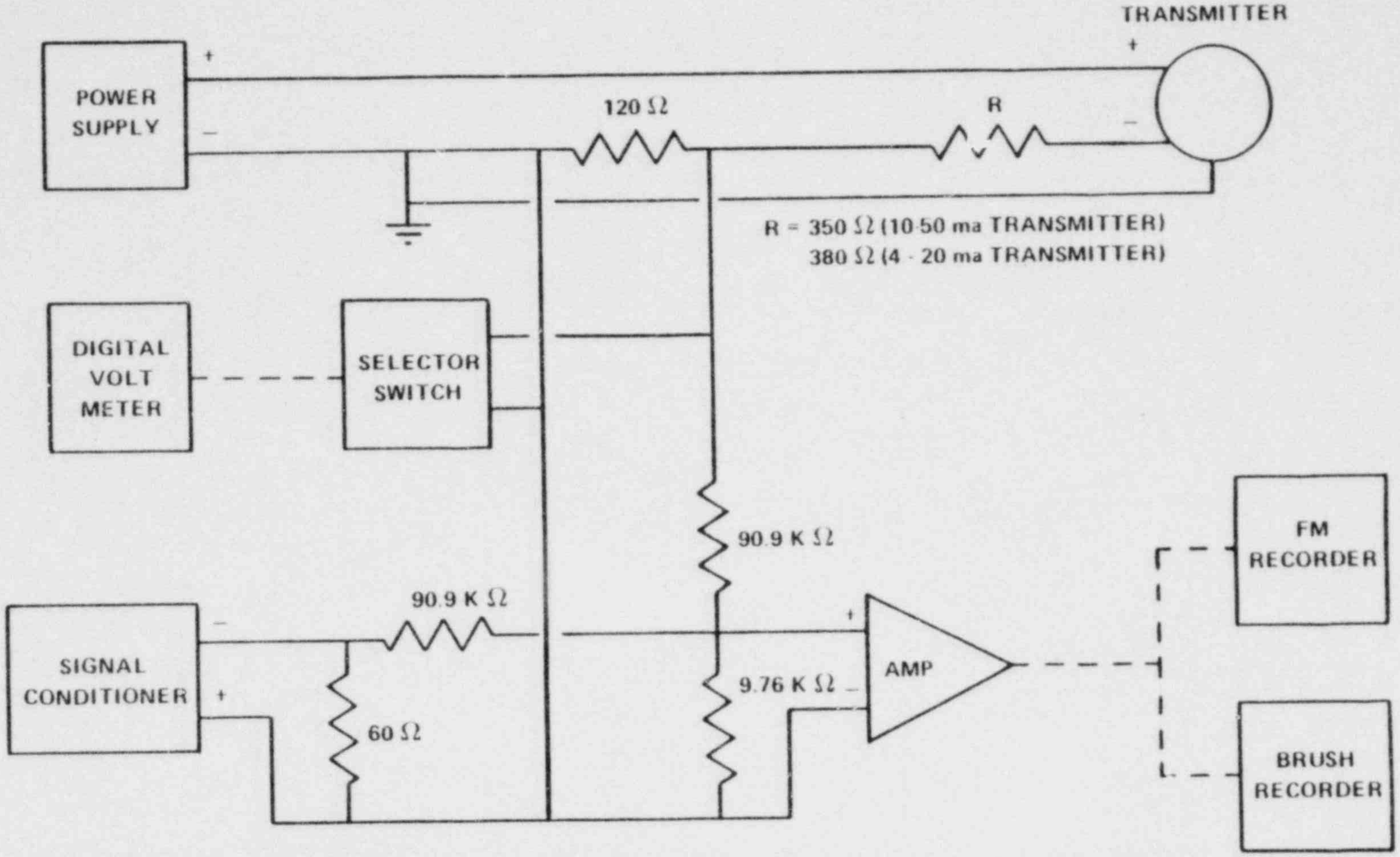

Figure 4 Electrical Supply Setup

16642-15

a,c

Figure 5. Transmitter Test Stand(Front View)

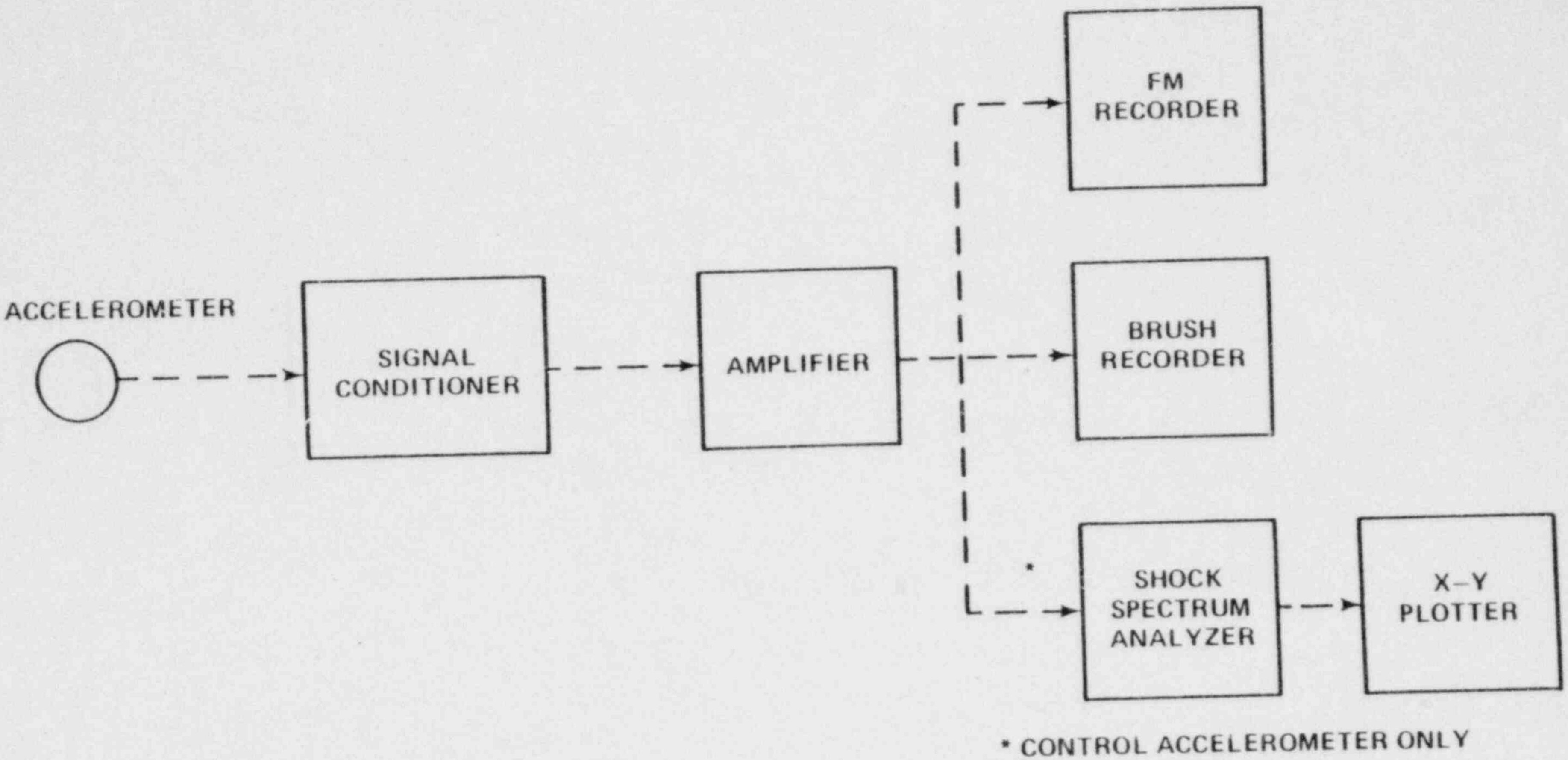

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Figure 6 Accelerometer Signal Flow Path

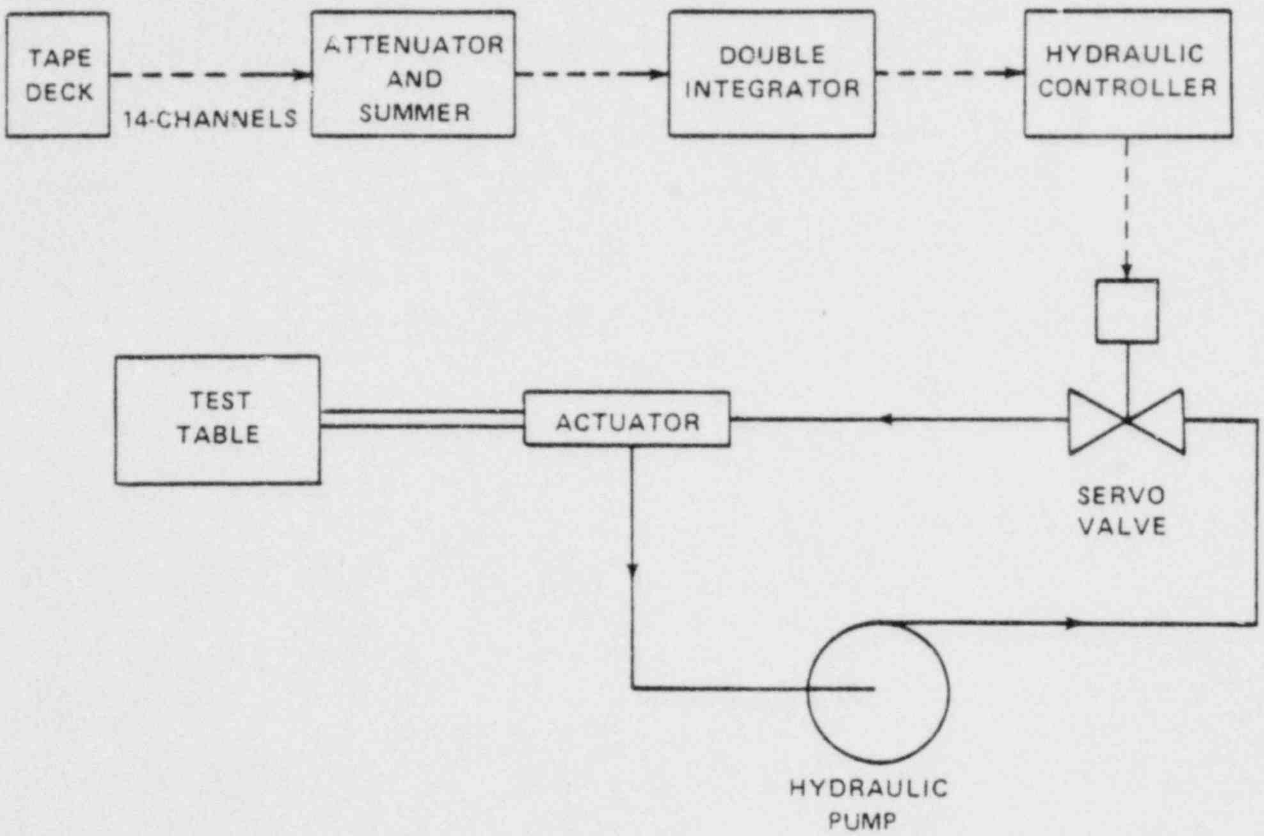

Figure 7 Input Signal Flow Path

APPENDIX

"A"

BARTON LOT #3 DIFFERENTIAL PRESSURE

TRANSMITTER SERIAL NUMBERS

[ ]a,c DIFFERENTIAL PRESSURE TRANSMITTERS

[ ]a,c

5239A

APPENDIX

"B"

TEST RESPONSE SPECTRUM

b,c,e

THIS PAGE REPLACES

FIGURES B-1 TO B-20

"TEST RESPONSE SPECTRA" WHICH

ARE WESTINGHOUSE PROPRIETARY

APPENDIX

"C"

DIFFERENTIAL PRESSURE TRANSMITTER

DRAWINGS

(QUALIFICATION GROUP B)

a,c

Figure C1. Westinghouse Drawing [ ][a,c]
Safety Class 1E Differential Pressure
Electrical Transmitter, Qualification Group B

a,c

Figure C2. Westinghouse Drawing [ ]^{a,c}
Single Sensor Bellows and Sealed Leg Systems,
Flange Mounting

a,c

Figure C3. Westinghouse Drawing [ ][a,c] Dual Sensor Bellows with Sealed Leg System, Flange Mounting