WCAP-8587
SUPP 2-E02A

WESTINGHOUSE CLASS 3

# EQUIPMENT QUALIFICATION
# TEST REPORT
# BARTON PRESSURE TRANSMITTERS-QUALIFICATION GROUP B
# (Seismic Design Verification Testing)


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## TABLES



## FIGURES

FIGURES (Cont)

## 1.0 OBJECTIVE

The objective of this qualification program is to demonstrate that the Qualification Group B 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 three Qualification Group B Pressure Transmitters.

## 2.0 EQUIPMENT TESTED

2.1 A total of three (3) ITT Barton Model [ ]a,c pressure transmitters were tested. All test transmitters were purchased under purchase order number [ ]a,c.

2.2 The reference transmitter used was a Westinghouse CID Veritrak Model Number 76PGI.

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 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 $45^{o}$ orientation.

3.2 Performance requirements for ITT Barton transmitter units Model Number [ ]$^{a,c}$ pressure transmitter are that the test units should not deviate more than $\pm$10% of calibrated span from its initial value during the seismic test. In addition, the test units should return to within their original specified reference accuracy of $\pm$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 three test units were mounted on a test fixture. The test fixture was bolted to a 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 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 shows the test fixture and test units prepared for seismic test.

The test transmitters were attached to the test fixture by four (4) 5/16 inch bolts at 240 in-lbs. torque. Pressure lines and flexible conduit were rigidly supported to the test stand.

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. 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 BH-3.

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 4 for each successful 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 and remained well within the required ±10% accuracy.

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 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

| DESIGNATION | MODEL NUMBER | SERIAL NUMBER | DRAWING#/REV # | CALIBRATED SPAN |
|---|---|---|---|---|
| BH-1 | [ | | | ] a,c |
| BH-2 | | | | |
| BH-3 | ] | | | |

TABLE II

REFERENCE TRANSMITTERS

| Designation | Manufacturer | Model No. | Serial No. | Calibrated Span | Output |
|---|---|---|---|---|---|
| BA-3 | Westinghouse CID Veritrak | [ | | | ]a,c |

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

| | BH-1 | BH-2 | BH-3 | BA-3 |
|---|---|---|---|---|
| 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 the required response spectra (See Appendix B).

NOTE: All numbers are in percent of calibrated span.

TABLE V

CHANGE IN STATIC OUTPUT READINGS

| | BH-1 | BH-2 | BH-3 |
|---|---|---|---|
| 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 | ] | | ] |

NOTE: All numbers are in percent of calibrated span.

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

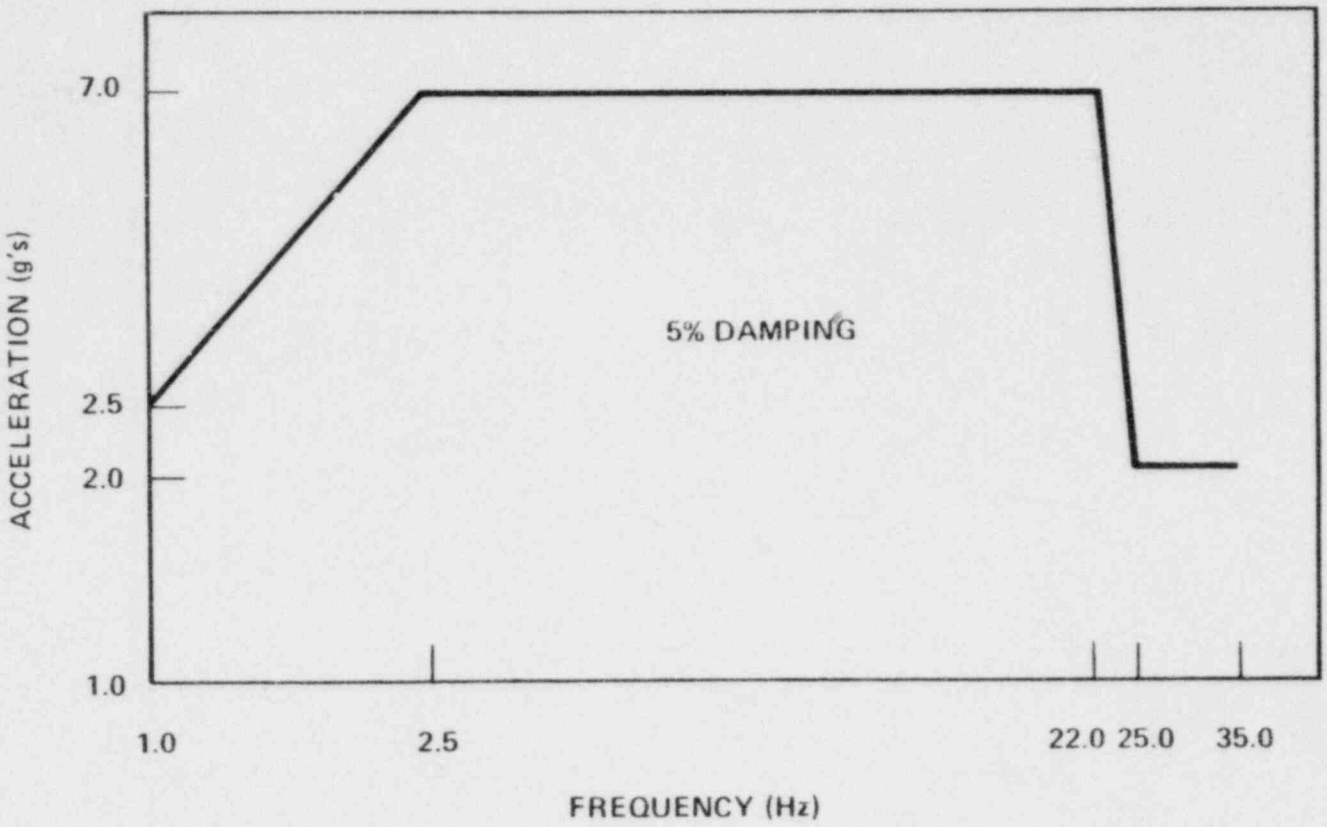


Figure 1 Required Response Spectrum for Safe Shutdown Earthquake (SSE) Transmitter Seismic Qualification (Note: Operating Basis Earthquake (OBE) Required Response Spectrum = 0.5 SSE)

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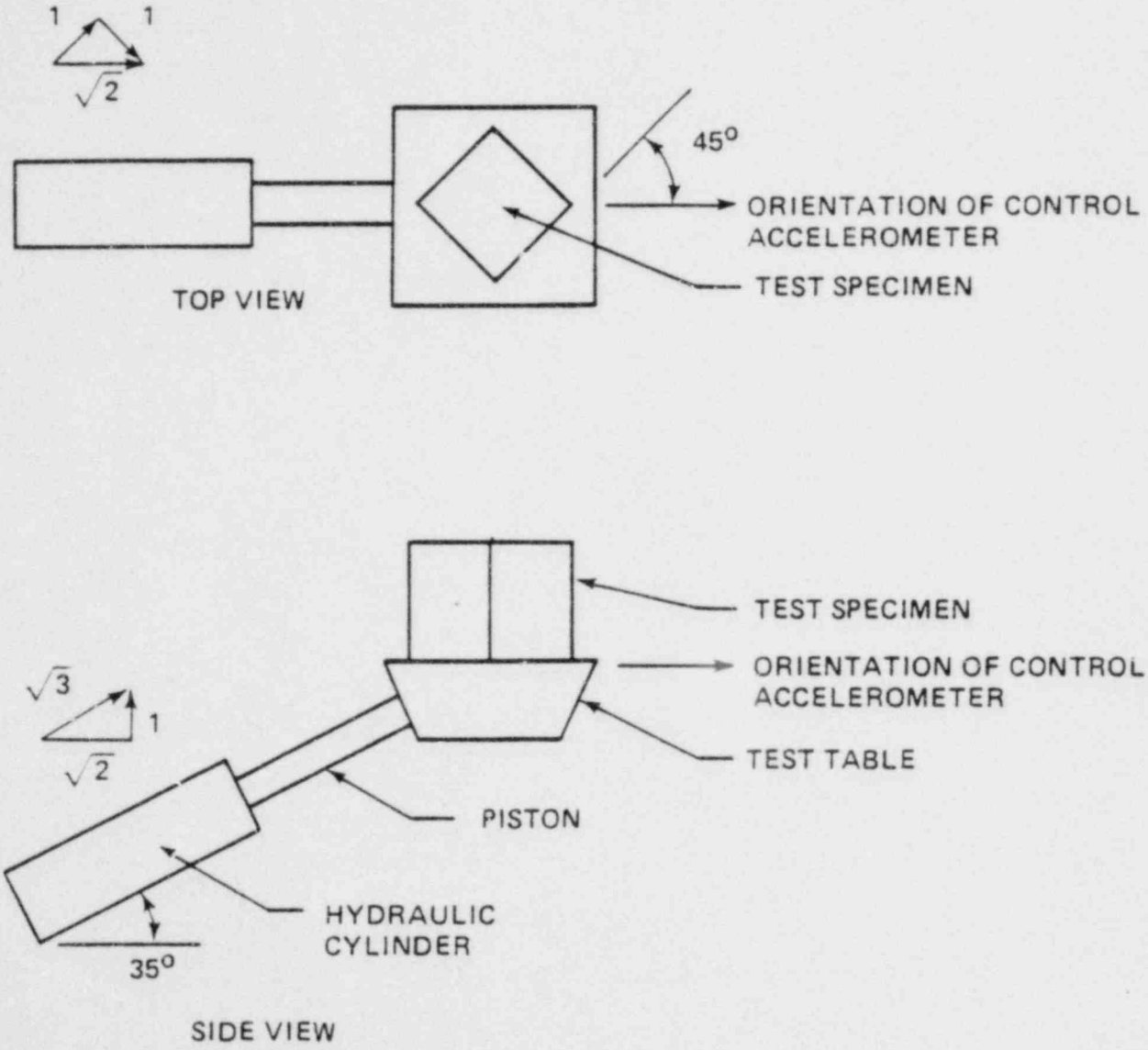


Figure 2 Test Specimen Orientation

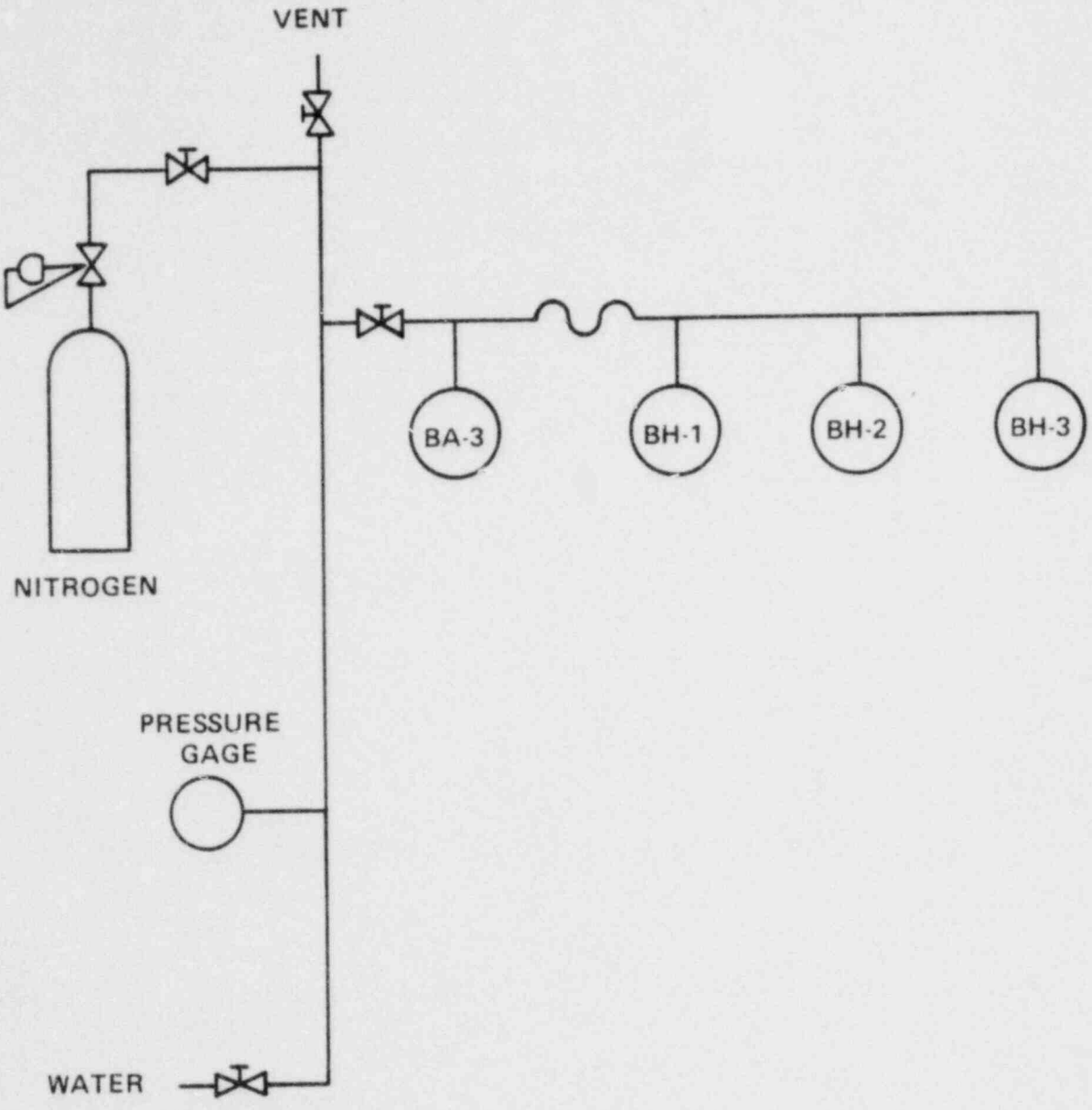


Figure 3 Pressure Supply Setup

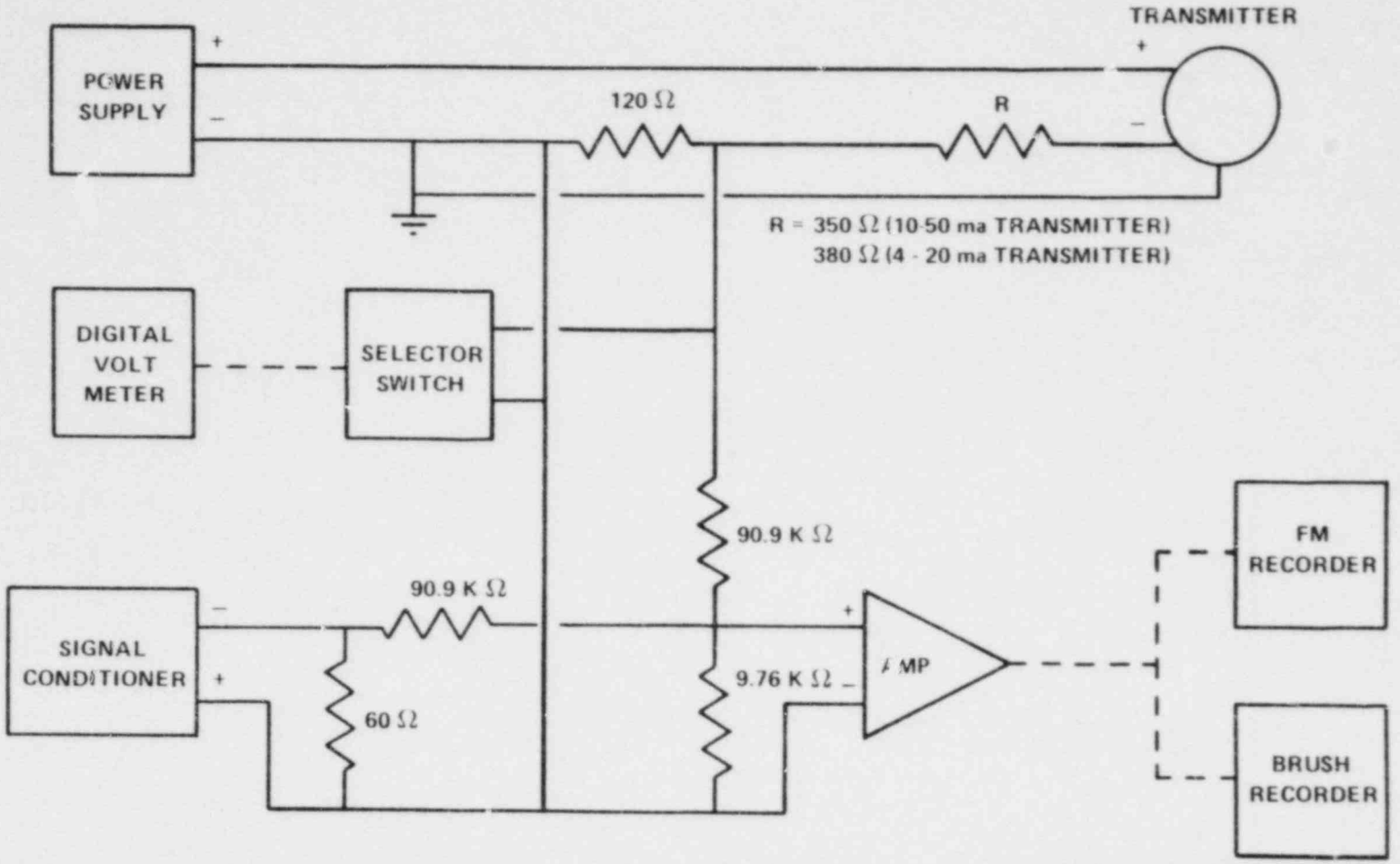


Figure 4 Electrical Supply Setup

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a,c

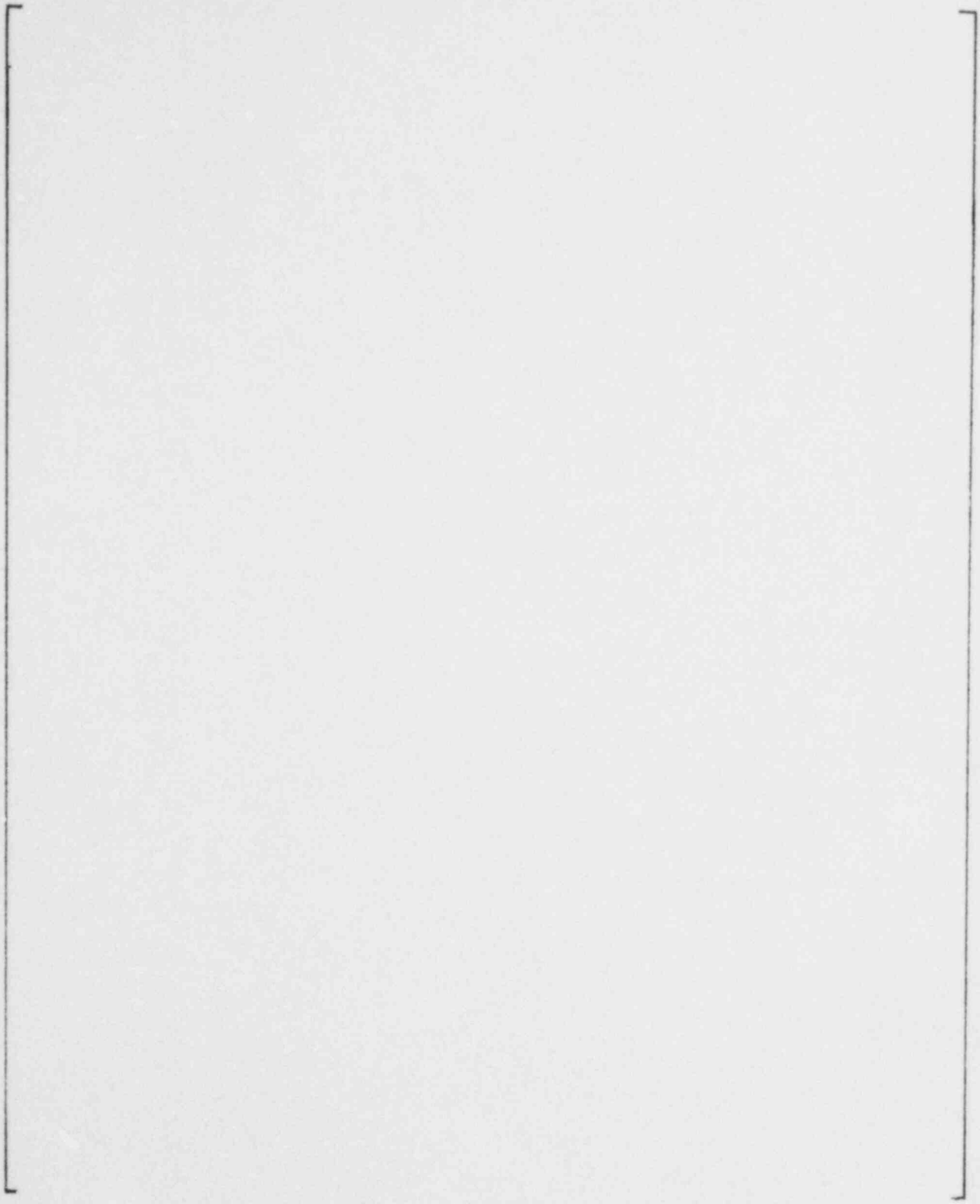

Figure 5. Transmitter Test Stand (Rear View) Test Units from Left to Right BH-1, BH-3, BH-2

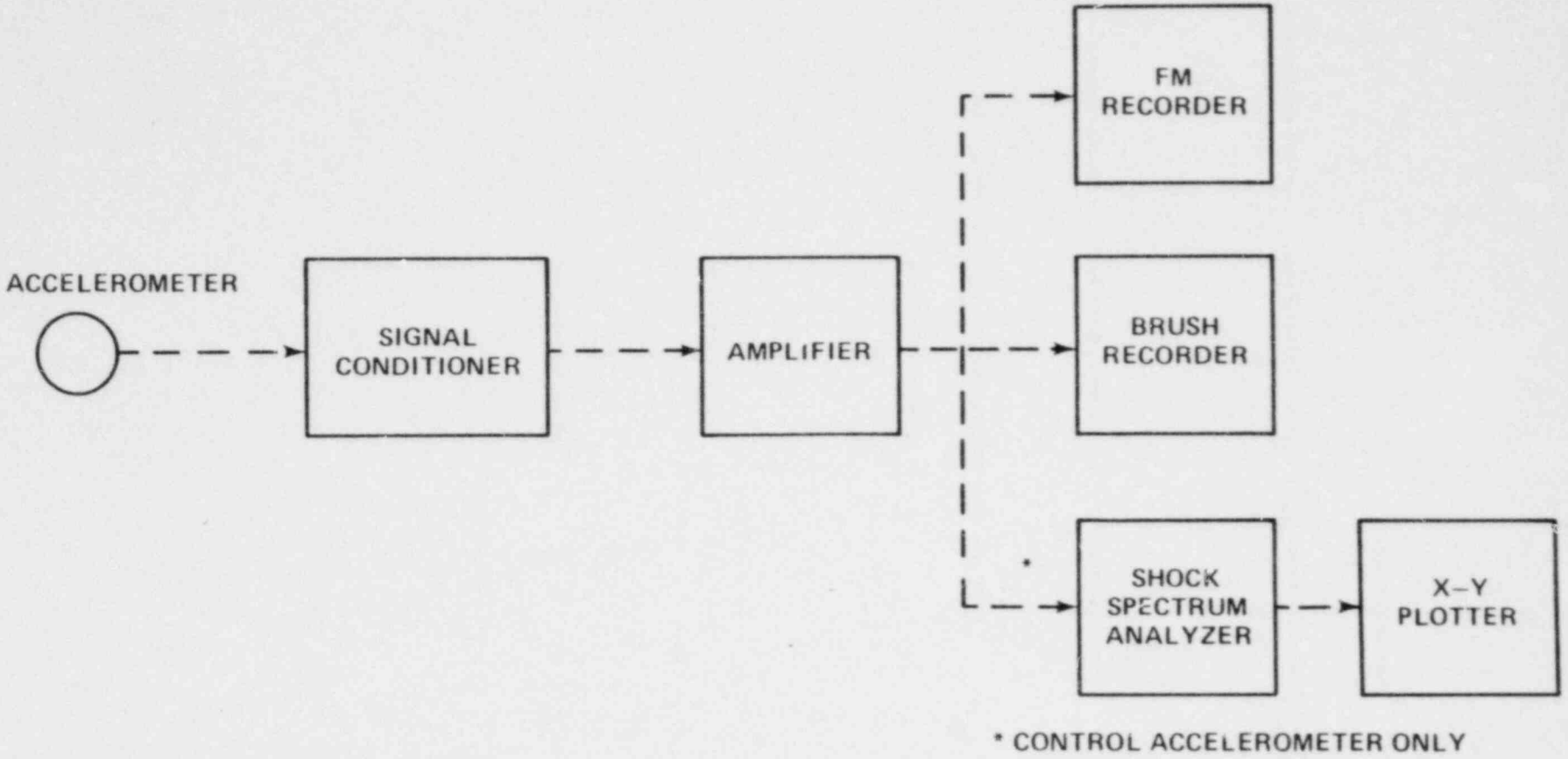


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Figure 6 Accelerometer Signal Flow Path

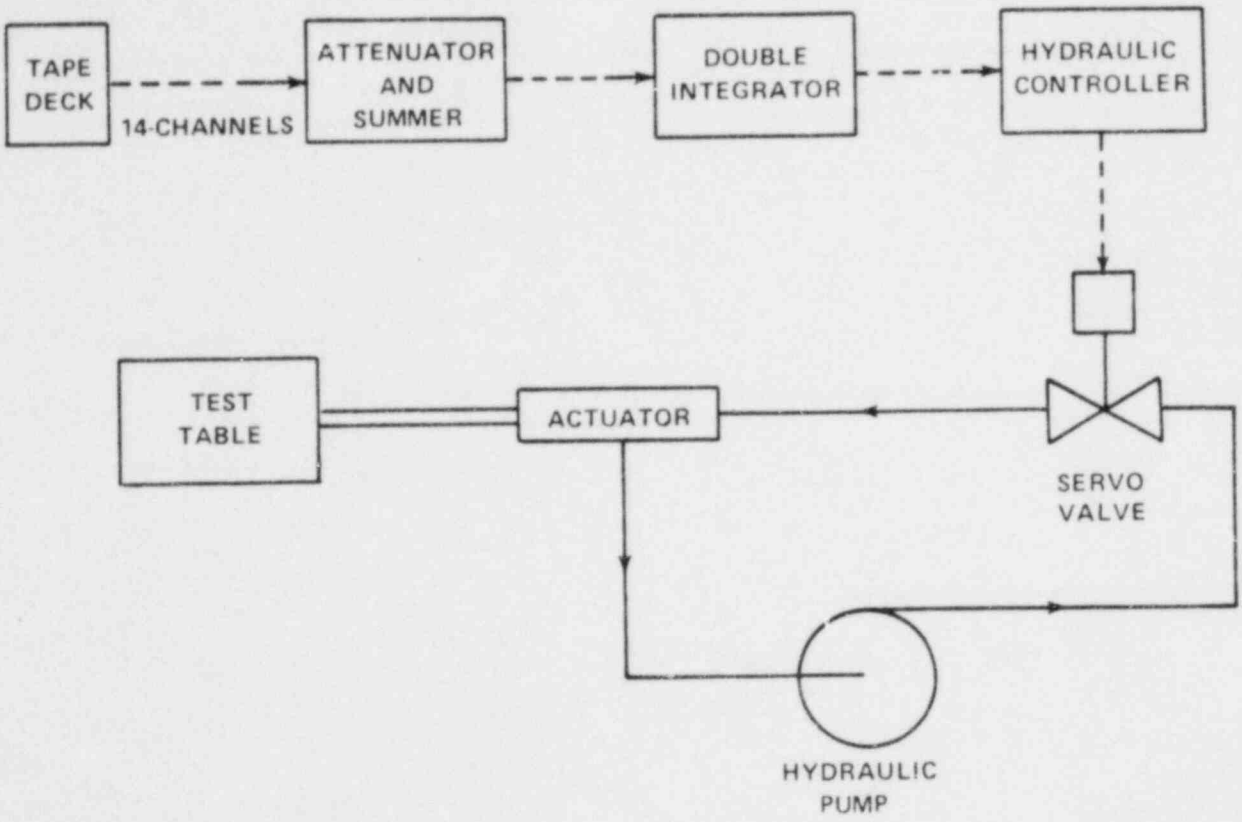


Figure 7 Input Signal Flow Path

# APPENDIX
# "A"
# BARTON LOT NO. 3 PRESSURE TRANSMITTER SERIAL NUMBERS

[ ]$^{a,c}$ Pressure Transmitters

[ ]$^{a,c}$

# 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"

PRESSURE TRANSMITTER DRAWINGS

(Qualification Group B)

a,c

[

]

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